A HYBRID PORTRAYAL OF VISUOSPATIAL ATTENTION THROUGH EYE TRACKING RESEARCH AND MODULAR DESIGN

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ABSTRACT

In the art studio studies, a hybrid depiction of recognition phenomenology through art-science lab collaboration research has become a crucial issue in the course of producing hybrid artworks. Visuospatial attention in a choreographic dance video was selected as a case for depicting its form in this study. In the hybrid depiction, the challenging issue was how to visualise the indescribable features of invisible objects from its mental information through the pictorial source, transparency and experience domains. In order to address these problems, an approach Demonstrate, Resemble, and Synthesise DRS was proposed based on the combination between eye-tracking research, pattern modular design, and traditional art principles. This approach involved three stages of visualisation: gaze features demonstration stage, physical properties resemblance stage, and pictorial aspects synthesise stage were proposed in this study. The first stage was to demonstrate the gaze features of the specific case through fixation matrix feature output. It was implemented through an eye-tracking video-sections based experiment using the Tobii T60 eye tracker and Studio^{TM} analysis software to collect and analyse the eye movements of ten international participants at the University of Malaya. Area of interest AOI statistics: AOI/gaze elicitation and AOI/pattern elicitation were used to identify the gaze qualities based on the fixation count and fixation length features. Results of this stage showed that the positive correlation and variety between features enable to use it as an information source for visualisation. The second stage was to resemble the physical properties using pattern modular design through additional table operation mod for visualising of the specific case. The properties width, height, color, pattern, frame, time, gist, space, and form were visualised. Outcomes showed that the patterns visualised have vertical geometrical forms. The final stage was to produce

hybrid artworks through traditional art principles for the specific case. The balance and movement principles were selected and ten hybrid artworks were created in this research work. This thesis contributed to developing a novel proposed collaboration framework between experimental scientific approach as an information source, mathematical approach as a transparency and visual art as an experience for hybrid depiction.

Keywords: Eye Tracking Research, Hybrid Portray, Modular Design, Visuospatial Attention

PENYERAPAN HIBRID PERHATIAN VISUOSPATIAL MELALUI PENYELIDIKAN MATA-PENJEJAKAN DAN RENA BENTUK MODULAR

ABSTRAK

Perjalanan meneroka pembangunan proses lukisan rasional bagi menghasilkan karya seni hidbrid menjadi isu penting gambaran hibdrid pengiktirafan fenomenologi melalui seni sains penyelidikan kerjasama makmal bagi kajian studio seni. Satu kes bagi menggambarkan kajian ini, visuoapatial dalam video tarian koreografi telah dipilih. Dalam proses penggambaran hidbrid, terdapat isu yang mencabar iaitu dalam visualisasi ciri-ciri objek yang tidak dapat dijelaskan melalui gambar berkenaan ketelusan dan domain pengalaman. Bagi menangani permasaalahan ini, panduan DRS "Demonstrate, Resemble and Synthesis" dicadangkan berdasarkan gabungan antara penyelidikan penjejak mata, corak reka bentuk modular dan prinsip seni tradisional. Terdapat tiga peringkat dalam panduan ini iaitu peringkat pandangan ciri-ciri, Peringkat persamaan sifat fizikal dan peringkat sintesis aspek bergambar. Peringkat pertama bagi menujukkan ciri-ciri pandangan dari kes tertentu melalui output ciri matriks penetapan. Perlaksanaan dibuat melalui eksperimen berasaskan video penjejakan mata menggunakan pengesan Maya Tobii T60. Ia merupakan perisian analisis untuk mengumpul dan menganalisi pergerakan mata daripada 10 orang peserta antarabangsa di Universiti Malaya. Bagi mengenalpasti kualti pandangan berdasarkan kiraan penetapan dan ciri-ciri panjang penetapan, kawasan kepentingan statistik AOI adalah AOI/elisation pemandangan dan AOI/elisation corak telah digunakan. Keputusan yang dicapai diperingkat ini telah menujukkan bahawa korelasi dan kepelbagaian antara ciri yang boleh digunakan sebagai eleman persamaan untuk visualisasi. Peringkat kedua menyerupai sifat fizikal menggunakan reka bentuk modular corak operasi meja tambahan untuk visualisasi dalam kes tertentu. Sifat ketinggian, kelebaran, warna, corak, bingkai, jisim, inti, ruang dan bentuk telah divisualisasikan. Keputusan di

peringkat ini telah menunjukkan bahawa corak yang divisualisasikan mempunyai bentuk geometri menegak. Bagi peringkat terakhir adalah untuk menghasilkan Karya Seni Hidbrid untuk kes tertentu. Prinsip keseimbangan dan pergerakan telah dipilih dan 10 karya seni hidbrid telah dicipta dalam penyelidikan ini. Tesis ini telah menyumbang kepada membangunkan kerangka kerjasama baru yang diajukan antara saintifik eksperimen sebagai sumber maklumat, pendekatan matematik sebagai ketelusan, dan seni visual sebagai pengalaman untuk penggambaran hibrid.

Kata kunci: Penyelidikan Penjejakan Mata, Penggambaran Hibrid, Reka Bentuk Modular, Perhatian Visuospatial.

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LIST OF SYMBOLS AND ABBREVIATIONS

DRS	:	Demonstrate, Resemble and Synthesise
RBG	:	Red, Green, Blue.
P	:	Pattern
C	:	Color
F	:	Frame
T	:	Time
G	:	Gist
F	:	Form
S	:	Space
Pmod	:	Pattern Mod
$Gmod_{color}n$	:	Gist mod color-number based
$Smod_{gray}n$	:	Space mod gray-number based
FMF	:	Fixation matrix feature
FC	:	Fixation count
FL	:	Fixation Length
HPVA	:	Hybrid Portray of Visuospatial Attention

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

In this chapter, an introduction is presented to hybrid painting practices through art-cognition-science collaboration research, pictorial representation of attention phenomena and the inspiration behind this study. Next, the problem statement, aims and objectives, research questions, and scope are defined. Moreover, a brief description of the contributions and significance of this study is also stated. Finally, the research outline and summary are described.

1.1 Introduction

The latest artistic experimental contributions are adapted to remark interest in art, science and technology collaboration. The setting for the future is to sustain the visual arts practices through producing versatile hybrid artworks. Approaches of painting within art-sciences methods witnessed few attempts that had been situated (Kagan, 2014, 2015; Rödder, 2015, 2017). For example, the study of the pictorial representation of visuospatial attention phenomena based on the art-science collaboration through digital eye-tracking analysis, mathematical design, and traditional painting is portrayed. The outcome was able to fulfill the concern about the standard of quality in relevant artworks. The hybrid painting practices through art-science-collaboration established the encounter between science, technology, and visual arts. The explorations included the meeting points of logic, encouragement, reflection and the reflexivity in producing a standard and sustained the quality of relevant artworks. For instance, an art-eye tracking collaboration approached by Bradley (2014) and Kirtley (2018) for art communication representation. Furthermore, an art-mathematical mimics collaboration approaches proposed by Krauß (2015) and Kim, Ryu, Kim, Kim, and Ahn (2016), and other art studio experimental collaboration approaches proposed by Linnell (2010), Rundle,

Robinson, Strang, and Wienroth (2014), and Summers (2007) for hybrid producing art forms. For more details see art-science collaboration depiction approaches in chapter 2.

In the Aspectual-recognition Representation philosophy is when the taxonomy of hybridization referred to the image of understanding, or in a general concept recognize as the pictorial representation (Lopes, 1996). The concept of the representational and the recognition picture provided a kind of hybrid theory of depiction that reflects both the symbolic and perceptual nature. In Lopes's theory, the understanding of picture is based on four criteria: pictorial aspects, recognition capacity, the source of information, and picture transparency. These criteria is combined between the perceptual nature and symbolic character of pictorial representation for defining new concept of understanding picture, which Lopes called it as hybrid aspect-recognition account. Therefore, in this study, the question on how to embed the form of cognition aspects has been raised. The present study evoke an initial question of how can artist shape the features that have invisible qualities when he/she do not possess the ability to recognize the visual features? (Al-Maqtari, Basaree, & Legino, 2014; Al-Maqtari, Basaree, & Legino, 2015).

Fortunately, Dominic Lopes (1996), Robert Hopkins (1998), and Michael Newall (2016) developed the theoretical accounts in defining the pictorial references and experience. Lope has been raised hybrid Aspect-recognition account contends on the use of the demonstration-mechanism mode for suggesting any applicable rational guideline that identifies the information of pictorial aspects from its mental source. Lopes's hybrid theory through Modality and Transparency domains provided a flexible ground to recognize any image based on Evan's demonstrative mode, which encouraged the researcher to propose her approach to depict the hybrid portrayal of the visuospatial attention in a choreographic video, female redefines oriental dance.

The vision of science on the particular attention case has also been adapted to deep investigation using eye-tracking research. The previous study was persisted in various fields such as neuroscience, psychology, psycholinguistics, ophthalmology, usability, human-computer interaction, package design and marketing researcher for biomedical mapping, industrial design, and educational purposes (Lorini & Piunti, 2007; Prasse, 2011). However, visuospatial attention is investigated for the critical visual perceptional enquiries of the evaluation of art beauty, thus making a decision for art design principles or artworks display in the exhibitions, installation art as well as public reaction and making a surprise in the side of visual arts.

In post-performance art aesthetic, a worthy practice of body movement does not only depend on the beauty values, but it should ensure that the attention of viewer is drawn to the visual field of body movement and that it is more central for perceiving cognitive judgments of efficiency (Jones, 1998; Osborne, 2004).

Now, the cognitive judgments of efficiency require the explanation of why somatic movements are of a large number of innovative attractive practice providing significant visual neural correlates of dance improvisation (Savrami, 2017). In addition, the challenges of performing art-cognitive evaluation are linked by a need to understand the visual-audio attention conditions. The latest model of information-processing stage suggested that a good acting of art style should be evaluated based on the perception and cognitive mastering (Leder, Belke, Oeberst, & Augustin, 2004).

Eye tracking studies have persisted in various fields such as neuroscience, psychology, and design theories implications for marketing and brand perception of performing arts, specifically focusing on dance organizations (Bedal, 2014). Other psycholinguistics, ophthalmology and creation theories implications were used for usability and human-computer interaction, specifically focusing on art evaluation,

communication, and educational purposes (Prasse, 2011). Previously performing art experiments using eye tracking have investigated how viewers' attention is drawn.

Particularly, in the person perception, dance, and entertainment investigation studies, the results have shown that there are robust relationships between music-body movement's synchrony and increasing of attention to enhance memory for attendant person attributes. Yet no consistent relationships were found between creativity and attention that linked any created styles to eye's responses (Carruthers, MacLean, & Willis, 2018), or any improvised styles to fixated-body regions (Woolhouse & Lai, 2014). A previous study by Woolhouse and Lai (2014) showed that music-dance synchrony and upper body movements factors give rise to increased visual observation times. They reported that the head-directed fixations recorded high dwell times of attention duration more than any other body region. However, they recommended a main question to be answered on which conditions in somatic movements that are specially designed to direct a viewer's gaze towards the torso-and head-directed fixations. Another study by Bedal (2014) examined how the psychological and neurological design implications are used to increase brand mindfulness for dance organizations. Three different dance companies, one local, one regional, and one international, were identified to design their environment through a performing arts industry, consumer psychology, behavioral neuroscience, and design theory researches combinations. Then, the output of multi-method analysis included neuro-imaging techniques, such as eye-tracking, were used to examine the effect of visual elements on the viewers. It was found that neuroscience and design can help in producing memorable brands for advertising and marketing purposes.

Three regions of body movements, including eye, head, and trunk, are often affected by age, task, and health conditions in the body movement strategies. In the gaze task, no

head movement is significantly recorded for gaze changes from a center position at less than 10°. However, the movement of eye can rotate horizontally up to 50°, whereas, the trunk movement can be observed when the gaze task reaches the target at gaze changes greater than 140° (Gadotti et al., 2016).

In attention responses to body movement, eye, head, and trunk movements' patterns were typically observed many times, namely saccades through infra-red pupil tracker. Video eye-tracker hardware and software systems were used to record the synchronized evaluation of body movement regions. There is limitation in the studies concerning the dance styles in natural settings and coordination of body movement to explore the attraction. This is due to the confounding effects of some characteristics such as body shape, height, facial attractiveness, and clothing features (Neave et al., 2010).

1.2 Problem Statement

The vital interest of pictorial representation through art-cognition science collaboration approaches is more focused in hybrid visualisation that contributes into both vision sciences and visual arts (Gerber, 2006; Shanken, 2006; Wienroth & Goldschmidt, 2017; Zschocke, 2010). Thus, the pictorial representation in cognition phenomenology is involved with the invisible qualities (Merleau-Ponty, 1968, 2004; Steeves, 2004), such as, the case of visuospatial attention in a dynamic scene (Berzhanskaya, Grossberg, & Mingolla, 2007; Rensink, 2000). In this case, the demonstration of the gaze features requires the use of eye-tracking approaches which have not systematically ranged in producing hybrid arts and also are questionable by scholars (Colabella, 2014; Kirtley, 2018).

Furthermore, in order to depict the pictorial aspects based on the image of understanding, three main domains pictorial source, resemblance, and experience are suggested through pictorial representation theories in terms of hybrid aspect-recognition representation which still unimplemented for visualization. The pictorial reference domain should be based on information-demonstration based; the resemblance domain requires applying a system of donation for visualisation; and the experience of depiction needs to be subjective through artist intention (Hopkins, 2003; Newall, 2016). Thus, three problems may be raised using art-cognition science collaboration representation for the visualisation purposes. The demonstration process of gaze features which requires fulfilling a high standard of correctness and positive output relation of the fixation matrix features to decide the selection of the resemble elements. Then, the resemblance of these features through second-order isomorphism condition, and finally, the artistic role in pictorial experience are challenged (Newall, 2016; Lopes, 2004). Benjamin and Iain (2005) stated that the representation of gaze features is determined using a fixation matrix feature; fixation count and fixation length metrics, in vision science and cognition physiology research. However, this has always been debatable when traced by visual artists. Furthermore, the resemblance process requires the setting a symbiotic system that first demonstrates data through intelligent intervening of the technology and then resembles those using mathematical procedures that are the challenges encountered by traditional visual artists (Von Borries, 2015). A system of modular design provided by Gauss sets up the way of shaping through simple mathematics in his book, *Disquisitiones Arithmeticae* [1], simple methods were then developed to simply create hybrid forms through the logic of integers and remainders using the table mod operations, pattern modular logic design by (Duval, 2004;

[1] This theory was published in 1801 and edited by Gauss & Fleischer in 1966, Gauss's theory in 1986, and Merzbach in 1981(Neumann, 2005).

Goldstein, Schappacher, & Schwermer, 2007; Harriss, 2011; Neale, 2012). Therefore, collaboration between eye-tracking technology in vision science, hybrid pictorial representation accounts in depiction, coherent concept of visuospatial attention in cognition science, and arithmetic modular-pattern design in mathematics could provide a credible conceptual and practical framework.

This study aims to shape the hybrid portrayal of visuospatial attention in a video in terms of art-eye tracking collaboration. Based on those kind challenging issues and the current study proposed a robust guideline of hybrid depiction. Therefore, the character through demonstrate, resemble, and synthesis (DRS), which combine with the three theories in a specific field. The first is a pictorial representation that is embedded with the hybrid aspect-recognition representation theory by Dominic Lopes (2004). The next is, the mathematics approaches specifically the number of theory argued by Carl Friedrich Gauss's *Disquisitiones Arithmeticae* theory in 1986 (2005), and Harriss's (2011) Pattern modular logic design. The final one is in the cognition science domain, particularly the coherence theory of visual attention in dynamic scenes provided by Ronald Rensink (2000). Indeed, an awareness of their domains was then used to provide a credible collaborative representation framework to achieve the aim of this study.

1.3 Aim

This study aims to shape the form of visuospatial attention in a choreographic dance video through a co-producing hybrid approach using eye-tracking research, modular design, and traditional art principles.

1.4 Objectives

The study aimed to achieve the following specific research objectives:

a) To identify the components of particular hybridization in terms of visual art-math-cognition science collaboration representation.

b) To determine knowledge of the gaze features using eye-tracking video analysis for the specific case.

c) To resemble physical properties for the specific case using pattern modular design.

d) To synthesise pictorial aspects through traditional art principles for the specific case.

1.5 Questions

To accomplish the above research objectives and therefore the particular study required to answer the following research questions:

a) What are the components of the hybridization for the specific case through visual art-math-cognition science collaboration?
b) How can the information of the gaze features in the specific case be determined through gaze data?
c) How can the physical properties of the specific case be resembled through pattern arithmetic design?
d) How can the pictorial aspects of the specific case be created through traditional art principles?

1.6 Scope of Research

The scope of this multidisciplinary study is the art-math-cognition-science collaboration for co-producing hybrid forms of artworks. It particularly focused on the case of cognition phenomenology, public visuospatial attention in the dynamic scene. It is interested to employ the technical processes of eye-tracking technology, modular

arithmetic-pattern based, and traditional art principles combination for co-creation. The case is scoped to the visuospatial attention in the dynamic scene, female redefine oriental dance video by Alexander Paulikevitch's performance. This research scoped as illustrated in Figure 1.1.

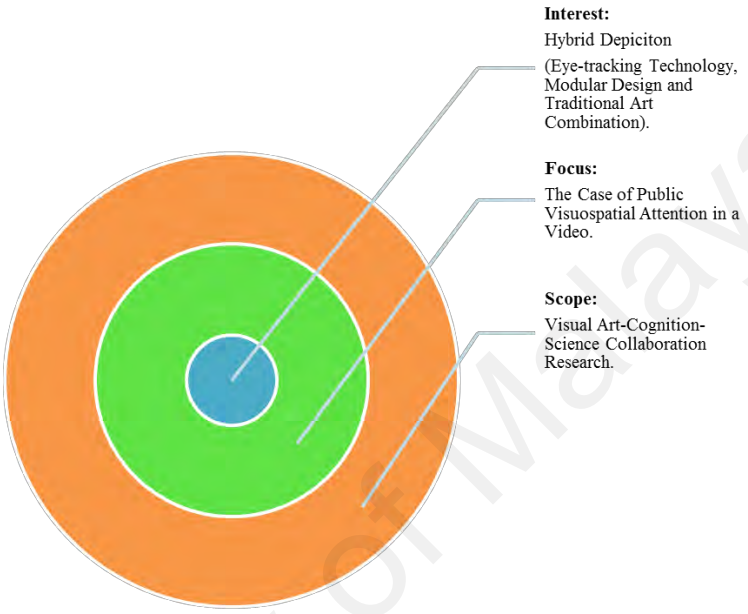


Figure 1.1: The scope of research.

1.7 Delimitation

There were no major problems encountered during the actual experiment except for some minor problems, as noted below:

a) The researcher encountered an unavailability of an eye-tracking lab at University of Malaya, which is only available in hard conditions at UITM University that provides privacy consideration with limit allowance and expensive rental payment.

b) The high cost of purchasing eye-tracking lab was one of the most challenges that the researcher encountered in this study. It was too expensive in which the cost was from $25000 to $45000.

c) After putting in a hard effort while contacting with eye-tracking brands in Malaysia and overseas searching about fit rental possibility, the researcher solved this countered problem by renting the Tobii lab with a fit price provided by SDS Associates SDN BHD lab and compared it to other labs in Malaysia.

1.8 Thesis Contribution

In this study, the eye-tracking-modular design-traditional art collaborative research work proposed a credible guideline in hybrid depiction stages to Demonstrate, Resemble and Synthesise DRS form aspects of visuospatial attention in dynamic scenes. This art experimental study provides a novel collaboration role between experimental scientific approach as a source of information, mathematical approach as a transparency and visual art as an experience of hybrid depiction. Below lists the contributions to the domain of hybrid depiction in visual art field:

a) The conducted literature exposes the latest existing art-science collaboration experiments for hybrid representation of invisible phenomena.
b) A new collaboration of hybrid visualisation is implemented using a proposed fixation matrix feature for the demonstration of gaze features of visuospatial attention in a choreographic dance video.
c) A valuable table of hybrid symbols defined the concepts of physical properties which are useful for further developing newer visualisation techniques of cognition phenomena.
d) A new simple step-by-step technique based on a pattern modular design, a color semantic method that transfers the empirical output from the scientific outcomes into visual properties for visual art field.

e) A creative technique based on traditional art principles which produce the hybrid art forms from the coherence features visualised rationally.

f) Finally, future research directions in the domain of hybrid depiction of cognition phenomena are provided.

1.9 Research Significance

This study provides a robust approach that is implemented in a painting processes guideline for the hybrid depiction of visuospatial attention phenomena. The output of this multidisciplinary art-math-cognition science collaboration research will benefit researchers who conduct research in the area of hybrid artwork depiction and vision-science scholars in social science and technology. The current philosophical debates associated with the hybrid depiction of invisible aspects of cognition phenomena are investigated in details in the literature review section. Furthermore, this study will also help digital artists, traditional artists, and other relevant hybrid scholars to visualise the invisible qualities for any phenomena in a simple way without using a complex algorithm or digital visualisation software.

1.10 Thesis Outline

This thesis is divided into seven chapters. Chapter 2 reviews the related work of hybrid depiction of visuospatial attention phenomenology. Chapter 3 provides a general description of the art-eye-tracking research methodology and visualisation processes that are employed in carrying out the research study. Chapter 4 demonstrated the gaze features based on fixation information for representing visuospatial attention in a video. Resembled physical properties of visuospatial attention in a video are visualised using a pattern modular design which is provided in Chapter 5. Pictorial aspects are synthesised for the specific case in Chapter 6. Finally, Chapter 7 concludes the research discussion and findings.

1.11 Chapter Summary

In this chapter, the inspiration behind this study is provided. The problem this research intends to address is already clearly defined. Research objectives, questions, scope, and contributions were also highlighted previously. Chapter 2 exposes an overview of hybrid depiction in art philosophy, attention phenomenon in cognition science, and the associated hybrid depiction techniques in the related studies that highlight the gapes in depicted techniques. The developmental concept of hybridization is discussed in the next chapter.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter, the literature relevant to a hybrid depiction field is discussed effectively to understand the dimensions of this thesis. The background of hybrid depiction is introduced, including its different philosophical accounts, concept formulations, and representation domains. Similarly, generative art taxonomy, art-science lab collaboration depiction methods, and visuospatial attention phenomenon are described in detail. At first, the concepts and branches of generative art and various generative artworks are identified in the existing literature. The generative artworks identified for hybrid depiction are reviewed for their techniques and outcomes. Secondly, the concepts and approaches of art-science lab collaboration for hybrid depiction are highlighted. The empirical approaches for hybrid depiction using multi-scientific and eye-tracking lab are reviewed for their techniques, limitations, and outcomes. Third, concepts and models of visuospatial attention phenomenon for vision science representation are provided in general. The eye system identification of visuospatial attention is reviewed for its physical aspects and coherence properties. Finally, the critical assessment of the relevant literature provided a comprehensive account of the hybrid portrayal of visuospatial attention in this research work.

2.2 Hybrid Depiction Background

The hybrid depiction is a term coined by Dominic Lopes (1996) in the book *Understanding of Pictures,* which revolves around an aspect-recognition representation or picture perception. However, recent debates of the hybrid depiction concept are widely applied in the context of art-science lab collaboration. Utilizing the term hybrid with art described the topic; Generative arts, which is the application of digital and traditional operating systems to create artworks. The term of generative art has its origin from an Italian word (Disego) to a complex ancient tool that combines between drawing

and design in the generative art (Colabella, 2014). The terminological history of generative art has started long back from Milan's Generative art Conferences in 1998, and the essential generated methods by Brian Eno in 1996 (Boden & Edmonds, 2009). The term of generative art can also be referred to the hybrid form of arts that used digital system or art rules for creation. Specialists of analytic aesthetics school are found primarily in the U.K. and U.S.A. Carroll's philosophy of art, and art and human nature books is a good example which elaborated with these questions (Carroll, 2004, 2012). According to Chappell (2005), the hybrid art is a kind of generating arts using independent systems like a mechanical or digital computer, or a set of rules of producing artworks-based hand. Furthermore, Colabella (2014) state that the generation-artworks community produces various artworks by the use of a set of specific rules that not necessarily implying complex computer system or a step-by-step algorithm. The created series abstract of screen print paintings through the combined rule-driven generation inverted by Martin's artworks from (1971b) to (1984) have now proposed the idea of generative art using the random distribution rules of number logic (Figure 2.2). In this research, the focus is on creating hybrid painting-hand based involving the use of multi-methods: eye-tracking demonstration method, digital resemble of modular design, and traditional principle art to depict the visuospatial attention phenomena.

2.3 Hybrid Depiction Philosophy

Many perceptual and non-perceptual theories of pictorial representation have been focused on the perception and representation of the picture such as convention, resemblance, causal relations, mental constructions and information. Although the previous theories cover a wide variety of such perceptions, this review will focus on the aspect-recognition account which emerges repeatedly throughout the latest debates of pictorial representation. Three main themes have been concerned to discuss the hybrid

depiction in the recognition theories: pictorial aspects, pictorial source, and pictorial transparency.

According to Mark Rollins (1999), the Hybrid depiction is referred to the Dominic Lopes's (2004) philosophy of Aspectual-recognition Representation which is a crucial concern belongs to both cognitive science and aesthetics. Aspectual-recognition Representation account is kind of a hybrid depiction that occurs through Evan's demonstrative mode of identification and indirect resemble. The perception of a picture in the hybrid depiction is drawn from both mental representations and perceptual strategies. The picture in his account is regarded as a piece of information that carries perceptual information of its subject through two processes: modality and transparency. Therefore, the concept of hybrid representation is oriented in the sense of the picture which has a denotative nature with two overlaps functions at the same time as follows:

a) Picture as a model: an object in the picture is considered as a subject when it serves as a source of information in the causal history of the picture.

b) Picture as a symbol: the content of the picture is the oriented subject in the picture which is at the same time as the main source of information.

2.3.1 Questions Concerning Hybrid Depiction

Most early theories of pictorial representation were concerned with the question of how to distinguish picture sort of representation from other forms. Simply, the accurate definition of the picture will be helpful in understanding the nature of pictorial representation. The picture is defined as a form that depends on recognizing the analog of artistic visual properties representations. According to Dominic Lopes (2000),"Pictures differ from descriptions because they belong to analog or syntactically and semantically dense, schema, and they differ from phenomena such as diagrams and

maps because they belong to relative schemes" (p.227). Three questions are raised (Leung, 2009, p. 10):

Q1: What is a representational picture?

Q2: What is the relationship between experiences of seeing the subject in the picture and experience of actually seeing the subject in person?

Q3: Why do we see particular objects in the marks on a picture surface rather than seeing something else?

Lopes contended that the answer to the first question would be the Theory of Picture. Pictures include a very wide kind of figurative or abstracts that are related to the knowledge of picture's perception. However, the answers to the second and third questions are linked to the Theory of Pictorial Experience. They focus on a perceiving of the picture through recognizing the themes in the aspects they represent. Similarly, Robert Hopkins (2003, p. 653) formulated questions concerning picture and pictorial representation as follows:

Q1: What is a picture?

Q2: What is pictorial representation?

Q3: What is the experience pictures characteristically generate?

Q4: What is it to understand a picture?

Furthermore, Hopkins' formulation of question one argues positively that the picture representation involves two kinds of depictions: pictorial and semiotic representations. He contended that the formulations of question two, three, and four address the experiential and recognition approaches. Although the similarity between Lopes' and

Hopkins' formulations of the nature of pictorial representation, Lopes states that there are three situations for the representational picture: some pictures recognized as non-representational such as abstracts paintings, a pictorial experience which is a product of depiction, and a notion of Understanding Picture that needs human recognition. Hopkin believes that all pictures and types of depictions are representational including abstract painting; the pictorial experience which is not only the product but essentially the core of depiction, and the understanding the picture needs human seeing.

It can be argued that the representational picture in Aspect-recognition Depiction is a painting about any invisible-cognition-phenomena such as the experience of human visual attention while watching a dance video. Does the hybrid form of the current case representational or non-representational? Or is it necessary to identify some of the common figures to have a real understanding of current painting through seeing approach? But, how can represent a visual content of the current invisible-cognition phenomena? These questions were raised in this study.

By its very nature, pictorial representing of any phenomena is classified into two fields: visibility and invisibility. Merleau-Ponty and Lefort (1968) promoted a new vision of visibility that belonged to a sort of hyper-reflection, hybrid-dialectic, and intuition-palpation as a landscape and topography needs to be explored in further studies. According to Merleau-Ponty and Lefort (1968),

> When through the water's thickness I see the tiling at the bottom of a pool, I do not see it despite the water and the reflections there; I see it through them and because of them. If there were no distortions, no ripples of sunlight, if it were without this flesh that I saw the geometry of the tiles, then I would cease to see it as it is and where it is—which is to say, beyond any identical, specific place. I cannot say that the water itself—the aqueous power, the sirupy and shimmering element—is in space; all this is not somewhere else either, but it is not in the pool. It inhabits it, it materializes itself there, yet it is not contained there; and if I raise my eyes toward the screen of cypresses where the web of reflections is playing, I cannot gainsay the fact that the water visits it, too, or at least sends into it, upon it, its active and living essence. (Merleau-Ponty & Lefort, 1968, p. xliii)

However, the sensible thing by Ponty's idea is not considered as space, but as a direction based on the presence of certain contracted trajectory of time. Its unity is the certain style that manages the space and time domain. This style depends on the movement of the body which gives us the initial analog of the scheme. It was said that "What we call a visible is, we said, a quality pregnant with a texture, the surface of a depth, a cross-section upon a massive being, a grain or corpuscle borne by a wave of Being" (Ponty& Lefort, 1968, p. xix).

A representational painting of visible thing is identified from a physical aspect that occupies in spatial and temporal location, like Synthesis, or a visible surface consisted marks of paint which be analysed in terms of a pixel, such as images on a computer screen. However, the representational painting of invisible thing is not in temporal and a spatial, but rather it is field being through recognizable knowledge. Furthermore, current ideas, however, do not discount these conceptions, but simply build upon them, to include self-concept of the hybrid depiction of invisible-recognition-phenomena.

Fortunately, Newall (2011) suggested a helpful formulation of hybrid recognition depiction that is applicable in such cases. It supported the Lope's formula that hybrid representation requires a typical mod of information identification and standard of correctness. It was defined Lopes's depiction formula that "A surface, ***X***, depicts ***Y*** if and only if, (1) ***X*** can occasion non-veridical visual recognition of ***Y***, (2) This non-veridical recognition accords with an appropriate standard of correctness" (p.44).

On the contrary, Michael Newall (2016) argued that the perception of pictorial depiction in terms of recognition is according to the experience of seeing pictures like the ideas of philosophers such Richard Wollheim, Christopher Peacocke, Robert Hopkins, and John Hyman. Although his formula requires identifying the identification mode and standards correctness, these standards could occur only through three

conditions: simulation of the visual system, engagement of recognition ability, and visual experience of seeing. According to Michael Newall (2011), "A surface, ***X***, depicts ***Y*** if and only if, (1) ***X*** can occasion non-veridical seeing of ***Y***, (2) This non-vertical seeing accords with an appropriate standard of correctness" (p.43).

The researcher argues that both the above formulas were not sufficient to identify the particular hybrid formula in this study. The current study, therefore, adopted a new definition of the invisible aspects with particular variables through the gaze movement axis in the next sections.

2.3.2 Hybrid Depiction Domains

Recent studies of pictorial representation are concerned with classifying the domains of Lope's account of depiction in his publications (Lopes, 2004, 2002& 2003). Leung (2009) outlined that there are eight basic domains highlighted aspectual-recognition theory: pictorial reference, information-based identification, thought constraints, pictorial aspects, pictorial system, pictorial recognition, pictorial meaning, and pictorial experience. However, Giovannelli (2008) focused on Lope's accounts in terms of sight and sensibility perspective and Hopkins (2008) explained the reasons for looking Lopes's for picture values in previous domains.

It is important to argue that the Leung outlines of Lopes's theory are central to the hybrid discussion in this study which helps to answer the main question of what are the domains of current hybridization. Therefore, the researcher discussed in details the domains of hybrid depiction to develop a new formula of hybridization as outlined below.

2.3.2.1 Pictorial Reference

Pictorial reference is a denotative symbol system, the core of a theory of depiction. Many theories of pictorial reference are provided to answer the question of how donative symbols are referred. Morizot (2011) argues that the hybrid account of pictorial reference considered Goodman's anti-perceptualism of the descriptive theory is inconsistent. The reason is Goodman's account of reference does not depend on the information of picture content. Based on this objection, Lopes states that the identifying of information through Gareth Evans's demonstrative mode which is consistent. This mod is characterized as belief-independent, non-conceptual, not affected by beliefs and desires, and associated with three features: neural processes, Sub-personal level of the brain, and psychological mechanism. According to Evans (1987), "Demonstrative Identification," "Self-Identification," and "Recognition-Based Identification," contain Evans's attempt at a detailed reconstruction of Russellian acquaintance, and constitute an important contribution to the raging debate about indexical" (p.279).

Therefore, the correct information is set through the standard of the correctness of interpretation. Two standards of correctly interpreting the information, those are:

a) Standard of correctness based on maker's intention: Hand-made 'manugraphic' pictures such as the traditional drawing and Synthesis.
b) Standard of correctness have a causal relation: information based on the content of photographs and pictures.

So any picture with primary or secondary subject matter is counter-example to that standard of correctness. For instance, let us consider the subject matter is primary if its depiction depends on nature direct modal *Y*. Painting *X* of that modal becomes the secondary subject matter. In case of Rembrandt's Synthesis of Bathsheba reading King Davids letter, Bathsheba is a primary source because her depiction depends on the

depiction of the modality (Rembrandt, 1654). But, in the case of a subject that have features which are not described visually like the current case study, which source of information fulfills the standard of correctness in the hybrid recognition depiction? This actually needs to demonstrate its information using an indirect smart interpretation.

2.3.2.2 Information-based Identification

Information-based identification mod is referred to as the demonstrative information system. The picture representation links with object perceptual information. Evans's demonstrative identification concept designed an identification element of object perception depends on a numerical discriminating knowledge. John Zeimbekis (2010) remarked that the identification of picturing should be based on the causal representational connections to viewer using a numerical discrimination mode.

> In this wider picture, information links satisfy one of two jointly necessary conditions for perception-based singular thought. They are causal representational connections to particulars that, in a given context, permit the discrimination of those particulars numerically as opposed to qualitatively. Such context-relative numerical discrimination is carried out on the basis of the egocentric, or perspectival, mental contents caused by information links? as when we pick out an object by its location and have contents expressible by 'the second item from the right,' 'the top shelf,' 'the thing behind that' For demonstrative identification not to remain thus restricted to a given perceptual con text, the subject has additionally to be able to locate the particulars identified on a nonegocentric, objective, unified representation of space. Yet, the presence of an information link remains a fundamental condition for discriminating knowledge, because it is the information link to particulars that divulges which location is to be thus mapped in the first place. (p.15)

Therefore, the information link of the current case in this study remains a fundamental condition for discriminating knowledge, because it is the information link to particulars that divulges which location is to be thus mapped in the first place of depiction.

In the second hand, identifying the source of information depends on either possessing piece of information through a causal origin source or the basis of the content. However, identifying the actual source of information does not trace the

content or the reliability of the system when we trace source through coronagraph historical reasons. Therefore, information-based content identification requires a reliable system, such as a visual analysis which can be used to convey descriptive information about all particular properties such art elements (shape, color, space, value, etc.) that denote a set of aspects in the general context.

2.3.2.3 Thought Constraints

The constraints of thought are the important condition of the process information-identification based. It means that information featured at a sub-personal level of the perceptual information system, which is also called as the 'information-based thoughts'. According to Evans (1987), the way of thinking should distinct the understanding of an object from others. Two constraints of thinking are provided for identification based on the content of the information as follows:

a) Russell's principle.
b) Generality constraint.

Russell's principle addressed that the idea is to think of any object, we should first have the capacity to recognize its concept through its oriented common thoughts which makes it different from others. In generality constraint, to have the thought that ***X*** is ***Y***, we must possess the concept of particular objects from others that enable us to understand thoughts like ***X*** is ***G***, and ***X*** is ***H*** for all the properties that one has a concept of or thoughts like ***X*** is ***G***, and ***Y*** is ***G*** for every object one has a concept of. However, Leung (2009) argued that the Generality constraint of the identification-based actual source need to understand the causal history.

The constraints, therefore, in this study is belonged to Russell's principles, not to the general constraint.

2.3.2.4 Pictorial Aspects

The pictorial aspects are the essential principle of Lopes's hybrid account that used to answer the second question of distinct pictures from other forms. It is referred to the structural selectivity through the properties of content as well as design in the picture. Leung (2009) divided the pictorial aspects into two types: the commitments and non-commitments of aspects which sorted within two selections as follows:

a) Inexplicitly non-committal selection: impracticability of determinacy is derived from selecting the determined properties of the object as having or not having by artist, noncommittal indeterminate. For instance: a painter may choose to depict old lady as having white hair or no white hair, indirect selection.
b) Explicitly non-committal selection: it is selected based on the structural features of depiction. Sometimes, the painter represents properties of the object as having or not having a blocked type of representation such as the head disappeared behind signboard example, direct selection.

However, a hybrid perspective refused the assumption that picture resembles vision or the single perceptual identification. The theory supported its point that cubist Synthesis or split-style is determinate through two or multiple perceptual identifications. Therefore, hybrid representation is contended to combine both commitments and explicitly non-commitments to specify hybrid aspects for impossible or paradoxical pictures with unusual visual experience. Here, commitments are referred to the physical pictorial aspects such as text, color, shape, space, and other properties. However, explicit non-commitments are not physical aspects; but rather, they are not ordinal aspects which are common to have. Therefore, the pictorial aspects of the hybrid portrayal have the following commitments in this study:

a) Unified with physically and coherency related.

b) Provided multiple compositions for one subject.

c) Essentially selective.

d) Entail explicit non-commitment.

2.3.2.5 Pictorial System

The pictorial system is the type of organization or design that distinguishes the picture from others presentations by the combination of commitments and explicit non-commitment aspects. Representation system of the hybrid painting is defined as a set of patterns that are created through the pictorial referents and its predicates. Pictures are described as having the same system of depiction if they share the same commitments and non-commitments regarding all types of the same features. Furthermore, the content in pictorial recognition-systems unlike linguistic systems which is limited, not conventional, not connected to anti-perceptualize, the choices of the systems are not arbitrary, and with artist preference relation (Luang, 2011). However, Lopes's claims that there are no theories distinguish pictorial systems from each other.

This led the researcher to conclude that the hybrid pictorial system is free depends on the selection of the artist. Thus, the modular logic design was selected in this visualisation research.

2.3.2.6 Pictorial Recognition

The pictorial recognition is referred to a competence of representation. A human can understand aspectual structured and the limitations of a picture in diversity systems of depiction. There are three forms of pictorial recognition: feature recognition, individual particular recognition, and kind recognition. Any person can recognize the feature or the kind of cat without knowing whether it is a particular cat that he/she saw before. Therefore, feature and/or kind recognition can happen without particular recognition.

However, the studies such as Casati and Pasquinelli (2007b) and Casati (2004) found that individual recognition needs a prior knowledge to perceive the appearance of objects in the past despite the changes, such as the facial recognition based on the period processes of time. This requirement of prior knowledge of recognition is described as dynamic recognition

Lopes, therefore, distinguished two types of depiction-based recognition through their information source: basic portrayal and basic depiction. Basic portrayal becomes when a picture represented by embodying information that allows understanding the object in a particular aspect, dynamic recognition. For example, we may see a photo of Mahathir bin Mohamad in any newspaper. By the features that we understand through the information over a long period of time, we understand that the man with recognized features is Mahathir. However, basic depiction depended on a feature or kind type of recognition. In addition, these two types of depiction-based recognition require a perceiver who possesses an ability of dynamic recognition in both content and subject recognition. Therefore, suitable perceiver for this type of recognition is that one who familiar with the subject and has the competent ability to recognize it. Also, the content recognition and subject recognition are the two kinds that distinguish pictorial recognition from other ordinal visual recognition.

These could argue that any pictures are recognized as the two-dimensional surface from their features that make up aspects of certain subjects. Therefore, the recognition dynamism of hybrid painting could be characterized through the following states:

a) The elasticity of recognition is not boundless, limited when the object across new aspect.
b) The ability of recognition is aspectual bounded related to kinds of aspects, variation dimensions.

c) The generative ability of recognition in an object is sufficient under the similarity of aspects.

d) Recognition-based thoughts satisfy Evan's generality two constraints.

e) Simultaneous subject-recognition can inform Content-recognition.

f) Resemble representation is dependent on the recognition-based process of content recognition and subject recognition, interpretation.

2.3.2.7 Pictorial Meaning

The pictorial meaning is the sense of the picture through visual information by the body storied information. Basic picturing is one of the ways to grasp the pictorial sense which includes basic portal and basic depiction. Lopes (1996) contended that the intention of the artist is not sufficient to fix the meaning of works. Pictorial intention differs from a communicative intention because the first one is involved in pictorial representation while a communicative intention can be involved in other presentation including pictorial. Furthermore, the primary and secondary sources are introduced to answer the puzzling questions which are related to distinguish and to relate meaning. A primary source is defined as a kind of object serving in the genesis of a picture which does not depend on other information nature. Despite, the secondary source is defined as a kind of object serving in the genesis of a picture, but it depends on the derived information from the primary source.

The researcher corresponds with Lopes's that the kind of sources of information distinguishes the meaning or portrayal description. The meanings of hybridization-based information are easy to identify based on the segmentation of groups in this study. Thus, two basic meanings of visuospatial attention are classified: section one (common style) and section two (uncommon style).

2.3.2.8 Pictorial Experience

Pictorial experience is referred to transparency. Lopes argued that pictorial experience is limited in four constraints: twofold of seen constraint, competence constraint, diversity constraint, and phenomenology constraint. The twofold of seen constraint is referred to both seen and recognises pictures, the competence constraint which is referred to the validation of recognising picture, the diversity constraint referred to as the transperancy, and the phenomenology constraint which reflects the knowledge of the phenomenon.

Christopher Peacocke (1987) holds that the seeing of depicted thing is virtually through the experienced resemblance of the outline shape. Robert However, Hopkin addressed that the combination between experiential theory and the boundaries of seeing provided the theory of experienced resemblance in outline shape. Actually, an explanation of pictorial experience is not limited to ordinary visual experience, it was aspectual acknowledges in recognition theories. Walton Walton (1973) asserted that only photograph can literally provide the appearance of objects. However, Lopes argued that the transparency of picture is considered as belief-independent and non-conceptual which need an autonomous system of representation. Therefore, the researcher concluded that the transparency is characterized as a second-order isomorphism and indirect resemblance in this research work.

2.4 Generative Art Taxonomy

Taxonomy of generative art means the classification of generative art design. It is classified in four design dimensions: Information Capacity, Notification Level, Representational Fidelity, and Aesthetic Emphasis (Pousman & Stasko, 2006). However, taxonomy is distinguished based on generative activities to eleven types. Some of them located and then Ignored, those were as follows (Boden & Edmonds,

2009; Dorin, McCabe, McCormack, Monro, & Whitelaw, 2012; Pousman & Stasko, 2006):

a) Ele-art includes an electrical engineering technology.
b) CA-art involves the use of the computer as an aid for art making.
c) C-art uses the computer as an essential part of the art-making process.
d) D-art uses digital electronic technology.
e) G-art generates works in part without an artist.
f) CG-art creates works by running program on the computer with minimal and zero interfaces.
g) Evo-art is based on random variation and selective processes.
h) R-art uses robots for artistic purposes based on physical machines.
i) I-art here represents the form or the content of art that affected by the public behaviour.
j) CI-art but here the form and content of some CG artworks are affected by the public behaviour.
k) Finally, VR-art reflects the interaction of viewer in a virtual generated world as areal.

2.4.1 From the Bottom up Generation

This is a subcategory of generative art that belonged to those clusters of contemporary generative art activity included electronic music and algorithmic composition, computer graphics and animation, the demoscene and VJ culture, and industrial design and architecture.

2.4.1.1 Electronic Music and Algorithmic Composition

Electronic music is a sub-branch of generative art that is concerned with the use of electronic musical instruments, synthesise of music algorithm and electronic music

technology for production. Brooks, Hopkins, Neumann, and Wright have proposed the models of the generative process at the micro level of performance and timbre (Brooks, Hopkins, Neumann, & Wright, 1957). Worth different techniques of dozen programs such as cellular automata, fractals, a-life, L-systems, chaos, and randomization were discussed in their article and magazine of working musicians (Pachet, 2002).

2.4.1.2 Computer Graphics and Animation

Computer graphics and animation are another sub-branch of generative art that is concerned with the pictures and movies created by using a computer. The famous works of computer graphics and animation were like the generative breakthroughs included Perlin Noise of smoke, fire, and hair imagery by Perlin and Hoffert (1989), the latest study in art directed hair-fire simulation by Wang (2016), the algorithmic beauty of plants through synthesis of DOL systems by Prusinkiewicz and Lindenmayer (2012), the digital landscape modeling and visualization; a research agenda by Ervin (2001), animation created for represent real world behavior using deformable modeling without painstakingly choreograph details by Terzopoulos and Fleischer (1988), and the physical Pixar and video game based machines by Heaton (2000).

2.4.1.3 Demoscene and VJ Culture

Demoscene is a sub-branch of generative art that is concerned with the producing of audio-visual demos through international computer art subculture. It depends on Randomization which appears in the youth culture movements that used generative technological labs, recording and animation studios and other social settings (Burger, Paulovic, & Hasan, 2002; Hartmann, 2010; Tasajärvi, 2004).

2.4.1.4 Industrial Design and Architecture

This is a sub-branch of a hybrid generation that is concerned with sharing interactive design process algorithms for the selection of variations in art creation, Robot art, and

math art (Winters, 2011). There were also other artists who belonged to the conceptual generative art who used the combinational physical and social systems such as Sol Lewitt and Hans Haacke in an artistic context. Artists such as Francois Morellet employed highly ordered and disordered systems. Moire Patterns used radial or parallel lines, and the chance operations to predict the coloration of grids for Synthesis. Other methods are shown by Sol LeWitt who used natural language and geometric transformation expression systems and Harold Choen's AARON system which combining between software artificial intelligence and robotic Synthesis devices to generate artifacts (Galligan, 2016).

In video art innovators, Steina and Woody Vasulka used video feedback which regarded as a good example of deterministic chaos to create works. Many others techniques are manipulated such as evolutionary computing by Scott Draves and Karl Sims, viral contagion by Joseph Nechvatal, autopoiesis which modifies public behavior participants in fifteen musical and robotic sculptures by Rinaldo, Noll's methods used computer art through the mathematical equations and randomness Demonstrates based on Bell Telephone Laboratories and Incorporated, and so many others experiments.

2.4.2 From the Top Down Generation

This is a subcategory of generative art that is concerned with a rule of generative art hand-based. It interests on a subset of art and more focusing on the philosophical perspective of generative art that trying to answer where is the beauty and how it is?

2.4.2.1 Rules of Generative Art Hand-Based

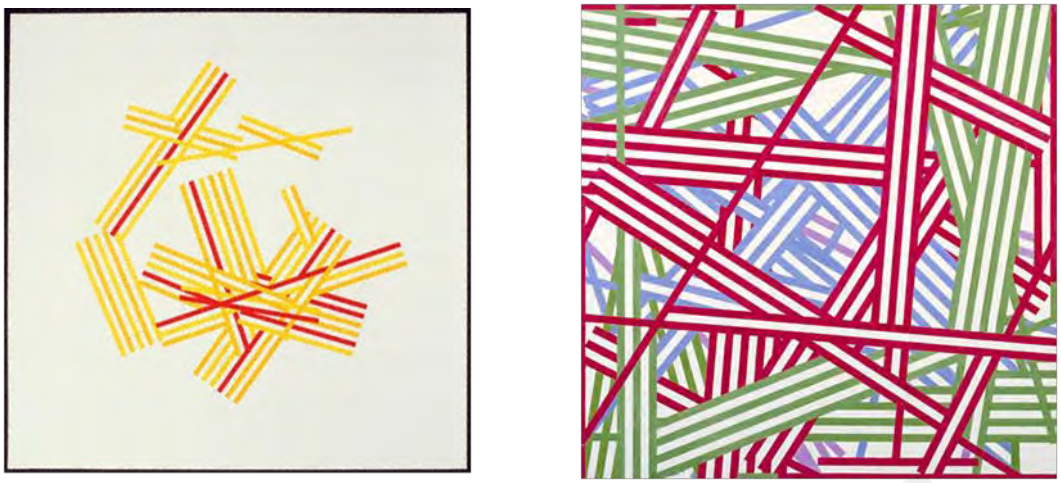
A rule of generative art hand-based is sub-branch of hybrid art that concerned in using simple math and rational approaches to create artworks. In the 20th century, some of the artists such as John Cage, William Burroughs, and Marcel Duchamp had

embraced generative principles to create their works. The work by Frieder Nake (1965) is the oldest example of generated arts as shown in Figure 2.1.

Figure 2.1: Frieder Nake's composition, fields of rectangular cross hatchings, 50 ×44 cm. Collection Etzold, museum Abteiberg Mönchengladbach, (Nake, 1965).

Nake's composition used the randomization style overlaid by vertical lines, computer drawing and ink on paper as a fecund generative ways by Duchamp, John Cage, and Frieder Nake (Montfort et al., 2012).

Other paintings by Kenneth Martin were showed that not all generative visual art need computer programming for creation. The serious abstract screen print paintings Chance and Order (1971), and Chance, Order, and Change (1980) were driven through combined a rule-driven generation with random choice using basic geometrical figures such as circle, square, dots, diagrams, and rules of proportion, (Boden, 2010). The paintings were shown in Figure 2.2.

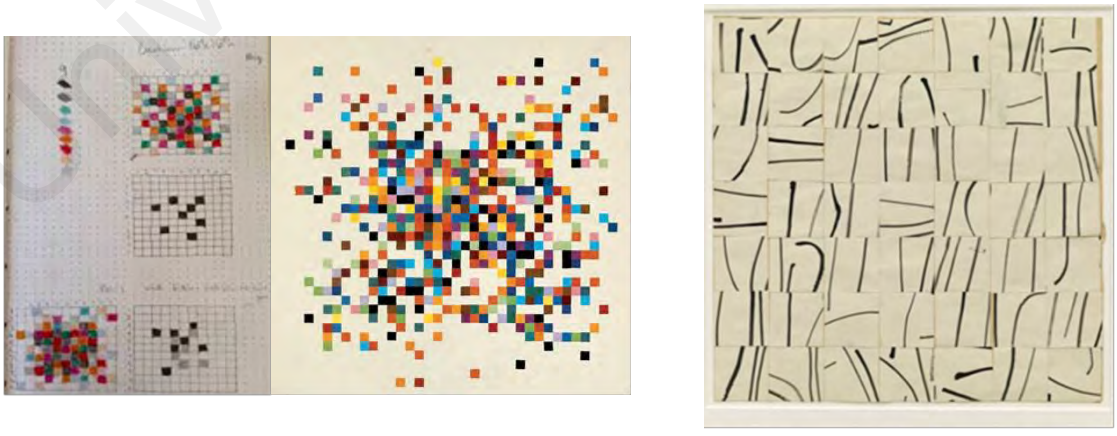


a) b)

Figure 2.2: Chance and Order Paintings by Martin (1971a, 1980). a) Chance and Order by Kenneth Martin, Screen print ink and paper (686 x 686 mm), b) Chance, Order, and Change serious by Kenneth Martin, Oil on Canvas (914 x 911 mm).

Figure 2.2a shows that the artwork has vertical and radius compositions based on the cross of lines as also appears in Figure 2.2b.

Ellsworth Kelly's technique has proposed the idea of assigning colors using grid or through resembling objects based on the determined placement of strips or squares pieces (Robertson, 1996). Figure 2.3a shows the spectrum colors arranged. And the brushstrokes were cut into 49 squares and arranged by Chance Figure 2.3b.



a) b)

Figure 2.3: Ellsworth Kelly's painting generative works. a) spectrum colors arranged by Chance, (97.2 x 97.2 cm). b) The work brushstrokes cut into 49 squares and arranged by Chance, (34.9 x 35.6 cm).

As shown above, Kelly marked off the square of the perimeter at regular spaces, 8 or 12 aside. Then points are numbered from 1 to 32 or 1 to 48 and written on slips of paper which then picked randomly to determine the sequence of points. The line is drawn from the first selected point to the second one, then from the third to the forth until the configuration is made based on the explored random sequence of points. Lines paths were paired not crosses, and when a path is cut by another, it operated the further parallel line. Also, by chance, the drawing was turned round to create motifs in a developed order.

For color, it is referred to the rhythm of constriction either harmony or opposition and used to identify the system or figure of movement. White color or sheaving lines are used to mark the space, see Kenneth Martin and Mary Martin's painting procedures which presented in the ex-chamber memo as illustrated in the Figures from 2.4 to 2.8.

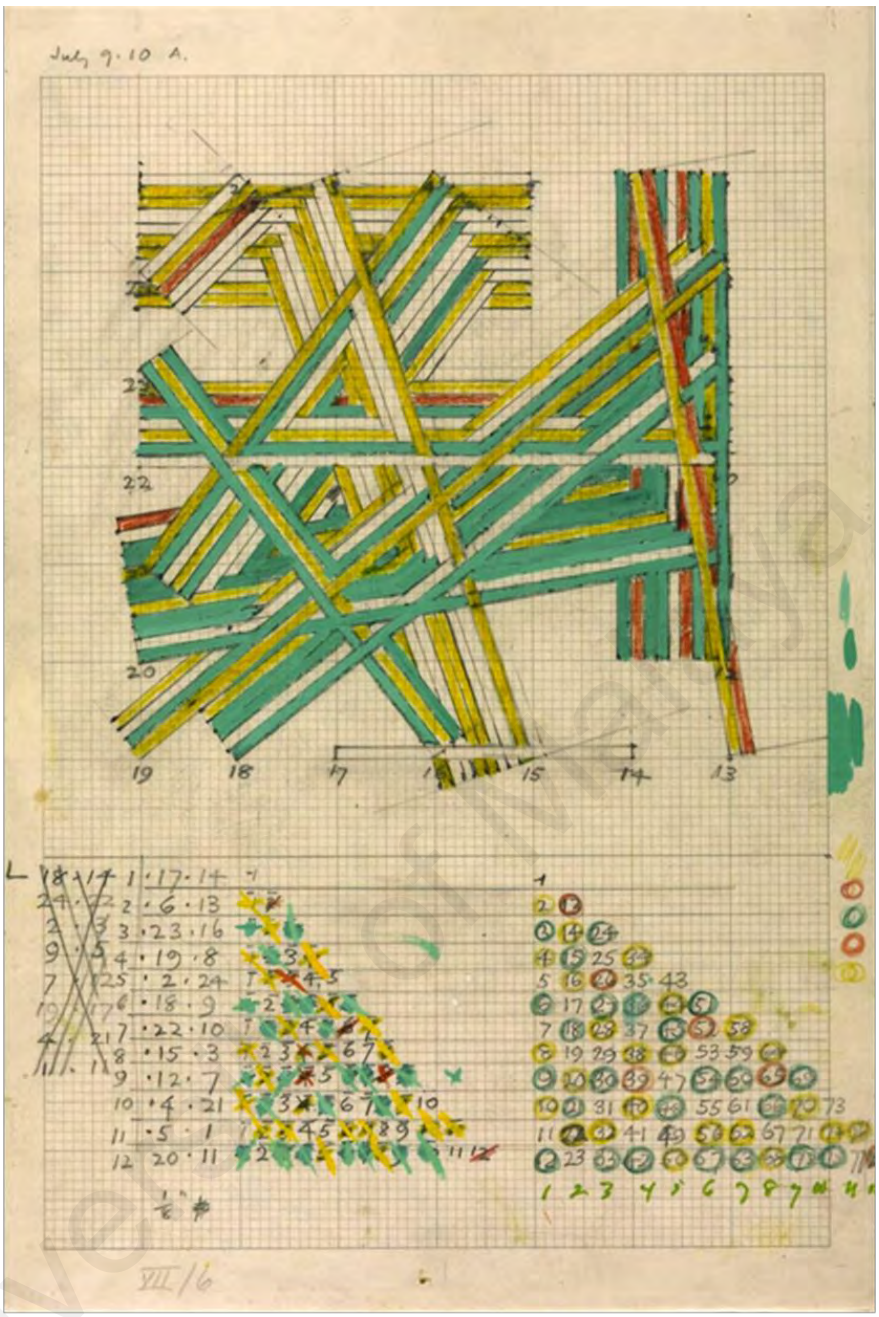


Figure 2.4: Crayon, pencil and wash on graph paper (343 x 229 mm).

Figure 2.4 shows that a painting used a pencil with two charts of numbers, variously circled in color, at bottom; numbered in green ink in another hand ‘1 2 3 4 5 6 7 8 9 10 11 12’ bottom right purchased from the Waddington Galleries, London (Grant-in Aid) 1974, (Martin, 1971b).

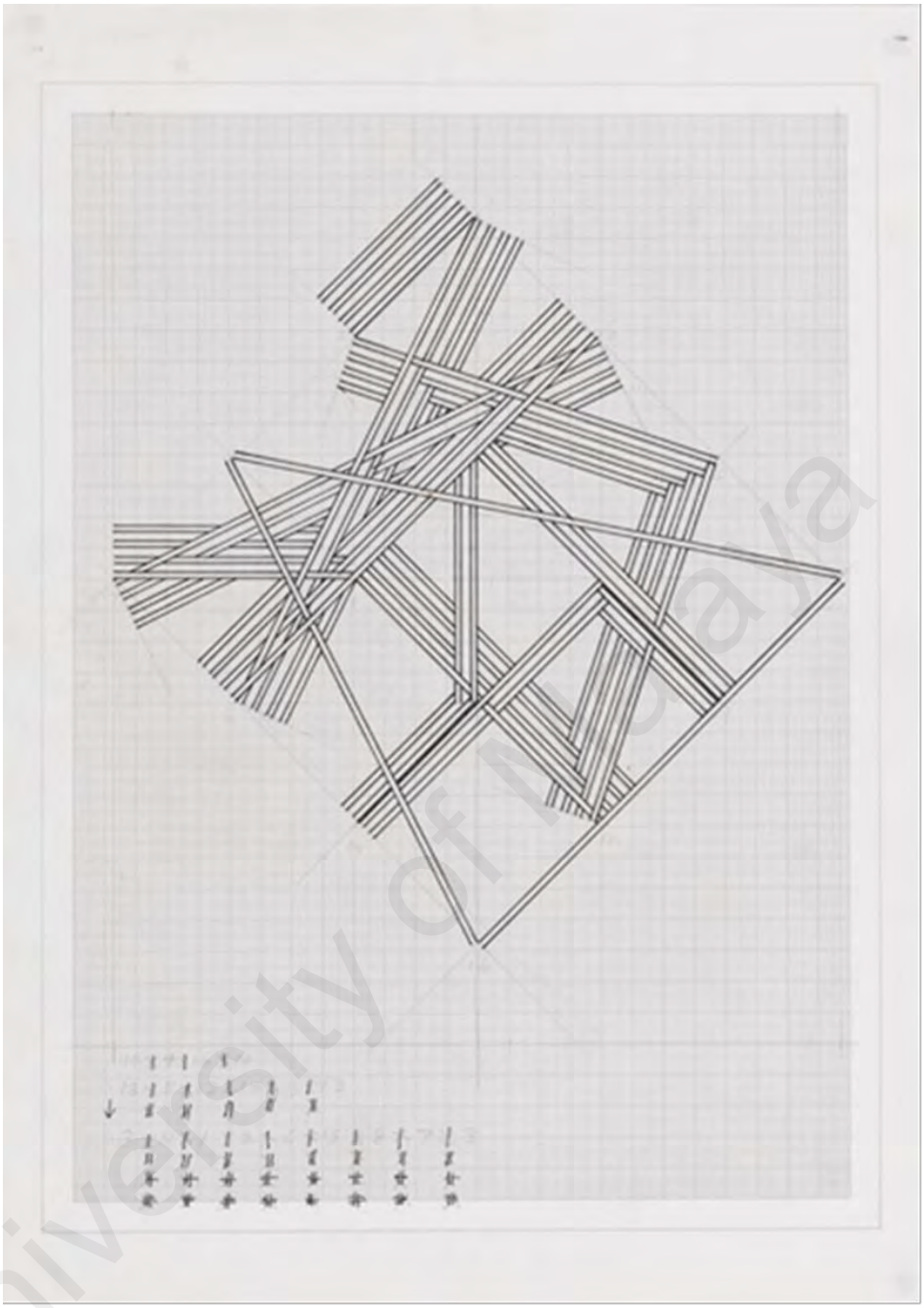


Figure 2.5: Kenneth Martin's, Chance & Order (3+5+8=16), pencil and ink on graph paper (42 x 29.8 cm) (Martin, 1976).

In Figure 2.7, lines follow the logic of 3+5+8=16 in creating the shape. Each number is labeled with specific line type and resembled in a certain position number. He used the single numbers 3, 5, 7, 9, 11, and 13 to represent the line type as also shown in Figure 2.8.

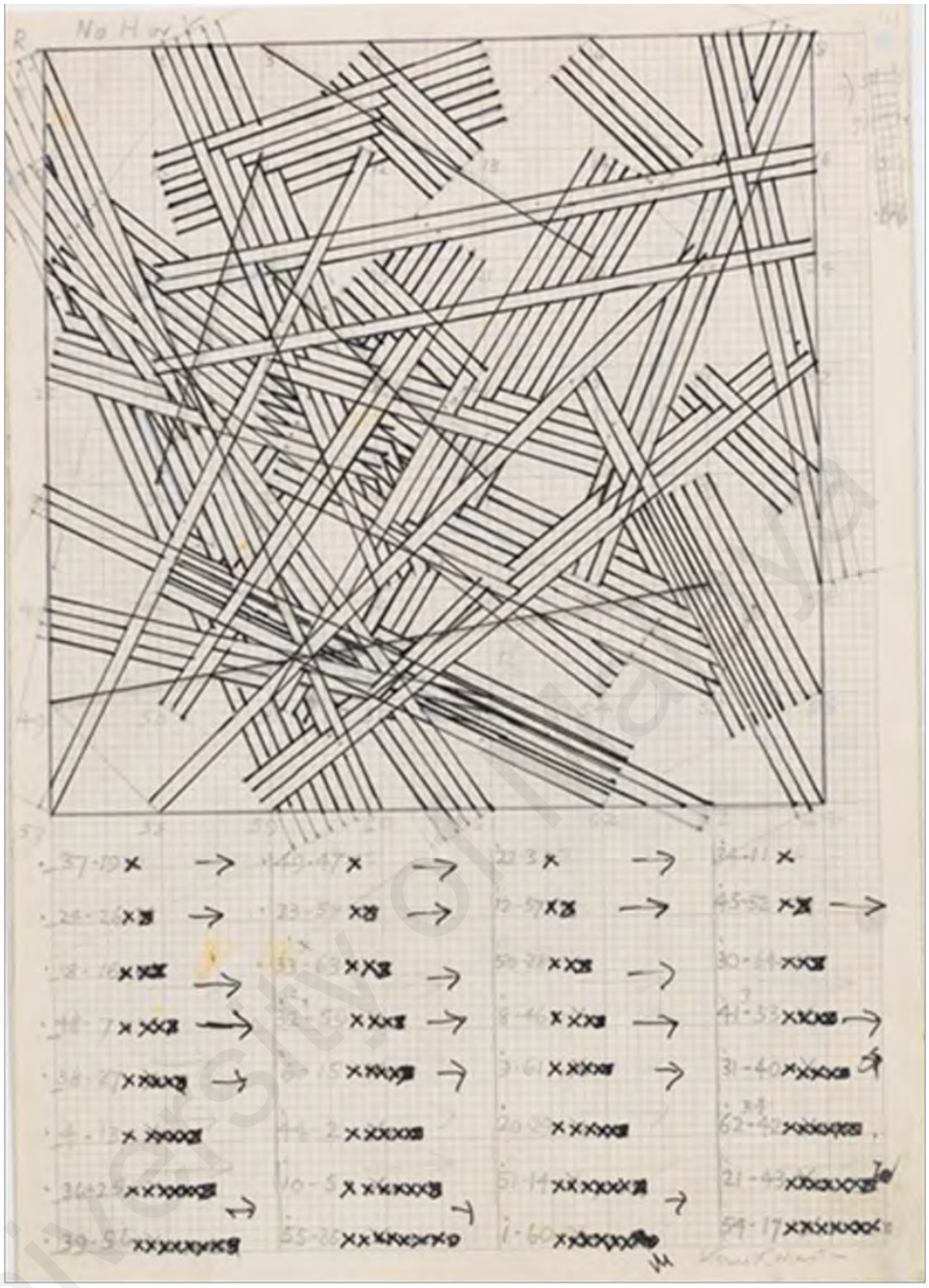


Figure 2. 6: Kenneth Martin No H or V (R) c. pencil and ink on graph paper (29.8 x 21 cm) (Martin, 1972).

It provides another shape based on number resembled but from 37 to 54. The same perspective of single numbers donation is used to locate the line types.

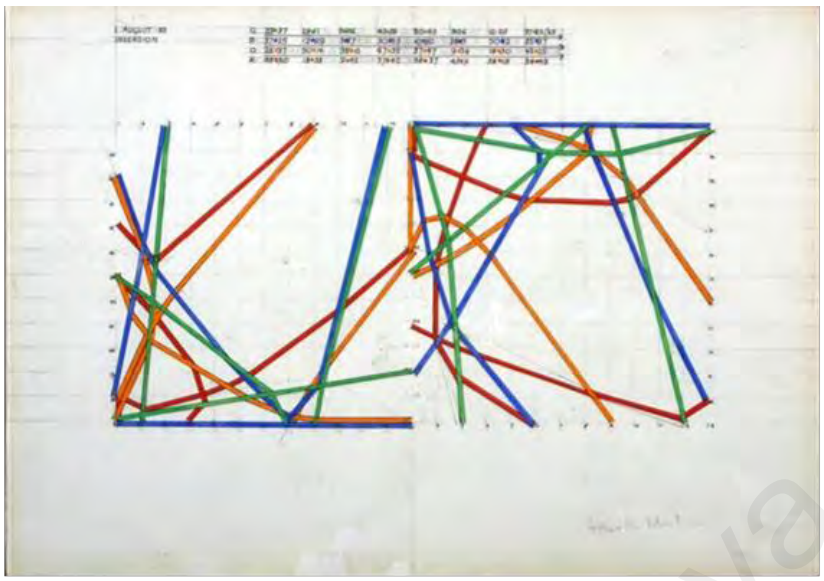


Figure 2.7: Kenneth Martin Order and Change technique (No Chance) (29.5 x 42 cm), (Martin, 1984).

Figure 2.7 shows generated form logic but based on one straight line by using a pencil pen and gouache on paper. This refers to a (No Chance) style of creation. Colors are labeled cross certain numbers using a free selection mode.

Another composition is created using a technique of expanding a permutation pen as illustrated in Figure 2.8.

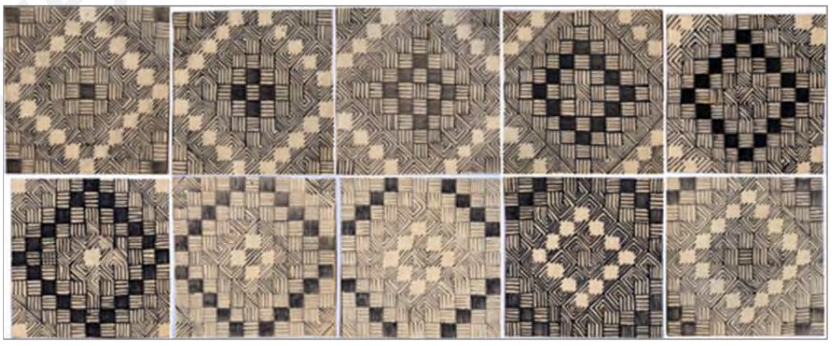


Figure 2.8: Mary Martin drawings (Martin, 1969).

Figure 2.8 shows ten patterns created from expanding permutation pen on paper 10 parts each (15 x 15 cm). This logic of creation provides various artistic compositions.

2.5 Art-Science Lab Collaboration Depiction Methods

According to Shanken (2006), hybrid depiction through art-science collaboration is referred to the concept of research and creation or university science-artist lab academics of integrated art into university curricula, stated that:

> The embrace of artistic collaborations by national and university research laboratories has played an important role in the development of AST in the US. As suggested above, one must consider the possibility that such labs also seek to enrich their public image by an association with the arts and to employ artists to give concrete and accessible form to the abstract and complex scientific concepts underlying their research. (p.8)

The quotation reflected that the new concept of creation has a reasonable means of the newfound credibility, the scientific character of artistic fields to redefine art itself for a great contribution. Rödder (2017) elaborated that hybrid science-art projects are presented in two features as stated below:

a) Science as an object of artistic production: this interest with questions of producing objects from scientific knowledge in an artistic context.
b) Scientific communication and outreach: this interest with questions of visualisation of scientific results such as scientific images and images of popular culture through using new technologies as artistic tools.

2.5.1 Mimic Empirical Approaches

In art-science collaboration experiences, there have been empirically reported projects in educational, communicational contexts and the traditional placing of artists in scientific labs. Such as the projects documented artists' imagination and analyses in multiple levels of boundary object and work, thus engaging them in co-producing hybrid artwork forms. Most of them asked the questions of research methodology in the research proposals of art students focused on how one can create research through scientific representation. They employed methods such as interviews and observations

from social science as well as experiments and chemical syntheses from science to create the creative procedures of producing hybrid forms through mimicking (Rödder, 2017).

The simulating study by Krauß (2015) about the link between sediment and sentiment, on observing a science-art-project used a strict protocol to set up a research practice method. The outcomes of the study are shown in Figure 2.9.

Figure 2.9: Hagen Schümann, Felix Meyer Wolters, and Komp works. Technique of UV-Print on Aluminium Dibond, (150 x 150 cm), the supplementary electronic material, (Krauß, 2015).

The practice as shown above, hundred paper sheets were crumpled, spray-painted and unfolded again. Then, they selected a predefined number and repeated the protocol three times to create a quantity of twenty-five tricolored sheets. The ten artworks were produced, and only three were selected for exhibition (Figure 2.9).

The recent study by Randerson, Salmond and Manford (2015) was emphasized on the weather conditions as a medium over the art meteorological science approach by Randerson and his team (Figure 2.20).

Figure 2.10: Janine Randerson Neighbourhood Air work created in 2012. Installation view at Screen Space, Melbourne. Sony 40-inch, flat-screen television. Custom software, Apple track pad and plinth (Randerson et al., 2015).

A unique and focused on an installation art project called Albedo of Clouds and Neighbourhood Air. They adopted sensory experiences through weather as the primary material. Their project proposed creative multi-directional flows with the meteorological art, weather instrumentation, digital data, and media art to generate effective forms of art. Actually, it is limited to the practices of installation arts outdoor type. This reflected the applicability of serving technology for producing hybrid forms.

Another recent study by Yoon Young, Jae Chun, Eunil, Hyoungkee and Byungseong (2016) was used the mathematical approach for core-creation. In their study, the researchers proposed a variation art algorithm for generating images by using a virtual system-based optimization algorithm. Experimentally, the topology optimization

method was used for setting up a multiphasic system design which formed two or three-dimensional layouts without baselines and beyond engineering applications in generating images. Their paper reported devising a virtual physical system called a health system, which is considered as a simultaneous drawing of multiple strokes in a painting as illustrated in Figure 2.11.

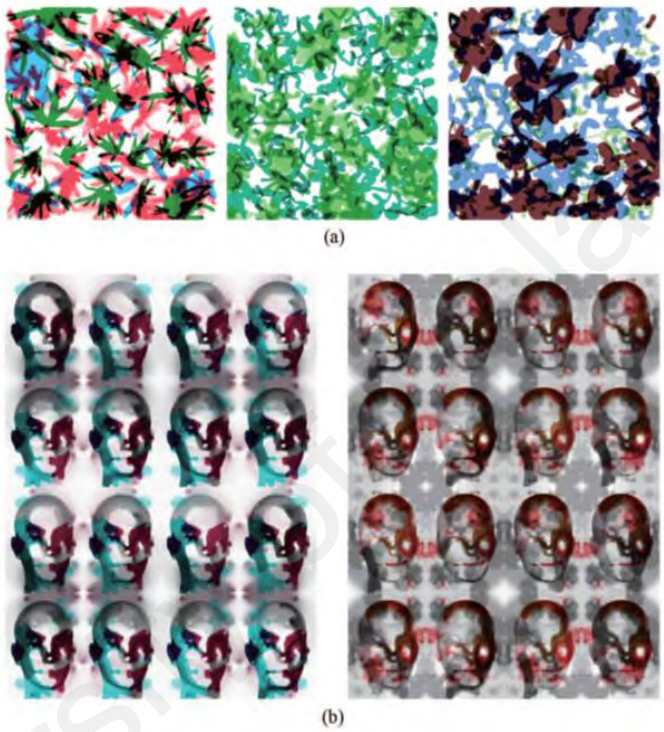


Figure 2.11: Yoon Young Kim created the above images through art algorithm using three colours with different parameter values. Namely; (a) referring to the images that were created without a base image, and (b) were those images of 4×4 format that created a base image of a mannequin face and were obtained separately with slight parameter variations from each other (Kim et al., 2016).

Figure 2.11a is referring to the images that were created without a base image, Figure 2.21b were those images of 4×4 format that created a base image of a mannequin face and were obtained separately with slight parameter variations from each other.

The Australian thesis entitled: *Exploring the experience of a place through the visual representation of aural presence* by Linnell (2010) at RMIT University was focused on producing artworks from the visual representation of a natural environment and public

sound interactions based on a sonic element. Interestingly, her study suggested the form of outdoor spaces based on recording the sonic presence. She combined with the digital sound data and traditional techniques in order to visualise the shape of the audio-natural of space sound. She used a dot-drawing test, wire piece paper, tone and line study, and paper pieces in the experiments for co-creation of small sounds (Figures 2.12& 2.13).

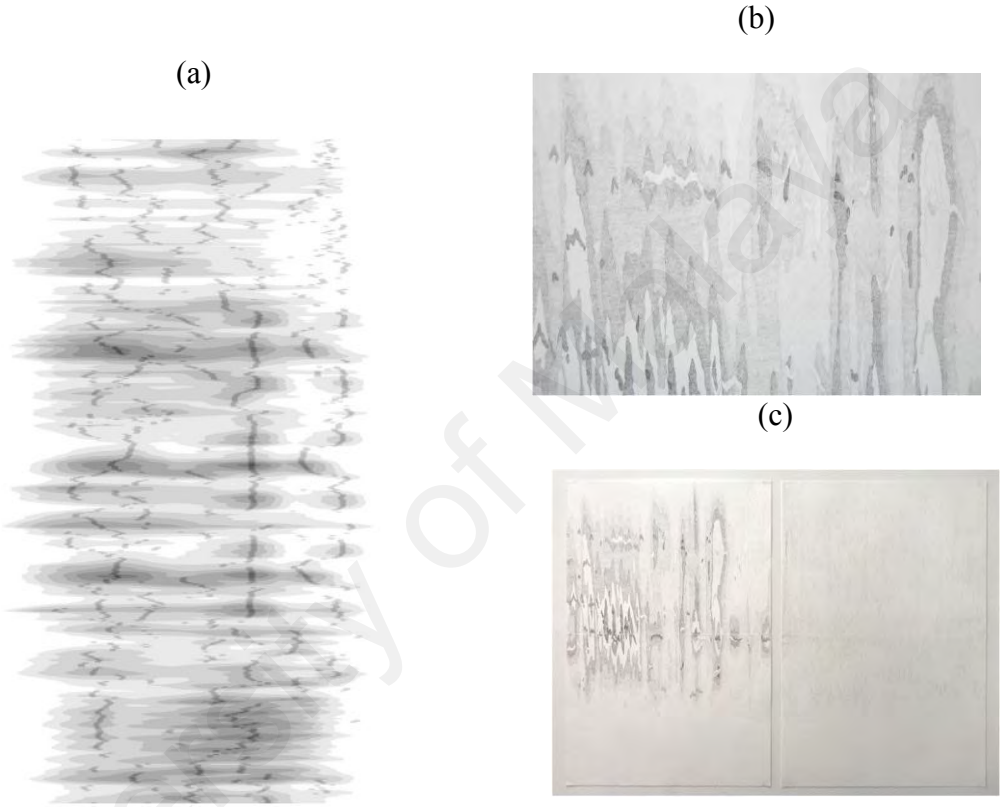


Figure 2.12: The producing artworks from the visual representation of a natural environment and public sound interactions based on a sonic element (Linnell, 2010).

Figure 2.12a is referred to a longer recording of seconds or less ambient noise, which was selected to be a basis for drawing work. Figure 2.12b refers to the work that was drawn by the tone and line study (70cm × 60cm), and Figure 2.12c is another work which is also based on tone and line study (160 cm × 120cm).

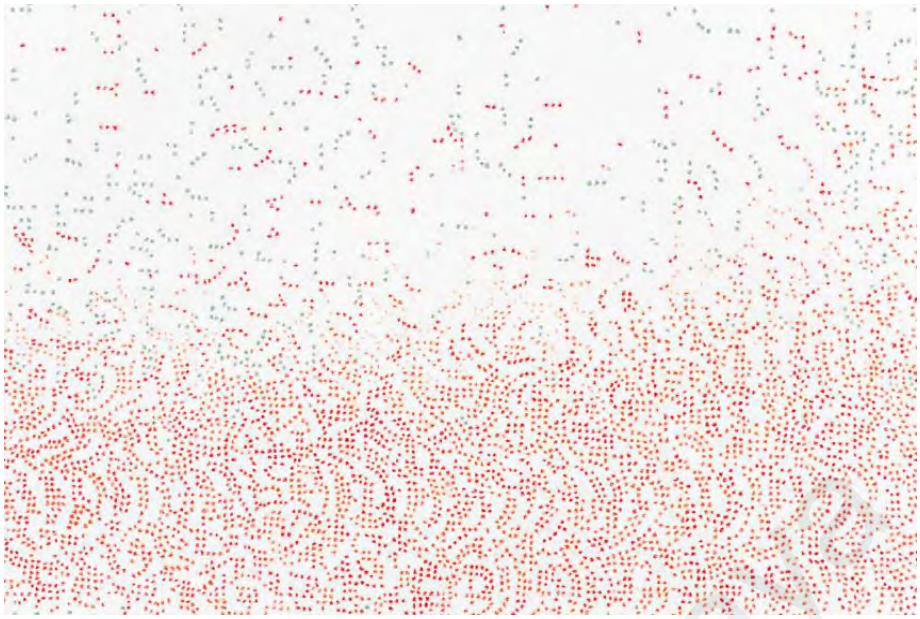


Figure 2.13: Small Sounds Work, 45 cm × 30 cm, (Linnell, 2010).

Figure 2.23 shows the Small Sounds work (45 cm × 30 cm). This work used dotes to resemble the results of aural analysis. Actually, the Linnell techniques traced directly to the biological maps of visual analytical which are adopted by artists and researchers for hybrid art-science mimic methods. The absence of clear specific guide of visualisation in terms of cognition or invisible representation using scientific tools make it difficult to decide the appropriate processes of visualization. This encourages the researcher to propose her guideline of hybrid depiction.

Another study by Waldenmaier (2010) reported work that involved carrying out experiments with a photograph, body movement, and environmental sounds. Photographs were captured on film long time-based and multilayered in camera-exposures which could relate anything that was happening that moment as shown in Figure 2.24.

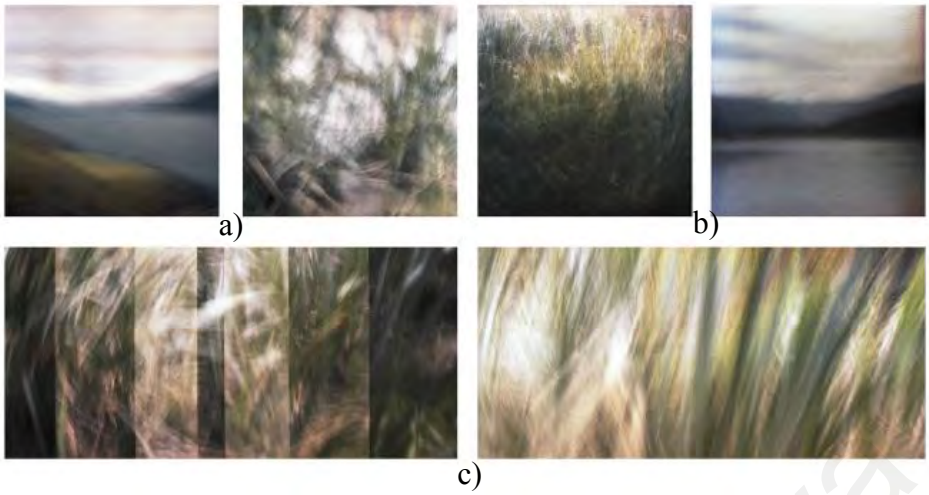


Figure 2.14: The experiments and outcomes of reflection on space in between. An exploration of the experience of time and sound in photographic imaging (Waldenmaier, 2010).

Figure 2.14a on the left side is the actual image and the right side is the resembled hybrid artwork as same shown in both Figures 2.14b and 2.14c. These works used the artistic effect manipulation through time and space reflection.

Summers (2007), in his study, *Missing Links-Evolutionary theory as a model and scientific intervention as a strategy for artistic process and production,* brought together contextualization and construction as a self-created system for producing art objects through biological forms as shown in Figure 2.15.

Figure 2.15: Art-biology Installation Artworks (Summers, 2007).

In this work, Evolutionary Theory, classification process, and taxonomy were used to develop technical specifications for synthesising objects and designing tools. The outcomes of this study were represented by the produced series of installations that reflected the effects of science invention in visual art creation.

2.5.2 Art-Eye tracking Approaches

An art-eye tracking research is used for the purpose of art evaluation. The previous empirical art-eye-tracking studies are used to show the amount of attention from the viewer. The visual information perception is important in composition, design, and creation.

For example, Kirtley (2018) examined about the factors of drawing viewer's attention in the artist Andrew Loomis's images and diagrams compositions. She tested the focal field of the image, the viewer fixation tracking paths, and compared them with the Loomis's measures and suggestions. The study concluded that the proposed elements by Loomis are not significantly influenced the attention of viewers. Also, the previous study by Brown (2009) answered the question of where the viewer's eye is attracted to the painting based on the art elements? The answer of attended areas in the painting used for creating a flow of painting and identified the boundaries that will be interested enough to retain the viewer's attention. The study founded that eye is attracted by the strong light and dark value of contrasts from the distance, hard edges, crossing lines, warm colors, and the complex details areas from the bottom based direction. And it confined by hard edges and the surrounded of values for each other, and the repeated shapes. And the eye needs some places to rest. Another study, Bradley (2014) explained how to guild the eye by gripping attention in terms of visual perception and art design principles. He suggested that visual information is so

important to the artist for production artwork and provided the concept of selective attention to be the core of design in art.

In conclusion, there are many projects on science-art collaboration, but most of the artworks were poor artistry which traced the signs or outlines of the biological shapes. The other difficulty, when the artwork did not specify the pictorial features of their hybrid forms based on the conceptual understanding of the theoretical self-phenomenology related objects in both science reviews, or selecting the tools and processes that reflect those invisible objects in seen fold beyond aspect-recognition perception of understanding hybrid imaginary. Therefore, this study identified the components of hybridization within both vision science and art.

Table 2.1 shows a summary of the empirical depiction techniques discussed as evaluated using the art-science collaboration research design.

Table 2.1: Summary of visualising techniques of art-science collaboration for hybrid depiction.

Study	Purpose	Approach	Technique Used	Limitation	Outcome
Krauß (2015)	Mimic	Simulation Art-Math Approach	Observation & Number protocol research practice method	The link between sediment and sentiment	Paintings
Randerson et al. (2015)	Mimic	Art-meteorological science approach	Multi-directional flows, Meteorological art, Weather Instrumentation, digital data, and Media art	The weather conditions as a medium	Installation Artworks
Yoon Young et al. (2016)	Mimic	Art-Mathematical Approach	A virtual system-based optimization algorithm	Generating Images	Digital Paintings
Linnell (2010)	Mimic	Art-Sound Approach	Digital sound data and traditional drawing techniques Combination	A natural environment and public sound interactions based on a sonic element	Paintings
Waldenmaier (2010)	Mimic	Photography-Sound Approach	A time-sound photography Experiments	Space Reflection	Pictures
Summers (2007)	Mimic	Art-Biology Approach	contextualization and construction system	Evolutionary	Installation Arts
Kirtley (2018)	Art Communication	Art-Eye tracking Approach	Eye tracking hard and software	The cues of draw viewer attention in the artist Andrew Loomis's images and diagrams compositions.	Loomis art elements Evaluation based on public attention
Brown (2009)	Art Communication	Art-Eye tracking Approach	Eye tracking hard and software	Art Elements	Art elements evaluation based on public attention
Bradley (2014)	Art Communication	Art-Eye tracking Approach	Eye tracking hard and software	Art design principles	Art elements evaluation based on public attention

2.6 Visuospatial Attention Phenomenon

Visuospatial attention in many empirical and theoretical studies at the neuropsychological and cognitive levels are considered closely related to consciousness and perceptual phenomenon, and their debates over are escorted in two issues: firstly, the significant relationships of consciousness, and secondary, attention and the important of the viability of representationism about consciousness. The previous second issue is what this research attempt to explore. Indeed, representation of attention in vision science examined in how to modulate the character of conscious and perceptual experience through eye-tracking studies. Hence, the visual attention information was demonstrated using eye-tracking method which is a good way to identify the coherent features of attention in this study.

2.6.1 A Brief Overview of Visual Attention Models

Particularly, Descartes (1991) provides his claims to answer the conflicts of the variety of attention theories through seven set objections to replay on what it is when we pay our attention. However, Bishop Berkeley (2009) in his book's *Principles of Human Knowledge* addressed that attention and abstractions are with the same process of the act. Actually, John Locke's goes further than either Descartes or Berkeley in treating attention account. He provides a positive account of concerning human understanding and link attention as a mode of thought through Modes of Thinking.

A representing of visual attention schema has been studied from the second half of the 19th century for biomedical mapping, industrial design, and educational purposes. Visual Attention has developed to an interdisciplinary phenomenon involving psychophysics, cognitive, neuroscience, and computer science. According to von Helmholtz and Southall (2005) in their book, *Treatise on Physiological Optics*, visual

attention is considered as a basic mechanism of visual perception through the gaze of the eye,

> When a person's of attention is directed for the first time to the double of images in a binocular vision, he is usually greatly astonished to think that he had never noticed them before, especially when he reflects that the only objects he has ever seen single were those that happened at the moment to be about as far from his eyes as the point of fixation. (p.7)

However, James Cutting (1983) contended that the mechanism of visual attention is more in parallel to imagination related to thought. His terms of the identity of attention are related to the focus of active aspects of attention. Duchowski (2017) referred to Gibson's term as a third factor of visual attention which is associated with intention and reaction of viewers. Broadbent's theory (1982), Selective Filter added a sensory character to the term of attention based on the demonstration of auditory experiments and the selective nature of auditory simulation information. In the contrast, Deutsch rejected the selective filter and limited capacity system of attention. He presented the concept of attention through the Importance Widthings of selection determination or relevant. Also, Noton and Stark (1971) developed the theory of visual attention in a parallel with Von Helmholtz and Jame. However, their point of view is opposite to Gestalt view of recognition. They proposed that a coherent image of the visual field is created fragmentary depended on the interested regions. Their argument supported James's perception of what is attention. In another hand, some philosophers referred attention to the orienting of the Where in the scene reflection instead of the What, Posner's Spotlight term in a particular. According to Andrew Duchowski (2007),

> The dissociation of attention from foveal vision is an important point. In terms of the "what" and the "where", it seems likely that the "what" relates to serial foveal vision. The "where", on the other hand, is a parallel process performed parafoveally, or peripherally, which dictates the next focus of attention. (p.10)

Moreover, Treisman (1988) proposed a Glue term as the form of integration theory of visual attention that attention picks its properties from a master map which shows

where the features are located beyond of what the identity of those features. Finally, the suggested Window Model provided by Kosslyn (1994) described as a selective aspect of perceptual processing in the visual buffer (A. Duchowski, 2007).

This selective directedness of attention showed that the disagreement between the theories is due to the nature of selectivity of attention. The selectivity sorted as three kinds of theoretical accounts: accounts in which are attention as resulting from brain capacity process towards multiple perceptual stimuli, accounts argued that attention linked with the capacity of subject's thinking, and finally accounts that required to make a coherence of weighting of sensory information of the action. The coherence account is selected in this study.

2.6.2 Eye System Identification

In the Neurophysiological field, the human visual attention system is referred to the brief eye fixations on the regions of interest which are also called Fovea. The visual angle that allows a good scrutiny of only a small part in the visual field where the central fovea vision run across 1-5° Duchowski (A. Duchowski, 2007). The eye is described briefly through the eye anatomy, the retina, and the eye movement's types.

2.6.2.1 The Eye Anatomy

In the eye anatomy, an eye is considered as the most complex organ seen and also human attention reflection (Segre, 2017). The human eye sees things in this world like a digital camera through the following process. Eye anatomy consisted of eleven parts: conjunctiva, iris, lens, pupil, cornea, conjunctiva, sclera, optic disc, optic nerve, macula, retina, and choroid as illustrated in Figure 2.16.

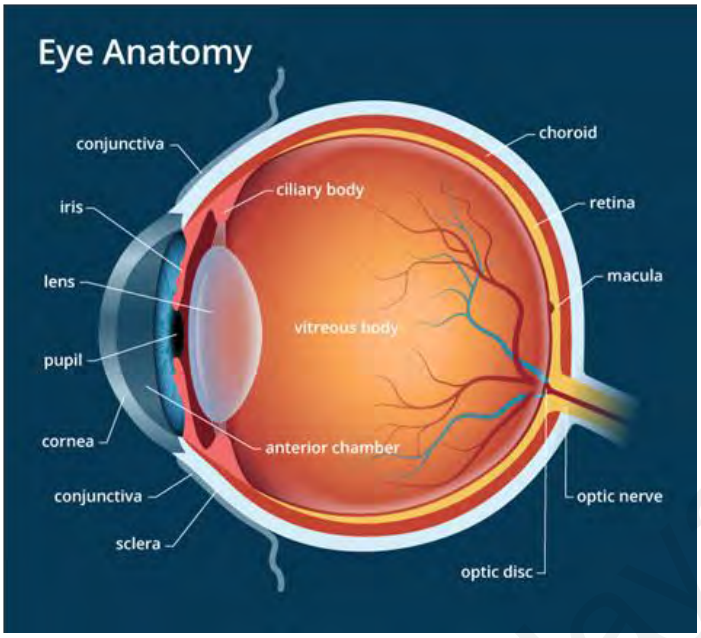


Figure 2.16: The Eye Anatomy (Segre, 2017).

However, the function of eye is classified as follows:

a) Eye as camera lens: The front surface of the eye which called Cornea received the internal light.

b) Eye as a diaphragm of the camera: Automatically, the iris of eye controlling the amount of the light by adjusting the size of the pupil.

c) Eye as an autofocus camera lens: Actually, there is a crystalline lens that is located behind the pupil. It focuses on near oncoming things in an accommodation process.

d) Eye as electronic signals: the focused light then reaches the retina and is converted the optical images into electronic signals to the visual cortex.

2.6.2.2 The Retina

The retina is referred to locate on the interior surface of the eye and contains some photoreceptors sensitive to light. Photoreceptors are responsible for converting the energy of light into electrical neural signals. Actually, Photoreceptors is described as rods and cones. Rods are referred to sensitive response to the dark chromatic light and night vision. However, cones related to the bright chromatic light and daylight vision (Segre, 2017).

2.6.2.3 Eye Movements Types

In optical phenomena, the types of eye movements in the horizontal median plane are divided into five types depends on the positions of fovea: saccadic, smooth pursuit, vergence, vestibular, and fixation (Dodge, 1903). Saccades are defined as the rapid eye movements that relocating the fovea to a new location in the visual field. Pursuit movements are referred to the tracked movements in the range of target motion. Nystagmus is defined as a conjugated eye movement by time series signal type. Finally, fixations are the movements of the eye that stabilized the retina over the stable interest object which is the appropriate type to conduct visuospatial attention in this study.

2.6.3 Gaze-Physical Properties

2.6.3.1 Spatial Vision

In psychophysics, spatial vision is an aspect that is considered as a domain of scene where the units of visual angle degrees (Duchowski, 2007).

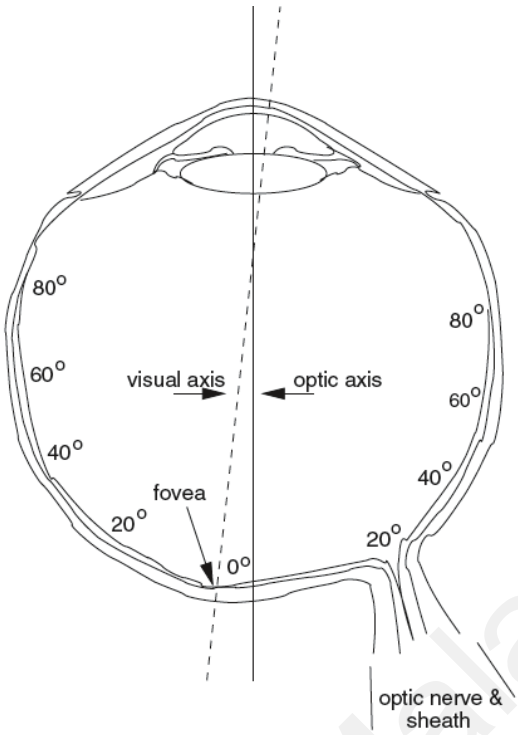


Figure 2.17: Spatial vision through density distributions of rod and cone receptor in the retinal (A. Duchowski, 2007).

Spatial vision consists of three features: visual axis, optic axis, and fovea axis as illustrated in Figure 2.27.

2.6.3.2 Temporal Vision

A temporal vision is a reflection of human attention to motion (Duchowski, 2007). The response of human attention to the dynamic scenes is described in two distinct features that are the persistence of vision and phi phenomenon demoralized in a TV, Cinema, and graphics of still images. Persistence is referred to the temporal sampling rate of human vision system by the retina. Whereas, phi phenomenon is reflected in the description of the apparent movement edge demonstrates by the human visual system.

2.6.3.3 Color Vision

A color vision is assigned through three types of the fovea's retinal cone photoreceptors blue, green and red. Blue is a peak at approximately 450 nm, green at

520 nm, and red at 555 nm wavelengths. As shown in figure 2.28, blue and yellow fields are larger than the red and green fields.

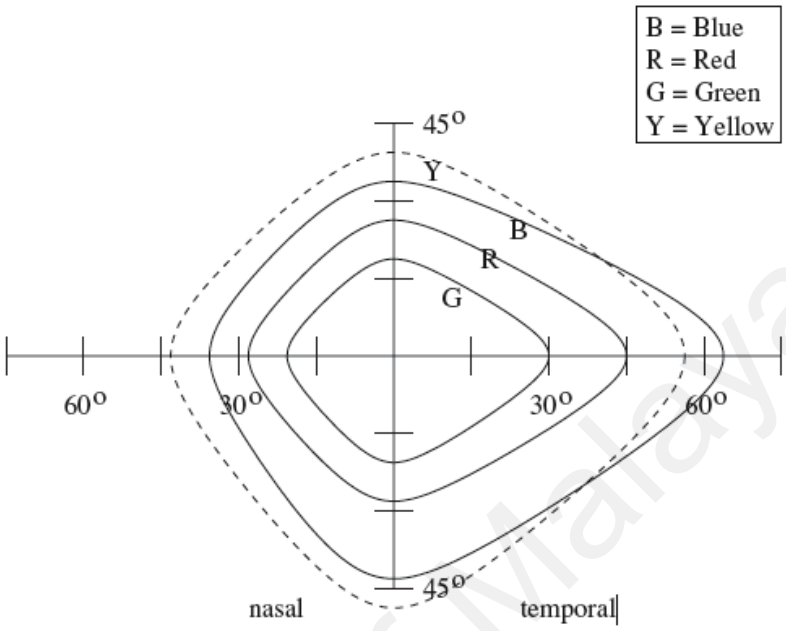


Figure 2.18: Visual fields for Monocular Color Vision (A. Duchowski, 2007).

2.6.3.4 Object-Coherence Based

Wolfe (1997) argued that attention is an idea to weld visual properties that are related to long-lasting representations of the object and to operate relatively quickly, at a rate of 20–40 items per second. However, Rensink (2000) proposed that effects of attention are concerned with a term of coherence. It donated the representation of attention with the agreement of spatiotemporal structure in a logical interconnection described in his quotation as follows:

> As used here, this term denotes not only consistency in a set of representational structures, but also logical interconnection, that is, agreement that the structures refer to parts of the same spatiotemporal entity in the world. Thus, two adjacent structures are spatially coherent if they refer to the same object, extended over space. Likewise, two successive structures are temporally coherent if they refer to the same object, extended over time. (Rensink, 2000, p.3)

Coherence has a triadic architecture which consisted of three independent setting systems, those were: a volatile structure which reflected a low-level system with rapidly highly detailed, a limited capacity attention system with stable object representations and limited-capacity non-attention system that guided a setting of attention. Visual attention in a dynamic scene is classified into three objects based on the coherence level as follows Rensink (2000):

a) Limited coherent of unattended proto-objects: It provides a sketch or map of the scene based on the visible properties to the audience. However, Jules's experiment (1984) founded that spatial coherence was negligible with limited reliable measurement reflected non-attended structure.
b) The extended coherence of attended objects: it depends on the perception of change that focused attention should deliver the coherence into larger-scale objects. For continuity, it allows them to retain the continuity over time and the appearance of a new stimulus to be treated as the transformation of an existing structure rather than the formation of a completely new one.
c) Lack of attention after effect: is concerned once the focus of attention is removed. If attention is converted to another object, a low coherence field cannot be maintained because only one object can be represented at a time.

It is important to state that the pictorial aspects of attention are classified into features of objects in the coherence structure of attention and the scene structure. The pictorial features of coherence are three:

a) Proto-objects: it referred to as prior to focused attention at low-level which have limited coherence in space and time that was formed in a parallel cross e visual field. When any new stimulus appears at the retinal location it replaced rapidly, thus it is considered as volatile.

b) Focused attention: it is a small number of proto-objects grasped in a renewal flux. It reflected the higher degree of coherence over time and space and the change of structure for the new stimuli in the existed location.

c) Released object: released object referred to the losing object of its coherence and melts back into its initial proto-objects, as an after-effect.

Whereas the pictorial aspects of the scene structure are also three, those are:

a) The gist of the scene: it reflects the abstract meaning of a scene (e.g., scene such as a city, picnic, etc.) and the most important objects in the context. It is constant, does not affect the eye positions or the changes of the layout of objects. Also, it provides a stable constraint that is related to the type of expected object. The gist can be determined by color, the distribution of line orientation, or the proto-objects that exist at low levels.

b) Layout: it reflected the spatial arrangement of objects in the scene without visual properties or semantic identity (Hochberg, 1968). It provides a non-volatile representation of the location and structures when the attention is located to the particular object in the scene. It can be provided for locating eye movements and attention changes. It focused on the entire scene or on an array of objects (Haber, 1985).

c) Schema: Invocation of an abstract scene schema stored in long-term structures presumably via gist or layout information. Once invoked, this could facilitate the perception of these two quantities, and ultimately through the associated interactions facilitate the perception of objects. It can also last indefinitely.

2.7 Reconfigure of Cognition Phenomena

Serious conferences in the previous years have been held that primarily discuss research in representing of invisible perceptual phenomena using the collaboration between technology and traditional painting. Ponty's (1961) stated that the gap in reconstructing cognition things belongs to the nature of visible and invisible phenomenology. The Merleau-Ponty's books, *The Structure of Behavior* in 1938, *Perception Understanding* (1945) and *The Visible and Invisible* (1968) had claimed sensitive essays of representing perception phenomena such as the nature of phenomenology, primacy of perception, behavior structure, and understanding. His accounts of human embodied in the world, self-conception, his views of art, objects, society and politics, and visible and invisibility (Matthews, 2006). Moreover, surveying Ponty's essays are particularly associated with the existentialism philosophical debate and its analysis of the existing experiences, perceptions, and difficulties, of human existence. Indeed, the ontological phenomenological, visible and invisible theory requires an inquiry into both the origin of truth and nature philosophy. The phenomena concerned is to answer two initial questions, those were: What is it that makes the visible a thing? And what is the visibility of the thing? What it means to be visible and what it means to be invisible? The invisible character of the object is related to sensorium not to empiricism, the recognition of sensuous data configures the invisible thing. According to Merleau-Ponty and Lefort (1968),

> The sensible thing is the place where the invisible is captured in the visible. To seriously show how the sensible thing exists between the absolute opacity of the sensuous quale and the absolute transparency of the essence, between the particular and the universal, it would be necessary to show a sensible matter which, in its very manner of occupying space and time, presides over space and time. It would be necessary to show a sense that is sensuous and a sensible matter that transcends itself, that is dimensional. But transcendental philosophy, dialectical philosophy, and intuitionist philosophy have rather endeavored to compose the sensible thing with our unreformed ideas of the visible and the invisible. (p.xlii)

This passage contended that the transcendental philosophy, the domain of hybrid aspect-recognition depiction, required an inherent understanding of the visible and invisible conjuncture for the thing based on its constitution. It is referred to on how the sense is created in an act transcending of the sense data to be visible thing through resembling signs. In the contrast, Dunayevskaya (2003) pointed that Sartre's negativity viewpoint claimed that reconstructing of sensible thing is attitude not of reflection but of vision, and rejected any efforts to reconstruct the thing without the constitutive mental acts, and the transparency analysis that explains how to constituted things is not related to only the cohesion, the matter of simple flesh meaning of the visible.

For modality and pictorial source, Lopes's contended that the kind of depiction is required a higher level of demonstration source with the standard of correctness. However, Newall (2011) considered Lopes's formula of aspectual-recognition as not sufficient in the pictorial experience of transparency. Similarly, Boden (2010) contended that the use of rules in art-making provides the satisfactory work. According to Margaret Boden (2010),

> The use of rules in art-making does not necessary implies that I have used the word in the past. The function of the rules in the process is a crucial issue. Where the rules one constraint sets, the art-making on part of the human artist is free, or almost as free, as ever. It is just that conditions are placed upon what is successful, whose results lie beyond that artists intuition. A satisfactory work must not violate the constraints. (p.133)

The researcher concluded that the hybrid portrayal of visuospatial attention shared three main domains: rational demonstration, indirect resemblance, and subjective depiction experience.

2.8 Requirements of Hybrid Depiction

In this study, the previous research sections concluded that the appropriate approach to depicting the visuospatial attention phenomenon requisites four main requirements:

defining of the hybrid formula related the phenomena, Modality standards, identifying the transparency features, and the pictorial experience system.

2.8.1 Symbols of Formula for Hybrid Depiction

The formula of hybrid depiction provided by Newall (2011) addressed two symbols ***X*** and ***Y***. ***X*** was to refer to a picture, surface or artwork. And ***Y*** was to refer to the phenomena or the nature model which is intended to depict. In this research ***X*** was referred to portrayal or painting, and ***Y*** was referred to the phenomena of visuospatial attention. To formulate the particular formula, the specifications are described in the following subsections.

2.8.2 Pictorial Reference Criteria

The researcher highlighted the criteria of hybrid depiction for predicting the pictorial reference domain of visuospatial attention as follows:

a) The identities of pictorial reference: information type, information-based identification mode, and the standard of correctness.
b) The hybrid aspects of attention picture: explicit commitments (physical properties: width, height, frame, pattern, color, space, gist, time, form), and explicit non-commitments (phenomenon features; gaze count and length features).
c) The pictorial meanings: the attention based on scenes.

2.8.3 Second-order Isomorphism Resemblance

The recognition approaches of depiction contended that the hybrid transparency of invisibility or other phenomena featured as a second-order isomorphism, meaning that the way of resembling the pictorial aspects are indirect. Furthermore, the system of

rational depiction should identify the following specifications in order to fill the competence of resemblance:

a) The rational model of resemblance.

b) The subjective selectivity.

2.8.3.1 Pattern Modular Design Logic

The Second-order Isomorphism requires selecting of symbolic systems. The researcher selected subjectively the resembling by using the logic of Harriss's (2011) Pattern Modular Design which is applicable to this study. This logic has belonged to Gauss's *Disquisitiones Arithmeticae* theory (Neumann, 2005). The pattern modular arithmetic design as a topic of arithmetic that dealt simply with reminders, integers and their properties in producing hybrid art forms (Harriss, 2011). The integers are divided by a fixed modulus and reduced the numbers to a fixed set [0…N-1] (Parsons, 2005). An example, we write (Harriss, 2011):

$a = b \pmod{m}$ where a and b are integers, and m is a natural number

For instance, in the case of result with value or mod 6, the fixed modulus 6 is called (*mod 6*). Therefore, the operation of addition and multiplication with integers is a result of a number which is divisible by 6 with a remainder of 0, 1, 2, 3, 4, or 5 as shown in Table 2.2.

Table 2.2: The operations of mod 6.

Numbers congruent in mod 6	Addition in mod 6	Multiplication in mod 6
10 ≡ 4 (mod 6) 10 – 4 is divided by 6 28 ≡ 4 (mod 6) 28 - 4 is divided by 6 36 ≡ 0 (mod 6) 36 – 0 is divided by 6	5 + 10 = 15 15 / 6 = 2 reminder 3 So 15 ≡ 3 (mod 6)	5 × 10 = 50 50 / 6 = 8 reminder 2 So 50 ≡ 2 (mod 6)

To operate the addition and multiplication tables for an example of mod 6 are as below (Table 2.2) and (Table 2.3):

Table 2.3: Table operation of addition for mod 6.

+	**0**	**1**	**2**	**3**	**4**	**5**
0	0	1	2	3	4	5
1	1	2	3	4	5	0
2	2	3	4	5	0	1
3	3	4	5	0	1	2
4	4	5	0	1	2	3
5	5	0	1	2	3	4

Table 2.3 is referred to an additional mode of the operation for creating pattern-color based. Each number is labeled with a specific color; (0: yellow, 1: orange, 2: green, 3: blue, 4: brown and 5: gray). The result of the addition is used to assign the color next to each number. Thus, 36 cells are colored based on number resemblance.

Table 2.4: Table operation of multiplication for mod 6.

×	**0**	**1**	**2**	**3**	**4**	**5**
0	0	0	0	0	0	0
1	0	1	2	3	4	5
2	0	2	4	0	2	4
3	0	3	0	3	0	3
4	0	4	2	0	4	2
5	0	5	4	3	2	1

However, Table 2.4 is referred to a multiplication mode of the operation for creating pattern-color based. Each number is labeled with a specific color; (0: yellow, 1: orange, 2: green, 3: blue, 4: brown and 5: gray). The result of the multiplication is used to assign the color next to each number. Thus, 36 cells are colored based on number resemblance. The pattern explored has a different distribution of colors which creates a different shape.

According to Marianne Parsons (2005), the simple ways of operating tables of such case (mod 6) in the followed quotation,

> Notice from the table 5 + 5 = 4. This seems strange in the usual sense of addition we are used to, but notice that in mod 6 this is true. In fact, 5 + 5 = 10, and we know that 10 is congruent to 4 (mod 6). So, it is true 5 + 5 does actually equal 4! Similarly the table above tells us 5 * 5 = 1. Now this no longer comes as a surprise because we know 5 * 5 = 25, but 25 is actually congruent to 1 (mod 6). Therefore, 5 * 5 = 1! The tables above are accurate for addition and multiplication... in mod 6 of course. (p.¶)

Indeed, Harriss's (2011) logic of pattern modular design oriented the researcher with a smart idea to fulfill the requirements of hybrid portrayal in this study.

2.9 Hybrid Portrayal of Visuospatial Attention

The researcher concluded to answer the first question of this study by providing four main identifications: hybrid formula definition, pictorial reference, pictorial experience, hybrid components which described in the next subheading.

2.9.1 Definition of Formula

A new formula of hybrid visuospatial attention portrayal is developed through using a relationship diagram analysis in this study. The first question was what are the components of hybridization for the current case through visual-cognition science collaboration? The relationship diagram analysis is comprised to answer the first question as follows, see Figure 2.29:

a) How to depict a hybrid picture of visual attention in a dynamic scene? Is selected as a question.
b) A symbol was added to the diagram for every aspect involved in the hybrid pictorial domain, Lope's formula.
c) Aspect was compared to modular of attention aspects, (fixation count = ***x*** to refer width, and fixation duration = ***y*** to refer height) as symbols of the artistic project.
d) 'Relationship' arrow was used to connect related aspects with symbols. The arrows were drawn from the aspect that matches to the one being related.
e) Arrows were counted.
f) The aspects with the most outgoing arrows were recognized as a driver.
g) The aspects with the most incoming arrows were recognized as a related.

Michael Newall (2011) defined the Lopes's hybrid formula of picture depiction. The demonstration mode is involved in two domains based-recognition, pictorial reference, and experience. It was defined "A surface ***X*** depicts ***Y*** if and only if (i) ***X*** can occasion non-veridical visual recognition of ***Y***, (ii) This non-veridical visual recognition accords with a suitable standard of correctness" (Newall, 2011, p. 44).

However, in the latest term by Newall, the same variables were given but in terms of seeing perspective, "A surface, ***X***, depicts ***Y*** if and only if, (1) ***X*** can occasion non-veridical seeing of ***Y***, (2) This non-veridical seeing accords with an appropriate standard of correctness" (Newall, 2011, p.43).

Similarly, in the painting, a surface ***X*** is restricted to the ability of painter to recognize the phenomenon ***Y*** from perceiving its aspectual properties. In Lopes's formula, the case of recognition is tangled with a motor-guiding vision that the perceptual information of these aspectual accords should be first operated from an

appropriate pictorial reference. Lopes mentioned in his model that the information of paradigm system should be a mechanism, demonstrative reference mode which embodied as a picture.

The representation of sensible thing needs perceiving its specific properties within high-demonstrative recognition ability using mechanism-medium based. However, the pictorial experience Transparency of ***X*** is featured as non-veridical visual recognition; ***X*** as painting can only represent the phenomena ***Y*** if the mode of transparency is second-order isomorphism or indirect resemblance (Leung 2009; Newall, 2011). Michael Newall (2011) claimed that the representing of painting ***X*** in both modality and transparency processes were not sufficient. He argued that an edge of recognition based-pixel picture is the primary stage of visual processing which reflects pixilation only. Therefore, recognition through the picture as a source may not appear into the higher-level of pictorial experience.

The higher-level of pictorial experience needs to share with subjective processes representing invisible phenomena in the art field. Triple processes of depiction were a good proposal to hybrid depict: demonstrative mod-based recognition, rational resemblance and self-art experience in three-folds unlike the suggested duality of ordinary perception of the twofold of seen by Wollheim (1998).

Based on the previous requirements, criteria, and design logic in the early sections, the definition of hybrid formula in this research is provided as follows:

A Hybrid Portrayal of Visuospatial Attention: a Painting ***X*** depicts the visuospatial attention phenomena ***Y*** if and only if: (1) ***X*** can occasion non-veridical visual recognition of ***Y***, and (2) this non-veridical visual recognition accords with a suitable standard of correctness according to the following specifications:

a) *Demonstrate (D):* typical-identification mode through the mechanism.

b) *Resemble (R):* visual modular semiotic relation.

c) *Synthesis (S):* self-artistic experience.

2.9.2 Pictorial Reference Identification

The pictorial reference is the attention information through eye-tracking research in this study as shown below:

a) Pictorial source: gaze movements data through information- based identification mod

b) Standard of Correctness: Fixation matrix feature Output.

c) Constraints: Gaze features.

d) Pictorial Aspects:

   i. An explicitly non-committal selection: Physical properties (width, height, color, pattern, frame, time, gist, shape, space, and form).

   ii. Inexplicitly non-committal selection: gaze feature (fixation count and fixation duration).

e) System: Tobii-60 eye tracking system.

f) Pictorial Recognition: types of basic portrayal, and the competence attention based on recognition kind of depiction.

g) Meaning: scenes, style groups.

2.9.3 Pictorial Transparency Identification

a) System: Rational resemblance approach using modular pattern design

b) Operation Mode: color semantic based on additional table operation mod.

c) Tools: Adobe Illustrator program and manual table mod operation

2.9.4 Pictorial Experience Identification

a) Medium: Painting

b) Approach: Self-artistic role based on art principles.

c) Style: free geometrical appearance.

2.9.5 Components Features of Hybridization

Three components of hybrid depiction of visuospatial attention through a relationship diagram analysis are illustrated in Figure 2.19 for this research.

a) Gaze features: the demonstrated Fixation matrix features by eye-tracking system.

b) Physical Properties: the resembled properties of the visuospatial attention based on pattern modular design logic.

c) Pictorial Aspects: compositions based on art principles.

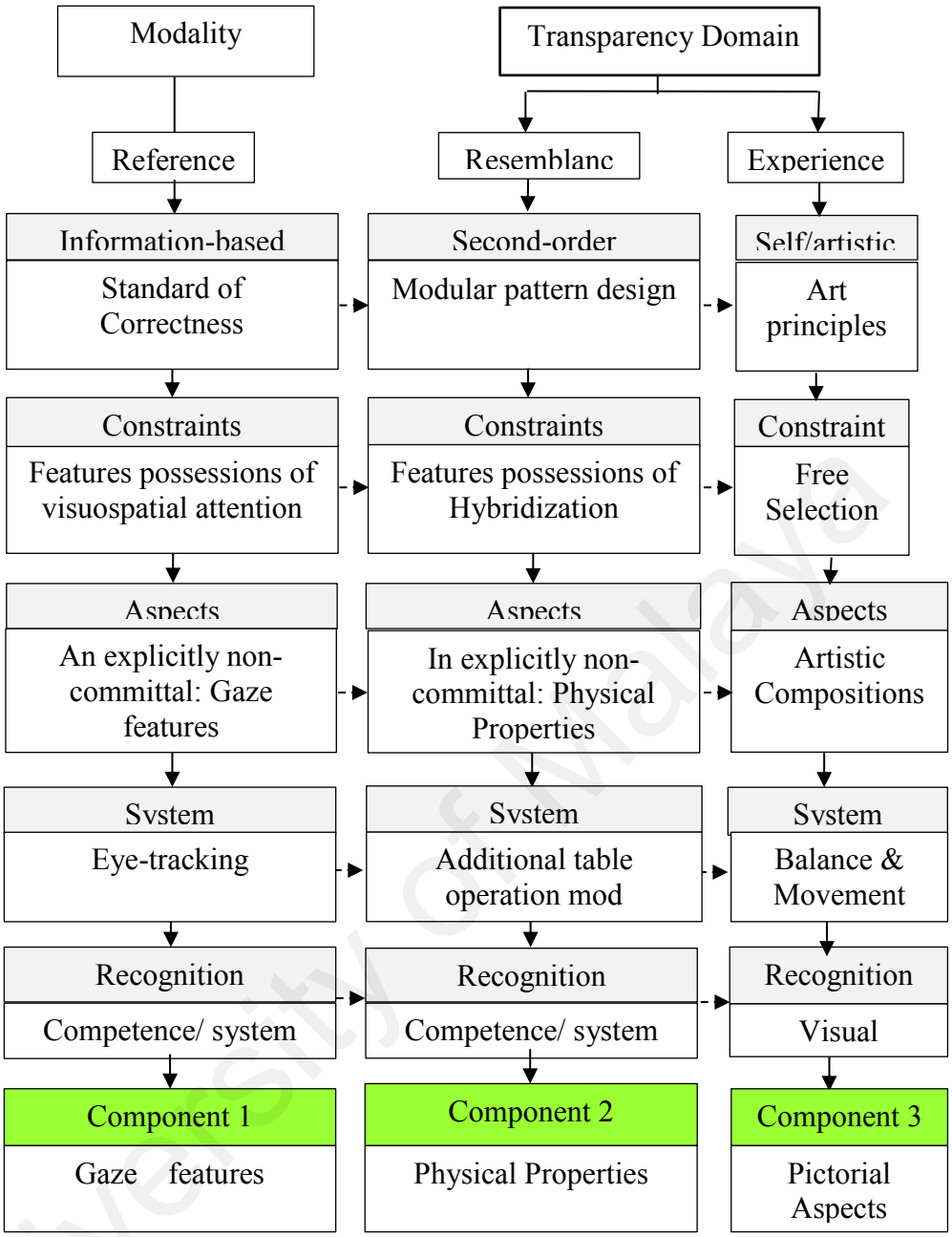


Figure 2.19: The components of hybrid depiction of visuospatial attention based on the relationship diagram analysis in this research.

2.10 Chapter Summary

In this chapter, a general critical overview of hybrid depiction in visual arts is discussed. The methods for generated hybrid artworks and art-science collaboration approaches are also discussed. A general review of related literature of vision science for visuospatial attention concepts, models, and gaze features was reported. The concepts and techniques identified from the literature for the demonstrations and

transparency problems in hybrid depiction were analysed for their formulas and limitations. The hybrid portrayal of visuospatial attention components was identified. The next chapter is the research methodology.

CHAPTER 3: RESEARCH METHODOLOGY

In this chapter, the general methodology used is described, for the development of research proposed guideline, for the hybrid depiction of visuospatial attention phenomenon in art-eye tracking lab collaboration research.

3.1 Introduction

In the previous chapter (chapter 2), the related art-science collaboration approaches were reviewed for visualising techniques of cognition phenomena in hybrid depiction. However, it will be observed from the output of this research literature review that the satisfaction of producing any hybrid form of art depends on the applying of the three processes information-mechanism demonstration, second-order-isomorphism resembles, and self-artistic role of the requirements used to represent the portrayal of visuospatial attention phenomenon. Thus, the identification of solid approaches to depict hybrid art-science forms of cognition phenomena has become essential for sustainability in visual arts. This study will develop a credible process that will use the combination between eye-tracking research as pictorial source of information, modular design as visualization, and art principles (balance and movement principles) as art forms for depicting visual attention phenomenon. Therefore, the step-by-step applications of this research proposed a flexible hybrid experiment for producing visuospatial attention art forms.

3.2 Hybrid Guideline DRS Conceptual Framework

The present study proposed a guideline Demonstrate, Resemble, and Synthesis (DRS) for hybrid visuospatial attention depiction. This guideline is used to depict the paintings of the cognition phenomena, and visuospatial attention in a video of the choreographic dance. DRS guideline was suggested in this study based on a combination of three main fields: (1) in the Pictorial Representation Theories, Hopkins (2003), Lopes (2004), Newall (2011), (2) in the Number Theory, Carl Friedrich Gauss's *Disquisitiones Arithmeticae* theory in 1986 (2005) and Harriss's (2011) Pattern Modular

Design, and (3) in Visual Attention Theories, Ronald Rensink's (2000) the Coherence Theory of Visual Attention in the dynamic scenes. Awareness of their domains was then used to provide a credible hybrid art-eye tracking collaboration depiction research framework to achieve the aim of this study. The literature review in chapter 2 based on the relationship diagrams concluded that the components of the hybrid visuospatial attention depiction were characterized as follows:

a) Gaze Features: demonstrated fixation matrix features fixation count and fixation length.
b) Physical Properties: properties of width, height, color, pattern, frame, time, gist, space, and form resembled using pattern modular design logic.
c) Pictorial Aspects: balance and movement compositions based on art principles.

Therefore, the conceptual framework for hybrid visuospatial attention depiction is suggested that to represent an independent variable (the visuospatial attention phenomenon in a video of choreographic dance) into a dependent variable (the hybrid portrayal of the visuospatial attention) which is based on the proposed hybrid guideline DRS in this study. Briefly, DRS are defined in detail as follows, as shown in Figure 3.1.

a) Demonstration D stage: it refers to the gaze features demonstration stage through eye-tracking system and fixation matrix features; fixation count metric and fixation length metric. However, the traced visual gaze pattern, heat map, is utilized to reflect the detail of a biological map of attention behavior.
b) Resemble R stage: it refers to the physical properties resemblance stage through modular arithmetic logic design for visualisation. Nine properties width, height, color, pattern, frame, time, gist, space, and form have resembled.

c) Synthesise S stage: it refers to the pictorial aspects synthesise stage through artistic composition created using traditional art principles.

3.3 Hybrid Guideline DRS Requirements

The proposed DRS guideline for visuospatial attention portrayal for hybrid depiction was developed using Tobii T60 Eye-tracker programming firmware version 2.1.1 for demonstration, pattern additional modular table operation logic for resemblance, and Adobe Illustrator software programming version CS5 for visualisation. The requirements were selected as appropriate for this methodology based on the fact that Tobii T60 provides significant accuracy and precision functions of gaze fixations that can simulate the analysis of watching dynamic scenes for grabbing attention (Tobii, 2011), Modular logic, easily, provides plenty of patterns through basic arithmetic, and Adobe Illustrator was applicable for this visualisation.

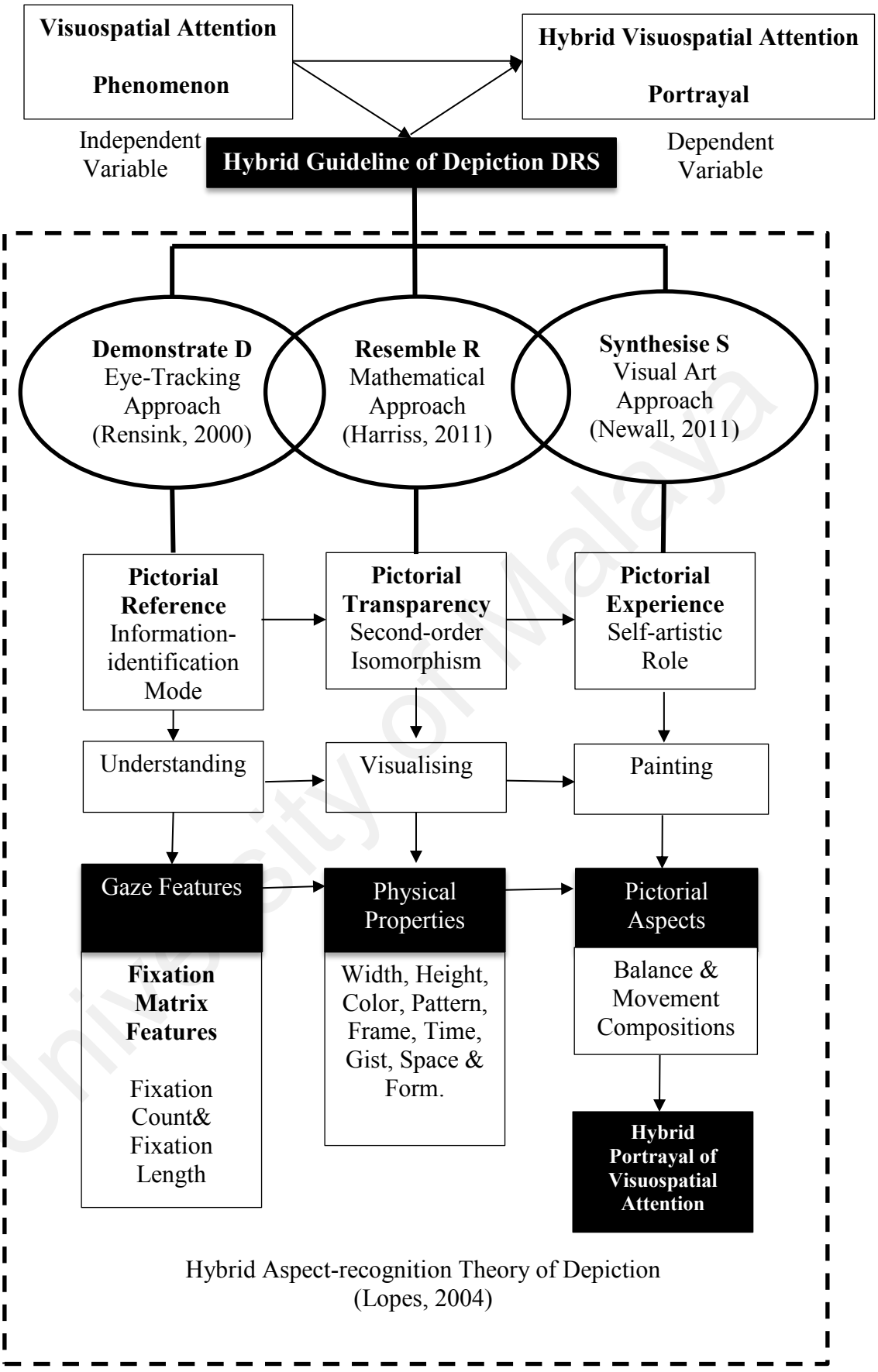


Figure 3.1: Hybrid DRS conceptual framework for visuospatial attention depiction in this study.

3.4 Art based-Collaboration Representation Methodology

In this research, the methodology belongs to the multidisciplinary Interpretivism paradigm. Hilary Collins's (2010, 2018) art-based collaboration representation method is determined as shown in Figure 3.1. Multi-qualitative methods involve gaze-video replay based observation, rule-math based visual method, and painting-based research is used (Barratt, 1980 ; Collins, 2010, 2018; Oierre & Zimmerman, 1997). The processes of the methodology in Figure 3.2 follow a statistical visualisation analysis to conduct the research purpose (Dzemyda, Kurasova, & Zilinskas, 2013). The purpose of this project was to find out how the visuospatial attention phenomenon section-based in the Choreographic dance video, is visualised using the proposed hybrid guideline DRS. The objectives were identified as follows:

a) To identify the domains of particular hybridization in terms of visual art-cognition science collaboration representation.
b) To determine knowledge of the gaze features for the specific case using eye-tracking video analysis.
c) To resemble physical properties for the specific case using pattern modular design.
d) To synthesise pictorial aspects for the specific case through traditional art principles.

And the research questions conducted were:

a) What are the components of the hybridization for the current case through visual art-cognition science collaboration?
b) How can the information of the gaze features in the specific case be determined through gaze data?

c) How can the physical properties of the specific case be resembled through pattern arithmetic modular design?

d) How can the pictorial aspects of the specific case be created through traditional art principles?

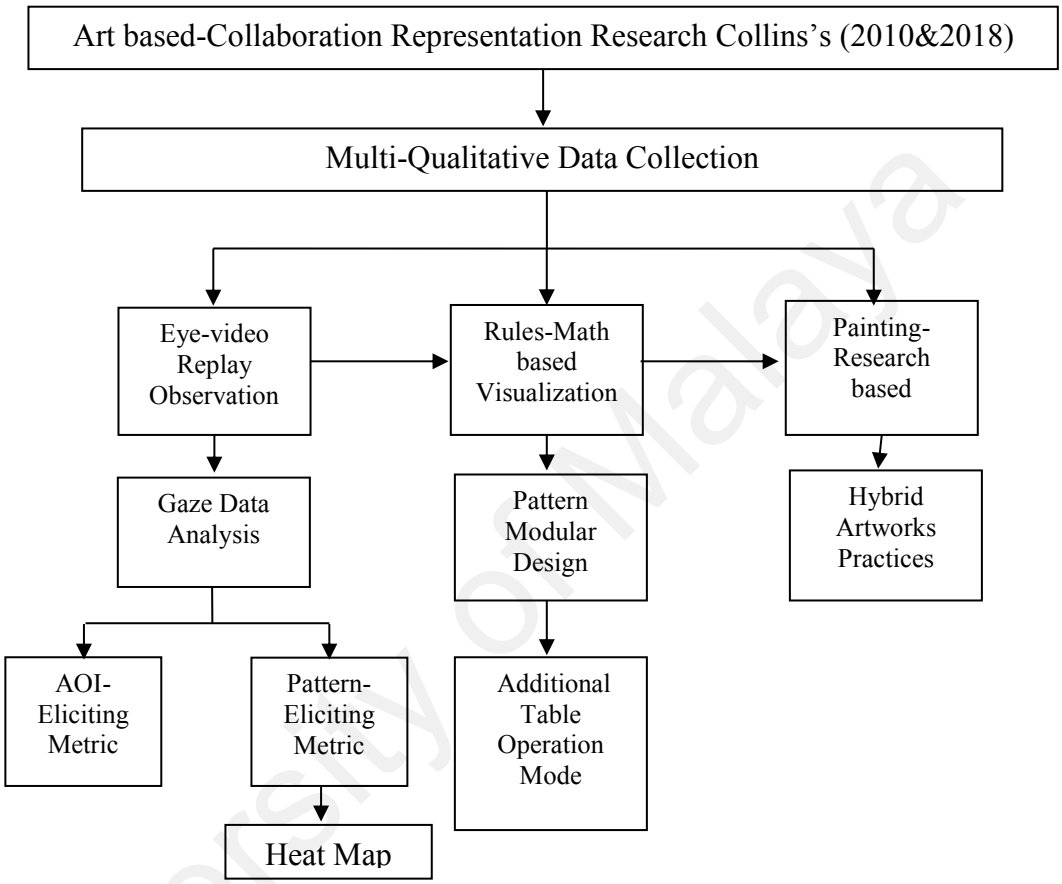


Figure 3.2: Research qualitative methods in this study.

3.5 Research Design

In this study, a collaboration representation-three-phase sequential design was utilized to represent the hybrid portray of visuospatial attention. Qualitative data were collected in three stages: gaze features demonstration stage, physical properties resemblance stage, and then pictorial aspects synthesise stage as shown in Figure 3.3. In the first stage, gaze features demonstration, eye tracking data analysis is used in order to analyse gaze movements and export the descriptive output data of the gaze features. Moreover, correlation and difference statistical analyses were used to get deep insight

related the phenomenon. It helps the researcher to select the appropriate data set input of the resemblance system for this study. The gaze features of visuospatial attention demonstrated in the first stage were then visualised in the second stage using pattern modular logic design. The resemblance process was to visualise the physical properties of visuospatial attention which involves nine properties width, height, color, pattern, frame, object, gist, space, and form. In the final stage, art principles are utilized to create hybrid pictorial aspects for the specific case. Therefore, ten hybrid artworks are created in pictorial aspect synthesise stage as examples to prove the applicability of DRS guideline in this depiction.

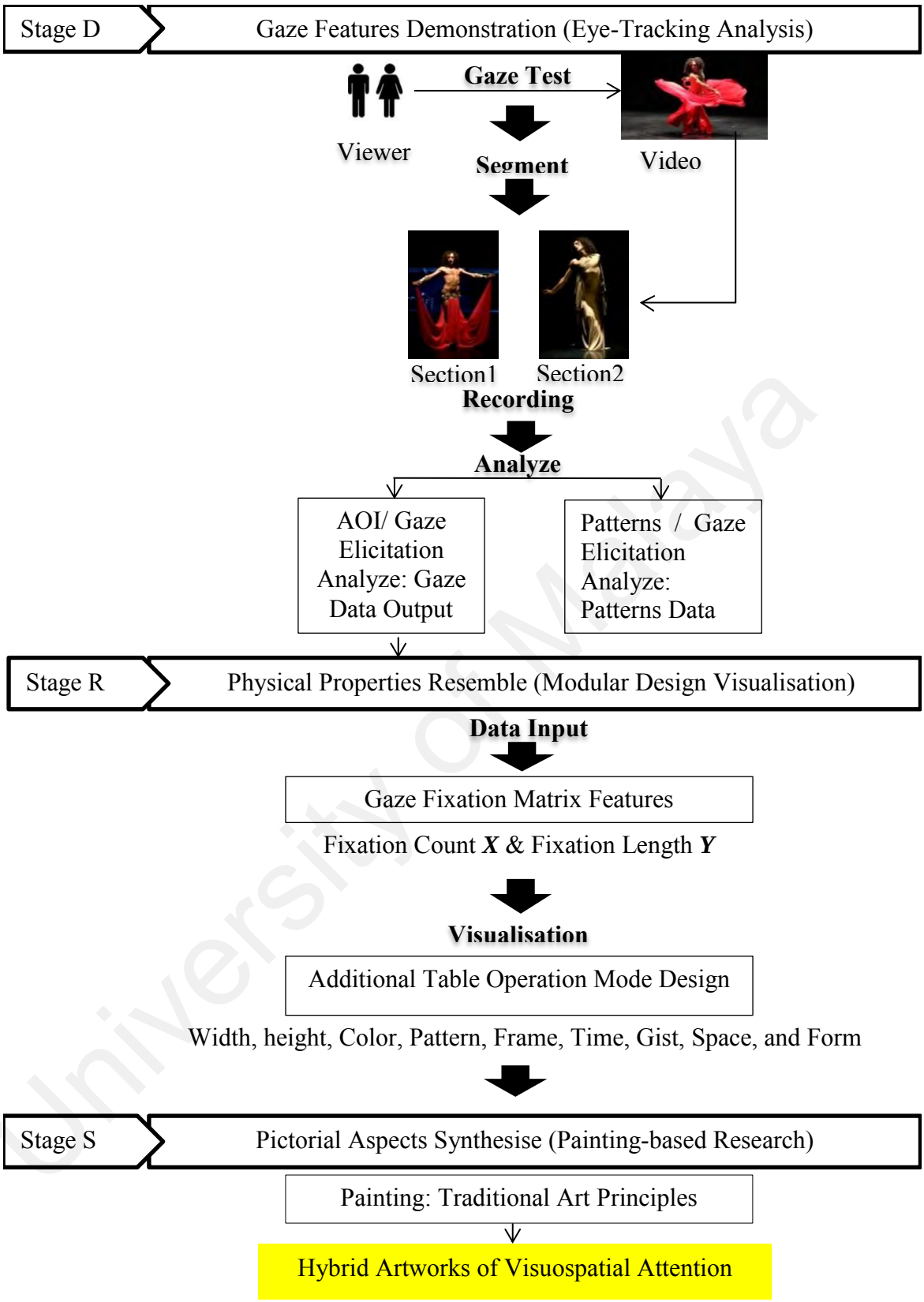


Figure 3.3: Research design and Stages

3.5.1 Gaze Features Demonstration Stage

In this section, the qualitative observation through eye-tracking approach was conducted. The observation was characterized as unstructured, undisguised, contrived, personal, mechanical, and non-participant. Therefore, the gaze data sample acquisitions are performed using an observation based-one shot case study, eye-tracking video reply data analysis. The recorded gaze data was analysed using two metrics AOI/gaze elicitation, and visual pattern/gaze elicitation. The eye-tracking processes were described in details in the next subheading.

3.5.1.1 Sample Frame

In terms of human gaze samples, the most serious disadvantage of selecting gaze sample for an eye tracking research is that fixation data will be collected based on uniform random sampling method. Tatler, Baddeley, and Gilchrist (2005) claimed that vision studies related upon would have been more useful if included shuffling random sample technique. However, most of the usability, advertisement, TV based-movies and user interface design case studies used the qualitative purposive sample for gaze replay's examination and production assessment. Similar to them, the desired output of this study was to record a qualitative data for artistic representation purpose. Therefore, gaze watching replays sample was used in this study (Pernice & Nielsen, 2009) as illustrated in Figure 3.4.

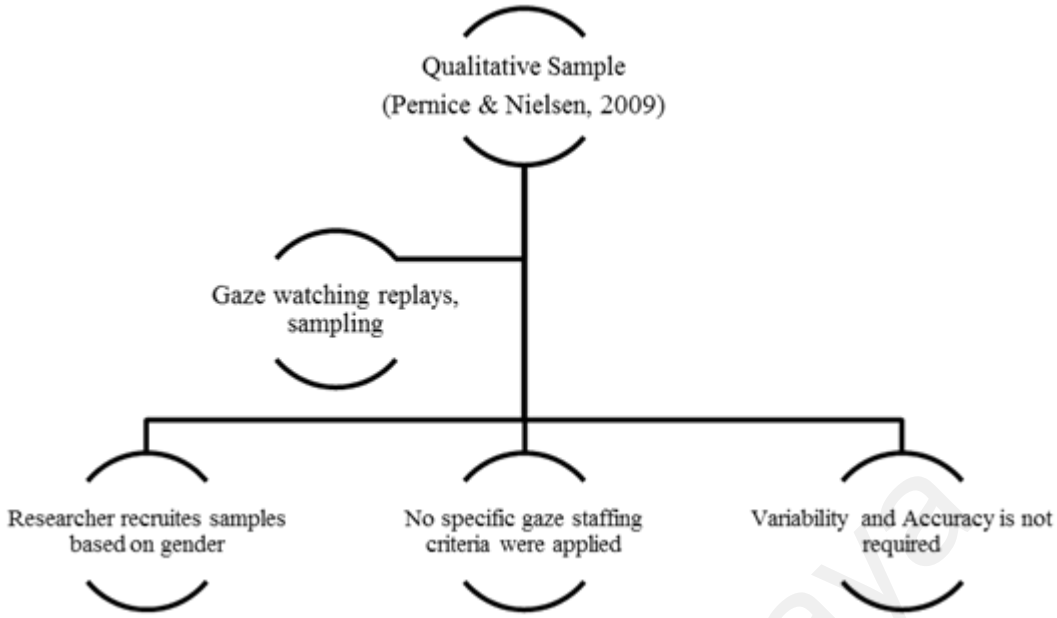


Figure 3.4: Sampling frame in this study.

Pernice and Nielsen (2009) in their book: *How to conduct eye tracking studies*, recommended selecting a small sample size for a qualitative output desired. They indicated that selecting big sample size for gaze studies is justified only in the cases that need more variability to quantify accurate detail such quantitative heat map output, for instance when the researcher needs to know how many people looked at the search box, and how long, in order to decides how red to color that area of the screen to know minute details of attention behavior.

Three criteria of sample estimation should be followed in a qualitative eye-tracking research such as: usability studies, design and creative art experimental studies, and focus group studies as follows (Pernice & Nielsen, 2009), as shown in Figure 3.5:

a) For creative practices: Only a small number (from 5 to 15 samples) of representative participants from any defined population are required. Adding many more participants will not help to find more usability problems for improving the design practices.

b) The time (segmentations) used per participant for both the test and the analysis should be high.

c) For results: Eye-tracking results cannot be generalized to be valid for the population, but they can be used to improve the product.

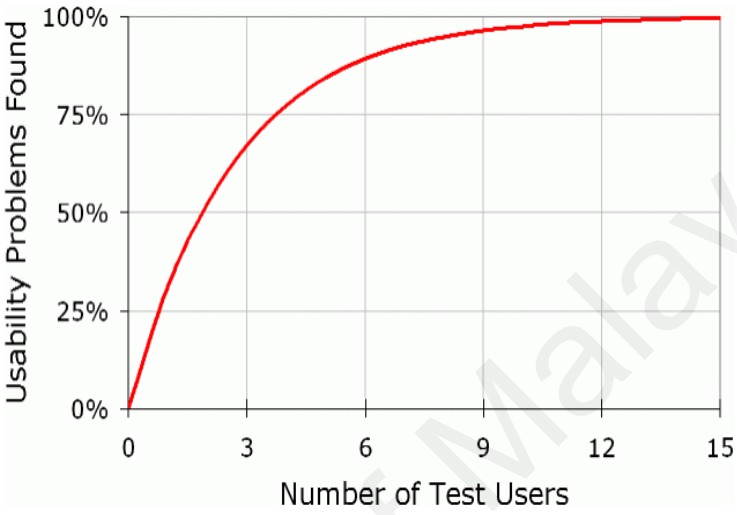


Figure 3.5: Gaze watching replays sample size (Pernice & Nielsen, 2009)**.**

As shown in Figure 3.6, with 5 participants you can find 85% of the usability problems in the creative studies, with 15 you can find all (100%). Therefore, in this study 10 samples are enough to demonstrate the gaze data for develop the painting practices. If we use higher sample size the outcome of gaze data will be huge and difficult to resemble in this study.

(a) ***Sample Size***

Ten participants, five males and five females' international postgraduate students from the University of Malaya were recruited and scheduled to participate in this study. Their ages ranged from 23 to 32 years old, six of them were masters and four of them were Ph.D. students specializing in social science. Participants were also compensated

with RM 50 in cash (10 participants) to drive to the SDS Associates Tobii lab at Kelana Mall, Selangor. No specific staffing criteria were applied. Some of them had glasses or contact lenses but this was not an impediment to tracking their fixation, (Figure 3.5).

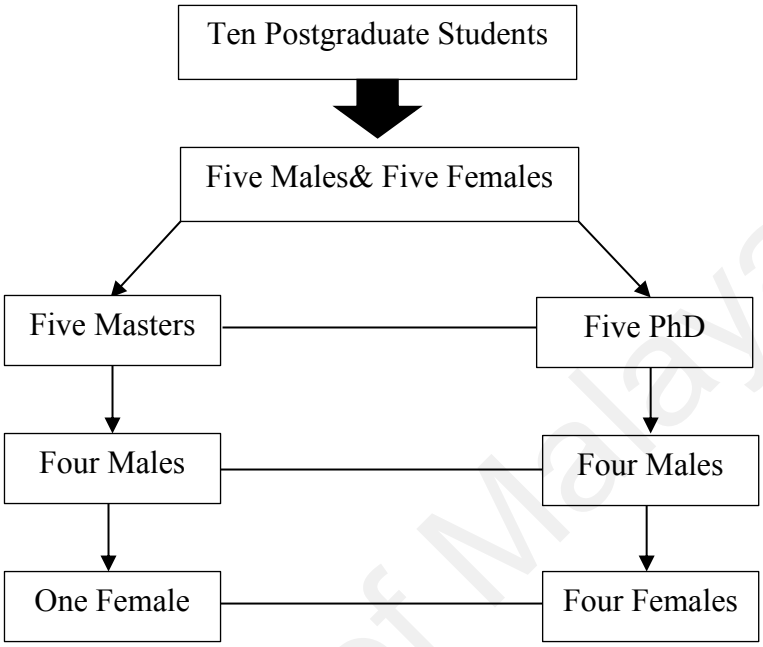


Figure 3.6: Gaze watching replays sample size.

3.5.1.2 Stimulus

A video of the choreographic dance, a female redefined oriental dance video, was selected in this study. Actually, YouTube browse gives researchers the widest range of media sources, such as private audiovisual online data and varied video clips library catalogs that archived artworks, movies, music, and dance performances etc. the researcher collected her stimuli from YouTube browse that stored at 60 Hz on the native TFT screen (1280 × 1024 pixels). A choreographic Baladi dance which was titled Tajwal (stroll) by Paulikevitch[2] (2014) was served as a stimulus of this gaze investigation.[3] Tajwal clip was chosen because it: (a) contains sufficient provocative

[2] Alexander Paulikevitch was the performer, Jawad Nawfal the musican, costumes by Krikor Jabotian, and lights by Ricardo Clementi in Tajwal.

[3] https://www.youtube.com/watch?v=m1TKH1Mis2I

styles of dance movements to attract attention. (b) is considered as an emotional stimulus which is better for attention inquires than neutral stimuli. (d) matches with the requirements of this study (Alpers, 2008; Nummenmaa, Hyönä, & Calvo, 2006). The total time of video was 83 second. Scenes were divided into two sections: section one was referred to common folk dance style as shown in Figure 3.6a, and section two was referred to uncommon mutilation dance style,[4] as shown in Figure 3.6b.

a) Section one: Common folk dance style.

b) Section two: Uncommon Mutilation Dance Style

Figure 3.7: Illustration of stimuli, choreographic oriental baladi dance tajwal (stroll), and total time: 83 seconds.

[4] The segmentations of scenes were described in more details in chapter 4.

In figure 3.6a, the dancer acted his performance traditionally. He moved his body based on the style of folk dance namely Balady dance. However, in figure 3.6b, the dancer acted differently by moving his body with uncommon mutilation style. The movement of the right arm only is appeared in the second style. These two different styles are examined by eye-tracking analysis in this study.

3.5.1.3 Eye Tracking Lab Equipment

A Tobii T60 tracker[5] was used to record participant's eye fixations during the watching of a video. No special head or eye equipment is required to wear from participants by using Tobii tracker in this study. Tobii model utilized two infrared light sensors located in the bottom of the Tobii PC monitor for tracking fixation based on pupil center reflection technique (PCCR); the retina infrared signals from participant's pupils is rebounded by a set of these sensors in a freely limited area of moving participants with an accurate recording. Tobii Studio™ Software Analysis was running on PC desktop with Windows XP operating system to analyse the recorded signals retina through determining the visible screen coordinates of the eye fixation. Camera based-eye tracker system was used to record the behavior of participants while watching the video as shown in Figure 3.7.

[5] http://www.slideshare.net/AcuityETS/tobii-t60-t120-user-manual.

Figure 3.8: Eye tracing equipment lab, photos by the researcher.

3.5.1.4 Fixation Matrix Feature Definition

In this research, the gaze features of attention are reflected from the fixation matrixes features; fixation count metric and fixation length metric, are defined as follows:

(a) ***Fixation count metric X***

Fixation count metric is defined as the number of fixations within an area of interest AOI[6], meaning the notability or the interest of scene that grabbing attention. However, the fixation count versus participant is counted based on each participant who had at least one fixation in a given AOI which is this study is based on (Poole & Ball, 2006). Thus, it is used to refer the physical attention width feature for the hybrid visuospatial attention portrayal in this study. Therefore, the attention width is denoted as ***X*** symbol.

[6] Area of Interest AOI is considered as a very useful tool for quantifying gaze data on a higher level. The AOI analysis defines the areas of interest within any stimuli.

(b) ***Fixation Length metric Y***

Fixation length metric is defined as the total number of fixations count within an area of interest AOI, meaning the act of fixation or the mental cognitive processing namely: attraction (Doherty, O'Brien, & Carl, 2010). However, the fixation length test versus participant is counted based on the amount time fixated for each participant who had at least one fixation in a given AOI. Thus, it is used to refer the physical attention height feature for the hybrid visuospatial attention portrayal in this study. Therefore, the attention height is denoted as ***Y*** symbol.

3.5.1.5 Gaze-Video Replay Data Analyses

Data analysis was guided by the theoretical propositions of depiction provided on an Eye tracking research based-gaze replay observation suggested by the review of literature on advanced learners Kirtley (2018), Bradley (2014), Brown (2009) Ronald Rensink (2000), Olk and Kappas (2011) and Zain, Razak, Jaafar, and Zulkipli (2011). Awareness of the domains of the hybrid art-eye tracking collaboration framework in the thinking of advanced learners in other domains was then used to provide direction to visual analysis and assessment in its interpretation.

The recorded gaze data was analysed using the Tobii Studio™ software. Tajwal video clip was exported to AVI format for the gaze analysis requirement. Indeed, this software offers a comprehensive platform analysis package for useful interpretation, comparison, and visualisation of eye gaze data, human behavior, user responses to usability testing, market research, and psychology. Providing an intuitive workflow for easily eye tracking processed, combining advanced instruments, supporting a large variety of stimuli, and allow for both large and small studies to be carried out in a timely and cost-efficient way, without the need for extensive training. The detailed analyses

used in the study were a descriptive area of interest AOI/gaze elicitation and pattern/gaze elicitation.

(a) ***Descriptive statistical analysis***

Two analyses are used in this study. First: Eye-tracking Software, inclided: Tobii Technology AB, Tobii studiotm model version 3.2.3.336 (Initial analyses for exporting fixation data). Second, SPSS statistical analysis software (version 21), included: A paired-samples t-test for formal compression. A 0.05 was considered significant.

The descriptive statistics analyses of visual activity, included:

a) Notability of Scenes: Percentage of participants who had fixated at least one fixation on the specific area of interest AOI.
b) Fixation Count: The number of eye fixations detected within a specific area of interest (AOI) during an interval of interest
c) Fixation Length: the fixation duration specifying how long an individual fixation lasted.
d) Visual pattern: Heat maps (gaze's directions for fixated-body regions).

(b) ***AOI/gaze elicitation***

Area of interest AOI is a statistic tool for quantifying gaze data on a higher level. It enables the researchers to define the areas of interest within stimuli, interpret data based on the direct gaze coordinates and bases their analysis on the frequency, time, etc. The AOI data, such as the fixation count and fixation length in one specific area are visualised in the statistics tool. In this study, AOI data included the following statistical descriptions as below:

i Gaze features information Output

Three analyses to identify the information of coherent features output based on the fixation matrix feature for the specific case were implemented using SPSS version 21. (1) Demographic analysis; frequency distribution and valid percentage of samples based on education, nationality, and gender demographic variables, (2) Descriptive analysis; fixation count metric and fixation duration metric extraction for features identity, (3) Inferential statistics analysis: the correlation statistical analysis was presented to test the features relationship, and T-test analysis was also presented to test the feature of variety for getting deep insight toward the phenomenon.

(c) ***Pattern/gaze elicitation***

A visual pattern is a dynamic or an image representation of the gathered data of the selected recording. Gaze pattern allows making a visual qualitative inspection of visual recognition results. Actually, the researchers used the visual patterns of attention to exploring the biological shape of attention which was referred to the modality domain. Visual AOI analysis involved the heat map pattern metric as shown in Figure 3.8.

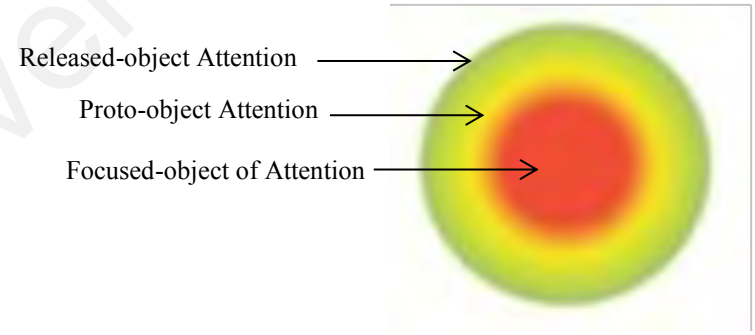


Figure 3.9: Heat map metric for attention behavior visualisation.

Heat map pattern has different colors to reflect the attention behavior based on fixation account or fixation length made in a particular area. Red color tones reflect the highest attention amount; focused-object attention feature, yellow tons reflect the less

attention amount; proto-object attention and green tones reflect the least attention amount; released-object attention.

3.5.2 Physical Properties Resemblance Stage

As discussed earlier, the aim of physical properties resemblance is to visualise the physical properties of visuospatial attention which consisted of the width, height, color, pattern, frame, object, gist, space, and form through a second-order isomorphism. Thus, the direct tracing of the heat map will reflect similar shapes which are rejected in the perspective of hybrid depiction based recognition approaches. A pattern modular arithmetic logic design is a flexible method modeled on different practice questions. It is considered as one of the best modes to resemble integer numbers into various visual forms easily. Various methods of operation tables are used for generative arts. The common methods are additional and multiplication table mod operations which the use of one of them is considered enough to create plenty of artworks. Additional and multiplication table operation mods were discussed in Chapter 2. Therefore, additional table operation mode is selected in this study and multiplication mode could use in further studies.

(a) ***Tools***

The researcher used an Adobe Illustrator CS5 program with the supporting equipment's Asus Laptop to resemble the hybrid aspects, see (Figure 3.9).

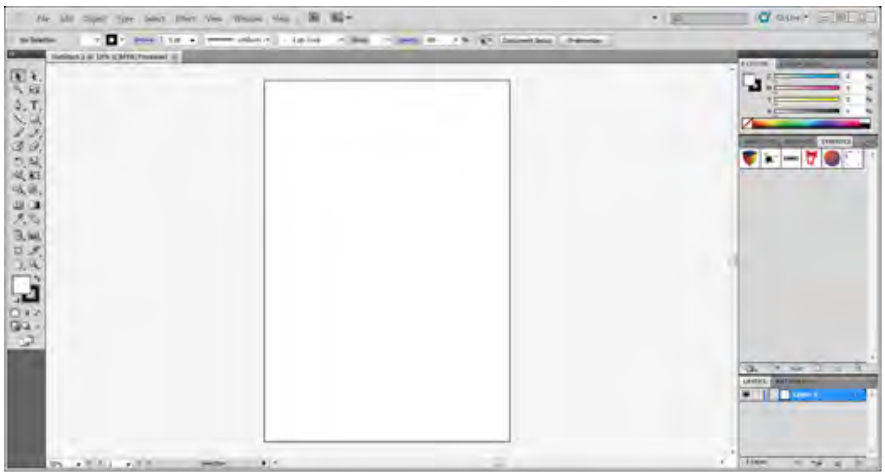


Figure 3.10: Illustrator CS5 program.

3.5.3 Pictorial Aspect Synthesise Stage

In this section, synthesise is referred to art compositions and paintings. The physical properties visualised from the previous resemblance stage were manipulated subjectively based on the traditional art principles to create hybrid paintings. In considering the painting-based research, painting as a context within research or a study inquiry is more than the formal performance on canvas. Further, it is an individual study that focuses closely on the visual culture practices. Therefore, painting as research is classified into four contexts, painting as theory, painting as form, painting as idea, and painting as act. The selected context was Painting as Act inquiry which refers to research with painting interdisciplinary. It focuses on interests invoking to set alternative practices and depiction perspectives associated with the public process (Sullivan, 2008).

3.6 Trustworthiness

Trustworthiness is deemed an essential element in supporting the finding of any qualitative research (Merriam, 1998).It involves validity, credibility, transferability, dependability, and conformability (Lincoln & Guba, 1985).

3.6.1 Validation

Validation refers to the accuracy of instruments in collecting the data. In this study, Tobii eye- tracker remote was used for collecting fixation data. Although, all Tobii eye trackers technologies communicate via TET server which is responsible for image processing performance and image parameters mapping to screen coordinates over TCP/IP. Weigle and Banks (2008) in the study entitled Analysis of Eye-Tracking Experiments Performed on a Tobii T60 reported that the way of generating gaze position based on the TET server was invalid. Their report showed that the valid clarification of gaze position for only one eye should be regarded invalid for another eye. According to Weigle and Banks (2008),

> When analyzing the validity of-Tobii's TET server automatically flags gaze reports as valid or invalid depending on whether the eyes are successfully captured and located by the imaging processes. Flags are applied per eye, so a report may indicate a report is valid for one eye but invalid for the other eye. The data from the full mock user study contains 28243 individual gaze reports. The TET server marks 1.65 percent of the left eye reports and 1.39 percent of the right eye reports as invalid. An invalid report is one for which the TET server could not detect the presence of the eye. Unfortunately, our analysis has already shown that reports for a single eye contain a significant position-dependent error in they gaze coordinate and are not reliable measures of gaze position on their own. Although it is possible to post-process the data to remove the error, if using the data interactively it appears that gaze positions reported valid for only one eye should be considered invalid for either eye. Under the assumption that gaze coordinates marked invalid for one eye should be treated as invalid for either eye, 1.89 percent of the 28243 reports are invalid. (p.8)

This quote was provided based on their results which conflicted with the assumption that validity of clarification should successful in both eyes. However, a recent report in Tobii T60 accuracy and precision asserted that Tobii T60 performance based on TET server was valid and accurate (Tobii, 2011). They tested the manipulated eye variables: ideal conditions, large gaze angles, varying illumination, white background, and varying head positions in most eye conditions while using Tobii T60 with TET server and found that they were stable. Accuracy was with acceptable average values ranging from 0.4 to 0.7 degrees. Also, precision was stable throughout their tests, but to some extent with

poorer results for bright illumination conditions. The validity of Tobii T60 was justified in this study. In addition, to ensure the internal validity of the study, the researcher employed the following qualitative strategies methods (Creswell, 2003):

a) Triangulation of data collection and analysis-multiple sources include a literature review, eye-tracking instruments and analysis, visual evaluation, and art-practices research.
b) Use rich-thick descriptions of the findings.
c) Peer examination-one doctor from the art program culture center. The University of Malaya will serve as a peer examiner.
d) An external auditor-one doctor from visual art department will serve as an external examiner.
e) Research bias clarification-researcher bias will be articulated under the subtitle 'the research role'.
f) For reliability, three techniques were employed. First, the details of the research scope, focus, interest, researcher role, instrument accuracy and validation, and the visual context from which methods and data are generated were provided. Second, multiple methods of data collection and analysis were used to provide strengthened reliability and internal validity. Finally, results and data analysis were reported statically and visually in order to provide accuracy.

3.6.2 Credibility

Credibility is achieved when the researcher constructs senses and meaning of respondent's perception and reaction toward phenomenon (Mertens, 2014). In the qualitative research, three ways are used for achieving credibility; they are depth description of data collected, member checks/ inter-raters, triangulation of methods and sources. A deep sense of triangulation was a basic part of the present study. Data

triangulation using different sources of data like gaze tracking replay recording, hybrid theoretical formulations, visual evaluation, and art were implemented to ensure credibility. Two Inter-rater strategies were utilized for a more credible and reliable analysis. Therefore this study is credible.

3.6.3 Transferability

Transferability is the third concerns in qualitative research. It shows how finding of specific study is reliable and can be replicated in another context by researchers. Marshall and Rossman (2006) stated that there should be multiple data sources and thick description to enable replication specific finding in different conditions for achieving transferability. This study highlighted the possibility to replicate it through the rich details and description of analysis and finding.

3.6.4 Dependability

Dependability refers to the consistency of the data in the description and interpretation of the finding in the specific study. In order to overcome this issue, interpretations brought out the exact words and/or reaction of respondents. Qualitative researchers should store their data securely for further assessment by researchers to check the consistent and dependable on the data collected (Merriam, 1998). To enhance dependability in the current study, two independent inter raters from computer information technology and visual art departments verified the hybrid pictures emerged from the gaze data and agreement reached.

3.6.5 Conformability

Conformability is the last concern which refers to the ensuring that the results are relevant to the study conducted. Therefore, researchers should provide an explicit account of the data gathered that it could be tracked (Mertens, 2014). For conformability, clear explanation on how data gathered, synthesised, and conclusions

reached is provided (Lincoln & Guba, 1985). However, critical part where analysis is always subjective (Creswell & Poth, 2017). In the current study, the researcher applied an in-depth analysis of data to provide a thick description of the phenomena represented visually.

3.7 Chapter Summary

In this chapter, the general methodology is described which is employed in the design and implementation of the proposed guideline for hybrid portrayal of visuospatial attention. However, a more specific detail of the DRS guideline for research contribution is explained in chapter 4, chapter 5, and chapter 6 respectively.

CHAPTER 4: GAZE FEATURES DEMONSTRATION

This chapter covers the eye-tracking procedures which are divided into three main sections: the brief introduction is highlighted in the first section, the proposed first stage, Gaze features demonstration using the fixation matrix feature is presented in the second section, and finally, the eye-tracking finding and analysis are also presented in the third section. It is statistically important for the findings to be displayed systematically in order to deal with the statements comprehensively so as to be consistent with the research questions.

4.1 Introduction

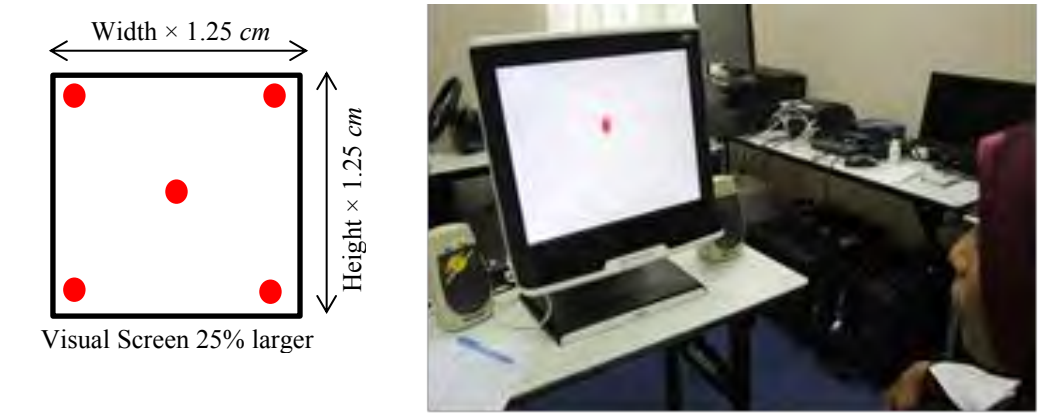
In this chapter, the contribution that is an art-eye tracking collaboration framework and experimental outcomes of a creative DRS guideline for the hybrid visuospatial attention depiction is implemented. The first stage of this guideline, gaze features demonstration utilized the descriptive statistics of the fixation matrix feature for the understanding of visuospatial attention in a choreographic dance video which is recorded using a YouTube browser. This basic contribution is the employment of a fixation matrix feature as an information-identification mode of the demonstration for the hybrid depiction reference domain. The advantages of the fixation matrix feature are its high accuracy to determine the visuospatial attention in a simple analysis for multi-purposes involving a depiction field. Thus, making fixation matrix feature as a fit representation element for resemblance purposes and this art-eye tracking collaboration framework as a unique inspiration contribution compared to other art-eye tracking collaboration contributions proposed by (Kirtley, 2018; Bradley, 2014; Brown, 2009) for representation art issues.

4.2 Gaze Features Demonstration Stage

Gaze features demonstration refers to the gaze matrix features identifications for answering the second question in this study. This is to extract the descriptive set of features output of the gaze features of the visuospatial attention for the next mathematical visualisation process in the pattern resemblance stage. This proposed demonstration stage; eye-tracking experiment procedures, segmentation, and area of interest AOI are performed. Therefore, different segments are discussed concerning what the area of interest AOI is selected, and how the gaze matrix features are extracted from the choreographic dance video in this section.

4.2.1 Eye-Tracking Experiment Procedure

An eye-tracking experiment is performed to extract the visuospatial attention output based on the gaze matrix features for the next stage. Participants have signed a consent form, granting the research permission to record their eye's fixations while watching the choreographic dance video, (totaling approximately 3 minutes). Separately, each participant is positioned in the center of the eye monitor, using a controlling of head movement in order to fixate the location of eyes. The calibration of eye movements measured the accuracy and precision values that were on the stimulus points on the native TFT screen (1280 x 1024 pixels). Participants were asked to keep their head as still as possible to avoid inaccuracy might happen by head movements as shown in Figure 4.1.



a) Gaze Calibration Feature

b) Gaze Calibration Procedures

Figure 4.1: Diagram of the study procedure. The gaze calibration feature showed: a) that the eye tracking monitor was calibrated using a regular five-dotes setting grid, and a fixation cross was present for 60 *ms* (measuring 1.25 × 1.25 pixels) at one of five locations in the border region of the screen. The center of the track box was set to 56 cm from the eye tracker. Photo by the researcher.

The eye tracking monitor was calibrated using a regular five-dotes setting grid, and a fixation cross was present for 60 *ms* (measuring 1.25 × 1.25 *cm* pixels) at one of five locations in the border region of the screen as shown in Figure 4.1a. The center of the track box was set to 56 *cm* from the eye tracker as shown in Figure 4.1b. Then participants explored the scenes with their fixations for a video-controlled period of time, as this ensured that they tested under the same conditions. The variables of the area of interest AOI were tested the full body movement based on the section. Each test session took on average of 5 minutes.[7]

4.2.1.1 Period of Data Collection

The period of data collection was short. It was carried out in 28/ Feb/ 2015 from 10:30 am to 9:45 pm by using Tobii eye-tracking Lab at the SDS Associates SDN BHD.

[7] The details of calibration procedures could view in Appendix B.

4.2.2 Segmentations

The segmentation process is the first step of the gaze information demonstration stage. Segmentation is the mechanism of dividing the frame of video into multi scenes. It is used to identify the area of interest AOI in the video for ease of analysis based on the aim study. Therefore, the video recorded was exported into AVI format and divided manually into 66 scenes-second based in order to extract the AOI statistics for gaze matrix analysis. The choreographic dance video, (totaling approximately 83 seconds), was segmented depending on the dance style into two sections the common folk style section and the mutilation style section. Dark, far and frequent scenes were not selected in this study, thus the total approximately time of the scenes was 66 seconds, section one consisted of 33 scenes started from the time 00:09 second to 00:42 second as shown in Figure 4.2, and section two consisted of 33 scenes started from 00:44 second to 00:83 second as shown in Figure 4.3.

Actually, the researcher selected Tajwal video and divided it to two sections using Tobbi software segmentation metric for the following reasons:

a) It contains sufficient provocative styles of dance movements to attract attention.
b) Its nature as is an emotional stimulus makes it better than neutral stimuli for attention inquires.
c) It matches with the dynamic event purposes of this study.
d) It an open accesses video.
e) The total time of the video was 83 seconds.
f) Scenes were divided into two sections. This is to help in reducing the frequency while using high time segmentations.
g) The 33 seconds in both sections (section one and section two) are used to fill the criteria of modular design for mod 34 of gist and space properties.

Figure 4.2: Segmentations of section one into 33 scenes/second based in this study.

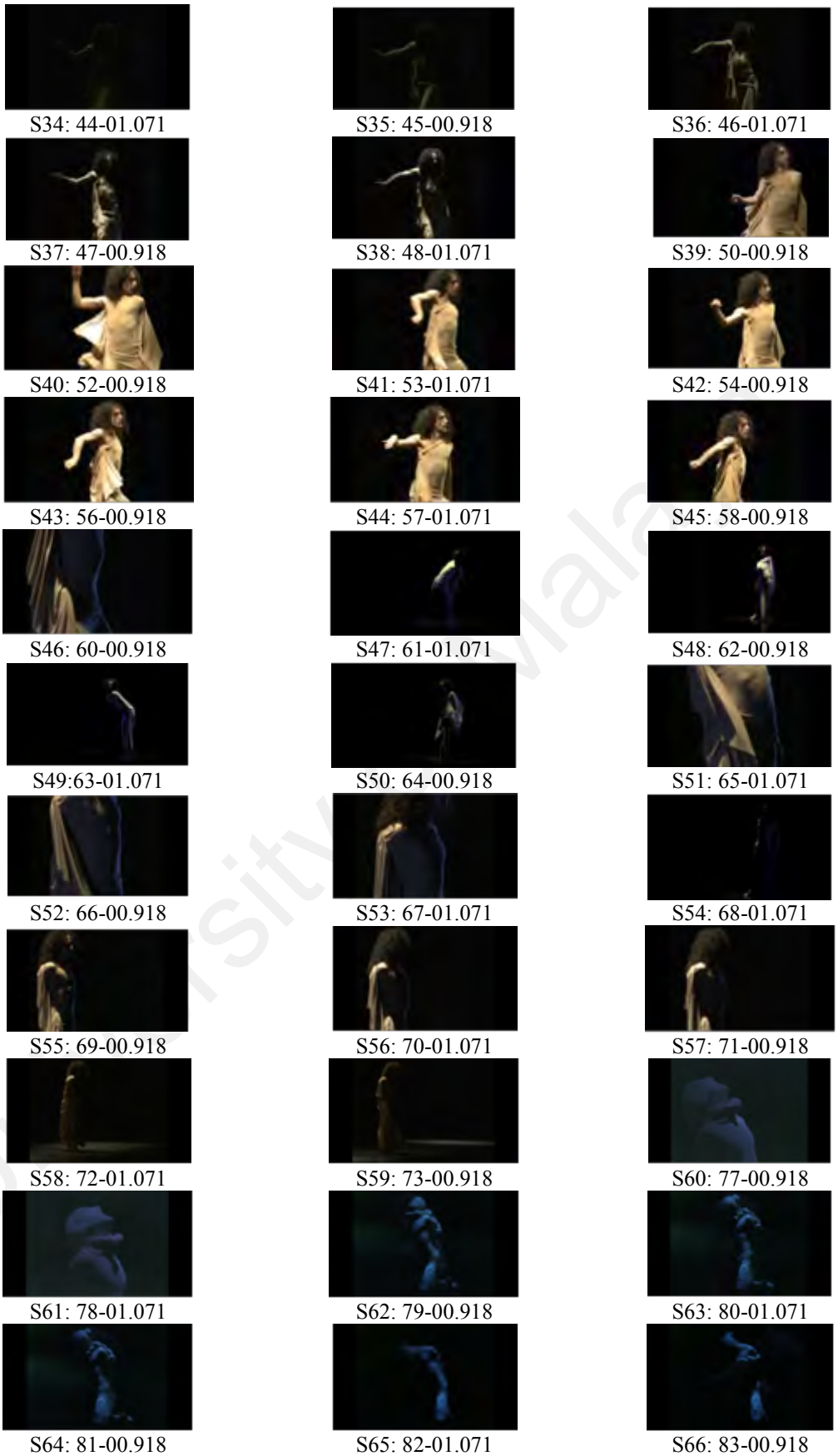


Figure 4.3: Segmentations of section two into 33 scenes/second based in this study.

4.2.3 Area of Interest AOI Selection

The area of interest AOI is the second step of the coherence features demonstration stage. AOI model is a tool through which the area of interest within any stimuli.is defined for quantifying the gaze data on a higher level. It is important to note here that the dance styles are selected only to ensure grabbing the attention for the depiction purpose. Thus, selecting of the AOI-full body movements based is considered as a useful selection which reduced complexity beyond depiction. Therefore, AOI was defined based on the selecting of the full body movement for section one as shown in Figure 4.4 and for section two in Figure 4.5. Two types of AOI analyses, AOI/gaze metric elicitation, and pattern/gaze metric elicitation were performed.

A Tobii Studio^{TM} software model was run to export eye movement measures for the selected area of interest AOI within the sections (Tobii, 2011). AOI was used as a fixed factor and participant, scene, fixation width, and fixation length was used as dependent variables. A model offers a comprehensive platform analysis set for useful interpretation, comparison, and visualisation of eye gaze data, human behavior, and user responses to various purposes. Furthermore, it provides an intuitive workflow for easily eye tracking processed, combining advanced instruments, supporting a large variety of stimuli, and allow for both large and small studies to be carried out in a timely and cost-efficient way, without the need for extensive training.

Figure 4.4: Full body is selected as area of interest AOI for the section one from AOI 1 to AOI33.

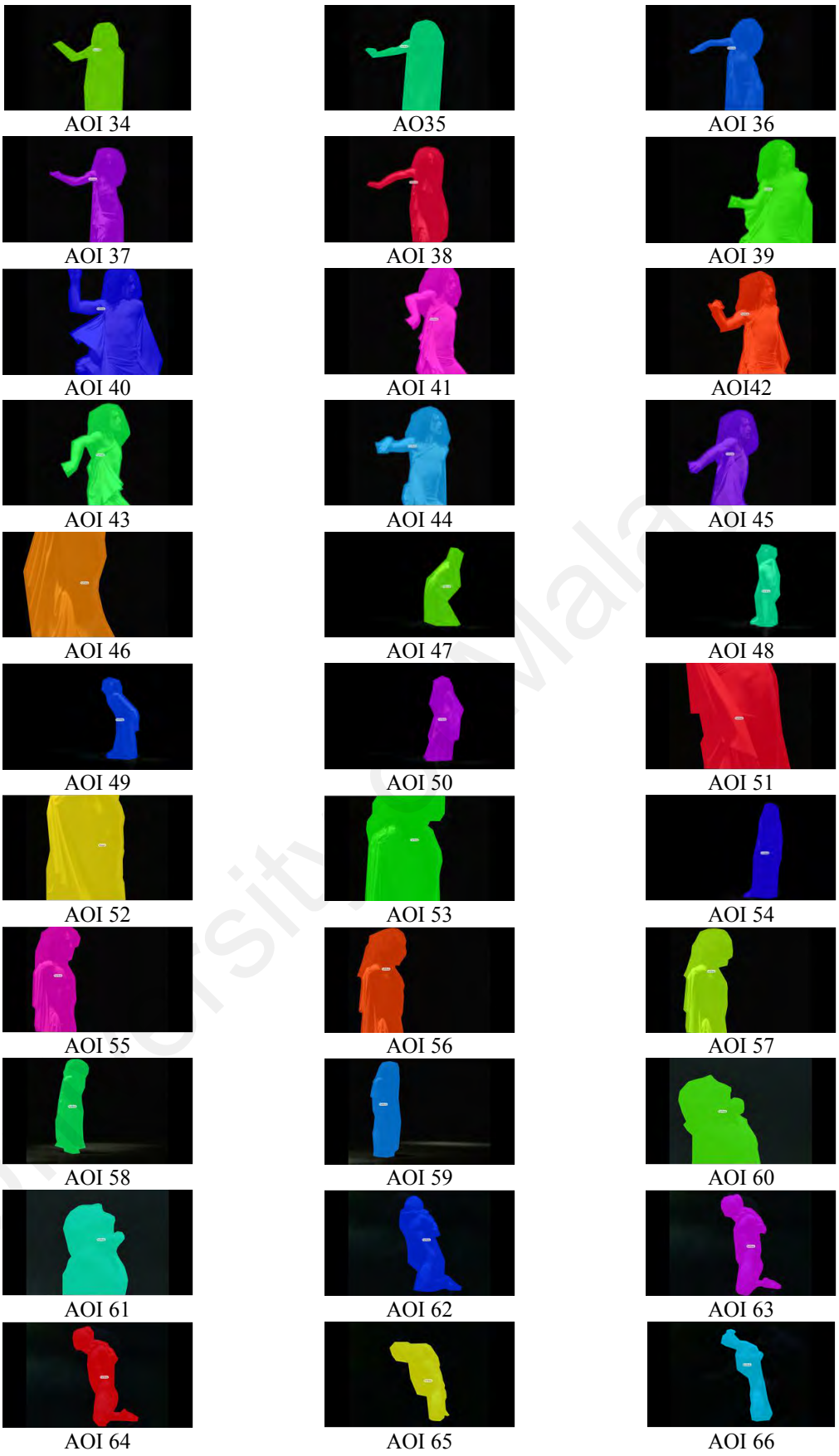


Figure 4.5: Full body is selected as area of interest AOI for the section two from AOI 34 to AOI66.

4.3 Experimental Results and Analysis

4.3.1 Descriptive Variables Profile for Gaze data

In line with the eye-tracking procedure, sections included the (66) scenes from the dance video. Gaze data variables were divided into two profiles, namely, fixation count, and fixation length. Gaze data statistics were also divided into statistics, namely, AOI/gaze elicitation analysis, and AOI/pattern elicitation analysis. Two categories of features of gaze are presented, fixation count and fixation length in this section.

4.3.1.1 AOI/gaze Elicitation Analysis per Section

(a) ***Results of Notability of scene***

The percentage of participants fixating on a scene refers to whether the noticeable scene is seen or not by the participants. In this study, AOI indicates the selection of the whole body movement for each scene-second based. Therefore, the more participants fixated on an AOI, the more interest was that scene overall. A participant who had at least one fixation in a given scene was also counted (Poole & Ball, 2006).

Results of gaze on AOI shows that all AOI was seen in section one as presented in Figure 4.6.

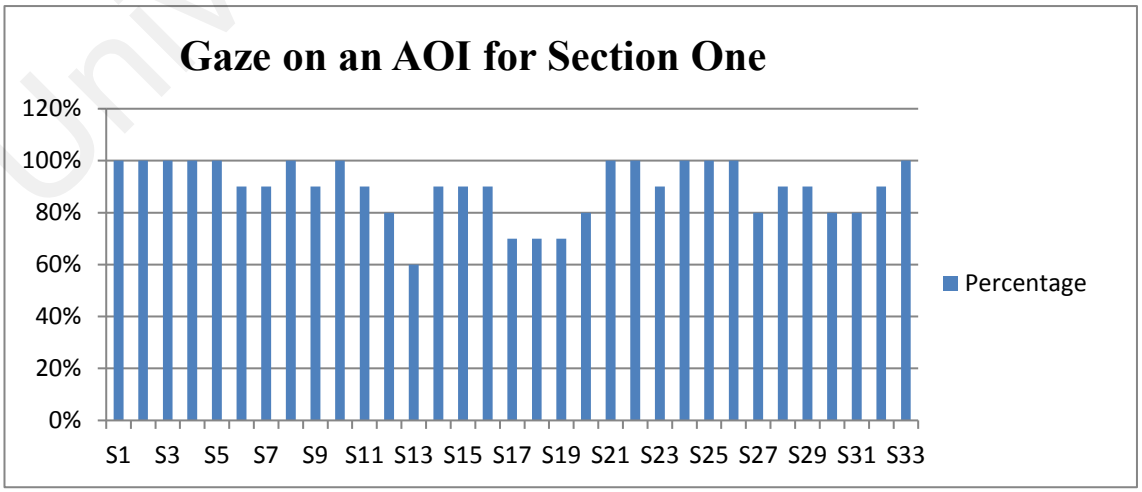


Figure 4.6: Fixation Percentage of Participants who had at least one Fixation On the Scene Of AOI in Section One.

The results showed that all the participants (100%) had at least one fixation and noticed thirteen scenes of dance styles in S1, S2, S3, S4, S5, S8, S10, S21, S22, S24, S25, S26, and S33 (Figure 4.7a). Additionally, a total of nine of participants (90%) had at least one fixation and noticed eleven scenes in S6, S7, S9, S11, S14, S15, S16, S23, S28, S29, and S32 (Figure 4.7b). Moreover, 8 participants (80%) had at least one fixation and noticed five scenes in (S12, S20, S27, S30, and S31) as shown in Figure 4.7c, while 7 participants (70%) had at least one fixation and noticed three scenes in S17, S18, and S19 (Figure 4.7d). Figure 4.7e shows that six participants (6%) had at least one fixation and noticed only one scene in (S13).

These results referred to section one: common folk dance style.

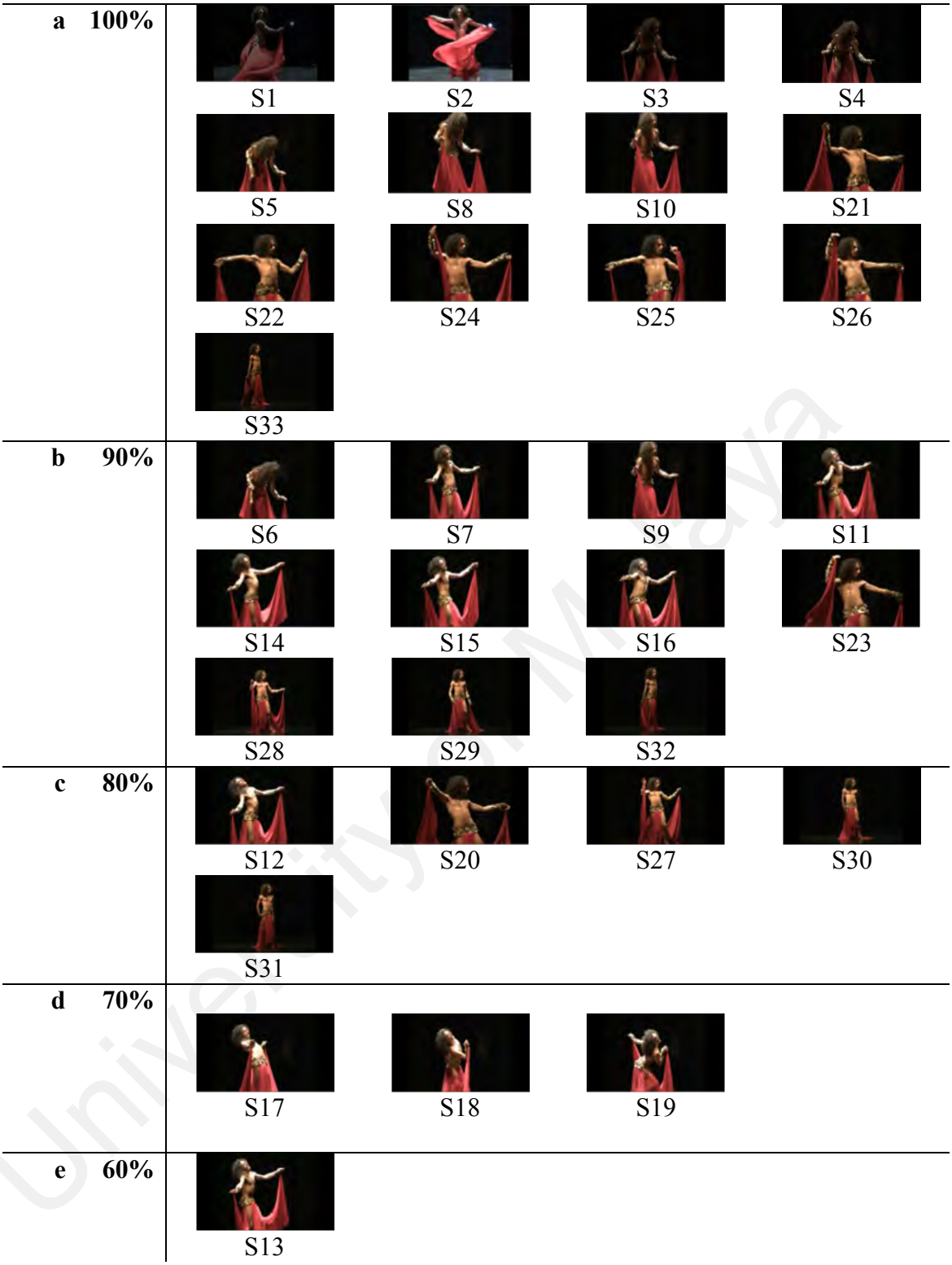


Figure 4.7: Fixation percentage of participants who had at least one fixation on the scene of AOI in section one. a) 13 scenes were noticed by ten participants, b) 11 scenes were noticed by nine participants, c) 5 scenes were noticed by eight participants, d) 3 scenes were noticed by seven participants, and e) only one scene was noticed by six participants.

Figure 4.8 showed the results of fixation percentage of participants who had at least one fixation on the scene of AOI in section two, uncommon mutilation dance style.

Figure 4.9a showed that the results revealed that all the participants (100%) had at least one fixation and noticed five scenes in S46, S59, S61, S63, and S64, nine participants (90%) had at least one fixation and notices fourteen scenes in S35, S37, S38, S39, S40, S41, S42, S48, S49, S51, S52, S54, S56, and S57 as shown in Figure 4.9 b, eight participants (80%) had at least one fixation and notices nine scenes in S34, S44, S47, S50, S53, S58, S62, S65, and S66 as shown in Figure 4.9c,, seven participants (70%) had at least one fixation and noticed three scenes in S36, S43, and S45 as shown in Figure 4.9 d,, six participants (60%) had at least one fixation and noticed only one scene in S55 Figure 4.9 e, and five participants (50%) had at least one fixation and noticed only one scene in S60 as shown in Figure 4.9f.

Examinations of notability showed that all scenes in the folk common dance style and uncommon mutilation dance style were attended by all participants.

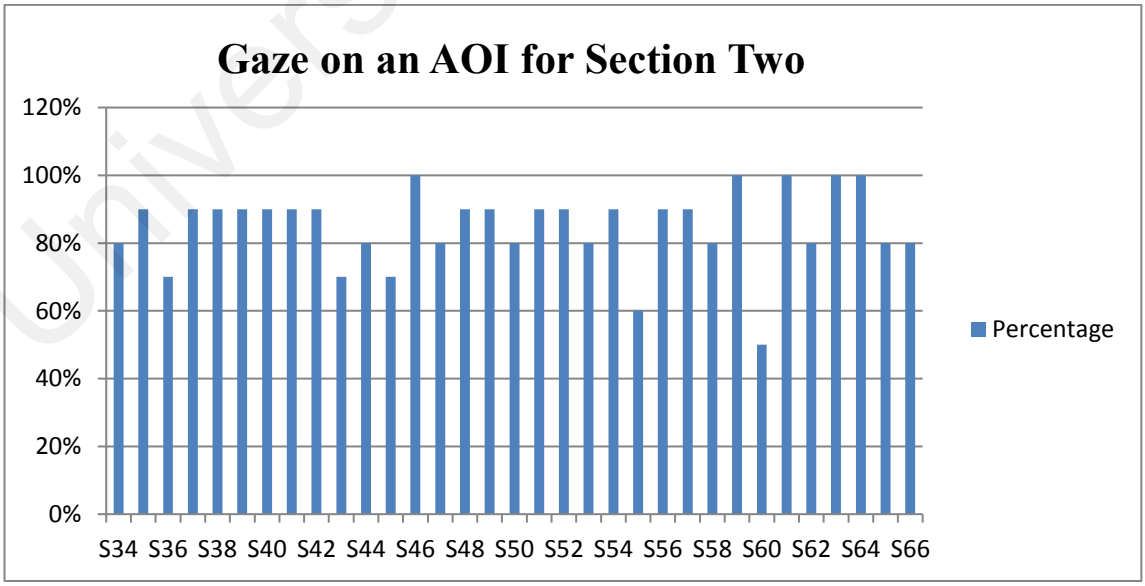


Figure 4.8: Fixation percentage of participants who had at least one fixation on the scene of AOI in section two.

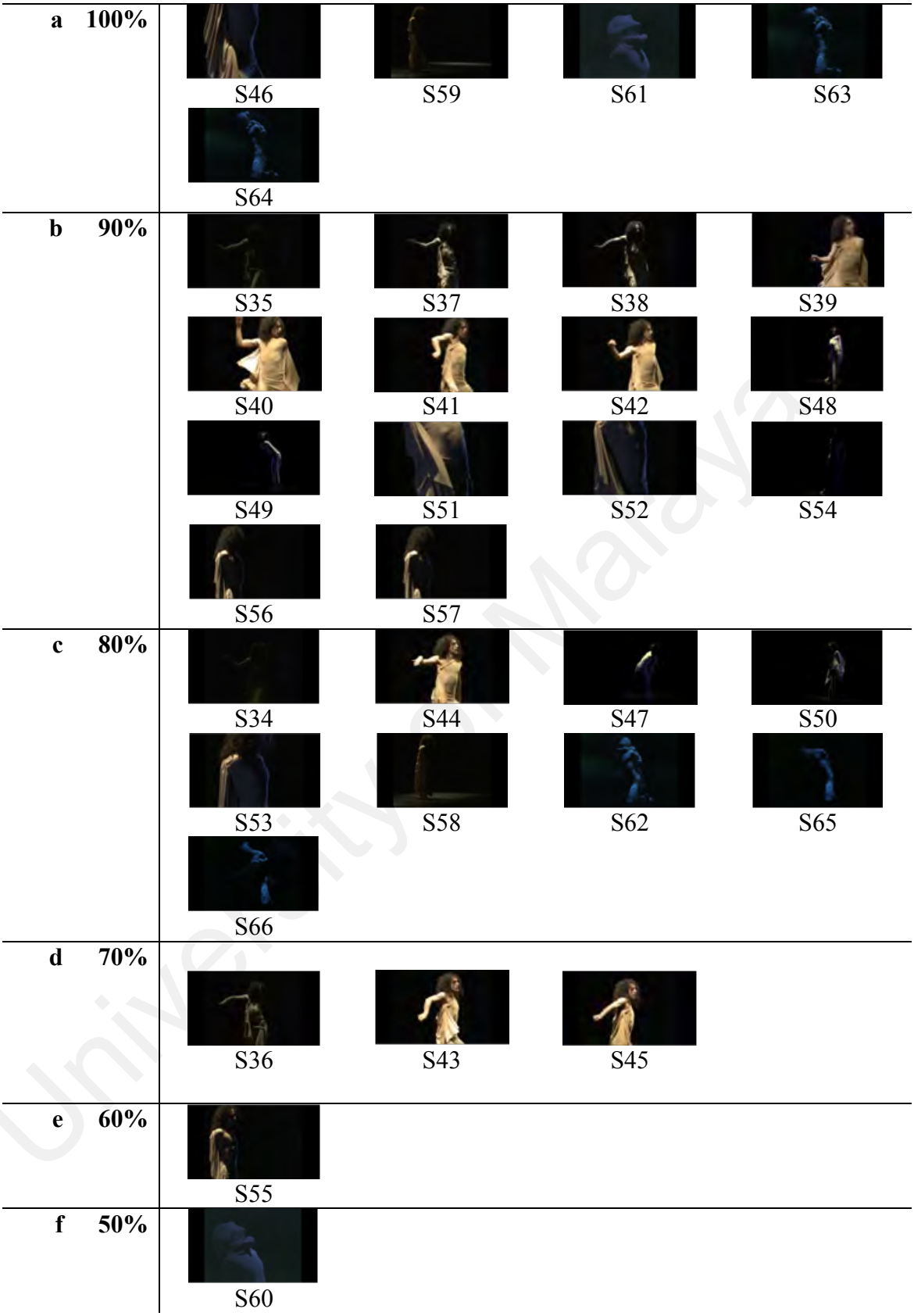


Figure 4.9 continued: Fixation Percentage of Participants who had at least one Fixation on the Scene of AOI in Section one. a) 5 scenes were noticed by ten participants, b) 13 scenes were noticed by nine participants, c) 9 scenes were noticed by eight participants, d) 3 scenes were noticed by seven participants, and e) only one scene was noticed by six participants f) also, one scene was noticed by five participants.

(b) ***Basic visual activity per scene***

Two visual factors per section (fixation count metric and fixation length metric) are tested in this study.

Fixation count metric is identified in this study. Information on three features was identified for AOI, fixation count average, fixation count relationships, and fixation count variety. They were to get an overall insight related to the specific case study. Means of fixation count are provided. The numerical data based on AOI/section, the relationships between fixation count and AOI/section is presented based on the correlation analysis, and in the final, the variety of features by T-test in which they are similar or different is also presented. This output is performed to identify the gaze features for the next stage in this study.

The fixation length metric refers to the mental cognitive processing. O'Brien and Carl (2010) defined fixation as the minimum duration in milliseconds and the pixel radius that depending on the setting of the study. This metric means a duration of fixation per AOI correlated positively with some factors refers either to cognitive effort or the difficulty understanding or processes of extracting information by users to that AOI in a computer interface evaluation studies (Goldberg & Kotval, 1999). Also, it indicates the engagement of that AOI in some way in visual art, usability and interactive studied. Thus, the longer the fixation, the more engagement scene the viewer looked to that AOI.

The information of the three analyses, an average of fixation length, AOI relationship, and AOI variety by T-test were identified to get an overall insight into the specific case study. This output is demonstrated to identify the gaze features also for the next stage of depiction.

Table 4.1 presents the descriptive statistical average of visual behavior features per scene.

Table 4.1: Basic visual activity statistics for experimental factors averaged across subjects.

		Common folk dance				Uncommon mutilation dance			
		Fixation Count		Fixation Duration		Fixation Count		Fixation Duration	
Factors		***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***
AOI-Scene	**S1**	2.07	(1.30)	0.27	(0.11)	1.50	(0.73)	0.31	(0.20)
	S2	1.86	(0.79)	0.40	(0.22)	1.88	(1.03)	0.31	(0.19)
	S3	1.74	(0.81)	0.34	(0.23)	1.93	(0.96)	0.37	(0.32)
	S4	1.75	(1.27)	0.33	(0.21)	1.74	(0.73)	0.36	(0.17)
	S5	1.35	(0.67)	0.49	(0.31)	1.71	(0.86)	0.40	(0.21)
	S6	2.00	(1.03)	0.28	(0.15)	1.65	(0.75)	0.26	(0.08)
	S7	1.76	(0.89)	0.33	(0.20)	1.91	(1.04)	0.29	(0.11)
	S8	1.68	(0.89)	0.47	(0.32)	2.08	(1.10)	0.35	(0.26)
	S9	1.90	(0.79)	0.36	(0.24)	1.74	(0.87)	0.36	(0.25)
	S10	2.19	(1.40)	0.31	(0.23)	1.78	(0.65)	0.38	(0.12)
	S11	1.33	(0.49)	0.38	(0.32)	1.89	(0.96)	0.45	(0.28)
	S12	1.92	(1.12)	0.35	(0.22)	1.67	(0.65)	0.39	(0.27)
	S13	1.69	(0.95)	0.42	(0.29)	2.10	(0.89)	0.32	(0.16)
	S14	1.76	(1.00)	0.50	(0.32)	1.80	(1.20)	0.45	(0.32)
	S15	1.94	(1.25)	0.36	(0.22)	1.37	(0.83)	0.43	(0.26)
	S16	1.90	(0.85)	0.36	(0.22)	1.74	(0.93)	0.31	(0.16)
	S17	1.69	(0.87)	0.32	(0.28)	1.38	(0.50)	0.42	(0.24)
	S18	1.40	(0.63)	0.36	(0.23)	2.42	(0.77)	0.37	(0.14)
	S19	1.65	(0.99)	0.38	(0.29)	2.56	(0.86)	0.27	(0.10)
	S20	1.84	(1.07)	0.31	(0.18)	2.62	(1.19)	0.26	(0.08)
	S21	2.42	(1.14)	0.35	(0.11)	2.00	(1.15)	0.46	(0.26)
	S22	1.62	(0.74)	0.53	(0.31)	1.00	(0.00)	0.08	(0.04)
	S23	2.00	(1.11)	0.30	(0.18)	1.62	(0.80)	0.48	(0.20)
	S24	1.50	(0.83)	0.41	(0.30)	1.38	(0.62)	0.55	(0.29)
	S25	2.05	(0.84)	0.41	(0.24)	1.94	(1.30)	0.41	(0.27)
	S26	1.89	(1.02)	0.38	(0.28)	1.47	(0.61)	0.47	(0.26)
	S27	2.05	(1.22)	0.38	(0.25)	1.38	(0.52)	0.65	(0.34)
	S28	2.00	(1.00)	0.38	(0.22)	2.95	(1.07)	0.29	(0.09)
	S29	1.32	(0.58)	0.38	(0.30)	1.72	(0.96)	0.29	(0.18)
	S30	1.91	(1.08)	0.33	(0.20)	1.96	(1.08)	0.33	(0.17)
	S31	1.63	(0.96)	0.54	(0.33)	1.81	(0.98)	0.26	(0.12)
	S32	1.88	(1.15)	0.32	(0.15)	2.06	(0.87)	0.37	(0.10)
	S33	1.57	(1.16)	0.30	(0.22)	1.70	(0.92)	0.35	(0.26)

AOI-scene, area of interest on body movement-second based; AOI-section.
Significant level α=0.05.

(c) ***Results of Fixation behavior per section***

Table 4.2 presents the descriptive statistical average, correlation, and t-test of visual behavior features per section.

Table 4.2: Basic visual activity statistics for experimental factors averaged across subjects.

	Common folk dance				**Uncommon mutilation dance**			
Factors	**Fixation Count**		**Fixation Duration**		**Fixation Count**		**Fixation Duration**	
AOI-Section	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***	***Mean***	***SD***
Average	0.9	(0.14)	2.2	(0.60)	0.85	(0.18)	1.9	(0.6)
Correlation p-value	0.019		0.019		0.003		0.003	
t-test p-value	0.25				0.04			

AOI-section, area of interest on body movement-total seconds based.
Significant level α=0.05.

i Average of Fixation

The average fixation count of AOI was expressed (mean ± SD). Means of fixation count on a particular AOI should indicate the importance or interest of that area of interest AOI to a participant (Prasse, 2011). Thus, the high fixation count reflects the importance or interest of that scene more than how attention clutching. In general, the no difference in the means of the fixation count data indicated that the AOI had wide but no important different dispersal fixations count between sections.

Table 4.2 shows that the AOI results of scenes in section one, on average, slightly had fixations (0.9± 0.14) *ms* as same as the scenes in section two (0.85±0.18) *ms*, (participants were 10, five men and five female aged from 23 to 32 years).

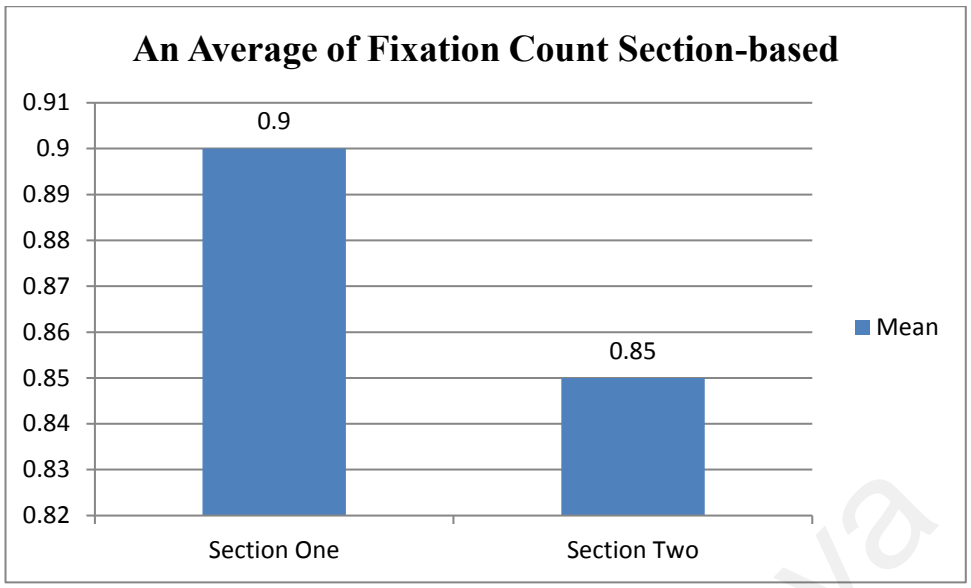


Figure 4.10: Colum graph of an average of fixation count based on sections. The mean in section one, on average, slightly had (0.9± 0.14) *ms* as same as the mean in section two (0.85±0.18) *ms.*

The Column graph of an average of fixation count showed that the mean in section one, on average, slightly had (0.9± 0.14) ms as same as the mean in section two (0.85±0.18) ms. Therefore, the AOI in section one was slightly interested like the AOI in section two as shown in Figure 4.10.[8]

The average of fixation Length of AOI was expressed (mean ± SD). Means of fixation length on a particular AOI should be indicative of the attraction of that area of interest AOI to a participant. Indeed, fixation of length zero does not represent in inclusions of the software Tobii studio™. So, this metric is limited only to that particular AOI had at least one fixation fixated by the viewer (Poole & Ball, 2006).

The results show in Table 4.2, when observing the average fixation length across all AOI based on sections, it appears that the average of fixation length is much higher per

[8] The details of descriptive frequency distribution and percentages table results and charts could view on Appendix D.

AOI in section one (2.2 ± 0.6) *ms* than AOI in section two (1.9± 0.6) *ms*, (Participants were 10, five men and five female aged from 23 to 32 years).

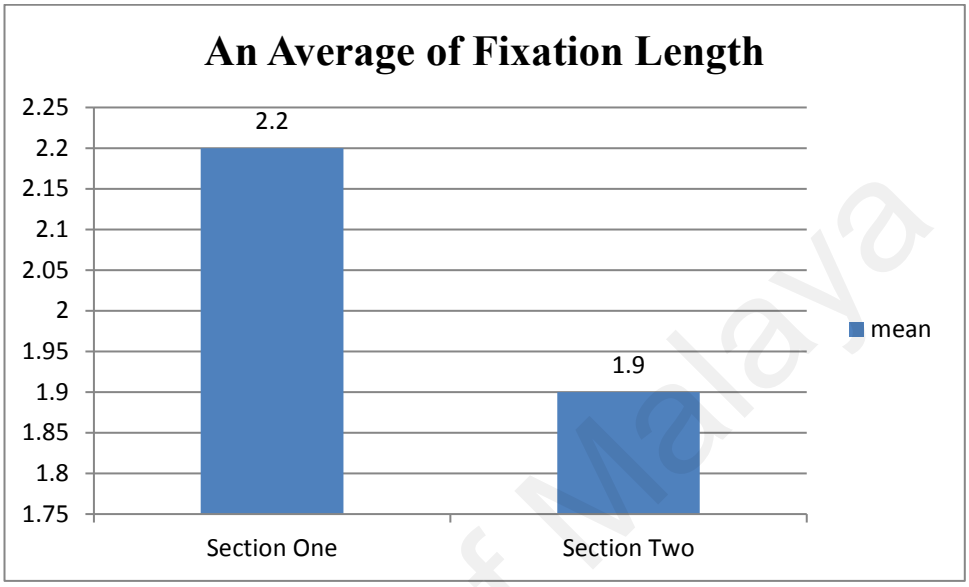


Figure 4.11: Colum graph of an average of fixation length based on sections. The results appear that the means of fixation length is much higher in section one (2.2 ± 0.6) *ms* than the means in section two (1.9± 0.6) *ms*.

Therefore, as shown in the Column graph in Figure 4.11[9], the means of fixation length are higher in section one than section two.

ii Fixation Relationships based on sections.

Hypothesis testing for the correlation of fixation count between sections:

H0: There is no correlation (positively or negatively) of the fixation count between section (1) and section (2) for AOI.

[9] The details could be found in Appendix D.

H1: There is a correlation (positively or negatively) of the fixation count between section (1) and section (2) for AOI.

Results showed that there is a positive relationship between sections of fixation count as shown in Table 4.2.

The correlation of fixation count between sections was referred to the AOI interest relationship. The correlation test between variables shows that there is a strong positively correlation in fixation count between section (1) and section (2) with correlation coefficient $r = 0.721$ since $p\text{-}value = 0.019$ less than significant level $\alpha=0.05$, which means that the Interest was in a relationship between sections and as presented in Table 4.2.

Hypothesis testing for the correlation of fixation length between sections:

H0: There is no correlation (positively or negatively) of the fixation length between section (1) and section (2) for AOI.

H1: There is a correlation (positively or negatively) of the fixation length between section (1) and section (2) for AOI.

In Table 4.2, the correlation between variables is showed that there is a strong positively correlation in fixation length between section (1) and section (2) with correlation coefficient $r=0.824$ since p-value $=0.003$ less than significant level $\alpha=0.05$. It means that the fixation length was in a relationship with AOI.

iii Paired-samples t-test result (Fixation variety)

The variety of fixation count between sections was tested using paired samples t-test. The indicated significant difference at 0.05 of fixation count between sections is referred that the section has various interests. Results show that a paired-samples t-test indicates which scores are not significantly affected between sections as shown in Table 4.2. A paired-samples t-test indicates that scores were not significantly affected between the section one (0.9±0.14) ms and section two (0.85±0.18) ms, $t(9) = 1.22$, $p < 0.05$, $d = 0.25$. The paired sample t-test indicates that $p > 0.05$. Therefore, the null hypothesis cannot be rejected. The paired sample t-test revealed that there is no difference between the fixation counts of AOI in the two sections (Table 4.2). It means that there is no difference of interest in AOI between sections.[10]

The difference of fixation length between AOI based on sections was tested using paired-samples t-test. In Table 4.2, paired samples t-test indicates that scores were significantly higher for the section one (2.2±0.6) *ms* than for the section two (1.93±0.6) *ms,* $t(9) = 2.44$, $p < 0.05$, $d = 0.04$. The Result indicates that $p < 0.05$. Therefore, the null hypothesis can be rejected. The paired sample t-test revealed that there is a relationship between the fixation length and AOI.[11]

4.3.1.2 AOI/Pattern Elicitation Analysis per Section

In the Tobii studio™ software, eye tracking patterns refer to analyse the attention by visual metrics such bee swam, gaze plot, static and dynamic heat map, and cluster. Bee swam is to represent fixation based on participants, gaze plot is for gaze view and order, a heat map was for attention behavior, and cluster refers to a cluster of attention (Olk &

[10] See an Appendix D.

[11] The details could be found in Appendix D.

Kappas, 2011). The researcher selected the heat map in this study. The static heat map was used to observe the behavior of attention whether much or less and in which area for each scene. Results of visual analyse for each section were presented to get a deep insight for tracing the real biological shapes.

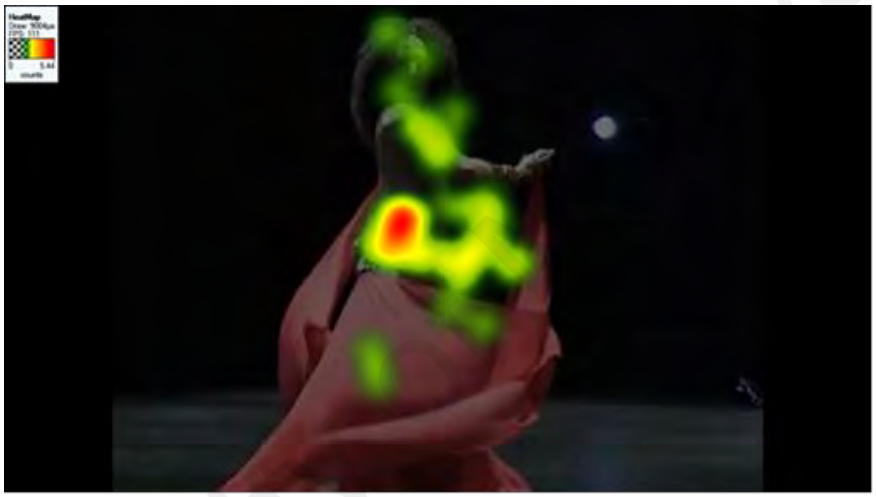
(a) ***Visual data results for attention per section***

There are many fixations in all scenes in general. In section one, heat map in the first scene (S1) showed that their attention is attracted to the motion of the (ribcage and torso), and to low-level visual features such as dark contours and shadows on the torso/ribcage. All of that is much more attention-grabbing than a uniformly-colored sheet of cloth for example as shown in Figure 4.12.[12]

It presented two pictures, Area of interest AOI and Heat map pattern analysis for S1. a) The area of interest AOI shows that the full body is selected as AOI. b) Heat map shows that their attention is attracted to the motion of the ribcage and torso in this study.

[12] Similar cases could view in Appendix E.

a)

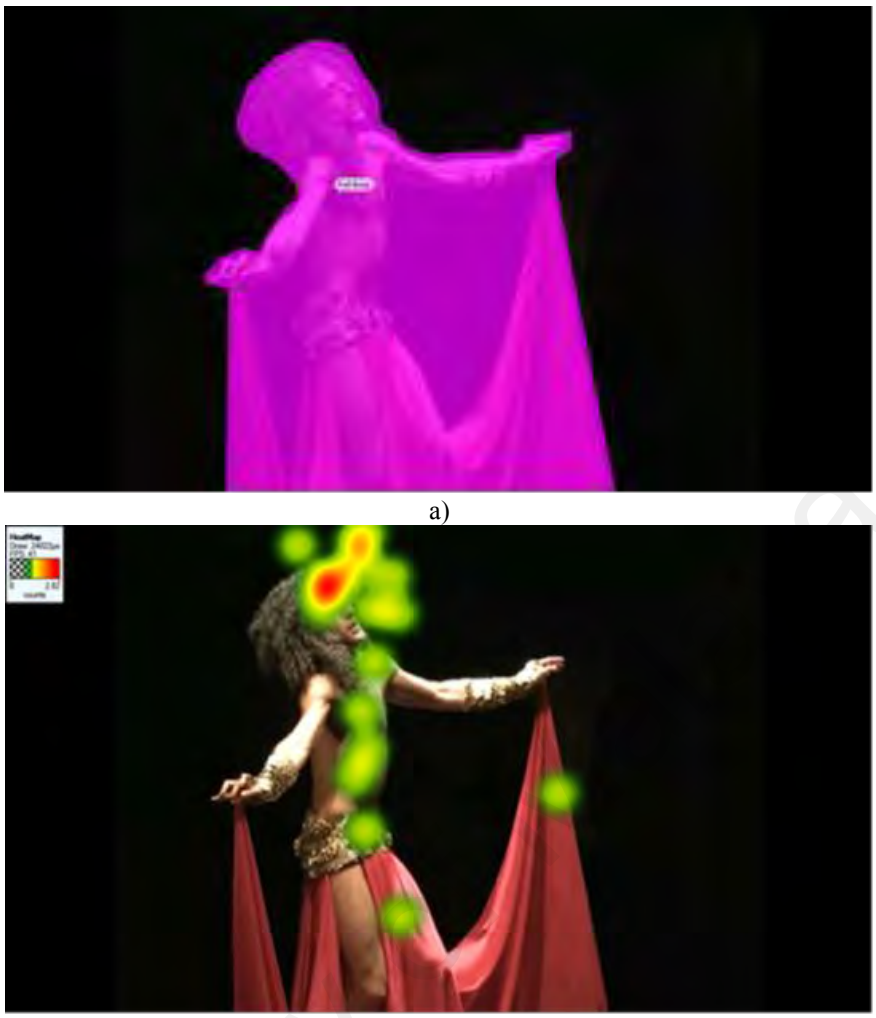


b)

Figure 4.12: The Visual Pattern Analysis for Scene S1.

Interestingly, the motion of head is attended more than other parts in the most of scenes in section one: S3, S4, S7, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S18, S20, S21, S22, S23, S24, S25, S26, S28, S29, S30, S31, and S33[13], see the example in scene S11. Figure 4.13 showed that the most of participants had at least one fixation and attended to the motion of head than other parts on an AOI.

[13] See Appendix E



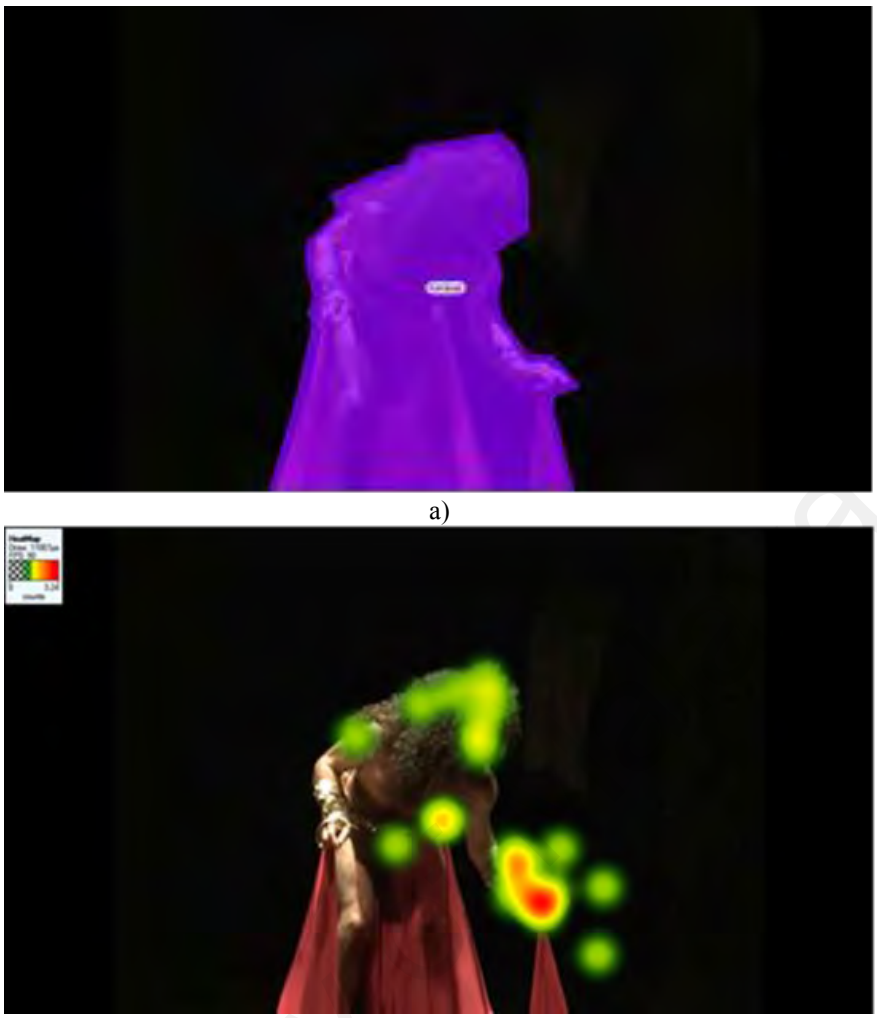
a)

b)

Figure 4.13: The visual pattern analysis in the scene S11.

It presented two pictures; area of interest AOI and Heat map pattern analysis for section one. a) The area of interest AOI shows that the full body is selected as AOI. b) Heat map shows that their attention is attracted to the motion of the head in this study.

The most of attention is attracted to the hand in both scenes five and six. In Figures 4.14, heat map for S5 showed that the motion of the left hand is the most noticeable area from participants. Also, attention attracted to low level visual features such as dark contours and shadows on the torso/ribcage, head, torso/waist, and area around the hand.



a)

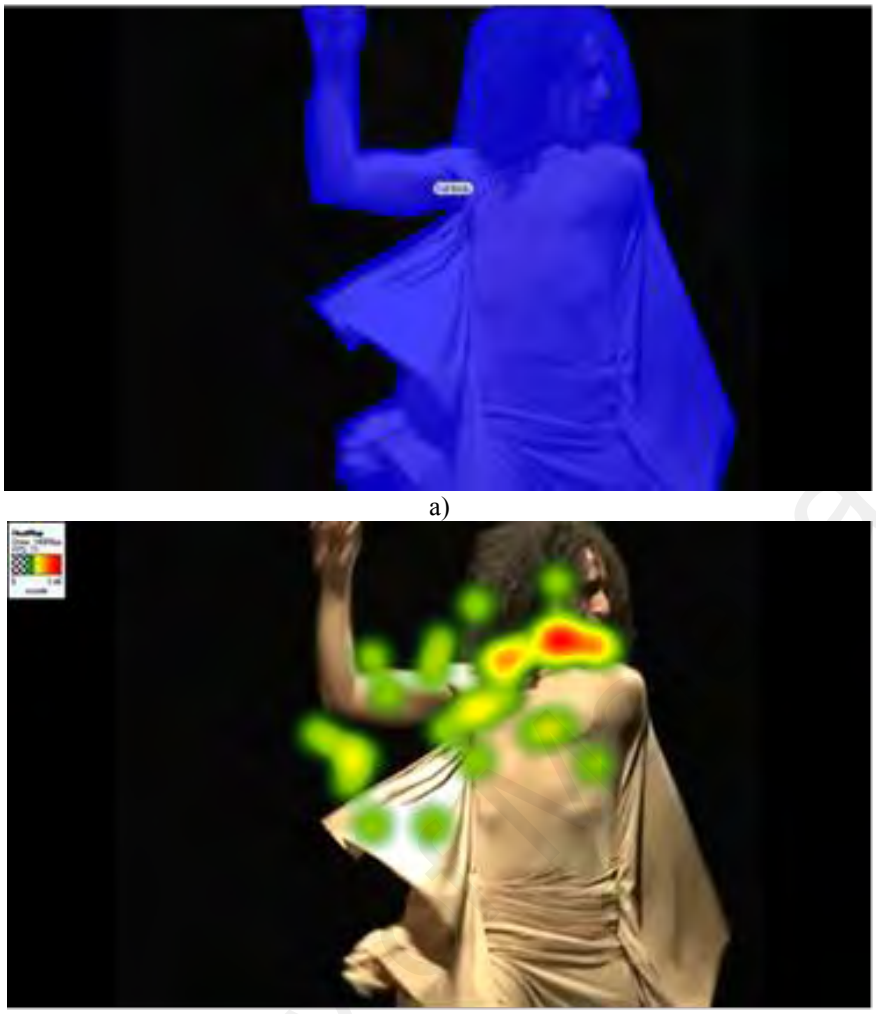
b)

Figure 4.14: The visual pattern analysis in the scene S5.

It presented two pictures; Area of interest AOI and Heat map pattern analysis for S5. a) The area of interest AOI shows that the full body is selected as AOI. b) Heat map shows that their attention is attracted to the motion of the head in this study.

In section two, the motion of the head, torso/ribcage, and hand were received more attention in the scenes for S34, S36, S37, S39, S40, S41, S42, S44, S45, S50, S35, S54, S57, S60 and S61than other scenes. The examples of head motion of heat map for S40 and S53 are presented in Figure 4.15 and Figure 4.16.[14]

[14] See other cases could view in Appendix E.



a)

b)

Figure 4.15: The visual pattern analysis in the scene S40.

Figure 4.15 presented two pictures; Area of interest AOI and Heat map pattern analysis for S40. a) The area of interest AOI shows that the full body is selected as AOI. b) the heat map shows that their attention is attracted to the motion of the head in this study.

a)

b)

Figure 4.16: The visual pattern analysis in the scene S53.

However, Figure 4.16 presented two pictures; Area of interest AOI and Heat map pattern analysis for Scene S53. a) The area of interest AOI shows that the full body is selected as AOI. b) the heat map shows that their attention is attracted to the motion of the head in this study.

Briefly, the gaze of participants showed that their attention most often attracted to the motion of the head and then hand in both sections, folk dance style/section one and evoking mutilation style/section two. However, the torso/waist and torso/ribcage are less attended.

4.3.2 Gaze Features Output

Based on the result of this study, gaze features by the exporting of fixation matrix output are obtained for the next resembling process as shown in Table 4.3.

Table 4.3: Gaze features outcomes for the next resemblance stage.

Fixation matrix features	AOI	AOI Outcomes		
		Quantity	Quality	
			Relationship	Variety
Fixation count	Section one	***X*** descriptive numerical data Output	Positive	Slightly similar short of widths
	Section two			
Fixation length	Section one	***Y*** descriptive numerical data Output	Positive	High different longs of heights
	Section two			

The output shows that positive relation of the fixation matrix feature based on AOI enables to utilize both metrics, fixation count and fixation length as resemble elements for visualising of the physical properties in Chapter 5. Therefore, the numerical data set of both metrics will be inserted as pre-data of resemblance using modular pattern design. The variety of gaze features between AOI proved that the shapes of patterns will appear in slightly similar short widths and various lengths of heights in the next stage.

4.4 Chapter Summary

This chapter discusses a contribution that presents a guideline for recognizing and then demonstrating the gaze features of visuospatial attention by utilizing fixation matrix feature, extracted from a dance video. Analyses performed in this thesis have identified that the data of gaze features are categorized into quantity data set feature and quality features of interest and attraction. In light of the finding of this section, the employment of fixation matrix feature has been determined to be a valuable procedure in identifying the coherence features of attention for the hybrid pictorial source domain.

CHAPTER 5: PHYSICAL PROPERTIES RESEMBLANCE

This chapter presents the pattern modular arithmetic design procedures which are divided into three main sections: the brief introduction is presented in the first section (section 5.1), the proposed second stage, physical properties resemblance using the additional table operation logic is applied in the second section (section 5.2), and finally, outcomes of visuospatial attention patterns resembled is presented in the third section (section 5.3). It is creatively essential for the outcomes to be displayed rationally in order to deal with the statements comprehensively so as to be consistent with the research questions.

5.1 Introduction

In this section, the contribution that is an art-mathematical collaboration framework and visualisation outcomes of a creative DRS practices for the hybrid visuospatial attention depiction is applied. The second stage of DRS, physical properties resemblance employed the Pattern modular arithmetic logic design for the visualisation for the demonstration of visuospatial attention in a choreographic dance video. This key contribution is in how to serve the operation table mode as a second-order isomorphism of transparency for the hybrid pictorial resemblance domain. The advantages are the tough and verity to visualise the specific case in a simple resembles mathematical processes for pattern design of hybrid artworks. Thus, making table operation mod as an applicable visualisation technique for producing hybrid artwork purposes of invisible and cognition phenomena compared to other mathematical mimics approaches proposed in (Yoon Young et al., 2016; Krauß,2015), and other experimental approaches proposed in (Randerson et al., 2015; Linnell, 2010). Therefore, additional table mod operation is utilized in this project.

5.2 Physical Properties Resemblance Stage

In this stage, physical properties resemblance refers to the resembled visual properties based on additional table mod operation for answering the third question of this research study. This is to visualise the patterns-section based of the visuospatial attention for the next creative section, pictorial aspects synthesise stage. The procedures of this proposed stage; table symbols definition, width and height data set input, and physical properties operation is applied. Therefore, nine properties are visualised width, height, color, patterns, frame, object, gist, space, and form for the hybrid visuospatial attention portray.

5.2.1 Table Symbols Definition

The table symbols definition is the first step of the resemblance stage. Symbols are defined based on the requirements of table mod operation using the color semantic method. It used to convert the numerical data set of fixation matrix feature of gaze into physical properties. The researcher selected three basic colors red, black and white to resemble the physical properties from the exported output of fixation matrix feature of coherence. The model of color (R,G,B) is used to define the colors red (255, 0, 0), black (0, 0, 0) and white (255, 255, 255).

Based on the positive correlation results between fixation matrix features and sections in the previous chapter, the researcher decided to do her visualisation through converting the fixation matrix, fixation count metric into the width of attention by the symbol ***X,*** and transferring the fixation length metric into the height of attention by the symbol ***Y***. Therefore, the proposed physical properties are defined in this research as shown in Table 5.1:

a) The width of attention ***X***: is an integer of fixation count number, (***X*** = fixation count ***n***).
b) The height of attention ***Y***: is an integer of fixation length number, (***Y*** = fixation length ***n***).

c) Color ***C***: is a selected basic color through RGB model with defining the values based on an equal number value.

d) Pattern ***P***: is a mod of color table operated based on the number of values of fixation count (***P*** = fixation count mod***n*)**.

e) Frame ***F***: is a frame of the pattern through the semantic coordinate system (***X, Y***).

f) Time ***T***: is an order of patterns based on the scene time orders, (***T*** = Pattern order).

g) Gist ***G***: is a mod of color table operated based on the total number of scene plus one (***G*** = scene $\text{mod}_{\text{color}}$ ***n***+1**)**.

h) Space ***S***: is a mod of gray table operated based on the total number of scene plus one (***S*** = scene mod_{gray}***n***+1**)**.

i) Form ***F***: is a combination of physical properties in this visualisation study.

Table 5.1: Physical properties symbol definition in the proposed stage by researcher.

Property	Symbol	Pictorial Reference	Pictorial Transparence
Width	X	Fixation count	X = fixation count n
Height	Y	Fixation Length	Y = fixation length n
Pattern	P	Fixation count	P = fixation count mod$n$.
Color	C	RGB model	Black: (0,0,0) White: (255,255,255) Red: (255,0,0) Values RGB-20
Frame	F	Fixation count and duration	Semantic Coordinate System (X, Y).
Time	T	Scene Time Order	T = Pattern order
Gist	G	Pictorial meaning based on section style	G = scene $\text{mod}_{\text{color}}\boldsymbol{n}$+1
Space	S	Section mods	S = scene $\text{mod}_{\text{gray}}\boldsymbol{n}$+1
Form	F	Physical properties	Physical Properties Combination

5.2.2 Width X and Height Y Data Set Input

The data set input is the second step in the physical properties resemblance stage. It refers to the width and length X, Y input data for visualising project. Therefore, the X and Y data is

input per section in this step. Data set input of width and length features for section one is presented in Table 5. 2.

Table 5.2: Data set input of width and length features for section one.

	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
X	10	10	10	10	9	9	10	9	10	9
Y	36	22	23	30	16	25	22	19	22	31
	S11	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S18**	**S19**	**S20**
X	8	6	9	9	9	9	7	7	8	10
Y	12	14	17	20	24	21	16	12	18	25
	S21	**S22**	**S23**	**S24**	**S25**	**S26**	**S27**	**S28**	**S29**	**S30**
X	10	9	10	10	10	8	9	9	8	8
Y	31	17	27	22	24	22	24	23	14	24
	S31	**S32**	**S33**							
X	9	9	10							
Y	17	25	21							

Data set input of width and length features for section two is presented in Table 5. 3.

Table 5.3: Data set input of width and length features for section two.

	S34	**S35**	**S36**	**S37**	**S38**	**S39**	**S40**	**S41**	**S42**	**S43**
X	8	9	7	9	9	9	9	9	9	7
Y	14	23	15	17	22	20	24	26	19	16
	S44	**S45**	**S46**	**S47**	**S48**	**S4**	**S50**	**S51**	**S52**	**S53**
X	8	7	10	8	9	9	8	9	9	8
Y	18	13	25	20	16	21	14	23	23	27
	S54	**S55**	**S56**	**S57**	**S58**	**S59**	**S60**	**S61**	**S62**	**S63**
X	9	6	9	9	8	10	5	10	8	10
Y	22	6	19	15	19	16	7	32	19	28
	S64	**S65**	**S66**							
X	10	8	8							
Y	23	20	18							

5.2.3 Physical Properties Operation

5.2.3.1 Color

Color property is defined using RGB color model. Three manual selection of basic colors black which expressed (R:0, G:0, and B:0) value, white (R:255, G:255, and B:255) and red

(R=255, G=0, B=0). An equal distance between red values is defined (R255–20, G=0, B=0), (Table 5.4).

Table 5.4: Color property identification based on GRB color model.

Black			White			Red			Red values		
R	G	B	R	G	B	R	G	B	R	G	B
0	0	0	255	255	255	255	0	0	R-20	0	0

5.2.3.2 Patterns

Pattern property is a mod of color table operated based on the number of values of fixation count (***P*** = fixation count mod***n*)**, see the example showed in Table 5.5.[15]

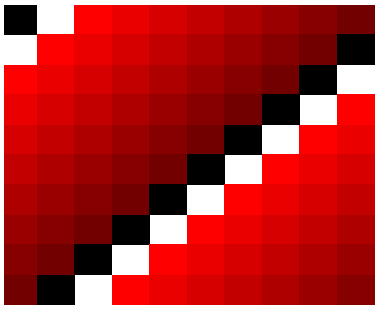
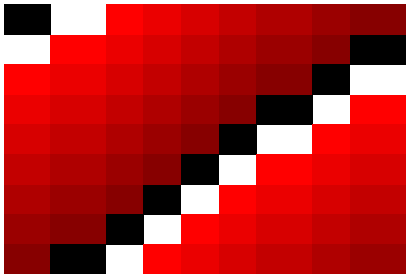
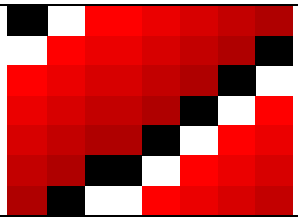
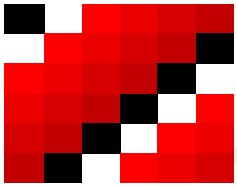
Table 5.5: Pattern *P1*mod 10 operated using an additional table operation. The explored Pattern 1 based on *P1*mod 10 operation is shown in Table 5.6 and Table 5.7.

+	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	R-20	G	B	C	V
0	0	1	2	3	4	5	6	7	8	9	0	0	0		0
1	1	2	3	4	5	6	7	8	9	0	255	255	255		1
2	2	3	4	5	6	7	8	9	0	1	255	0	0		2
3	3	4	5	6	7	8	9	0	1	2	235	0	0		3
4	4	5	6	7	8	9	0	1	2	3	215	0	0		4
5	5	6	7	8	9	0	1	2	3	4	195	0	0		5
6	6	7	8	9	0	1	2	3	4	5	175	0	0		6
7	7	8	9	0	1	2	3	4	5	6	155	0	0		7
8	8	9	0	1	2	3	4	5	6	7	135	0	0		8
9	9	0	1	2	3	4	5	6	7	8	115	0	0		9

The gaze number results of fixation matrix feature showed that there were five values in section one (10, 9, 8, 7, and 6). Thus, five patterns (***P1***mod 10, ***P1***mod 9, ***P1***mod8, ***P1***mod 7, and ***P1***mod 6) are defined in section one as shown in Table 5.6.

[15] The additional table operation for each mod could view in Appendix F1.

Table 5.6: Patterns of section one operated by using an additional table operation. Five values are demonstrated in section one (10, 9, 8, 7, and 6) as labeled in Table 5.2 for ***X*** set. Therefore, five patterns (***P1***mod 10, ***P1***mod 9, ***P1***mod8, ***P1***mod 7, and ***P1***mod 6) are explored based on the same procedure of additional operation table shown in Table 5.5.

Pattern 1: *P1*mod 10	Pattern 2: *P1*mod 9	Pattern 3: *P1*mod 8
		
Pattern 4: *P1*mod 7	Pattern 5: *P1*mod 6	
		

However, six values are explored in section two (10, 9, 8, 7, 6, and5). Thus, six patterns (***P2***mod 10, ***P2***mod 9, ***P2***mod8, ***P2***mod 7, ***P2***mod 6, and ***P2***mod 5) are defined in section two as shown in Table 5.7.

Table 5.7: Patterns of section two operated by using an additional table operation. Six values are demonstrated in section two (10, 9, 8, 7, 6 and 5) as labeled in Table 5.3 for ***X*** set. Therefore, six patterns (***P1***mod 10, ***P1***mod 9, ***P1***mod8, ***P1***mod 7, ***P1***mod 6, and ***P1***mod 5) are explored based on the same procedure of additional operation table shown in Table 5.5.

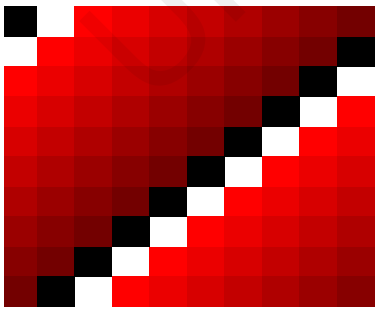
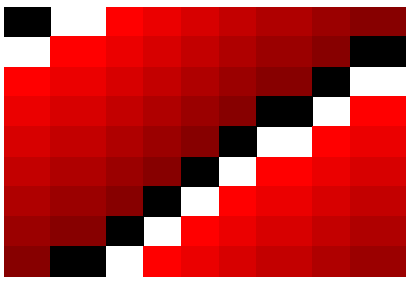
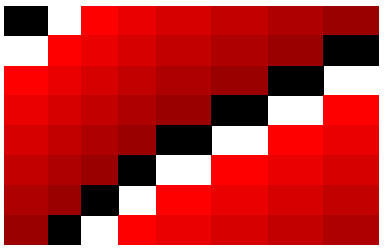
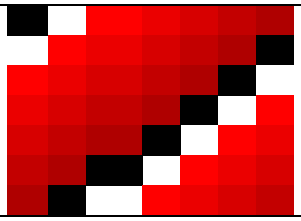
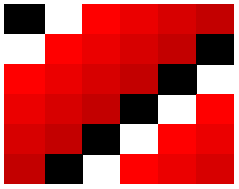
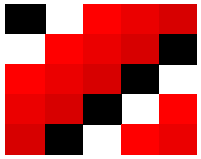
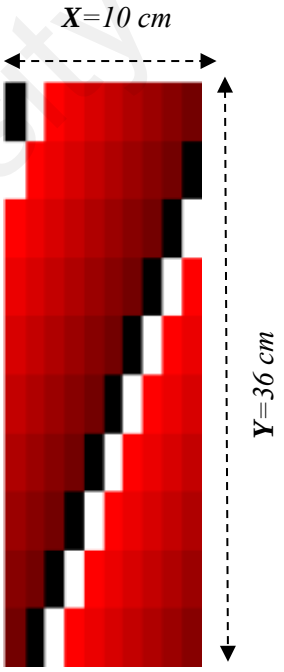
Pattern 1: *P2*mod 10	**Pattern 2: *P2*mod 9**	**Pattern 3: *P2*mod 8**
		

Table 5.7 continued: Patterns of section two operated by using an additional table operation. Six values are demonstrated in section two (10, 9, 8, 7, 6 and 5) as labeled in Table 5.3 for ***X*** set. Therefore, six patterns (***P1***mod 10, ***P1***mod 9, ***P1***mod8, ***P1***mod 7, ***P1***mod 6, and ***P1***mod 5) are explored based on the same procedure of additional operation table shown in Table 5.5.

Pattern 4: *P2*mod 7	**Pattern 5: *P2*mod 6**	**Pattern 5: *P2*mod 5**
		

5.2.3.3 Frame

This property is a frame of the pattern through the semantic coordinate system (***X, Y***). Frames were adjusted based on the output of width and length metrics ***X*** *and* ***Y*** as shown in Figure 5.1. Therefore, 66 patterns are framed in this step (33 for section one, and 33 for section two).



Gaze Features Output	
X	10
Y	36

Figure 5.1: Frame adjusting of pattern 1 in this study. The frame axis (***X***=10 cm, ***Y***=36 cm) based on the gaze output labeled in Table 5.2. Other frames could view in Table 5.8.

As shown in figure 5.1, the pattern is adjusted based on its gaze features output (***X, Y***). The visual outcome presents that the pattern has a rectangular shape. Other patterns are adjusted also based on their data output as shown in the next table 5.8.

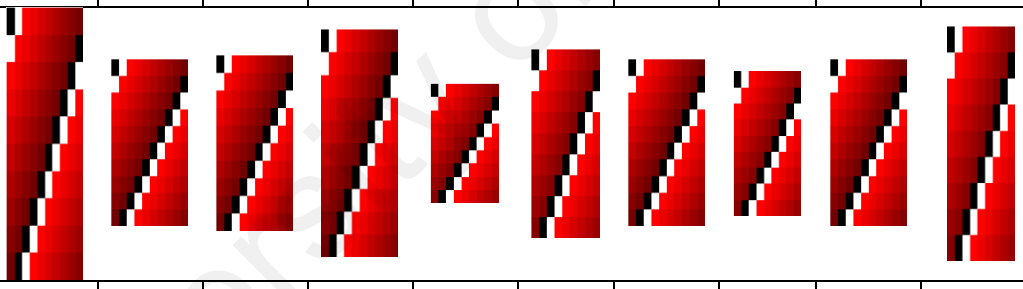
5.2.3.4 Time

Time property is an order of patterns based on scene time orders, (***T*** = Pattern order) in this study. Therefore, the previous framing of sixty-six (66) patterns was replaced based on the time order of scenes, 33 patterns in section one as shown in Table 5.8, and 33 patterns in section two as shown in Table 5.9.

Table 5.8: Time property of patterns from S1 to S33 for section one. Patterns are arranged based on the order of scene-second based.

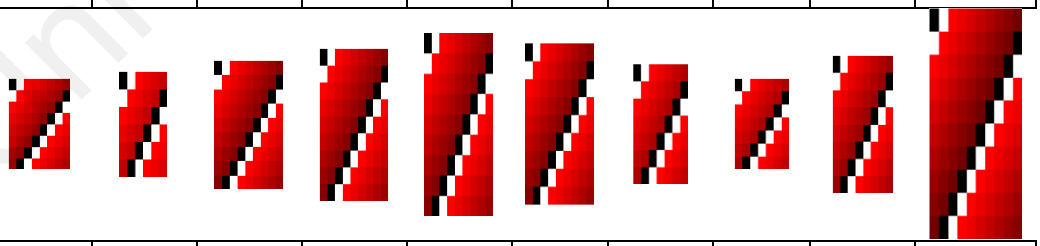
	S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**
X	10	10	10	10	9	9	10	9	10	9
Y	36	22	23	30	16	25	22	19	22	31

Outcome



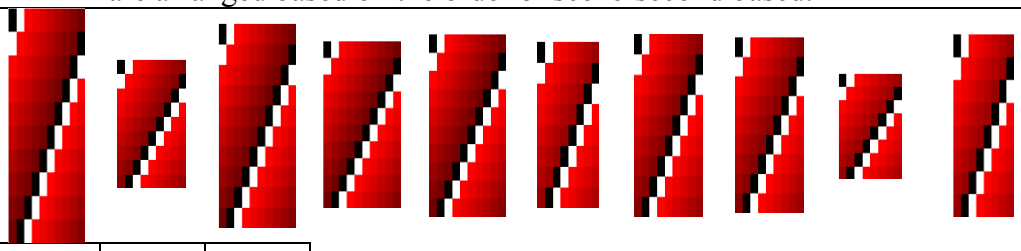
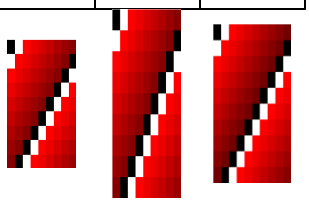
	S11	**S12**	**S13**	**S14**	**S15**	**S16**	**S17**	**S18**	**S19**	**S20**
X	8	6	9	9	9	9	7		8	10
Y	12	14	17	20	24	21	16	12	18	25

Outcome



	S21	**S22**	**S23**	**S24**	**S25**	**S26**	**S27**	**S28**	**S29**	**S30**
X	10	9	10	10	10	8	9	9	8	8
Y	31	17	27	22	24	22	24	23	14	24

Table 5.8 continued: Time property of patterns from S1 to S33 for section one. Patterns are arranged based on the order of scene-second based.

Outcome			
	S31	**S32**	**S33**
X	9	9	10
Y	17	25	21
Outcome			

33 patterns are visualised based on the gaze feature output for section one. All the patterns have similar width and differently various heights as shown in Table 5.8.

Table 5.9: Time property of patterns from S34 to S66 for section two. Patterns are arranged based on the order of scene-second based.

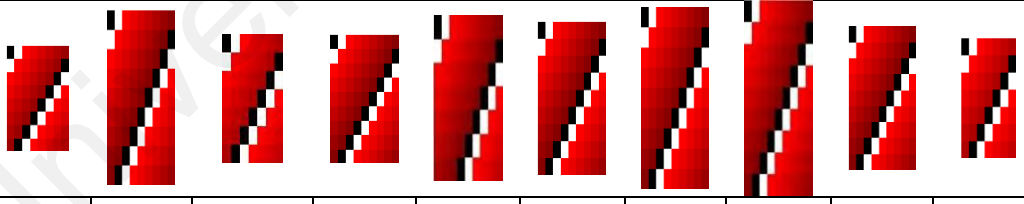
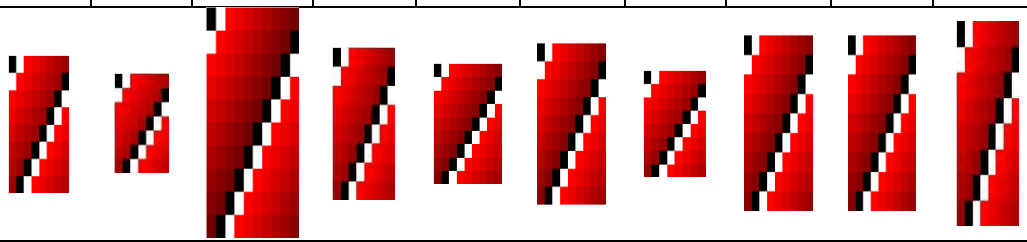
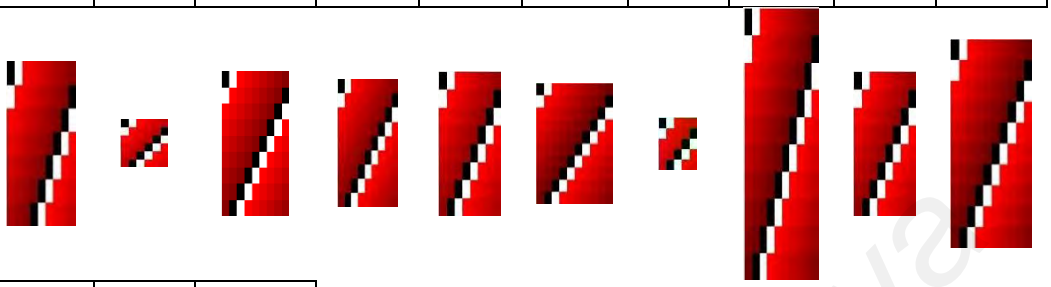
	S34	**S35**	**S36**	**S37**	**S38**	**S39**	**S40**	**S41**	**S42**	**43**
X	8	9	7	9	9	9	9	9	9	7
Y	14	23	15	17	22	20	24	26	19	6
Outcome										
	S44	**S45**	**S46**	**S47**	**S48**	**S49**	**S50**	**S51**	**S52**	**S53**
X	8	7	10	8	9	9	8	9	9	8
Y	18	13	25	20	16	21	14	23	23	27
Outcome										

Table 5.9 continued: Time property of patterns from S34 to S66 for section two. Patterns are arranged based on the order of scene-second based.

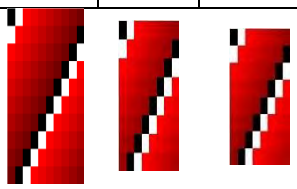
	S54	S55	S56	S57	S58	S59	S60	S61	S62	S63
X	9	6	9	9	8	10	5	10	8	10
Y	22	6	19	15	19	16	7	32	19	28

Outcome



	S64	S65	S66
X	10	8	8
Y	23	20	18

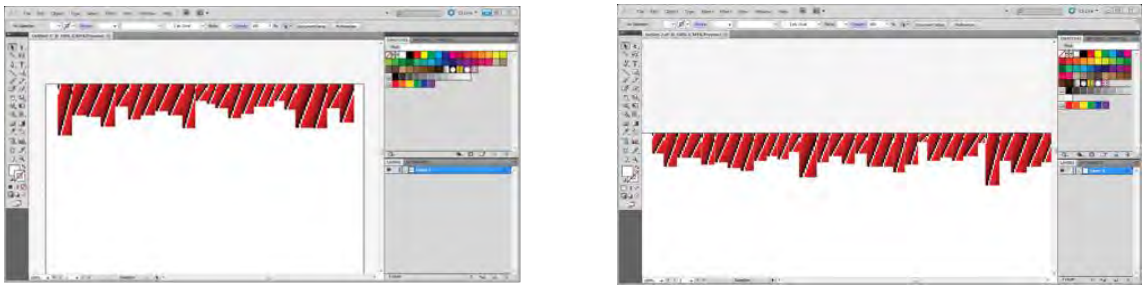
Outcome



Similarly for section two, 33 patterns are visualised based on the gaze feature output. All the patterns have similar width and differently various heights as shown in Table 5.9.

5.2.3.5 Gist

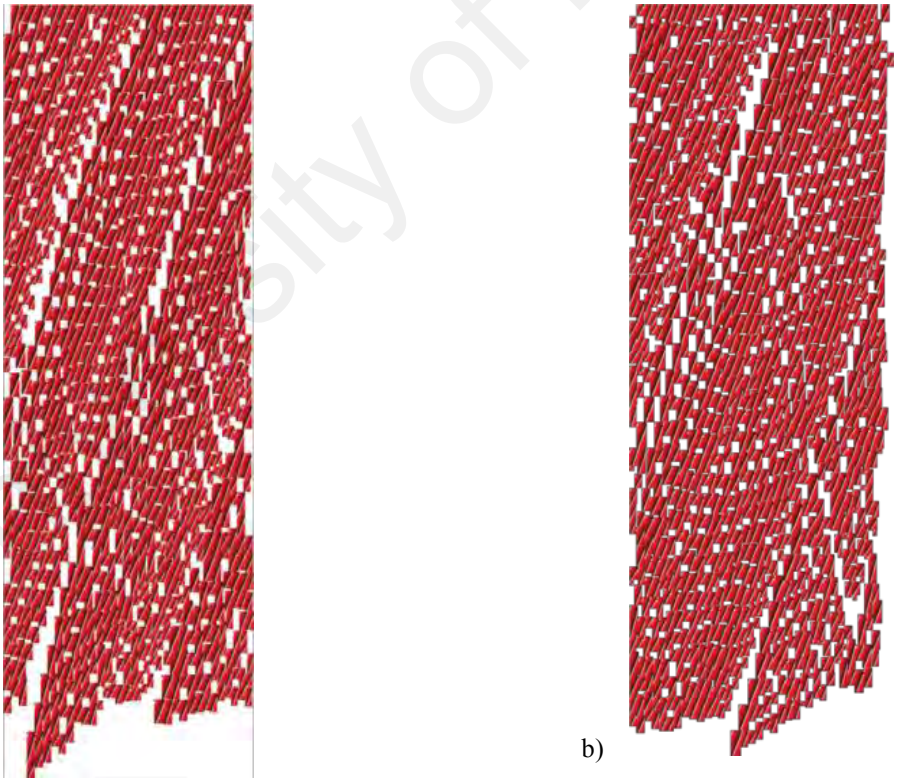
Gist property is a mod of colored table operated based on the total number of scene plus one (***G*** = scene $\text{mod}_{\text{color}}$ ***n***+*1*). There were two sections, section one (S1 to S33), and section two (S34 to S66). Thus, two gists were defined ***G1***mod 34 and ***G2*** mod 67and then composed using Adobe Illustrator program in this step as illustrated in Figure 5.2.



a) b)

Figure 5.2: Gist process by using adobe illustrator program. a) Gist 1 is based on *G1***mod** 34. b) Gist 2 is based on *G2* **mod 67**. The input data of additional table operation labeled in Appendix F2 for both sections.

The processes of additional table operation for ***G1***mod 34 and ***G2*** mod 67 are too long and could view in Appendix F2. The outcomes of gist operation through table mod are sown in Figure 5.3a for section one and Figure 5.3b for section two.



a) b)

Figure 5.3: Gist property. a) Gist 1 is based on (*G1*mod 34) for section one, and b) The gist 2 is based on (*G2* mod 67) for section two. These patterns are exported from the output labeled in Appendix F2 for section one and section two.

Two Gists are visualsed in this study. The appearance of them seems have slightly different look. Each pattern explored in the previous tables of time property was inserted in the additional operation mod based on the mod of each section. Thus, the gist of section one is visualized using the logic of *G1*mod 34 and the gist of section two based on the *G2* mod 67. The tables operated for *G1*mod 34 and *G2* mod 67 could view in Appendix F2.

5.2.3.6 Space

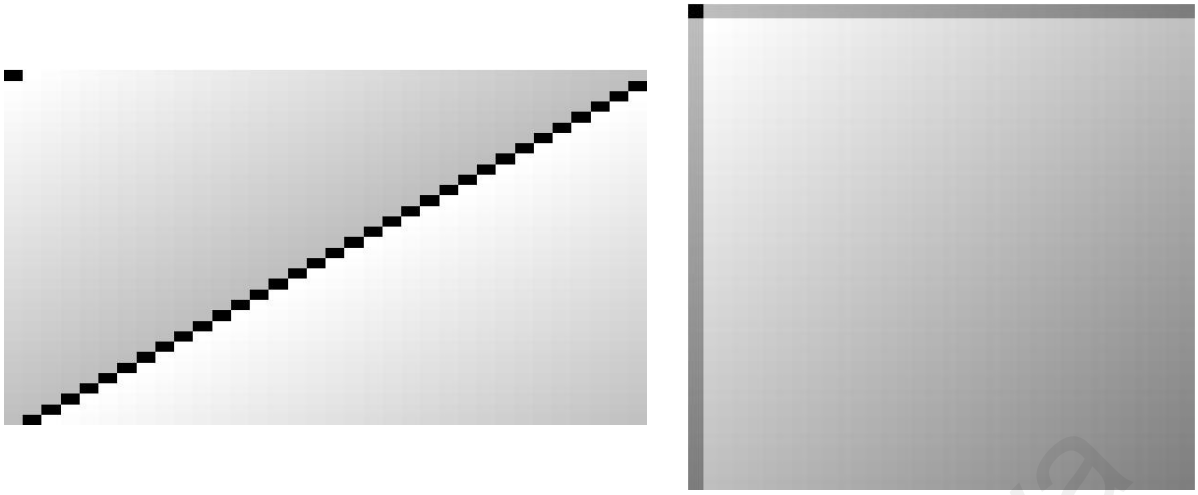
Space property is referred to the meaning of scenes or background. The empty was represented by the gray values which defined by (RGB-2) in this study. Thus, space is defined as a mod of gray table operated based on the total number of scene plus one (***S*** = scene $\text{mod}_{\text{gray}}\boldsymbol{n}+1$**)**. There were two sections, section one (S1 to S33), and section two (S34 to S66), therefore two spaces is defined (***S1***mod_{gray} 34) as shown in Table 5.10 and (***S2*** mod_{gray} 67) as shown in Table 5.11 in this study.

Table 5.10: Space property ***S1***$\mathrm{mod}_{\mathrm{gray}}$ 34 resemble through additional table operation mod for section one.

+	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	RGB	
0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33		0
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	255	1
2	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	253	2
3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	251	3
4	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	249	4
5	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	247	5
6	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	245	6
7	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	243	7
8	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	241	8
9	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	239	9
10	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	237	10
11	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	235	11
12	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	233	12
13	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	231	13
14	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	229	14
15	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	227	15
16	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	225	16
17	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	223	17
18	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	221	18
19	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	219	19
20	20	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	217	20
21	21	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	215	21
22	22	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	213	22
23	23	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	211	23
24	24	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	209	24
25	25	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	207	25
26	26	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	205	26
27	27	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	203	27
28	28	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	201	28
29	29	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	199	29
30	30	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	197	30
31	31	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	195	31
32	32	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	193	32
33	33	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	191	33

Table 5.11: Space property ***S2*** mod_{gray} 67 resemble through additional table operation mod for section two.

+	0	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	RGB	
0	0	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66		
34	34	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	189	34
35	35	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	187	35
36	36	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	185	36
37	37	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	183	37
38	38	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	181	38
39	39	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	179	39
40	40	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	177	40
41	41	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	175	41
42	42	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	173	42
43	43	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	171	43
44	44	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	169	44
45	45	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	167	45
46	46	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	165	46
47	47	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	163	47
48	48	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	161	48
49	49	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	159	49
50	50	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	157	50
51	51	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	155	51
52	52	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	153	52
53	53	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	151	53
54	54	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	149	54
55	55	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	147	55
56	56	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	145	56
57	57	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	143	57
58	58	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	141	58
59	59	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	139	59
60	60	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	137	60
61	61	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	135	61
62	62	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	133	62
63	63	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	131	63
64	64	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	129	64
65	65	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	127	65
66	66	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	125	66



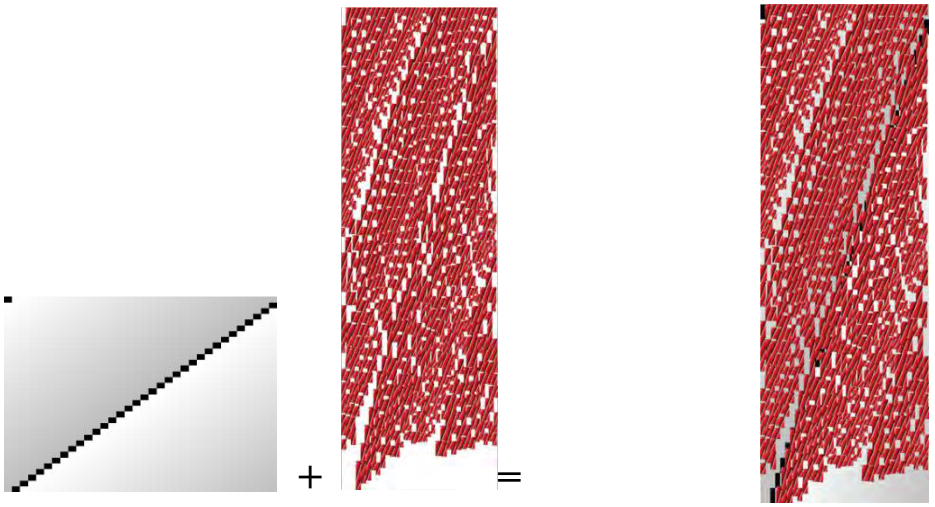
a) Space 1: ***S1***$\text{mod}_{\textbf{gray}}$ 34 b) Space 2: ***S2***mod_{gray} 67

Figure 5.4: Space property. a) Space 1 is operated by (***S1***mod_{gray} 34) for section one which explored from the data labeled in Table 5.10. However, b) Space 2 is operated by (***S2***mod_{gray} 67) for section two which explored from the data labeled in Table 5.11.

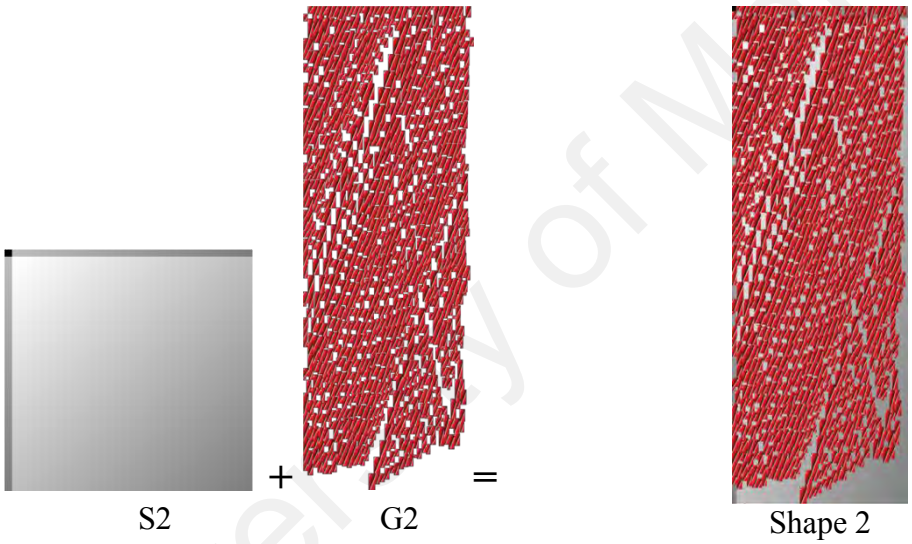
Space 1 is operated by using the logic of **S1**mod_{gray} 34 for section one which explored from the data labeled in Table 5.10. However, b) Space 2 is operated by using the logic **S2**mod_{gray} 67 for section two which explored from the data labeled in Table 5.11. The outcomes of space show that the space of visuospatial attention has two different backgrounds, Space 1 as appear in Figure 5.4a and Space 2 as appear in Figure 5.4b. The gray values provide a diagonal black line in Space 1 and two vertical and horizontal lines in the left side of space.

5.2.3.7 Form

Form property is the final physical properties in this section. It is based on the previous properties combination in order to design the pattern of visuospatial attention for the next synthesise procedures. Therefore, two forms were visualised in this section, see (Figure 5.5).



a) Space1+ Gist1 = Shape 1



b) Space 2+ Gist 2 = Shape 2

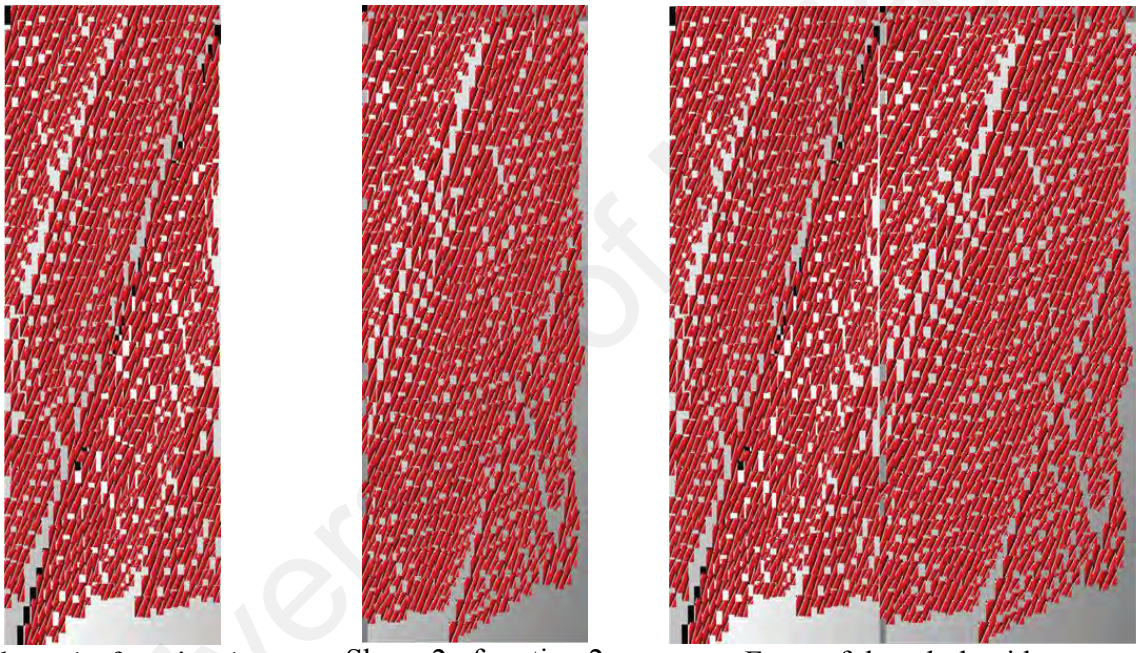
Figure 5.5: Form property a) Shape 1 is visualised based on the combination between S1 and G1 for section one, and b) shape 2 of section two is based on the combination between G2 and S2 for section two.

The shapes of each section is visualised in this study. Shape one is created based on the combination between S1 and G1 and Shape two based on S2 and G2 combination as illustrated in Figure 5.5. The visual outcomes of form property of visuospatial attention prove that the description of features of gaze output fulfills the standard of correctness for hybrid

depiction; the descriptive data that labeled in Table 4.8 predicted previously in Chapter 4 showed that the variety of gaze features will appear in slightly similar short widths and various lengths of heights. Figure 5.5 confirmed the same results of demonstration stage.

5.3 Hybrid Visuospatial Attention Form

This section is the final stage of physical properties resemblance. Interestingly, the researcher explored the hybrid visual shape of visuospatial attention in a video dance by combining the shape 1 and shape 2 using Adobe Illustrator program. The outcome is shown in Figure 5.6.



Shape 1 of section 1 Shape 2 of section 2 Form of the whole video

a) Shape 1+ Shape 2 = b) Visuiospatial Attention Form

Figure 5.6: Hybrid form of visuospatial attention is created through the combining between shape 1 and shape 2 by using Adobe Illustrator program. a) is referred to the combination between shape 1 of section one and shape2 of section two, and b) is referred to the explored form of the whole video.

Finally, the form of visuospatial attention was created after nine steps of resemblance. The visualization conducted pattern modular design-color based using additional table operation. This form shows that the visuospatial attention has a vertical symmetrical composition. The most area of a top picture was covered by red values, significant shapes. However, the less

area as shown in the down of picture was covered with gray colors, significant space. The form of visuospatial attention was visualised in this study.

5.4 Chapter Summary

This chapter introduces a contribution that applies a guideline for visualisation the physical properties of visuospatial attention in a video by utilizing pattern modular logic design. The technique applied in this project has explored that the form of specific case is vertical geometric patterns. In a particular, the outcomes of this chapter have been explored to be a unique and simple process in visualising the physical properties of visuospatial attention for the hybrid pictorial transparency domain.

CHAPTER 6: PICTORIAL ASPECTS SYNTHESISE

Pictorial aspects synthesise is the final stage of the proposed DRS guideline for hybrid visuospatial attention portray in this thesis. This stage presents the hybrid art forms created through form element of visuospatial attention based on the traditional art principles. It divided into three main sections: the introduction is presented in the first section (section 6.1), the proposed third stage, pictorial aspects synthesise using the design of pictorial aspects through traditional art principles is produced in the second section (section 6.2), and the hybrid forms of arts in the final section (section 6.3) is created. It is artistically crucial for the compositions to be produced imaginative in order to deal with the statements comprehensively so as to be consistent with the research questions.

6.1 Introduction

The artistic crucial contribution that is creating hybrid form compositions of an inventive DRS approach for the specific case is produced. The stage of pictorial aspects synthesise used the traditional art principles practices for the creation of visuospatial attention in a choreographic dance video. This study has employed the eye-tracking outcome as an information source for visualising attention patterns. Then, the visualised patterns were used to create various art compositions in the hybrid pictorial experience domain. The advantage is the essential and integral to establish novel collaboration role between experimental scientific approach as a source of information, mathematical approach as a transparency and visual art as an experience for hybrid depiction.

6.2 Pictorial Aspects Synthesise Stage

In this stage, pictorial aspects synthesise refer to the hybrid art forms produced based on the traditional art principles arrangement for answering the fourth question in this study. This is to create the artistic compositions through manipulating of visualised pattern. The explored

pattern labeled in Figure 5.6c is the basic element design for producing various forms of arts in this study. This stage provided the hybrid experience of depiction that was used in this study. It involved the description of style, art elements and principles, technique, and final artworks.

6.3 Pictorial Experience of HPVA

A hybrid experience of depiction is a term coined by Dominic Lopes philosophy (1996), Understanding of Pictures, which revolves around modality X and transparency Y. the latest critical point views by Newall (2011& 2016) on Lopes's philosophy claimed that the representing of painting X in both modality and transparency processes were not sufficient by using cognitive perspective of depiction. He argued that an edge of recognition based-pixel picture and the numerical source of information are the primary stage of visual processing which reflects pixilation only. Therefore, recognition through the picture as a source may not appear into the higher-level of pictorial experience. The higher-level of pictorial experience needs to share with subjective processes for representing invisible phenomena in the art field. Therefore, the researcher developed the definition of HPVA as: a Painting X depicts the visuospatial attention phenomena Y if and only if: (1) X can occasion non-veridical visual recognition of Y, and (2) this non-veridical visual recognition accords with a suitable standard of correctness according to the following specifications:

a) Demonstrate (D): typical-identification mode through eye-tracking approach.
b) Resemble (R): visual modular semiotic relation through modular design.
c) Synthesis (S): self-artistic experience through traditional art principles.

Furthermore, Colabella (2014) stated that the generation-artworks community produces various artworks by the use of a set of specific rules that not necessarily implying complex computer system or a step-by-step algorithm. Traditional forms of arts could be produced

through both step-by-step simple logic of number design and artist manipulation. Thus, this study could be considered as an art experiment that belonged to the branch of contemporary art generation and post-modern philosophy. It could enrich the field of contemporary art practices in further works.

6.3.1 HPVA Style

In artistic experience, art styles are described as the way of the artwork looks. It's the manner in which artists depict or portray their subject matter and how they express their ideas. Art style is determined by three factors, first: the employment of art elements, compositions, and principles, second: the way the artists handle the medium, method or the technique that the artists use, and finally: the philosophy behind the artwork. All of these characteristics of style are defined by the choices artists make as they compose their artwork (Singer et al., 1997).

The style of hybrid portrayal of visuospatial attention was a geometrical modular art style. All patterns had a rectangular units based on the demonstrated numerical results of the descriptive number of fixation width and length. See the rectangular units in the attention pattern in Figure

Figure 6.1: The rectangular units in the pattern of visuospatial attention. Each unit is visualized based on the demonstrated values of fixation width and length in this study.

6.3.1.1 Elements and Principles in Hybrid Perspective

Today, beauty is no longer the initial value in contemporary generative art where conceptual art is not based on the aesthetic values of realistic representations. The Fine Arts are seen as offering more realistic representations of concepts using traditional visual

elements such as line, shape and colors in visual contexts. For example, 'the sun is yellow', 'the sky is blue,' the objects are arranged in space as we normally expect and seen. On the other hand, the objects, elements, and art principles in contemporary art perspective are often ignored because the process of choosing their location is formulated without the use of realistic representations. Thus, figures arrangements may appear distorted to the viewers.

Indeed, cognition simulation can help assess the degree of visual attention of a viewer and evaluate the nature of their response and therefore help artists produce the compositions of their generative artworks through the explored new patterns of cognitive concepts. Therefore, this study explored nine elements of art that reflect the hybrid value to visual art. These elements can only be visualized in a second process of visualisation before exploring the new patterns of creation. See the details in Chapter 5 for hybrid elements.

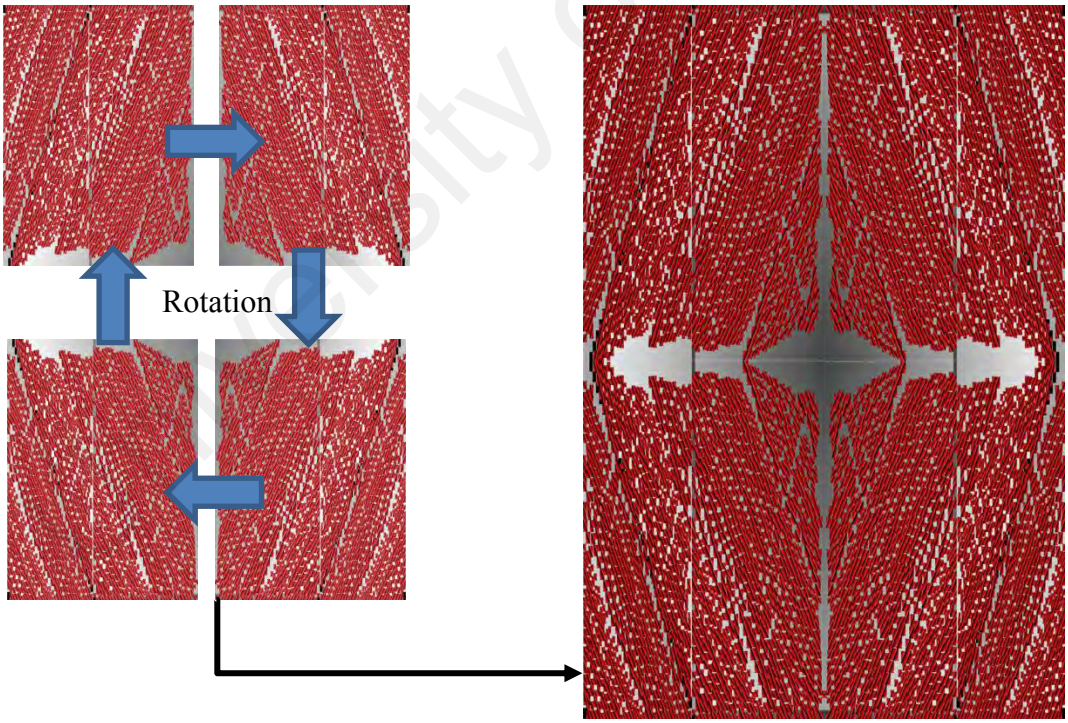
In traditional arts, there are seven principles of art, balance, proportion, emphasis, variety, movement, rhythm, and harmony which used to organize or design the visual elements for creating compositions (Ecker, 2003). The practices of this stage selected only two principles of art: the balance and movement are utilized for design compositions for the following reasons:

a) The style of artworks was geometrical which match with the balance principle.
b) The study was based on the performance art stimulation. The representation of dance sections added new features which are based on significant time properties. Therefore, the movement art principle was selected. Ten compositions have been created in this study.

(a) ***Hybrid Creation through Balance Principle***

In traditional art, balance principle refers to the sense of stability achieved through the weight of the object. It involves three types of balance: symmetrical balance, asymmetrical balance, and radial balance. The symmetrical balance refers to the repetition when one object is mirrored on the other side, the asymmetrical balance refers the visual balance through visual elements, and the radial balance refers to the arrangement of elements around a central point in all direction. Five compositions are digitally designed through the explored attention pattern using crop and rotation tools as shown in Figure 6.1, Figure 6.2, Figure 6.3, Figure 6.4, and Figure 6.5.

Figure 6.1 presented the first composition of visuospatial attention hybrid form through radial balance principle.

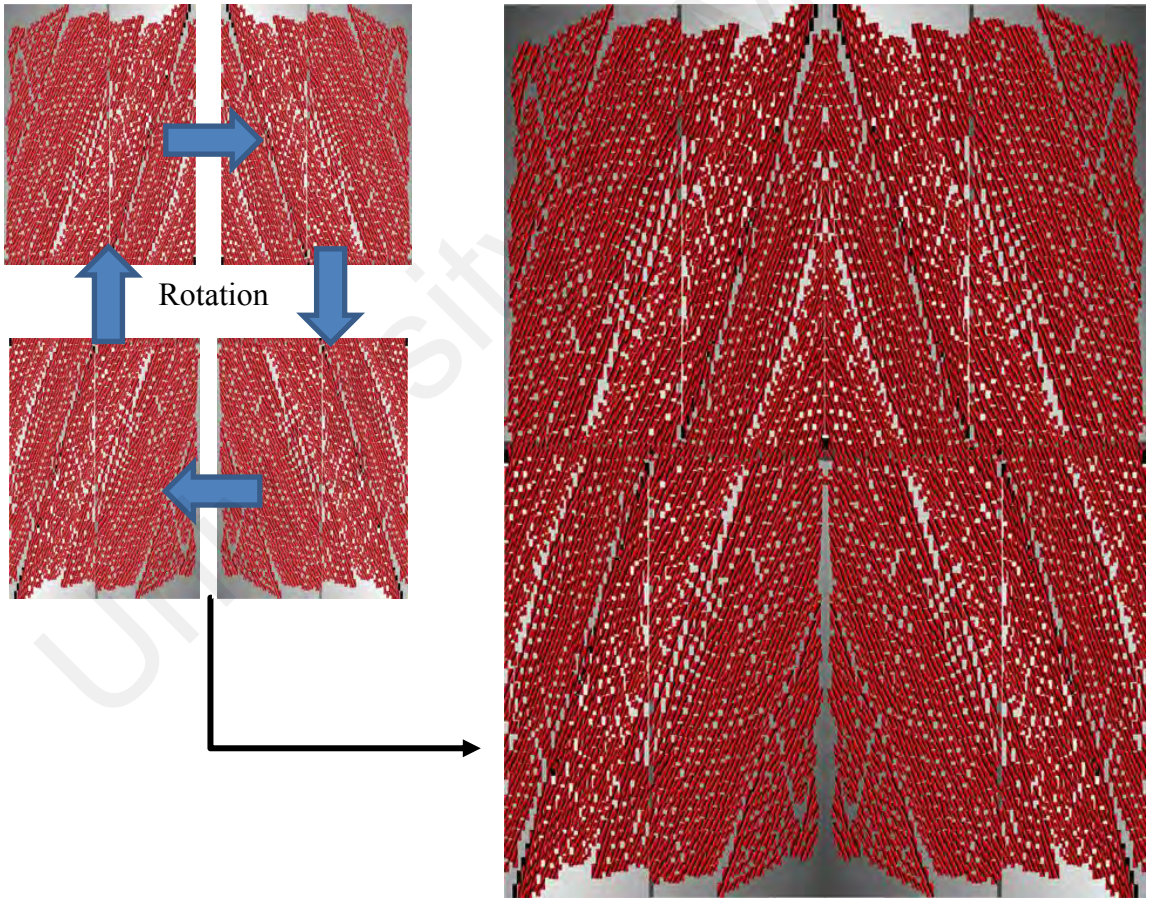


a) Rotation Process b) Hybrid Artwork

Figure 6.2: The first composition of visuospatial attention hybrid form through radial balance principle. a) the rotation process and b) the hybrid artwork.

In Figure 6.1, the first composition appears as a shape which looks like a human eye. The rotation of the form exported in Figure 5.6 into four different locations created a radial balance composition in this study. A deep radial contrast from the central dark point into light region attracts the viewing to it compulsory. In this stage the forms were subjectively created using art principles. The previous chapter of visualisation only based on a numerical data output reflections which already labeled across related figures and tables in Chapter 4 and Chapter 5.

Figure 6.2 presented the second composition of visuospatial attention hybrid form through symmetrical balance principle.

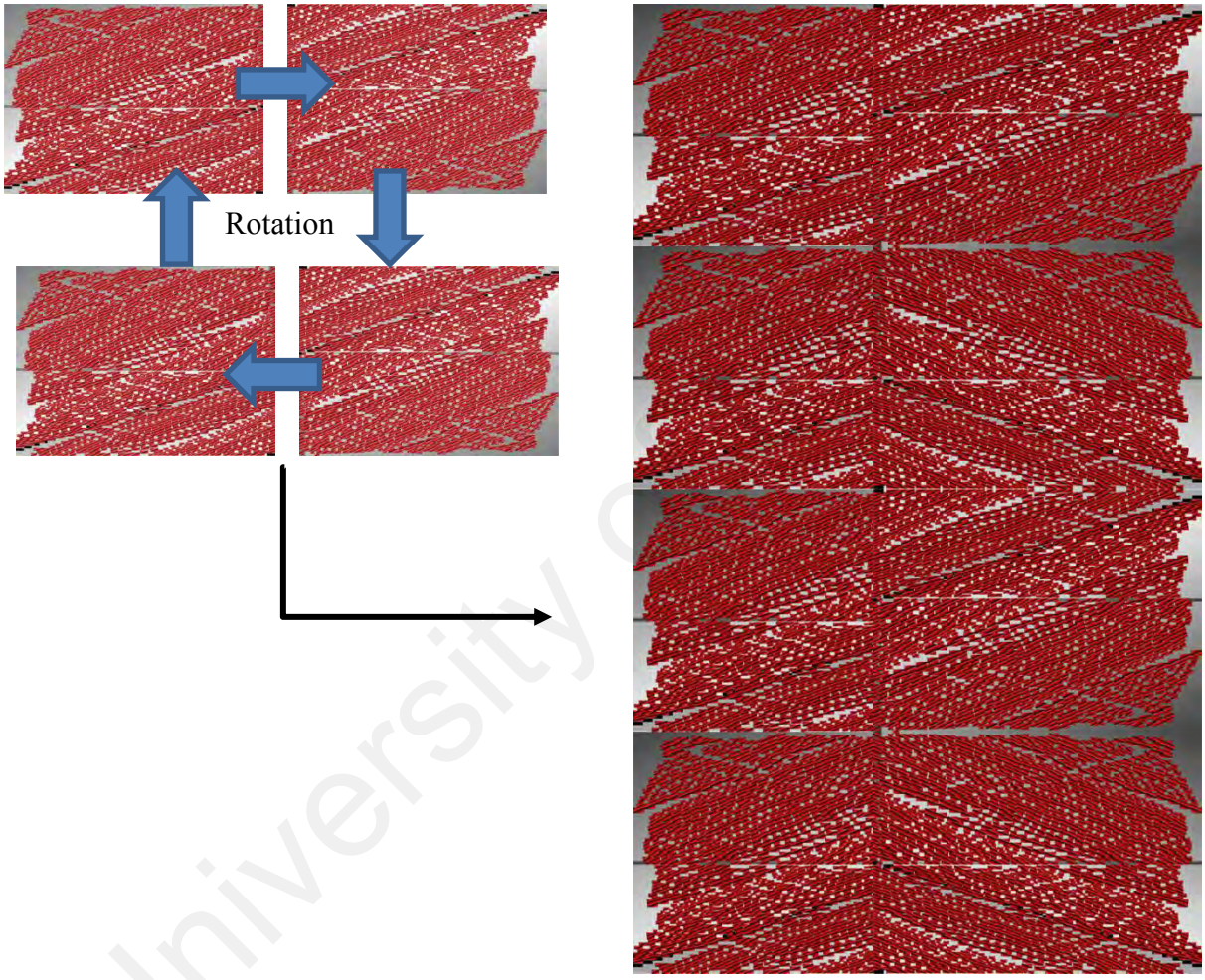


a) Rotation Process b) Hybrid Artwork

Figure 6.3: The second composition by symmetrical balance principle for visuospatial attention. a) the rotation process and b) the hybrid artwork.

This second composition is based on the symmetrical balance principle. The composition was appears as pyramidal structure with triangle edges.

In the next form as presented in Figure 6.3, the third composition by asymmetrical balance principle is used to create the hybrid form.



a) Rotation Process b) Hybrid Artwork

Figure 6.4: The third composition of visuospatial attention by asymmetrical balance principle. a) the rotation process and b) the hybrid artwork.

This form reflects four horizontal shapes. The whole structure appears as a leaf of tree. It was created by the rotation and flipping from a horizontal into vertical locations.

Figure 6.4 shows the forth composition which created by an asymmetrical balance principle.

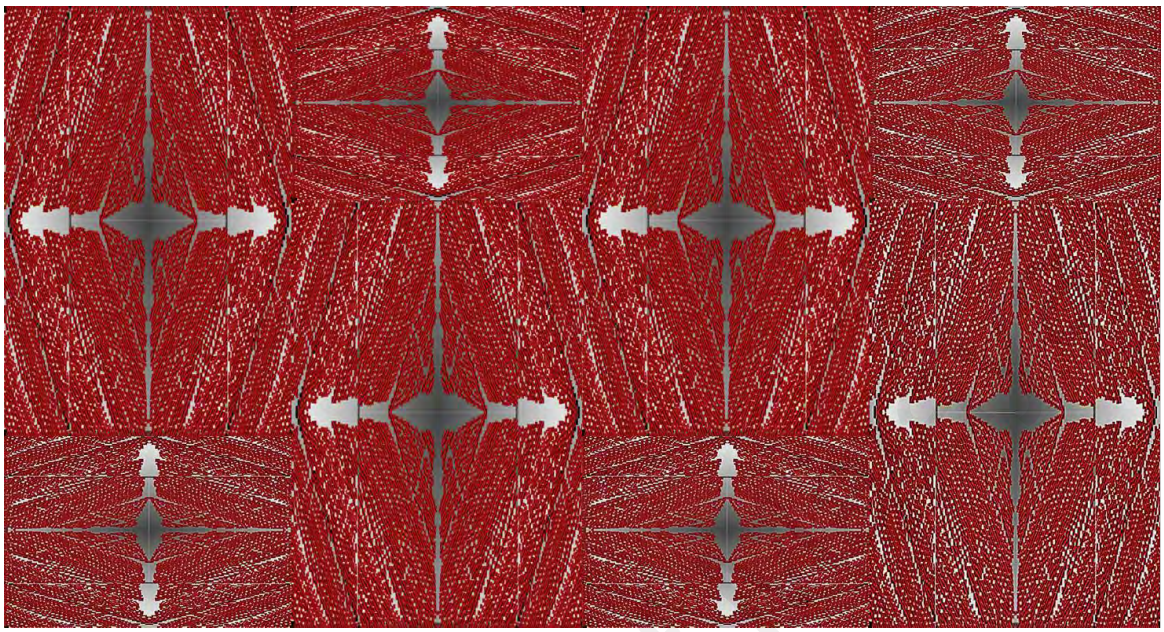
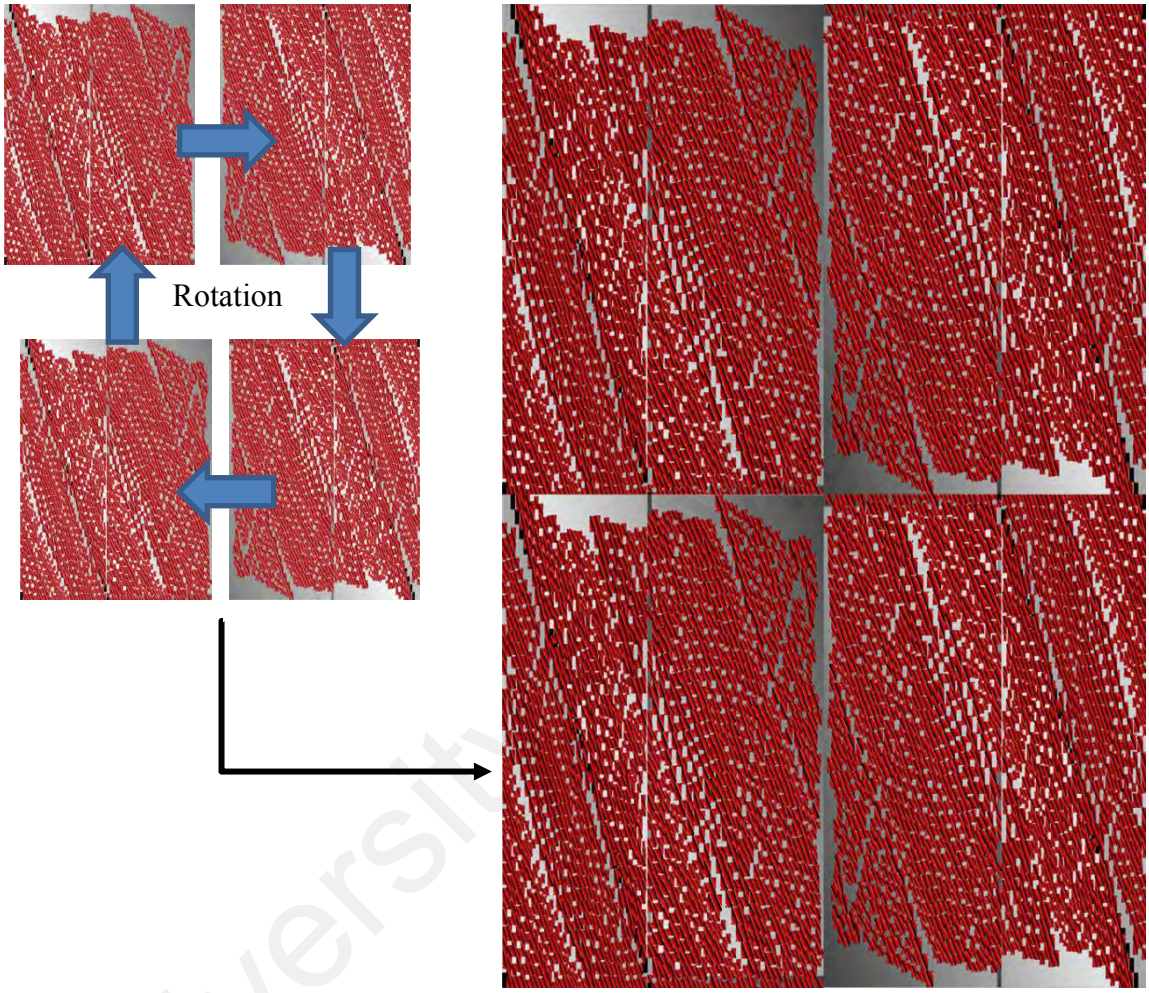


Figure 6.5: The forth composition by symmetrical balance principle.

This hybrid form of art is created using a balance of symmetry. However, the different between sizes of patterns reflect a harmony rhythm of visual viewing. It looks as many eyes moving in a horizontal row. Here, the hybrid form links itself as forms of eyes to recognize visuospatial attention phenomenon. Thus, the form confirms the point view of recognition domain based on prior knowledge of common understanding of things in the visual objects. This contends that the perspective of Ponty's invisibility definition is correlated with visibility.

For the fifth form appeared in Figure 6.5, the radial balance composition created a structure with four movement pieces around central point.



a) Rotation Process b) Hybrid Artwork

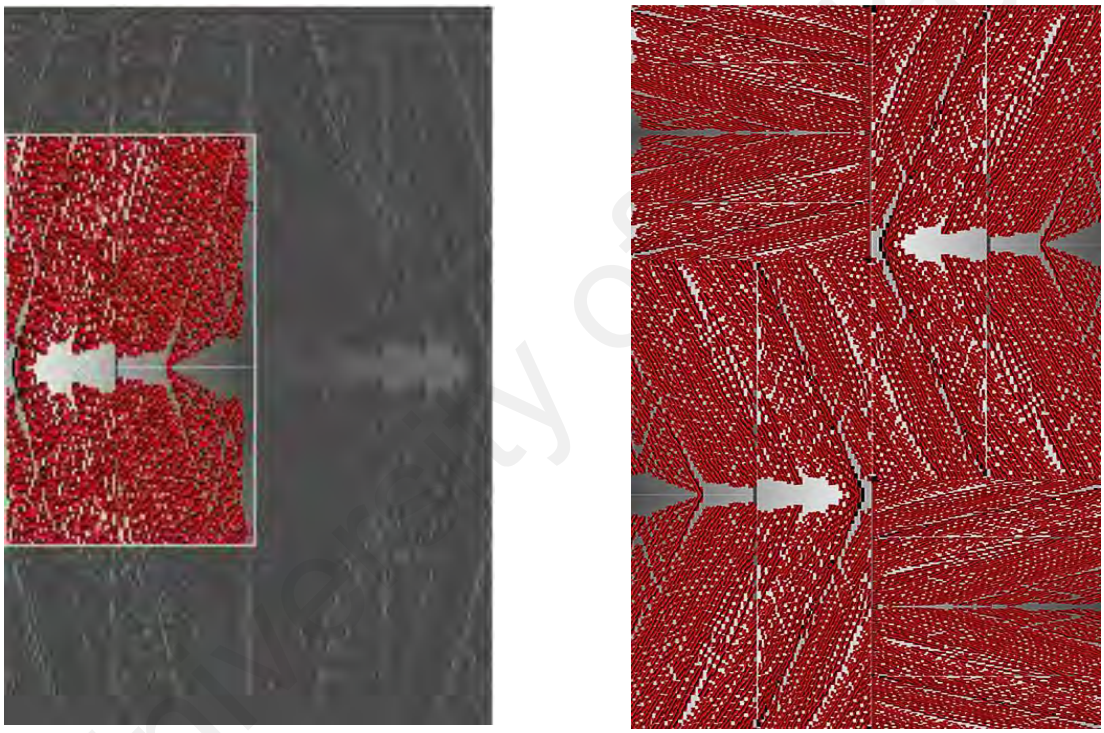
Figure 6.6: The fifth composition by radial balance principle. a) the rotation process and b) the hybrid artwork.

The hybrid form as shown above contended the same conclusion as discussed in the previous form labeled in Figure 6.4. Newall and Lope provided a good view related aspect-recognition account for pictorial experience. Therefore, DRS is considered as rational and applicable in producing hybrid art forms in terms of aspect-recognition perspective for this study.

(b) ***Hybrid Creation through Movement Principle***

This principle can be created when purposefully placing the art properties in a way which create a path that you intend your viewer to follow. Five compositions are digitally designed through visual elements using crop and rotation tools as shown in Figure 6.6, Figure 6.7, Figure 6.8, Figure 6.9, and Figure 6.10 in this study.

The following composition is presented in Figure 6.6. A different form was created to show the free structure which could be created by another principles of arts.

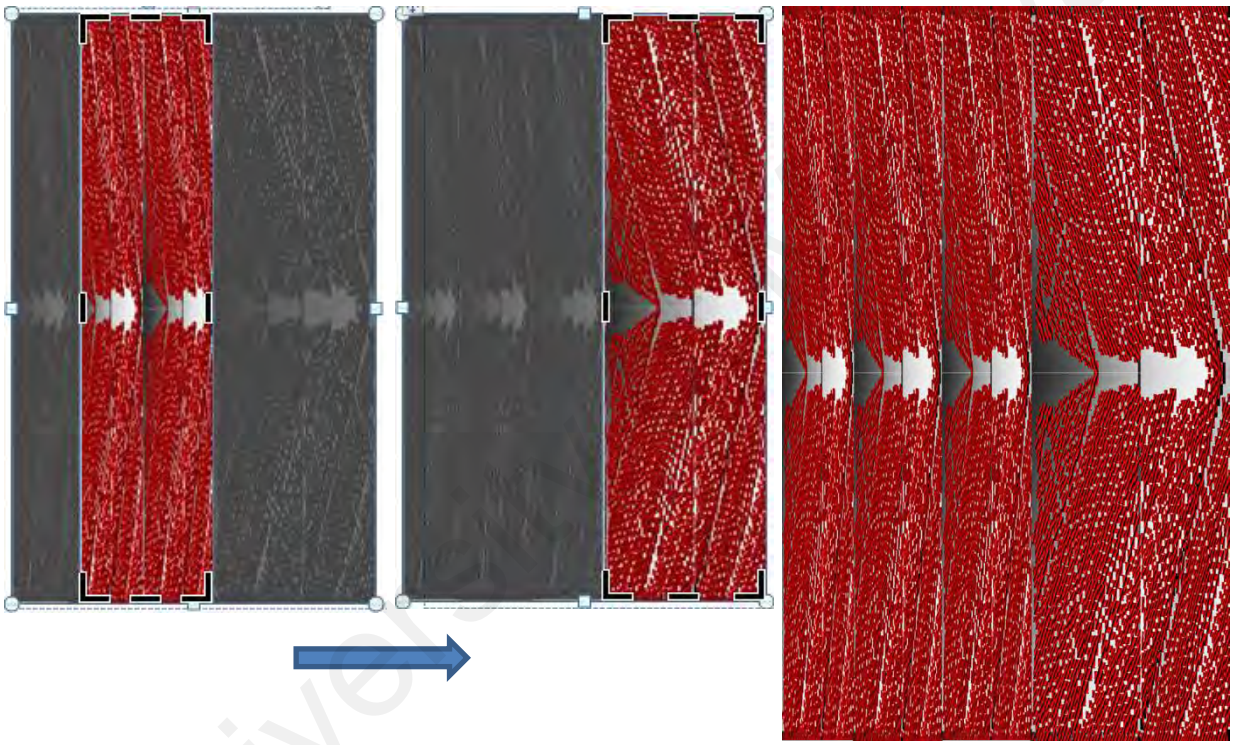


a) Crop Process b) Hybrid Artwork

Figure 6.7: The sixth composition through movement principle. a) the crop process and b) the hybrid artwork.

Crop feature is used to extract the objects for movement compositions. These objects are arranged oppositely as shown in Figure 6.6b. Thus, you can see the objects swimming into different direction with fixable and free composition. This approved that any artist can extract his/her own objects to synthesise them after applying the demonstrating and visualising processes.

Figure 6.7 is another form that used movement principle for creation.



a) Crop Process b) Hybrid Art form

Figure 6.8: The seventh composition through movement principle. a) the crop process, and b) the hybrid artwork.

Figure 6.7a shows how the researcher crop her objects to synthesis them in one structure. The direction of the explored object from left to right appears in Figure 6.7b. It shows that the objects are not limited to the visualizing of a scientific output of gaze features. You can create multi forms beyond the strict mapping of tracing biological shapes or indirect resemblance.

In the following Figure 6.8, a hybrid form is created based on the repetition of the previous figure.

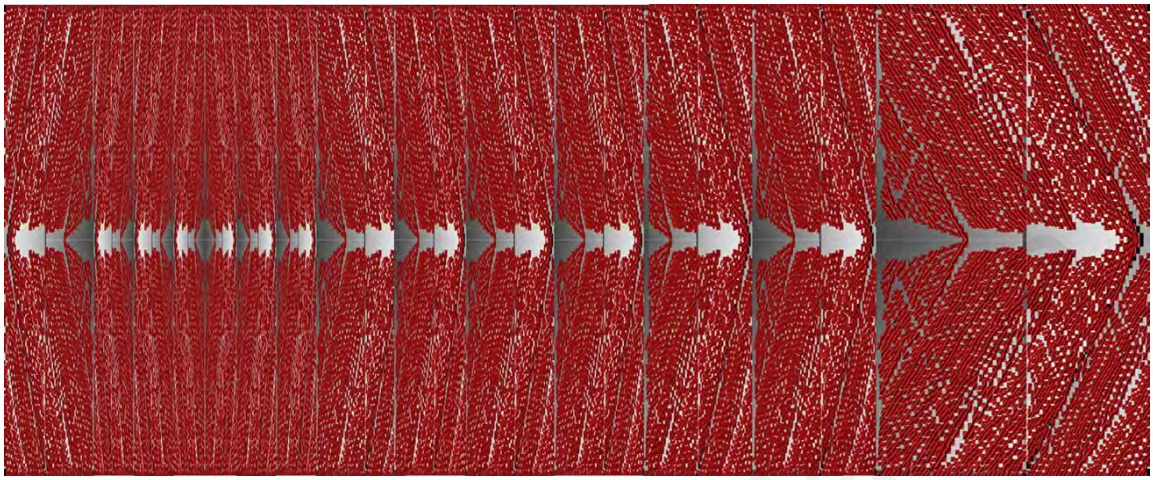


Figure 6.9: The eighth composition through movement principle. The selected object is repeated 14 times to create this hybrid form.

This form focuses on repeating the moment object from the left to right side. Various shapes could be created only by using this manipulation to create plenty of paintings. The researcher explored that most of the shapes created in this study provide a significant object to direct our viewing. See also the form in Figure 6.9.

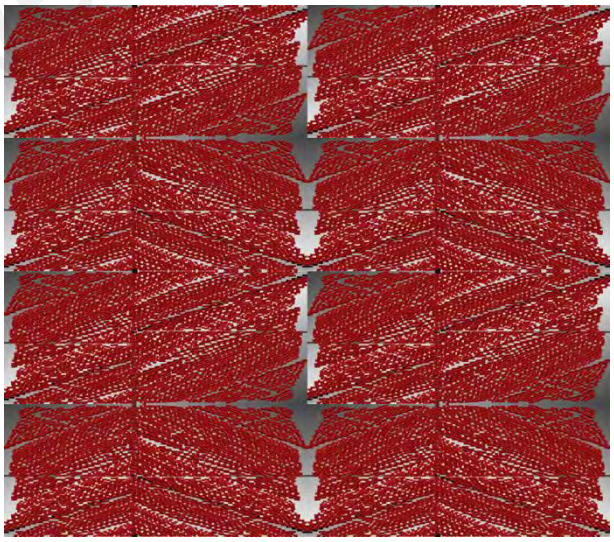


Figure 6.10: The ninth composition through movement principle.

Finally, the tenth composition through movement principle is presented in Figure 6.10.

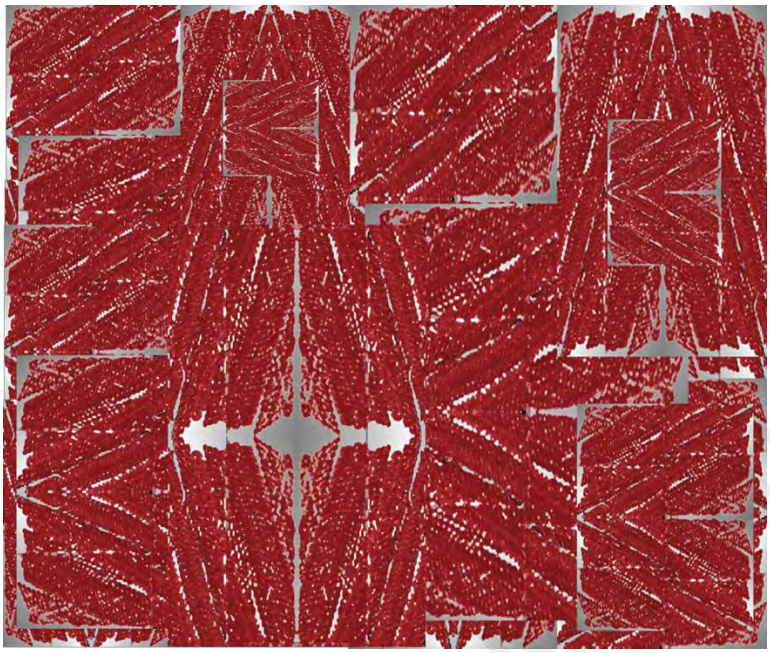


Figure 6.11: The tenth composition through movement principle.

Based on the above hybrid form, the researcher concluded that the proposed DRS guideline is applicable. The form presents the same pattern as shown in Figure 6.1. Therefore, this technique would help artists to create their own units to operate any hybrid forms.

6.3.2 HPVA Technique

The technique producing the forms of hybrid arts was digital art method using adobe illustrator software program. It involved rotation, crop, and filter processes. The created art forms of HPVA will be printed digitally with acrylic painting in canvas.

6.3.3 Philosophy behind HPVA

In academia today, mainly in art aesthetic and psychology studies, there is a growing interest in the relationship between paintings and cognition science. In other words, the focus is on how represent the reaction of eyes to movements and depicting paintings. Although the relation between attention and movement objects in performance art is undeniable, how to

embed where to put form properties of attention phenomenon is indescribable context for two reasons. First, traditional understanding of aesthetic when it comes to the judgment of beauty is questionable. Second, the normative formal elements of art, such as lines and colors, visual balance, etc., are difficult to read in invisible locations, denying beauty or aesthetic judgment as a value of these works. Because of this, an objective approach to hybrid art-cognition science collaboration can bring a different kind of value to generative art based on the response of the viewer, which we call a 'hybrid value' or the third aesthetic.

6.4 HPVA Art Forms

The researcher has sketched various forms of arts for the current case. These sketches were manipulated subjectively to finalise the final portraits of HPVA. Ten compositions were created as shown from Figure 6.12 to Figure 6.21.

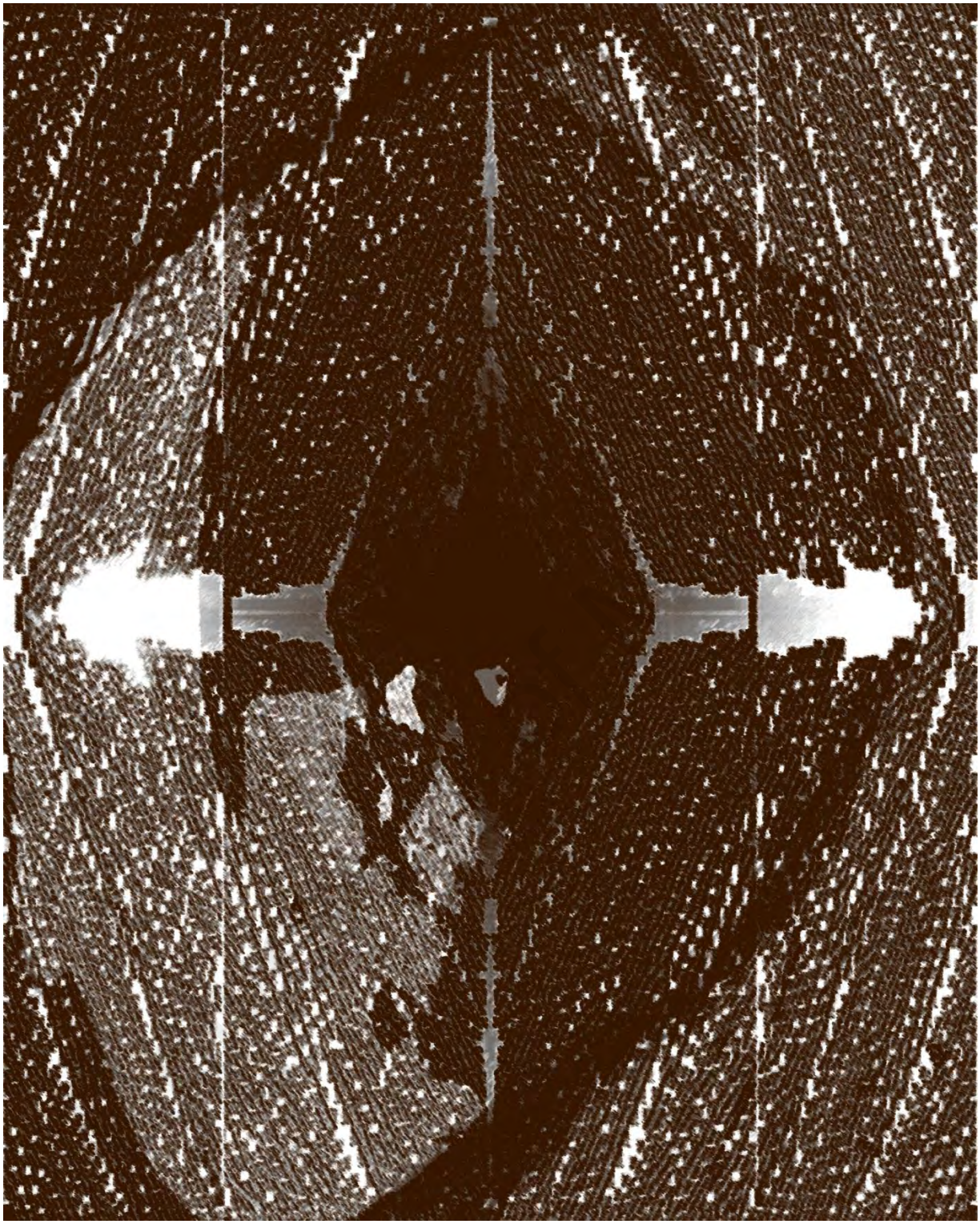


Figure 6.12: The first Composition of HPVA.

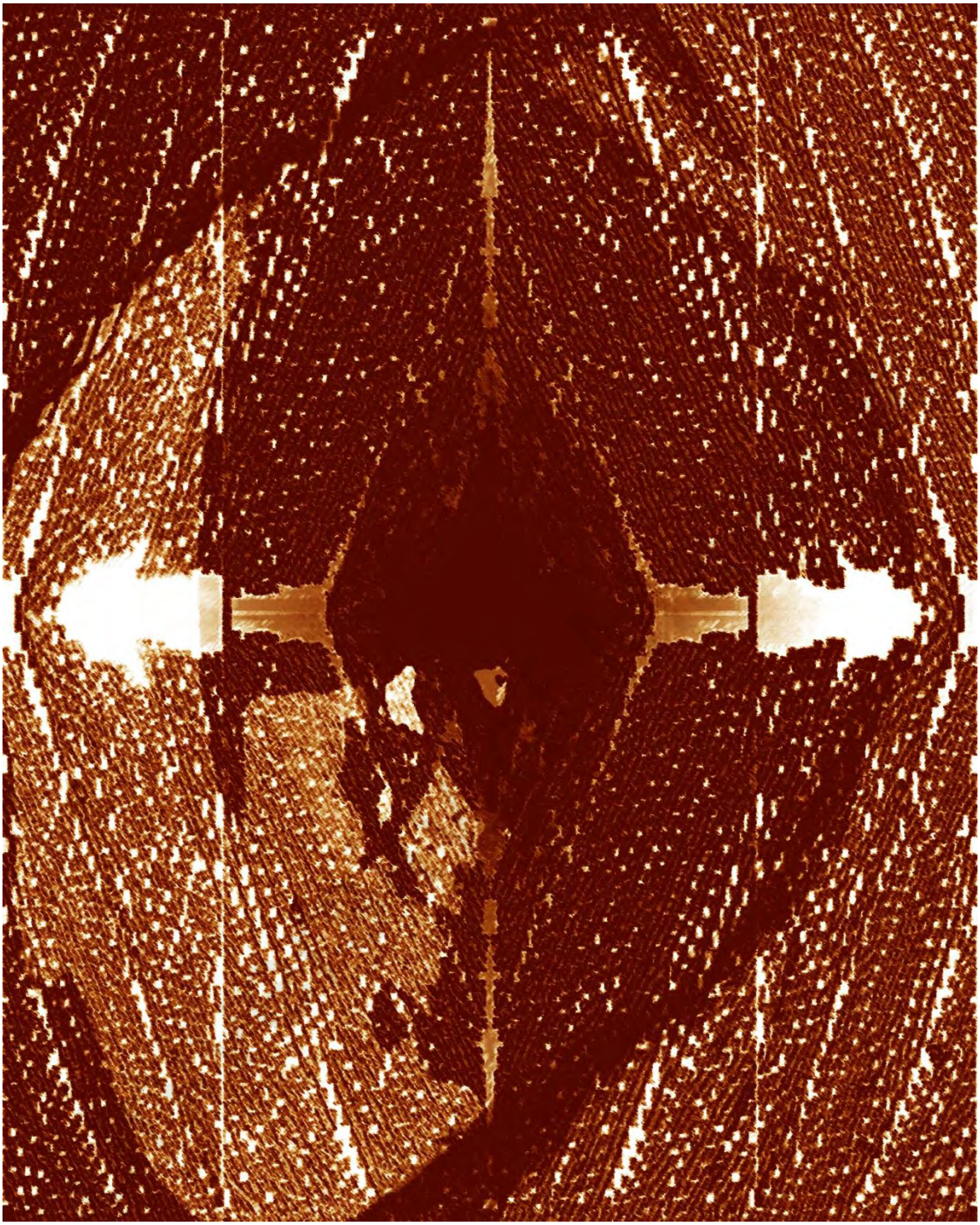


Figure 6.13: The Second Composition of HPVA.

Figure 6.14: The Third Composition of HPVA.

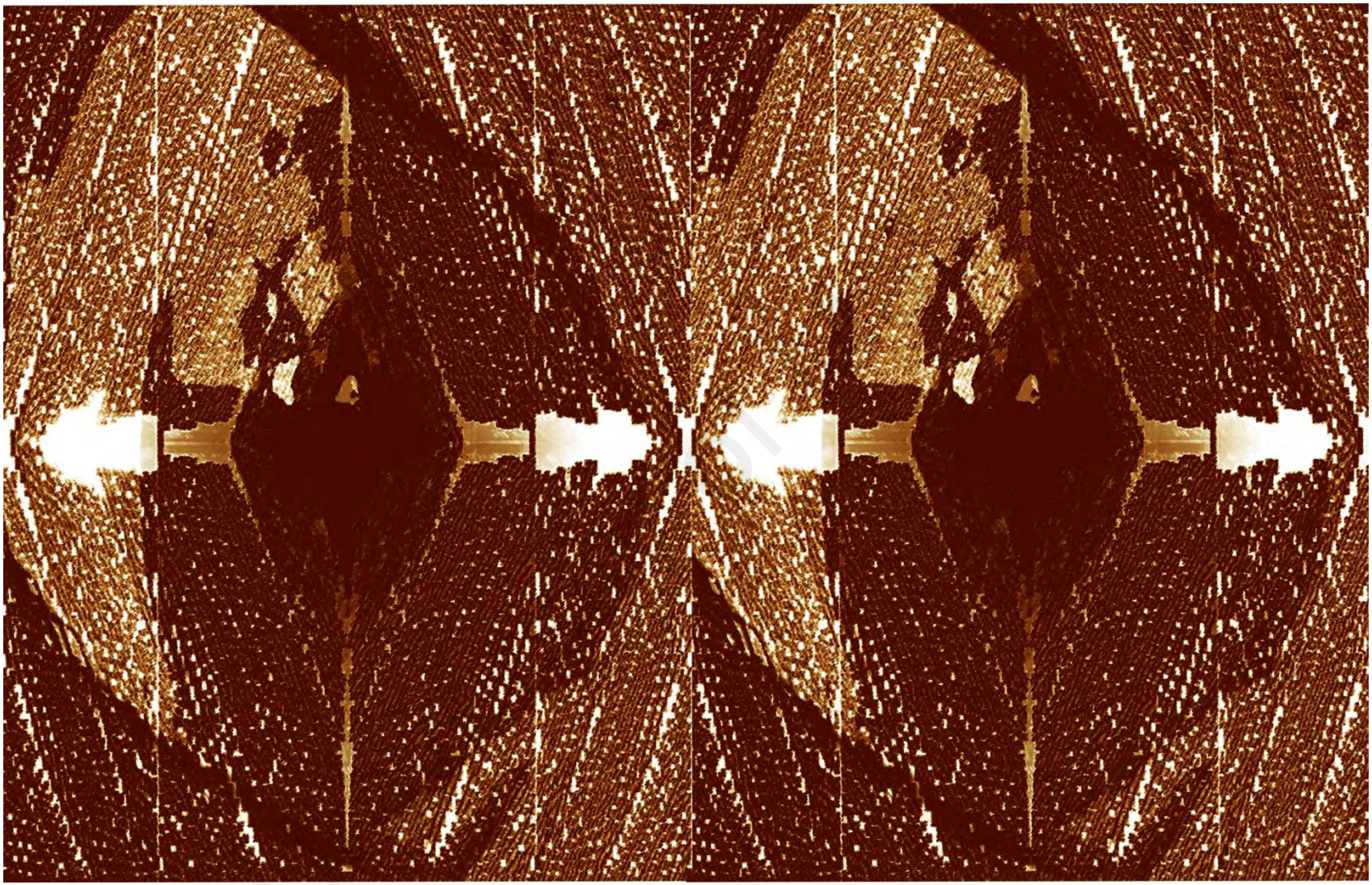


Figure 6.15: The Forth Composition of HPVA.

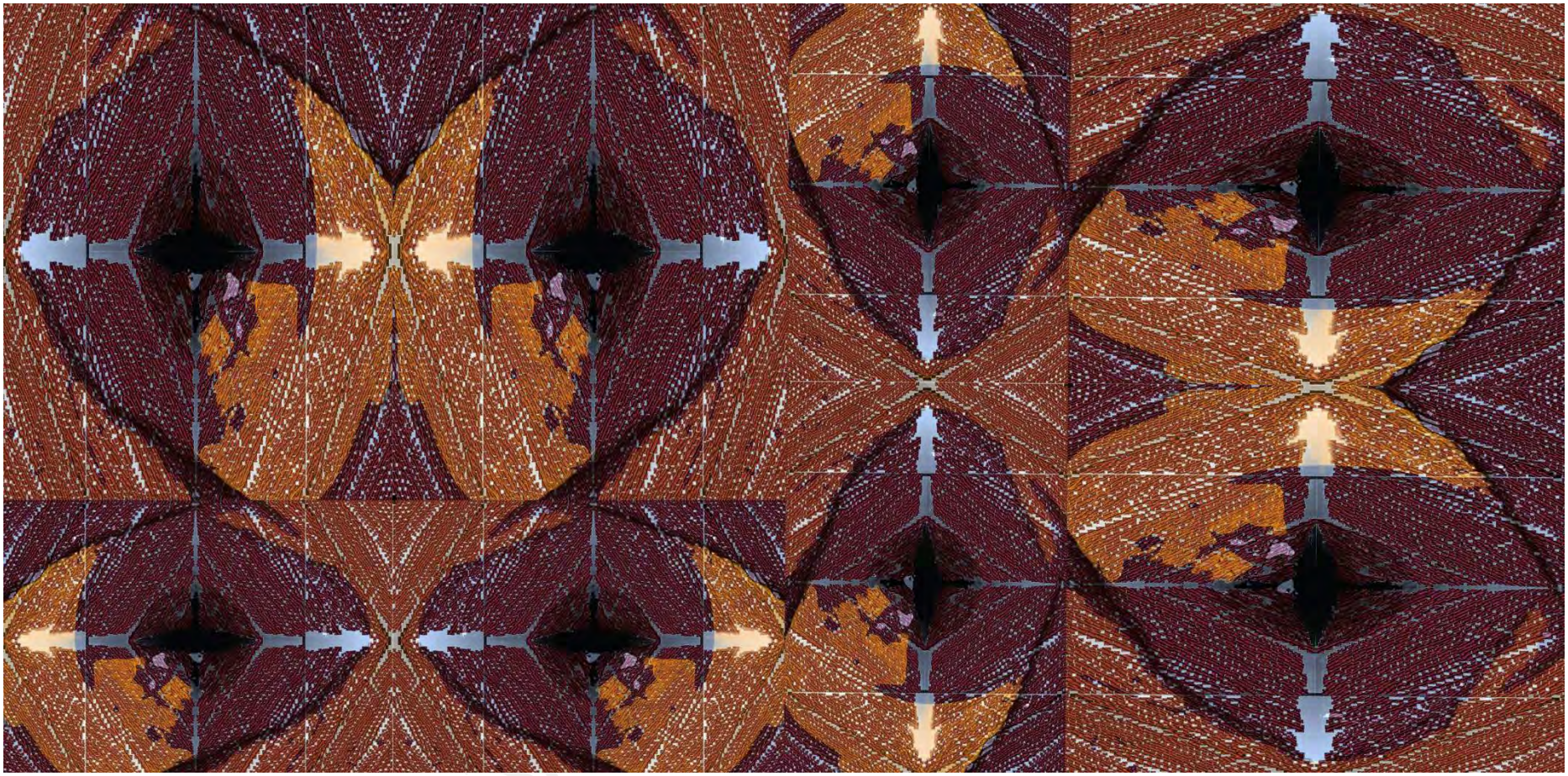


Figure 6.16: The Fifth Composition of HPVA.

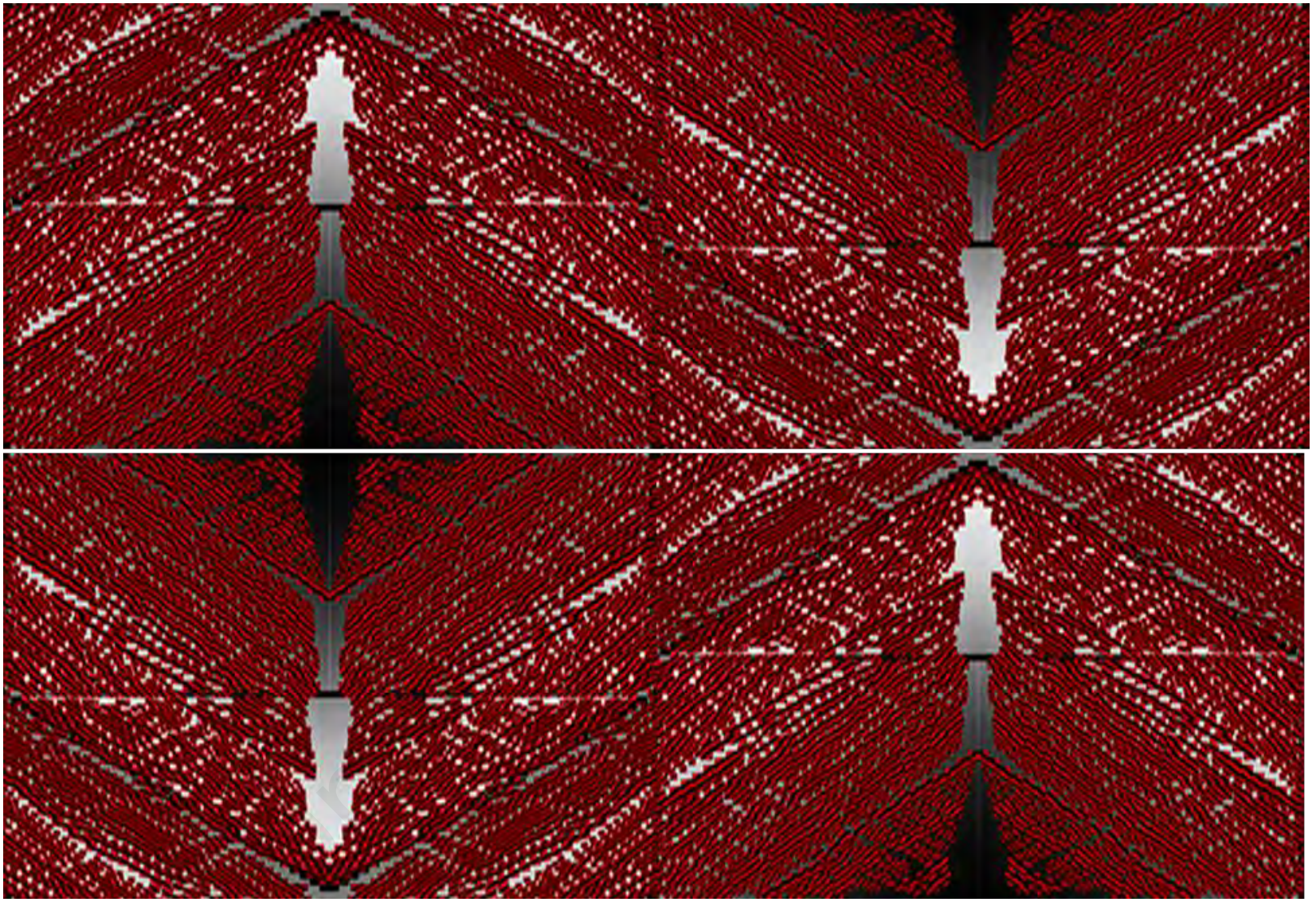


Figure 6.17: The Sixth Composition of HPVA.

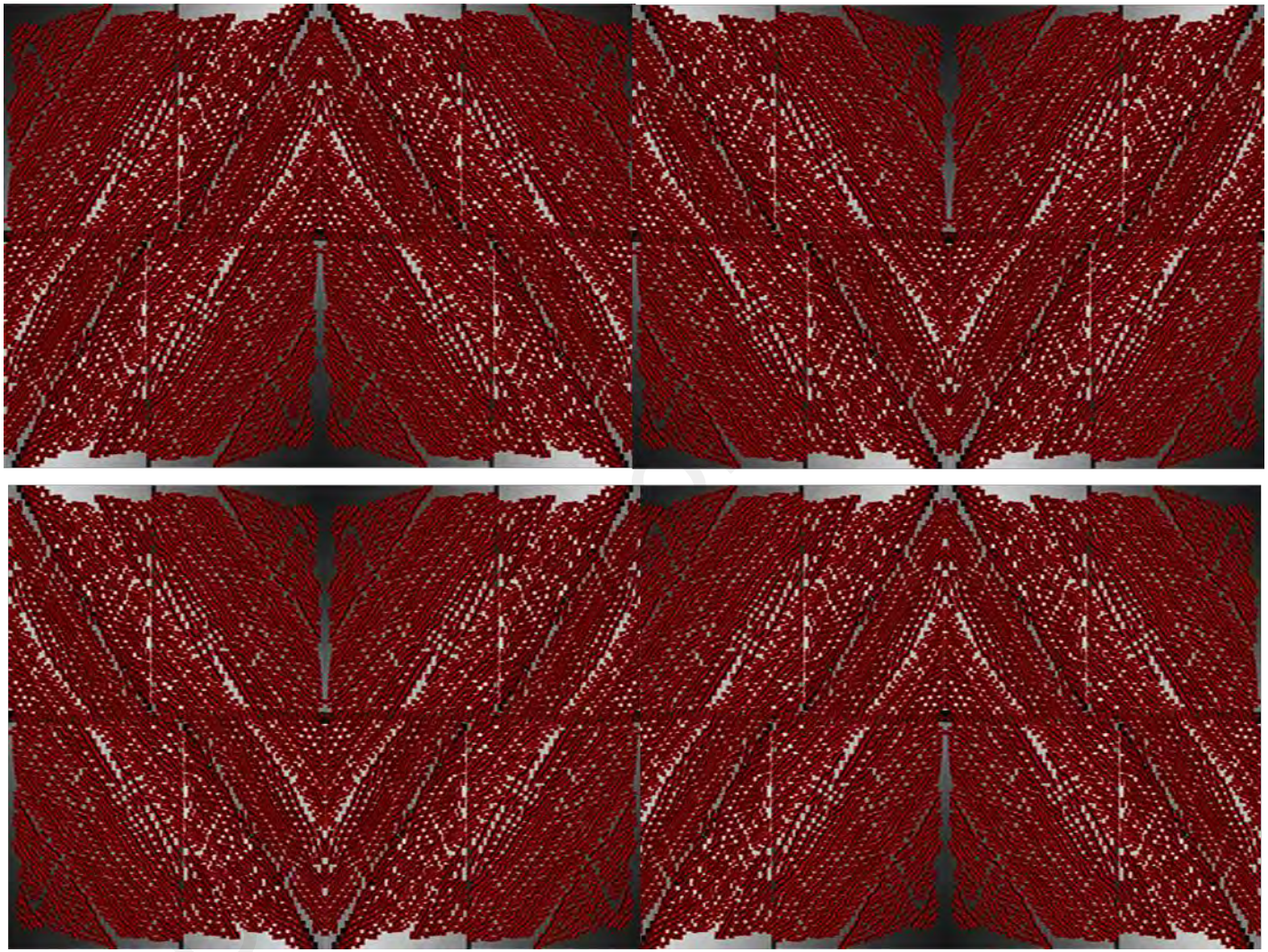


Figure 6.18: The Seventh Composition of HPVA.

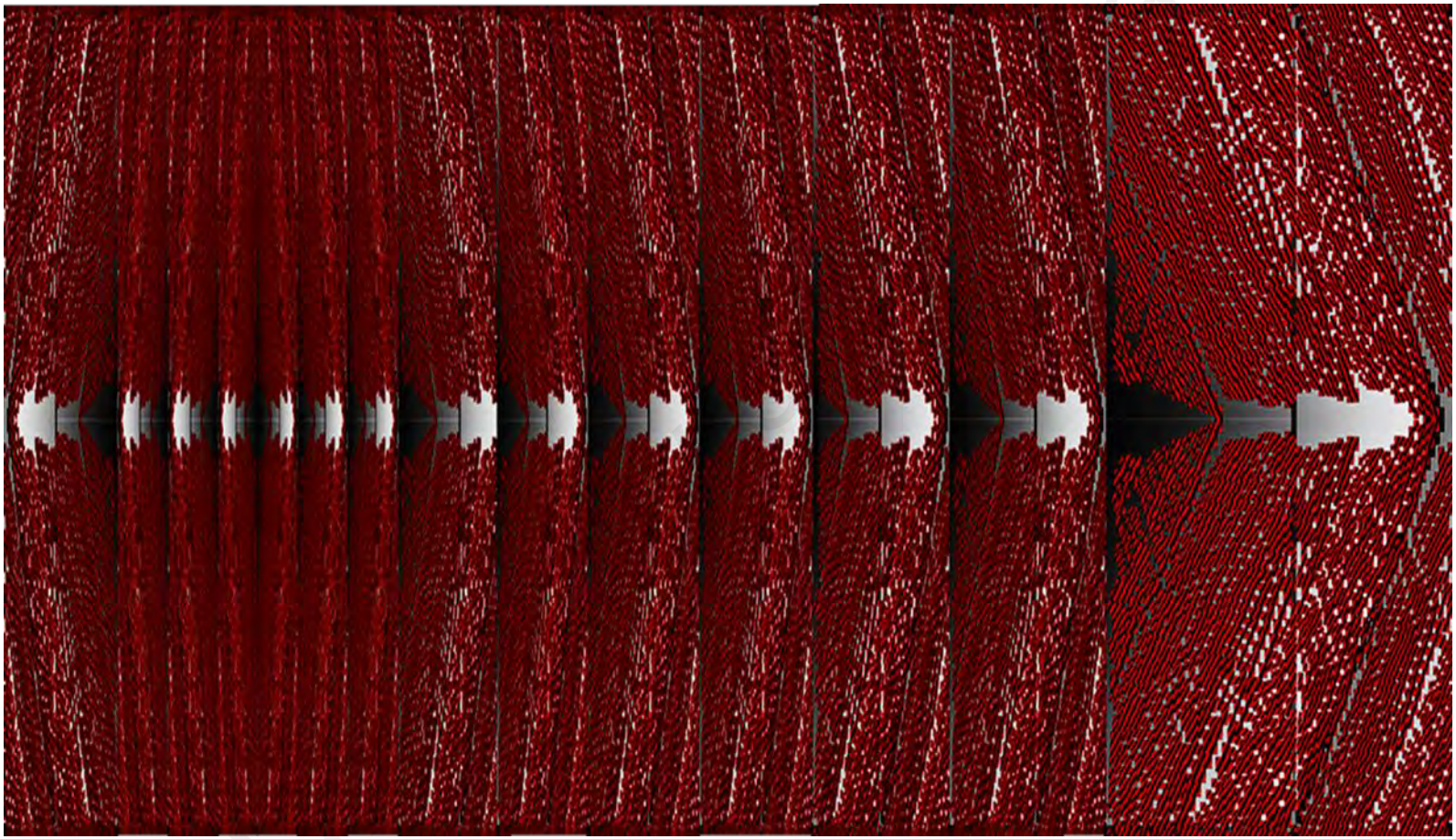


Figure 6.19: The Eighth Composition of HPVA.

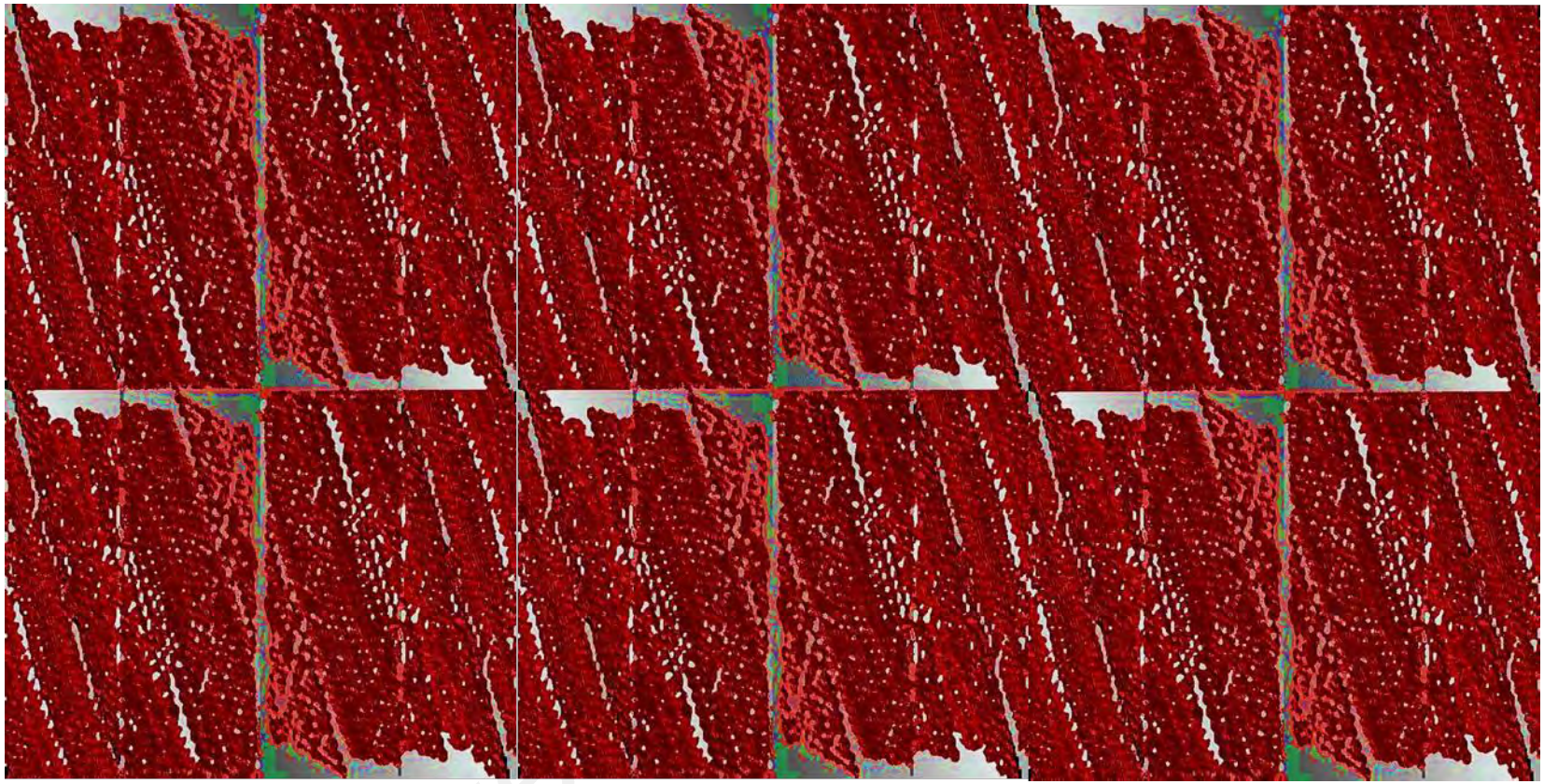


Figure 6.20: The Ninth Composition of HPVA.

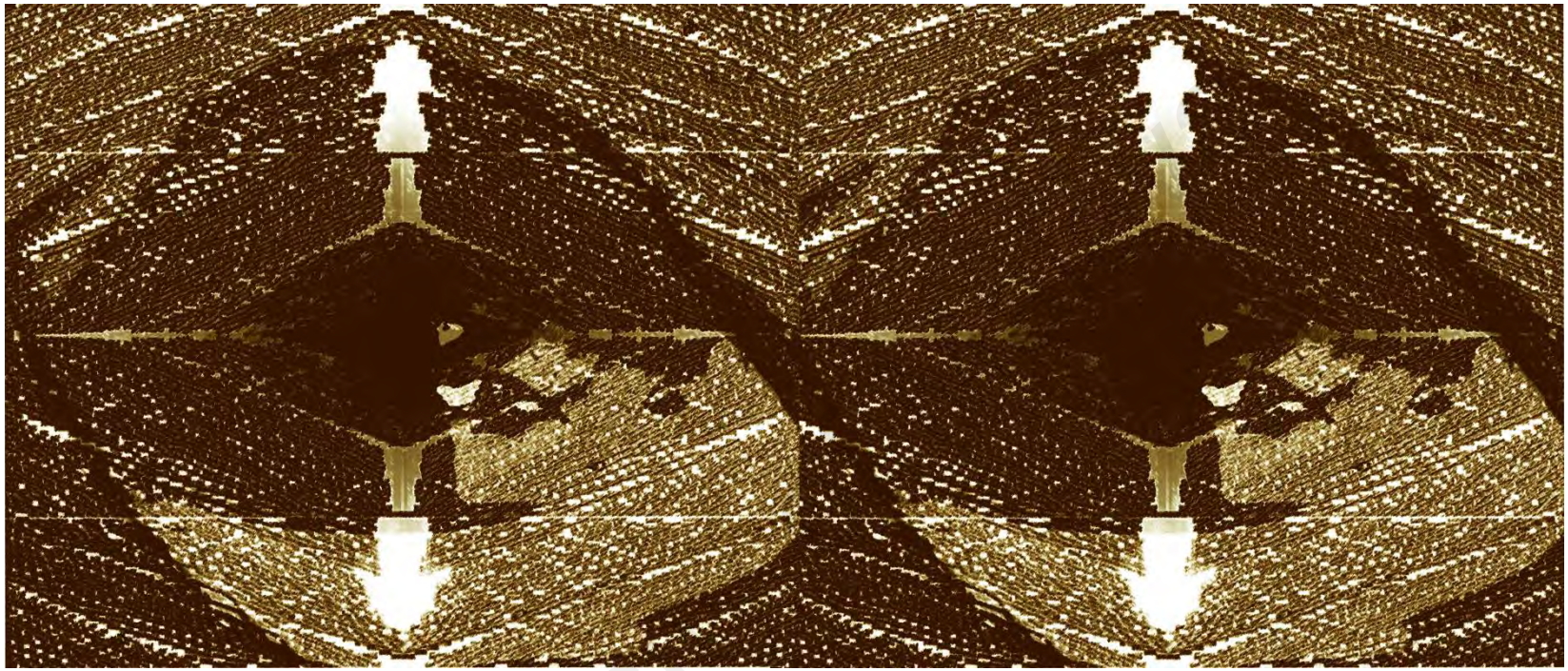


Figure 6.21: The Tenth Composition of HPVA.

6.5 Chapter Summary

In this chapter, a contribution that applies an approach for creating the pictorial aspects of visuospatial attention in a video by utilizing pattern modular logic design is presented. The technique applied in this section has produced ten various hybrid forms of arts. The findings of hybrid forms in this study have been produced to be creative works of arts of visuospatial attention in a specific case for the hybrid pictorial experience domain.

CHAPTER 7: CONCLUSION AND FUTURE WORK

A thesis of the hybrid portrayal of visuospatial attention through eye tracking research and modular design is concluded by a fulfillment of the objectives set out in chapter one. This chapter aims to highlight an important brief of the research contribution and also provide a direction for future research.

7.1 Reappraisal of the Research Objective

The first objective is to define a new concept of a hybrid depiction that could utilize in art-cognition science collaboration for the purposes of producing hybrid forms of art. This concept identifies the components of the hybridization for the specific case through the overview of visual arts and cognitive science perspectives. In order to achieve this objective, the combination between three approaches: first, the hybrid theories of pictorial representation by Lopes (2004) and pictorial experience by Newall (2011), the mathematical approaches through the number of theory by Gauss in 1986 (2005) and modular design by Harriss's (2011), Finally, the cognition science, the coherence theory of visual attention in dynamic scenes provided by Ronald Rensink (2000) are discussed. Three components of the hybridization, gaze features, physical properties, and pictorial aspects are identified that can be explored through DRS guideline stages for hybrid visualisation.

The second objective is to develop a new contribution to collaboration between art and vision science based on an eye-tracking approach for representation of the attention phenomena in visual arts. It is to employ the fixation matrix feature as a source of the pictorial reference, the first requirement of hybrid depiction. In order to achieve this objective, the use of the metrics of fixation count and fixation length is proposed that determined the gaze features from the descriptive output of attention. first, the video is divided into two sections based on the style of dance and then the area of interest AOI is

selected based on the full body movement. The descriptive statistics of fixation metrics: AOI/gaze elicitation analysis and AOI/pattern elicitation analyses are implemented. Two sets of information are determined: the quantity descriptive numerical data and the quality characters of attention for the decision of visualisation of features. The first stage of the proposed guideline gaze features determination has been accomplished.

The third objective is to develop a new contribution of collaboration between art and mathematically based on pattern modular design logic for visualising the attention phenomena. It is to employ the pattern modular design logic as a transparency, the second requirement of the hybrid depiction. In order to achieve this objective, the use of the additional table operation mods was employed that visualised the physical properties of attention from fixation matrix feature output. Three steps of visualisation the table symbols definition, width ***X,*** and height ***Y*** data set input, and the physical properties operation were proposed. The second stage of the proposed guideline physical properties resemblance has been applied.

Finally, the fourth objective is to create a credible contribution of producing hybrid artforms through a specific sequential art practices. It is to show the how of transfer the role of scientific function into an artistic practice through traditional art principles. In order to achieve this objective, the traditional art principles are selected based on balance and movement principles that created ten hybrid art forms in this study. The third stage of the proposed guideline pictorial aspects synthesise has been designed.

7.2 Discussion

7.2.1 Gaze Features Demonstration

An eye-tracking method has been served as a source of information for hybrid portrayal creation of visuospatial attention. It was used to demonstrate the gaze features of visuospatial attention in a choreographic dance video. This was to fulfill the standard of the correctness which is considered as the main criteria of hybrid art experimental studio for attention representation in this study. Thus, a gaze features demonstration stage based on the analysis of the fixation matrix feature is introduced. The purpose is to extract the fixation matrix feature output between AOI, and then analyses their correlation and differences based on the predefined video sections (common folk dance and uncommon mutilation dance). The fixation metrics were counted from participants who had at least one fixation in a given AOI. The performance of this proposed stage was evaluated in order to ascertain its solid based on two different metrics namely: fixation count and fixation length. The fixation count metric is defined as a number of fixations on an important area of interest AOI that grabbing attention. However, the fixation length is defined as a total number of fixations duration on an area of interest AOI that reflects the act of fixation.

The outcome of this analysis demonstrates that there are two information sets of gaze quantity data and quality data for visuospatial attention depiction. The quantity data, a set of both metrics will be used as a pre-input data in a modular pattern design. However, the quality data shows that the positive relationship of fixation matrix features between AOI per section enables to use both fixation count and fixation length for resemblance. Moreover, the variety of gaze features informs that the shape outlines of specific patterns will be appear with slightly similar shorts of width and various longs of height.

The results of AOI/gaze elicitation, fixation matrix feature, shows that visuospatial attention is strongly correlated with the area of interest AOI of the common folk and the evoking mutilation dance styles in the case of redefining gender roles 'oriental female stereotypes dance' *TAJWAL* video. However, participants interest seem to attend similarly in section one (0.9± 0.14) *ms* and section two (0.85±0.18) *ms,* expect their fixation act or attraction which significantly different, higher in the folk-section one (2.2±0.6) *ms* than mutilation-section two (1.9±0.6) *ms.*

The isolated AOI whether in the early or late scenes were attended often in both sections. However, those with low fixations maybe due to the complexity of representation which can be achieved without focused spatial attention. Actually, these data seem to support two different suggestions in cognitive neuroscience: that a focal spatial attention requires a scene with different features to capture strong attention in a complex or/and video. Even the complex perceptual can be judged with reduced focal spatial attention[16] (Wu, Libertus, Meyerhoff, & Woldorff, 2011). However, gaze duration seems to support several point views in Tachistoscopic cognition studies that is a familiar area of interest can be effected within a very short present duration as well as a few tens of milliseconds, unlike the unfamiliar one which draws long gaze. Just and Carpenter (1976) explained of the reason why participant continues to fixate a scene after receiving the information through the cognitive processes relationships to the absence of an instruction to move eye and stability required from the processor.

The result of gaze/pattern elicitation, heat map, shows that the motion of the head is highly attracted by the attention in both sections, then the motion of hands. However, the torso/waist

[16] low fixations.

is grabbed less attention in the specific case. This is due to the factor of surprise through the isolating of the prior knowledge and expectations (Casati & Pasquinelli, 2007a). Prasse (2011) argued that all the scenes received almost equal percentages of participant's interest which likely means that the scenes share same features or the participants did not interest much.

7.2.2 Physical Properties Resemblance

The physical properties of visuospatial attention in a choreographic dance video were visualised through a credible visualisation technique in this stage. It is robust to handle the resemblance process with a mathematical approach to fulfill the second requirement of hybrid depiction, second-order isomorphism in this study. Thus, physical properties resemblance stage based on the visual procedures of the pattern arithmetic modular design is applied. The goal is to visualise the hybrid form of visuospatial attention to use it as a pattern of design for the next stage of synthesizing. This pattern was created from the combination of the seven properties, color, patterns, frame, time, gist, space, and form. The visualisation process of this suggested stage was presented in order to establish a simple step-by-step technique based on a color semantic method that converts the empirical data set from science field into hybrid forms for visual art field.

A valuable table of hybrid symbols defined the concepts of physical properties for this stage which is useful for further resembling attempts of cognition phenomena. The width of attention ***X*** property is defined as is an integer of the fixation count descriptive number, the height of attention ***Y*** property is defined as an integer of the fixation length descriptive number, the color ***C*** property is selected basic color through RGB model with defining the values based on an equal number value, pattern ***P*** property is defined as a mod of color table operated based on the number of values of fixation count, the Frame ***F*** property is defined as

a frame of pattern through the semantic coordinate system (***X, Y***), Gist ***G*** property is a mod of color table operated based on the total number of scene plus one, Space ***S*** property is defined as a mod of gray table operated based on the total number of scene plus one, and finally a form ***F*** property is defined as a combination of physical properties in this visualisation study.

The visual outcome of this stage visualises the physical properties of visuospatial attention portray in this study. Moreover, the researcher explored that the final resembled patterns have vertical geometrical shapes for both sections. This is due to the fixation length results which are higher than the fixation count output.

In this stage, the mathematical visualising process was based on the number logic which was more flexible than other complicated digital visualizing processes. It served a simple numerical design logic that could be used easily by many artists than the algorithm techniques proposed by Yoon Young et al. (2016), A *Variational Art Algorithm for Image Generation*; It also more logically than the direct tracing of charts and visual analysis graphs followed by Linnell (2010) in her study, *Exploring the experience of a place through the visual representation of aural presence;* and finally the resemblance was explored cognitionaly through opserving the significant evidence for the specific phenomenon in this study rather than a direct mimic applied by both Krauß (2015) in his study, *Linking sediment and sentiment: on observing a sci-art project, and Weather as medium: Art and meteorological science study by* Randerson et al. (2015).

7.2.3 Pictorial Aspects Synthesis

Various hybrid forms of the visuospatial attention in a choreographic dance video are produced by creating the pictorial aspects in this stage. An inventive design through basic compositions design is performed to fulfill the requirement of hybrid depiction, experience in this study. Thus, the pictorial aspects synthesise stage based on the art principles are

manipulated subjectively. The goal is to form the hybrid portrayal of visuospatial attention in the specific case in this project. Two principles of art balance and movement are chosen to produce ten hybrid forms of art as shown previously. The tools of crop and rotation are used to manipulate the compositions for the final outcomes. This section respectively shows that the final stage of DRS guideline, pictorial aspects synthesise, is creatively applicable for art-science collaboration for hybrid depiction.

Actually, the main concern in aspect-recognition philosophy was the experience of depiction. Lopes (2004) point view of pictorial experience reflected the perspective of objectivism. The depiction on his account is tied with two main criteria; the information-demonstration based using mechanism to fulfill the standard of correctness, and the transparency through indirect resemblance. However, the latest formulas by Newall (2011) oriented the representation of objects should structure through the domain of seen. Thus, the strong procedures of hybrid depiction should use a framework which based on the combination between objective and subjective approaches of visualization. Therefore, this approach consisted of two objective processes: a rational scientific perspective for demonstration as a data source and mathematic design as visualization, and, one subjective process of synthesis for painting in this study.

7.3 Research Implication

The implication of this thesis is that the DRS model proposed for hybrid depiction of visuospatial attention would help in visualising the cognition phenomena that may be suspect of these three stages of visualisation without relying on the pre-embedded information in the related phenomenon such as a visuospatial attention in a dynamic scene which it may not always be present in the hybrid depiction of the cognition phenomena. Moreover, the approach proposed would also help in providing essential information of attention toward a

choreographic dance video, female redefines oriental dance for vision science. Furthermore to this research, new researchers in hybrid art-science collaboration research can also make use of the framework of the proposed guideline as a standard for newer visualisation techniques and produce artworks.

7.4 Originality and Contribution to Body of Knowledge

The value of this collaborative research that is based on the advantages of extended research in the area of hybrid art-cognition science collaboration research. With consider of the DRS approach contribution, future research can extend the proposed approach for the hybrid depiction of cognition phenomena that involves invisible coherence features. In this research, the DRS guideline proposed can only depict attention phenomena through eye-tracking research because that each phenomenon requires using its fit demonstration procedures. Therefore, it will be of great benefit if the proposed DRS approach in this study is extended to deal with other emotion phenomena such as happy, sad, anger, love etc. or invisible phenomena such as sound, time, the movement for producing various hybrid art forms.

Concerning of the gaze features demonstration contributions, this study implements a fixation matrix feature, using fixation count and fixation length for a specific case. However, issues may arise if gaze features output that used for pre-insert data of visualising process have a negative correlation quality. Therefore, it could be useful if other distinctive features can be used to develop the visualisation process of the proposed DRS approach. With concerning the physical properties resemblance contributions, it implements a pattern modular design, using additional table operation mod for visualising the properties color, pattern, frame, time, gist, space, and form for hybrid visualisation. Therefore, it could be useful if can use multiplication operation mod or other operation types for extended other

forms of hybrid arts. In the concerning, the pictorial aspects synthesise contributions, only two principles, balance, movement of art are applied for producing works. Thus, it could be useful if other principles such as proportion, emphasis, variety, rhythm, and harmony can be used for further creations.

The original contribution of this dissertation to the body of knowledge is an implementation of an eye-tracking statistics and pattern modular design that can be used for hybrid depiction of visuospatial attention in dynamic scenes using proposed novel features of gaze that are determined from fixation matrix and physical properties which are visualised by modular design. This is to assist hybrid artists in the visualisation of the cognition phenomena when such a phenomenon is presented as an invisible object with indescribable features when intending to produce artworks, painting in particular. This would enrich the practices of visual arts based on satisfying rational approach.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

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1- Al-Maqtari, S. A., R. O. Basaree, and R. Legino. 2016. "A hybrid model of drawing: Pictorial representation of visuospatial attention through an eye tracking research and numerical logic of lines." 653-666. (Book chapter, Scopus). (Published) https://www.scopus.com/record/display.uri?eid=2s2.084955420687&origin=inward&txGid=c391bd6a86bae4955c219e71e7e207fd

2- Al-Maqtari, Shareefa Abdullah, Ruzaika Omar Basaree, and Rafeah Legino. 2015. A Hybrid Model of Drawing: Pictorial Representation of Visuospatial Attention Through an Eye Tracking Research and Numerical Logic of Lines. Paper read at International Colloquium of Art and Design Education Research (i-CADER 2014). (Springer). (Published) https://link.springer.com/chapter/10.1007%2F978-981-287-332-3_67

3- Al-Maqtari, SA, RO Basaree, and R Legino. 2014. A hybrid model of painting: pictorial representation of visuospatial attention through an eye tracking research. Paper read at Proceeding of the 2014 International conference on education technology and education 2014. (Published). http://www.inase.org/library/2014/interlaken/EDU.pdf#page=97

4- Al-Maqtari, Shareefa Abdullah, Ruzaika Omar Basaree, and Rafeah Legino. 2018. Third Eye: A Hybrid Portrayal of Visuospatial Attention Through Eye Tracking Research and Modular Arithmetic. ICCVAD 2018: International Conference on Communication, Visual Arts and Design. High Impact Conference Credentials. ISI conference. (Accepted).