

AUTOMATIC RECOGNITION OF FRESHWATER ALGAE (*Oscillatoria sp.*)
USING IMAGE PROCESSING TECHNIQUES WITH ARTIFICIAL NEURAL
NETWORK APPROACH

AWATEF SAAD SALEM SAAD

FACULTY OF SCIENCE
UNIVERSITY OF MALAYA
KUALA LUMPUR

2012

**AUTOMATIC RECOGNITION OF FRESHWATER ALGAE
(*Oscillatoria sp.*) USING IMAGE PROCESSING TECHNIQUES WITH
ARTIFICIAL NEURAL NETWORK APPROACH**

**AWATEF SAAD SALEM SAAD
SGJ100010**

**THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF BIOINFORMATICS**

**INSTITUTE OF BIOLOGICAL SCIENCES
FACULTY OF SCIENCE
UNIVERSITY OF MALAYA
2012**

UNIVERSITI MALAYA

ORIGINAL LITERARY WORK DECLARATION

Name of Candidate: AWATEF SAAD SALEM SAAD (I.C/Passport No: 569470)
Registration/Matric No: SGJ100010

Name of Degree: MASTER OF BIOINFORMATICS

TITLE (“AUTOMATIC RECOGNITION OF FRESHWATER ALGAE (*Oscillatoria sp.*) USING IMAGE PROCESSING TECHNIQUES WITH ARTIFICIAL NEURAL NETWORK APPROACH ”):

Field of Study:

I do solemnly and sincerely declare that:

- (1) I am the sole author/writer of this Work;
- (2) This Work is original;
- (3) Any use of any work in which copyright exists was done by way of fair dealing and for permitted purposes and any excerpt or extract from, or reference to or reproduction of any copyright work has been disclosed expressly and sufficiently and the title of the Work and its authorship have been acknowledged in this Work;
- (4) I do not have any actual knowledge nor do I ought reasonably to know that the making of this work constitutes an infringement of any copyright work;
- (5) I hereby assign all and every rights in the copyright to this Work to the University of Malaya (“UM”), who henceforth shall be owner of the copyright in this Work and that any reproduction or use in any form or by any means whatsoever is prohibited without the written consent of UM having been first had and obtained;
- (6) I am fully aware that if in the course of making this Work I have infringed any Copyright whether intentionally or otherwise, I may be subject to legal action or any other action as may be determined by UM.

Candidate’s Signature

Date:

Subscribed and solemnly declared before,

Witness’s Signature

Date:

Name:

Designation:

AUTHORDECLARATION

I hereby declare that the work in this project is the result of my own investigation, except where otherwise stated. I declare that it has not been previously or concurrently submitted as a whole for master degree at UM or other institutions.

Affirmed by:

AWATEF SAAD SALEM SAAD

Signature: -----

Date: -----

Matric No: -----

ACKNOWLEDGEMENTS

My appreciation goes to my supervisor, Dr. Sorraya Bibi Malek, for her excellent supervision and valuable comments and guidance that motivated me in conducting this research. My gratitude also goes to all lecturers for their dedicated work and valuable ideas that inspired me as I completed my Masters degree at the University of Malaya (UM). I would also like to give thanks to Mr. Mogeab Ahmad Mosleh for the time he spent tutoring and guiding me on using the MATLAB software, which aided in the success of our program.

I am deeply grateful to my husband, Ali. Without his support and patience, I would not have been able to finish my Masters degree. My special thanks go to my sons, Mohamed and Ahmed, and my daughter, Rodina. I would also like to thank my friend, Hayat Mansoor, for her support during my period of study. Finally, I would like to thank my parents, sisters, and brothers for their unconditional support.

ABSTRACT

Cyanobacteria can be used as indicators to offer relatively exclusive information pertaining to ecosystem condition. Cyanobacteria react quickly and predictably to a broad range of pollutant. Thus provides potentially constructive early caution signals of worsening environment and the possible causes. Therefore the aim of this study is to develop an image processing and pattern recognition methods to detect and classify *oscillatoria* genus from Cyanobacteria found on tropical Putrajaya Lake (Malaysia). Computer-based image analysis and pattern recognition methods were used to construct a system that is able to identify, and classify selected Cyanobacteria genus automatically. An image analysis algorithm was implemented to contrast, filter, isolate and recognize objects from microscope images. Image preprocessing module used to contrast images, to remove the noise, and to improve image quality. Segmentation module used to isolate the different objects found in input image. A combination of Feed forward artificial neural network (ANN) with feature extraction module was used to train and recognize oscillator images. System accuracy was measured by using manual and automated classifying methods, and developed system showed a great accuracy system reach to 90%.

Keywords: Automated system; *Oscillatoria ps*; Image processing; recognition; Classification; Neural Network.

ABSTRAK

Cyanobacteria boleh digunakan sebagai petunjuk untuk menawarkan maklumat yang agak eksklusif yang berkaitan dengan keadaan ekosistem. Cyanobacteria bertindak balas dengan cepat dan boleh diramal untuk pelbagai jenis pencemar. Oleh itu memberikan isyarat amaran awal berpotensi membina persekitaran yang semakin teruk dan punca-punca yang mungkin. Oleh itu, Tujuan kajian ini adalah untuk membangunkan pemprosesan imej dan kaedah pengiktirafan corak untuk mengesan dan mengklasifikasi genus *oscillatoria* dari Cyanobacteria dijumpai pada tropika Putrajaya Lake (Malaysia). Kaedah pengiktirafan berasaskan komputer analisis imej dan corak telah digunakan untuk membina satu sistem yang mampu untuk mengenal pasti dan mengelaskan genus Cyanobacteria terpilih secara automatik. Algoritma analisis imej telah dilaksanakan Sebaliknya, penapis, mengasingkan dan mengiktiraf objek dari imej mikroskop. Modul pra pemprosesan imej menggunakan imej Sebaliknya, untuk menghapuskan hingar tersebut, dan untuk meningkatkan kualiti imej. Modul segmentasi yang digunakan untuk mengasingkan objek yang berbeza yang terdapat dalam imej input. Gabungan Feed rangkaian neural ke hadapan tiruan (ANN) dengan modul pengekstrakan ciri telah digunakan untuk melatih dan mengiktiraf imej pengayun. Ketepatan sistem telah diukur dengan menggunakan kaedah mengklasifikasikan manual dan automatik, dan sistem yang dibangunkan menunjukkan sistem ketepatan yang hebat sampai ke 90%.

Kata kunci: Automasi sistem; *Oscillatoria* id; Imej pemprosesan; pengiktirafan; Klasifikasi Rangkaian Neural.

TABLE OF CONTAINS

CONTENTES	PAGE NO.
CHAPTER ONE: INTROUCTIONS	1
1.1.Introduction:	2
1.2.Problem of the Study	3
1.3.Objective of the study	3
1.4.Scope of the study	4
1.5.Constraints and Limitation	4
1.6.Outline of the Study	5
CHAPTER TWO: LITERATURE REVIEW	6
2.1. Overview about Algae	7
2.2. Automated recognition system for algae	8
2.3. Identification and classification of algae	9
2.4. Algae taxonomy and classification methods	10
2.5. Cyanobacteria	12
2.6. Cyanobacteria Blooms	14
2.7. Occur of cyanobacteria Blooms	15
2.8. Toxicity of cyanobacteria Blooms	15
2.9. Toxicity of Cyanobacteria in Lakes	16
2.10. Treatment of Cyanobacteria Blooms	16
2.11. <i>Oscillatoria</i> sp.	17
2.12. Matlab Software	19
2.13. Advantages of MATLAB	20
2.14. MATLAB image Processing Toolbox	21
2.15. Artificial Neural Networks(ANNs)	21
2.16. MLP Neural networks	24
CHAPTER THREE: MATERIAL & METHODS	27
3.1. Study Site: Putrajaya Lake	28
3.2. Tools used for Sample Collection	29
3.2.1 Plankton net	29
3.2.2 Bottles:	30

3.2.3 Dropper:	30
3.2.4 Glass slide and Coverslip	30
3.2.5 Light microscope	31
3.2.6 DinoLite - DinoCapture 2.0 camera	31
3.3. Image Processing	32
3.4. Method of system development	37
3.5. Image Pre-processing Model	37
3.6. Segmentation Model	39
3.7. Feature Extraction Model	39
3.8. Classification and identification Model	42
3.9. Artificial Neural Networks	43
CHAPTER FOUR: RESULTS & DISCUSSION	46
4.1 Results	47
4.2 Discussion	48
CHAPTER FIVE: CONCLUSION & FURTHER WORK	51
5.1 Conclusion	52
5.2 Future Works	52
REFERENCES	53
APPENDECIES	58

LIST OF FIGURES

Figure 1: Example of images algae collected	11
Figure 2: Example of images <i>Oscillatoria</i> collected	19
Figure 3: A simple multilayer perceptron	23
Figure 4: location of Putrajaya Lake	28
Figure 5: Plankton net	29
Figure 6: Bottles	30
Figure 7: Dropper	30
Figure 8: -Glass slide and Coverslip	31
Figure 9: Light microscope	31
Figure 10: DinoLite - DinoCapture 2.0 camera	32
Figure 11: Images of algae	33
Figure 12: Conversion of original image into grayscale using MATLAB.	34
Figure 13: 'Sobel' operation on a grayscale image.	34
Figure 14: Conversion of dilated gradient mask image into segmented image	35
Figure 15: Image fill operation conducted on image after image segmented image.	35
Figure 16: The image processing.	36
Figure 17: Developed System Architecture.	37
Figure 18: (a) Major Axis L, and Minor Axis m. (b) Object Width Factor strips	41
Figure 19: Examples for Extracted (a) Area, and. (b) Perimeter	41
Figure 20: System Interface	43
Figure 21: Screenshot of MLP ANN	43
Figure 22: Confusion matrix of testing data from 'Test' file for GFNN	48

LIST OF TABLES

Table 1: classification and compare some kinds of algae, which collected by images.	12
Table 2: Classification of Oscillatoria	20
Table 3: MATLAB toolboxes	28
Table 4: Species used for comparison and image classification	33
Table 5: Extracted Feature used by classifier in this study.	41
Table 6: Elements used to build the MLP ANN automated image recognition	44
Table 7: Division of images used in the classification process.	45
Table 8: Comparison Results between Automatic and manual process	47
Table 9 : Confusion matrix of testing data from 'Test' file for GFNN	48