NETWORK GAME

(LITERATI)

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ABSTRACT

This thesis steps towards developing a networked game, Literati game system that supporting two players at one time. The main aspect of this thesis is to produce a networked gaming system, which process players requested to play the game and enabling users to play the graphical game with people through the network. The algorithm design and implementation method must not only be workable, but also highly efficient in terms of execution speed and response time.

With the powerful networking features of Java applet, it is expected that this project would produce a real game engine. Multithreading is an important aspect of network game. Therefore, efficient and robust servers that process separate client connections in separate threads are needed.

Java applet is a well-known and widely used example of mobile code (a variation on the traditional client-server model). It should be an interesting, time and value worth topic to research on. By using Java applet, it will give a good interactive response since it does not suffer from the delays or variability of bandwidth associated with network connection.

The possible applications of multimedia-networked system are endless, as the demand to support interactive communication among groups of users has increased significantly. The category of networking would serves to be a small foundation from which to base the future scenario of other reliable multicast and real time web based gaming system.

ACKNOWLEDGEMENT

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CHAPTER 1

INTRODUCTION

Chapter 1 – Introduction

1.1 Overview

Literati is a word game where up to two players compete by creating words from various letter tiles. The game is played on a 15x15 grid. Players create words by placing tiles at the cell on the board. Scores are totaled off the point values of each letter tile. The first player creates a word using the center cell and other players, in turn, play off of the tiles on the board to create new words. The game is over when all the letter tiles are played or no player can spell a valid word with the tiles they have left. The player with the highest score will win the game.

1.2 Project Motivation

Literati is an existing word game ... has already been developed but not yet in Bahasa Malaysia. Development literati in Bahasa Malaysia can enhance the vocabulary of all Malaysians when playing this game. Beside that, it will also encourage all level of Malaysian to master Bahasa Malaysia as our native language. It is a worth to play game since it enriches our vocabulary besides having fun.

1.3 Project Objectives

Core objectives of the project are as listed below

- To test the effectiveness of the techniques in the game when it is put online

- To find the technologies used in network gaming

Chapter 1 – Introduction

1.1 Overview

Literati is a word game where up to two players compete by creating words from various letter tiles. The game is played on a 18x15 grid. Players create words by placing tiles at the cell on the board. Scores are totaled off the point values of each letter tile. The first player creates a word using the center cell and other players, in turn, play off of the tiles on the board to create new words. The game is over when all the letter tiles are played or no player can spell a valid word with the tiles they have left. The player with the highest score will win the game.

1.2 Project Motivation

Literati is an educational internet game. Literati in English already been developed but not yet in Bahasa Malaysia. Development literati in Bahasa Malaysia can enhance the vocabulary of all Malaysians when playing this game. Beside that, it will also encourage all level of Malaysian to master Bahasa Malaysia as our native language. It is a worth to play game since it enriches our vocabulary besides having fun.

1.3 Project Objectives

Core objectives of the project are as listed below:

- To test the effectiveness of the techniques in the game when it is put online
- To find the technologies used in network gaming

1.4   Project Scope

The project is aimed to develop a simple game that can be played over the Internet. It can be a medium for leisure or entertainment without losing its purpose. Generally, literati can be divided into four parts, which is authentication module, interface module and engine module.

The project scope of literati for **authentication section** includes:

* Development user log-in management system

The project scope of literati for **interface section** includes:

* Development Graphical User Interface (GUI) using Java applet and JSP

The project scope of literati for **engine section** includes:

* Development user turn option application

* Development point calculation application

* Development word validation application

* Development data storing and accessing application

* Development tile placing application

* Development game-ending application

1.5   Scope of user

Anybody can play the game. The flow to play the game is decided to make it simple and easy to use. The features can be accepted by all kinds of age and easy to understand.

1.6   Expected Outcome

Expected outcomes of **authentication section** include:

- Setting of maximum user

- User identity and password is verified correctly and return

Expected outcomes of **interface section** include:

- User login page

- New user register page

- User fails to login page

- GUI for the game

Expected outcomes of **engine section** include:

- Correct point calculation at the end of game

- Result of word checking

- Ensure user places tile correctly

- Ensure user place the tile in the blue cell

1.7   Project Schedule

A Gantt chart is an easy way to schedule tasks. It is essentially a chart on which bars represents each task or activity. The length of each bar represents the relative length of the task. Table 1.1 is an example of Gantt chart where time is indicated in horizontal dimension and description of activity makes up the vertical dimension. This is the schedule for the system.

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Preliminary Study and Planning	1 wk	Mon 6/10/02	Fri 6/14/02	
Literature Study	1 wk	Fri 6/14/02	Thu 6/20/02	
System Analysis	6 wks	Thu 6/20/02	Wed 7/31/02	
System Design	7 wks	Tue 7/16/02	Mon 9/2/02	
Prototype	4.2 wks	Mon 9/2/02	Mon 9/30/02	
Development and Coding	12 wks	Mon 9/30/02	Fri 12/20/02	
Unit Testing	1 wk	Wed 1/1/03	Tue 1/7/03	
System Testing	1 wk	Tue 1/7/03	Mon 1/13/03	
Documentation	3 wks	Wed 1/1/03	Tue 1/21/03	
Implementation and Maintenan	3 wks	Wed 1/1/03	Tue 1/21/03	

Table 1.1 : Project Schedule

CHAPTER 2

LITERATURE REVIEW

Chapter 2 - Literature Review

2.1 Analysis Studies

2.1.1 Case Study 1 – Literati (Yahoo's game)
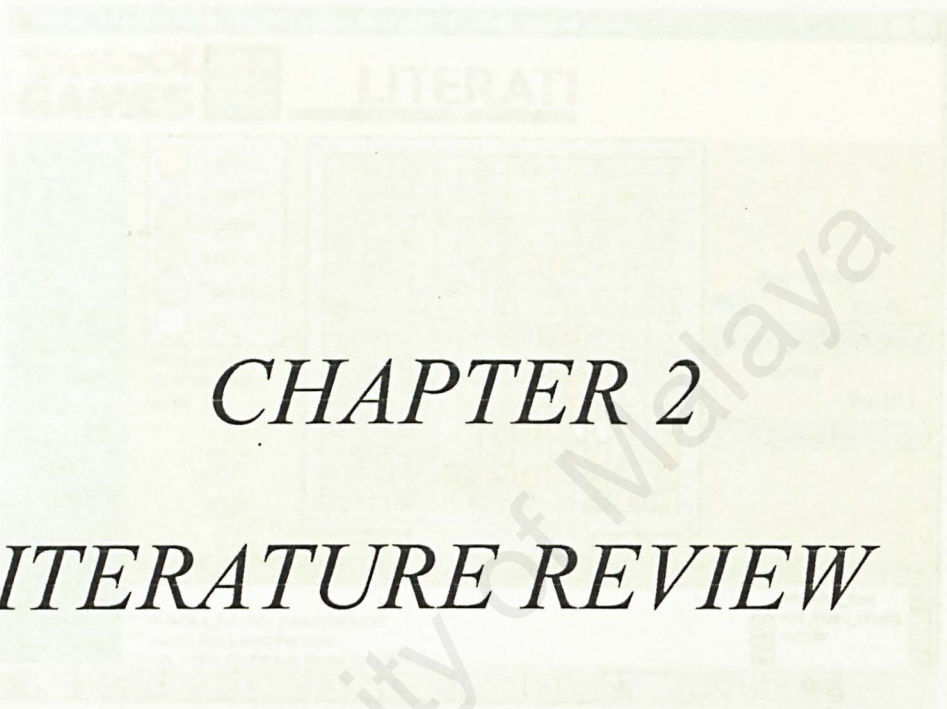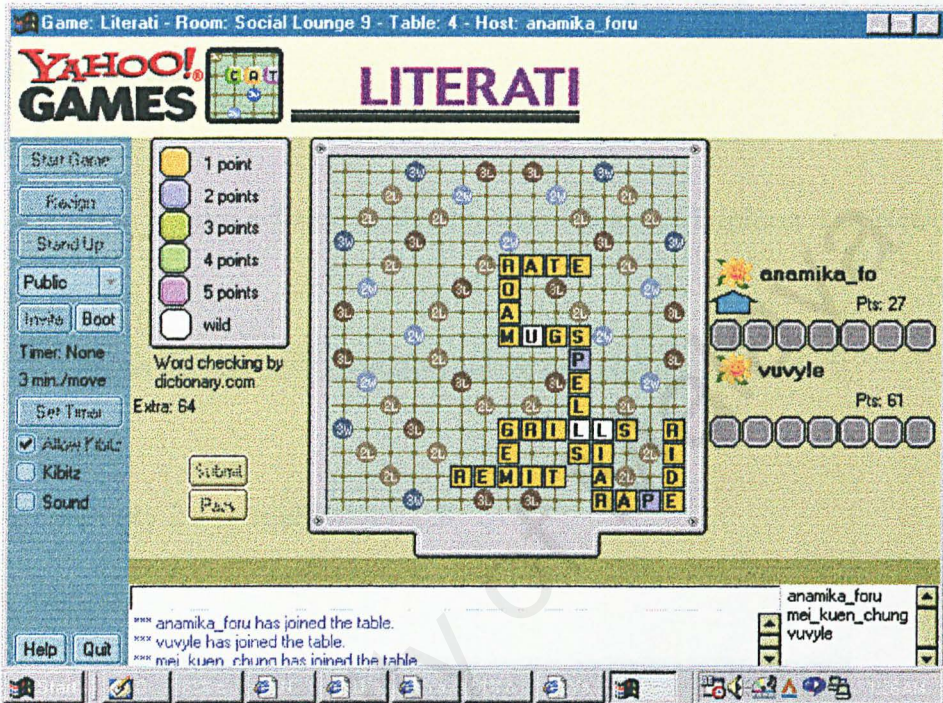
Figure 2.1 : Screenshot of the Yahoo's Literati

Literati in Yahoo's game is a Java-based game on the web. It is a word game where up to maximum four players compete by creating English words from various letter tiles. The game is played on a 15x15 grid. Players sitting in the same room compete by creating words by placing tiles at the intersections on the grid. This game is running by the Java's applet.

System requirements:

- Pentium3 or higher

- Windows 98/NT4/2000/ME/XP

2.1.1.1 Result of Study

Strength:

- It does not need to have extra software or compact disc to install the game because it is a internet game

- General information and help document are provided for the convenience of user especially the beginner

- There are many stages provided for the players according to their strength

- It is a free game

Weaknesses:

- The game require a Java-enabled browser - Internet Explorer 4 or Netscape 4 or newer

- User has to register to Yahoo first before can play this game

2.1.2 Case Study 2 – BrickShooter 2.5
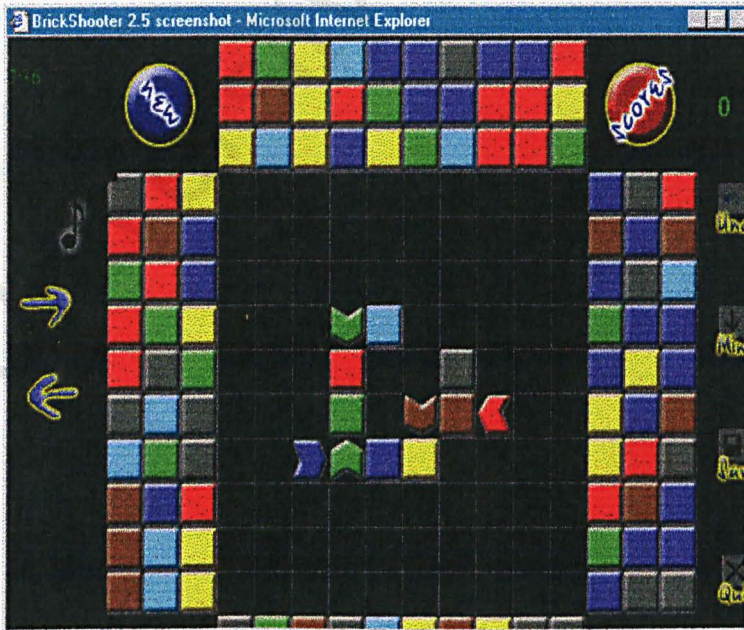
Figure 2.2 : Screenshot of the BrickShooter 2.5

BrickShooter is a combinatorial computer game based on an original idea. The game has 6 levels of difficulty, so it can give a lot of pleasure to both beginners

(including kids) and experienced players who like difficult puzzles. Players have to solve combinatorial puzzles appearing while playing.

System requirements:

- Pentium2 or higher

- Windows 95/98/NT4/2000/ME/XP

2.1.2.1   Result of Study

Strength:

- New Idea

- Skin support

- New skin - "Patchwork"

- Improved algorithm of bricks' moving

- Nice MIDI track

- On-line Hall of Fame

Weaknesses:

- The interface is quite confusing

- Not easy for beginners to play

2.1.3   Case Study 3 – Astral Arrows 1.0

Figure 2.3 : Screenshot of Astral Arrows 1.0

There is a field with 6x6 cells. Each field can be empty or contain a colored brick with arrow on it. Arrow direction depends on the bricks color (or vice-versa). Player can manipulate these bricks by clicking on the brick to move it accordingly to it's arrow direction. Groups of two or more bricks having the same color disappear, but each turn some new bricks come to the field. Player has to destroy bricks to earn points. The goal is to earn as much points as you can. The game ends when there are no empty cells left on the field so it's impossible to place incoming bricks on it.

System requirements:

- Win9x, Win2K, WinXP

- P-166

- Resolution - 800x600

2.1.3.1   Result of Study

Strength:

- New and unique idea

- Simple but interesting interface

- Better than other simple "match the color" game

Weaknesses:

- Only support single mode

- More suitable for children

2.1.4 Case Study 4 – Wzebra 3.2
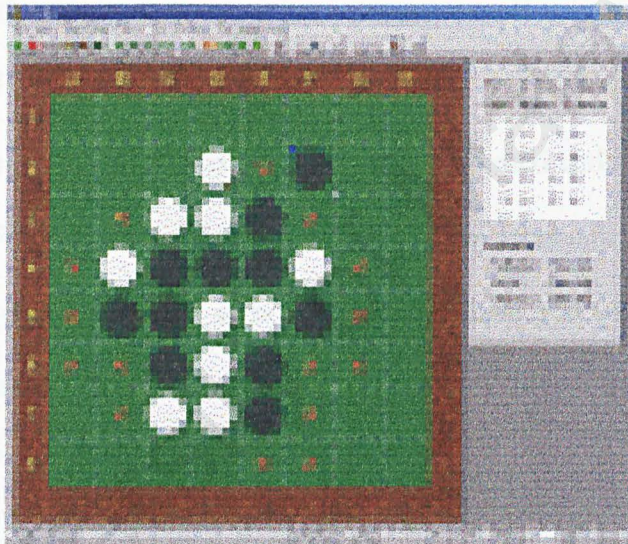
Figure 2.4 : Screenshot of Wzebra 3.2

Wzebra is Windows version of Zebra. The only difference between WZebra and the program Zebra which used to play on the Internet Othello Server is that WZebra does not think on the opponent's time.

There are several functions useful for analyzing games. A position can be set up on the board. WZebra can analyze a game entered interactively on the board, player can switch colors at any time during a game. WZebra can solve the position for perfect play.

System requirements:

- Windows 95 and above

- Processor - Pentium

- Memory - 32MB

- Resolution - 800x600

- Disk space - 20MB

2.1.1.4   Result of Study

Strength:

- Playing strength ranging from beginner to strong expert

- Help files in HTML is provided for beginners

- Move lists in any reasonable text format can be imported and analyzed

- Many useful features to simplify game-play: Move takeback, move preview
  (see the position arising after a move has been made and what options this
  gives the opponent) and board rotation

Weakness:

- WZebra tends to be somewhat pessimistic when evaluating the merits of a
  position. This is most easily spotted when Zebra is set to analyze a game; in
  an even position it will often find both players about 1 disk behind

- If a position which can never occur in an Othello game is created using the
  position editor, Zebra is likely to get confused and might make strange
  moves. This is because Zebra's knowledge was derived from positions taken
  from real Othello games, not random positions.

2.1.5 Case Study 5 – SkyMaze
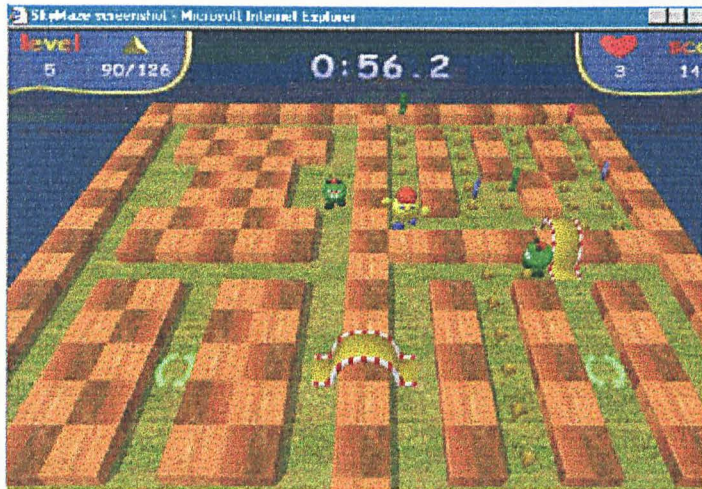
Figure 2.5 : Screenshot of SkyMaze

SkyMaze is the REAL 3D scene and professionally animated characters in this Pacman-like arcade game. Player play the game by leading hid Sky hero through the maze and collect crystals. Bad opponents will try to stop him in the journey. Player can select his hero for a great journey whether SkyBoy or SkyGirl. Player has to play through level after level and battle wily monsters to win the game.

The full version offers 50 mazes with power shields, freeze bonuses, magic bridges and other features.

System requirements:

- 3D Graphics card
- DirectX 7.0 or higher
- Windows 95/98/ME/2000
- Processor 300 MHz or higher
- 32 MB RAM
- 15 MB free disk space
- Sound card - optional.

2.1.1.5   Result of Study

Strength:

- Real 3D graphics

- Cool music score

- Joystick support

- Save/Load support

- User-friendly interface

- Install/uninstall support

- Lifetime technical support

- Vivid graphic

Weakness:

- Require good hand eye coordination when playing

2.2   Software Architecture

There are a few software architectures available now: mainframe architecture, client-server architecture, two-tier architecture and three-tier architecture.

2.2.1   Mainframe Architecture

In mainframe system architecture, all operation is within the central host. User interacts with the host through a terminal that captures keystroke and sends that info to the host. Mainframe architecture is not tied to a hardware platform. User interaction can be clone using PCs and UNIX workstations. A limitation of mainframe architecture is that it does not easily supports graphical user interface or accesses to multiple databases from graphically dispersed sites.

2.2.2 Client-server Architecture

Client

Client is a networked information requester, usually a PC or workstation, that can query database and/or other information from a server. Clients rely on servers for resources, such as files, devices, and even processing power.

Server

Server is running program or process on a networked computer that accepts requests from the programs running on other computer to perform a service and respond appropriately.

Client-server

Client-server is a network architecture in which each computer or process on the network is either a client or a server. Client-server architecture implies a cooperative processing of requests submitted by a client, or requester, to the server, which processes the requests and returns the results to the client. The client manipulates the data and presents the result to the user.
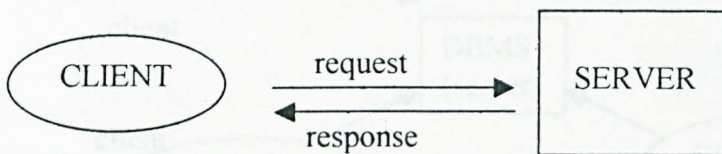
Figure 2.6 : One-to-One Client Server

Client-server solutions can be in a many-to-one design that is more than one client typically makes requests of the server.

2.2.3 Two-Tier Architecture

Two-tier architecture refers to client/server architectures in which the user interface runs on the client and the database is stored on the server. The actual application logic can run on either the client or the server. There are only the architecturally tiered data server and client.
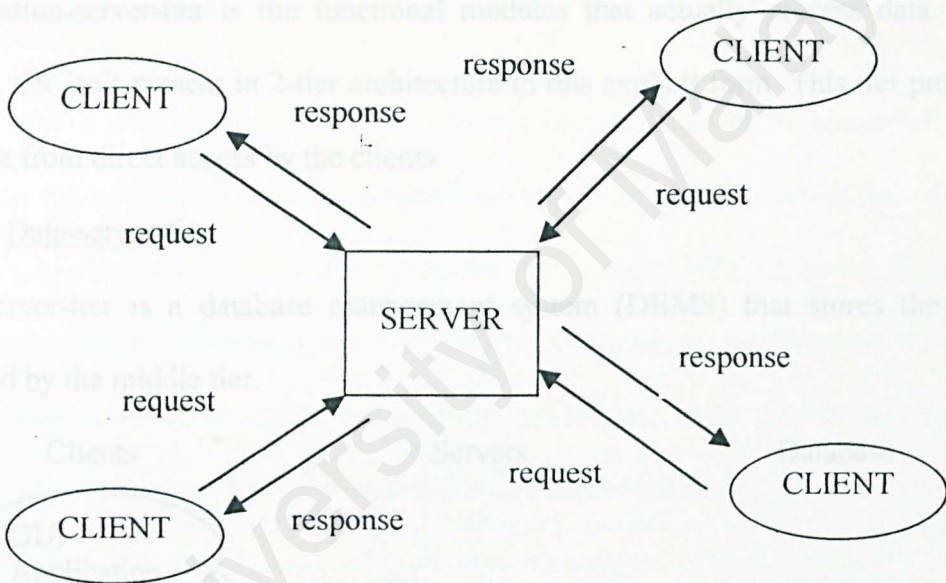
Figure 2.7 : Many-to-One Client Server
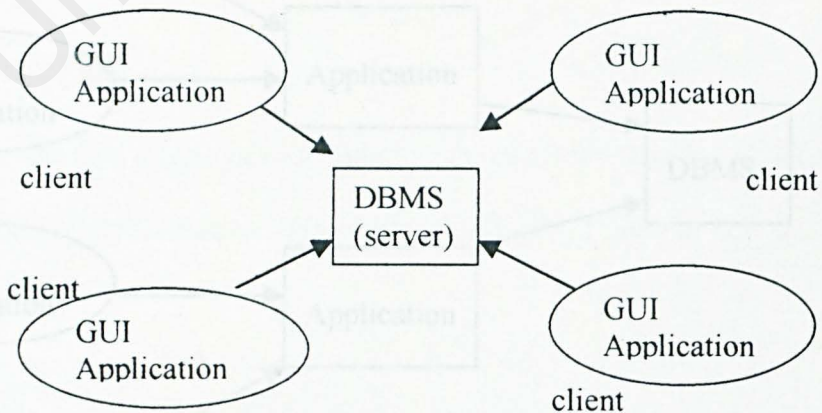
Figure 2.8 : 2-Tier Architecture

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2.2.4 Three-Tier Architecture

Three-tier architecture is a variation of client/server architecture consisting of three well-defined and separate processes, each running on a different platform:

- The three tiers consist of:

1.   Client-tier

Client-tier is the user interface, which runs on the user's computer.

2.   Application-server-tier

Application-server-tier is the functional modules that actually process data. This middle tier isn't present in 2-tier architecture in this explicit form. This tier protects the data from direct access by the clients.

3.   Data-server-tier

Data-server-tier is a database management system (DBMS) that stores the data required by the middle tier.

Clients   Servers   Database

GUI Application

GUI Application   → Application

                                                                    DBMS

GUI Application   → Application

GUI Application
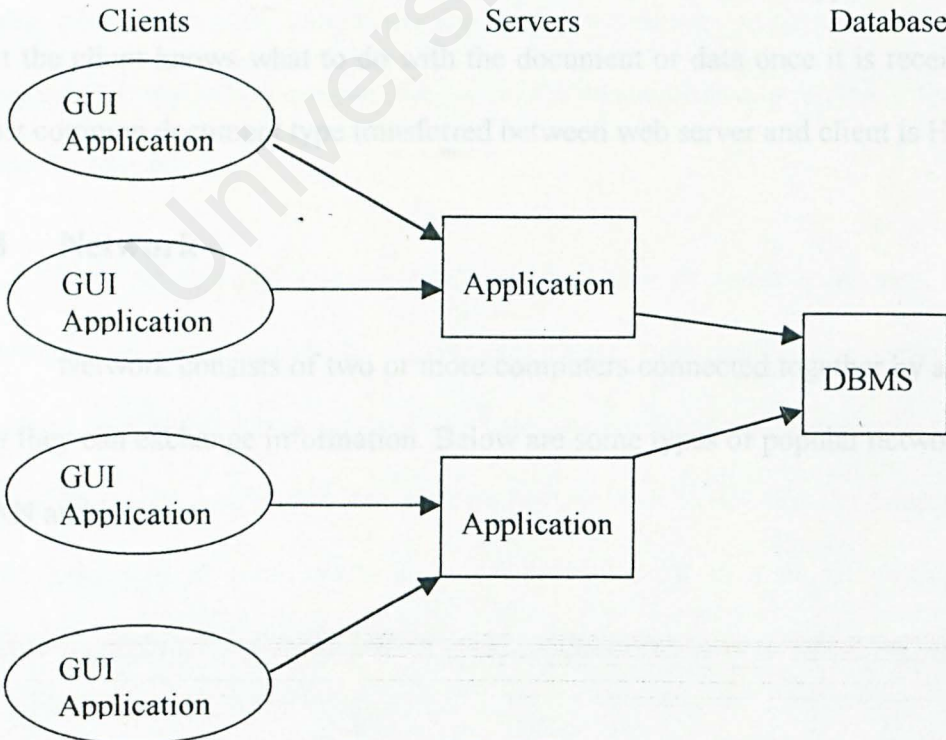
Figure 2.9 : 3-Tier Architecture

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2.2.5 Conclusion for Software Architecture

The three-tier architecture is chosen for this project because it is easier to implement and design. The three-tier design has many advantages over traditional two-tier or single-tier designs.

Advantage of using three-tier architecture :

- The added modularity makes it easier to modify or replace one tier without affecting the other tiers.

- Separating the application functions from the database functions makes it easier to implement load balancing.

In this project, the three tiers consists of web browser as client-tier, web server as application-server-tier and database server as the data-server-tier. A web server can be defined as a computer program that receives HTTP requests from web browser for document. Web server will achieve and process the data from database server. Web server return both the document and the document type to the client so that the client knows what to do with the document or data once it is received. The most common document type transferred between web server and client is HTML.

2.3   Network

Network consists of two or more computers connected together by a cable so that they can exchange information. Below are some types of popular network: LAN, WAN and internet.

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2.3.1 Local-Area Network (LAN)

A LAN is a connection between two or more computers, which allows users to share files, programs, or data with a minimum of effort. In LAN, computers are located in one physical location, like a building or just one floor of a building. A LAN tends to use just one set of networking options. For example, a LAN generally uses one network operating system, one type of cable, and one logical topology. Typically, a LAN connects the computer in a department, a building or several buildings situated near each other. A LAN is not limited to any particular computer operating system. DOS, Macintosh, and UNIX can all run across a LAN. Actually, they can all run across the same LAN at the same time, if the right software is used.

2.3.2 Wide-Area Network (WAN)

A Wide Area Network (WAN) is a government-regulated public network or privately owned network that crosses into the public network environment. It doesn't matter whether the area being bridged is across the country or across the street. If the geographical separation crosses over a public thoroughfare, a WAN is required to make the connection.

The WAN is typically used to connect two or more local area networks (LANs). Generally, a LAN is a privately owned communications system that is designed to allow users to access and share resources (computers, printers, servers) with other users. LANs that are interconnected by a WAN may be located in the same geographical area, such as an industrial park or campus setting, or in geographically separate areas, such as different cities or even different regions.

2.3.3 Internet

Internet is a collection of communication networks interconnected across 2 or more LANs or sub-networks. It is a global network connecting millions of computers. More than 100 countries are linked into exchanges of data, news and opinions.

Each Internet computer, called a host, is independent. Its operators can choose which Internet services to use and which local services to make available to the global Internet community.

There are a variety of ways to access the Internet. Most online services, such as America Online, offer access to some Internet services. It is also possible to gain access through a commercial Internet Service Provider (ISP).

2.3.4 Conclusion for Network

Since this is an online game system that may access by people nation wide, internet is the most suitable network to be used in this project. Users from different states can access the system if they have internet access.

2.4 Web Server

A Web server is a software that respond to client requests by providing resources. Every Web server has an IP address and possibly a domain name. For example, if an user enter the Uniform Resource Locator (URL) address, **http://www.deitel.com/mainmenu.html** into your browser, this sends a request to the server whose domain name is deitel.com. The server then fetches the page named mainmenu.html and sends it to the user's browser. During this interaction, Web

servers and browsers communicate using platform-independent HTTP (Hypertext Transfer Protocol), a protocol for transferring requests and files over a Internet.

There are several popular web server : Apache, Microsoft Internet Information Server (IIS) and Personal Web Server (PWS).

2.4.1 Internet Information Server (IIS) v5.0

IIS is an enterprise-level Web server that is included with Window 2000. IIS v5.0 is good as both a first-time Web server for those familiar and comfortable with Windows operating systems, and a high-end server for hosting providers and large corporate installations. It handles the basics well and is better integrated in Windows than previous versions. IIS v5.0 also comes with performance and feature enhancements that will be attractive for mission-critical tasks.

2.4.2 Personal Web Server (PWS)

PWS is entry-level/mid-range server for Windows 9x/NT platforms. It is a scaled-down version of the commercial Information Internet Server (IIS) included with the Server edition of Microsoft Windows NT. PWS is ideal for educational institutions, small businesses and individuals because PWS does not require the PC on which it is installed to be used exclusively as a Web server. PWS is a great entry-level Web server that makes it easy to publish personal home pages, serve small Web sites, and share documents via a local intranet.

PWS is one of the best servers available for helping to get users up and running quickly. Wizards are included to guide users through the process of setting up home pages and sharing files, and the PWS administrator reduces the complexity

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of actually running the Web server itself. Users can also use the familiar Explorer interface or PWS's Personal Web Manager to share directories, start and stop the server, and view Web site statistics.

One of the best uses for PWS is as a platform for testing out Web sites on Windows 95/Windows NT Workstation computers before hosting them on the Internet. This allows users to check the validity of links, scripts, and applications as well as to ensure that the overall organization of the site is functioning correctly.

PWS presents the ability to develop transactional Web applications using the Microsoft Transaction Server. Overall, while most large enterprises will likely bypass Microsoft's Personal Web Server for the high-end Internet Information Server, PWS will remain one of best available options for individuals wanting to serve their own personal home pages and for small organizations needing to host their own Web sites.

2.4.3 Apache

Apache is currently the most popular web server in the market according to statistics at NetCraft. This particular web server is quick at handling requests and responses. It is available as Open Source and is definitely free of charge. It Apache were to support Servlets and Java Server Pages, an additional patch would have to be added to link with the original Apache web server. This particular patch is called Apache Jakarta Tomcat. The main problem here is that these servers is quite difficult to be configured for use. There are a lot of configurations need to be done.

2.5　Operating System

　　An operating system is the software that provides the interface between the hardware of a computer system and the applications programs that are used on it. Simply put, the operating system provides the link between the hardware of the computer and the user. It is a platform that performs basic tasks, such as recognizing input from the keyboard, sending output to the display screen, keeping track of files and directories on the disk, and controlling peripheral devices such as disk drives and printers.

　　Besides that, the OS makes sure that different programs and users running at the same time do not interfere with each other. OS provides a software platform to allow application programs run on it.

The most popular operating systems currently are UNIX, Windows 98, Linux and Windows 2000.

2.5.1　UNIX

　　UNIX is a much older operating system that was created in the late 1960s. Unix is available on a wide variety of computer systems, including personal computers, workstations, mainframes and supercomputers. It was developed for, and is particularly well-suited to, multi-user systems, but is now also run on 'stand-alone' machines.

　　UNIX began as an open source project that became widely used in Universities, scientific labs, and by the U.S. government. The philosophy behind the design of UNIX was to provide simple and powerful utilities that could be pieced

together in a flexible manner to perform a wide variety of tasks. Over the years, hundreds of talented programmers contributed their own improvements to Unix making it extremely robust, stable, and fast.

However, UNIX is more difficult to learn because a lot of command are used and isn't as widely supported as Microsoft Windows 2000.

2.5.2   Windows 2000

Windows 2000 is Microsoft's latest version of popular Windows NT Operating System. Windows 2000 Server has big improvement over Windows NT 4.0. The changes, both fundamental and cosmetic, have made Windows 2000 faster, more reliable, heavier-duty, and easier to use.

2.5.3   Windows 98

Windows 98 is based on the popular Microsoft Windows 95 Operating System, and is designed for the consumer market. Windows 95/98 were designed for backward compatibility with older DOS and 16bit programs, as well as providing a platform for the newer (back in 1995) 32 bit programs.

Windows 98 works better by making it simple to access the Internet and by providing better system performance along with easier system diagnostics and maintenance. With Windows 98, users' system plays better as well with support for the latest graphics, sound, and multimedia technologies, the ability to easily add and remove peripheral devices with support for Universal Serial Bus (USB), and it also enables users to watch TV on PC. Besides that, Windows 98 is compatible with more software (including games) and hardware.

2.5.4   Linux

Linux has gradually become a popular operating system for Internet/ intranet serving purposes. With a host of performance enhancements that will benefit Web sites and Internet sites of all sizes, Linux is a stable and high-performance operating system for Internet usage.

Linux has made progress, primarily in functionality important to Internet infrastructure and Web server capabilities, including a greater selection of drivers, easier installation, GUI-based front ends for Web administration and window management.

2.6   Database Server

Database is a computerized record keeping system. More completely, it is a system involving data, the hardware that physically stores that data, the software that utilizes the hardware's file system in order to store the data and to provide a standardized method for retrieving or changing the data, and finally, the users who turn the data into information.

Databases were created to solve the problems with file-oriented systems in that they were compact, fast, easy to use, current, accurate, allowed the easy sharing of data between multiple users, and were secure. The important thing is that a database allows you to store data and get it or modify it when you need to easily and efficiently regardless of the amount of data being manipulated. For multiple purpose use, not only file system but database management systems (DBMS) were expected powerful in this sense. The effectiveness of the database include:

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a. Ensuring the data can be shared among users for a variety of applications.

b. Maintaining of the data is accurate and consistent.

c. Ensuring that all data required for current and future application will be readily available.

d. Allowing the database to evolve the needs of the users grow.

e. Allowing the users to construct their personal view of the data without concern the way data are physically stored.

To add, access, and process data stored in a computer database, a database server is needed. There are several database servers available : Oracle, MySQL and Microsoft SQL Server.

2.6.1 Oracle8i

Oracle8i is one of the most stable databases available in the market. It can run on almost every platform. Oracle8i not only provides the advanced tools to manage all types of data that is found in today's most popular web sites, but it also to provides the performance and scalability needed to support these large sites and other mission-critical applications.

In today's fast-paced business climate, application developers have been pushed to produce advanced applications not only quickly, but also with inherent flexibility to meet ever-changing needs. Oracle8i introduces additional support for Java, today's most popular and productive programming language by including a robust, integrated, and scalable Java Virtual Machine (Java VM) within the server. This expands Oracle's support for Java into all tiers of applications, allowing Java

programs to be deployed where they perform best, either in the client, server, or middle tier without recompiling or modifying the Java code.

Oracle, having invented the relational database, continues to lead and revolutionize the database industry by introducing iFS and Oracle interMedia with Oracle8i Enterprise Edition. iFS, the Internet file system, provides the easy-to-use functionality of a file system combined with the advantages of all data, such as text and web pages, in a single server--data integration with the cost savings of a single server. Oracle8i Enterprise Edition also introduces Oracle interMedia, which allows businesses to manage and access multi-media data, including image, text, audio/video, and spatial data.

Finally, Oracle8i also provides Oracle Enterprise Manager, which includes an easy-to-use-centralized console, a rich set of management tools, and the extensibility to detect and solve any problems that may arise. It also includes several administrative applications for performing day-to-day tasks for databases and applications, such as scheduling backup routines.

2.6.2   MySQL

MySQL is a very fast, multithreaded, multi-user and cross platform database. MySQL is provided by MySQL AB, which is a commercial company that builds its business providing services around the MySQL database. It is available as Open Source Software. This means that anyone can study the source code and modify it (in certain conditions) to fit their needs. It can be download for free with non-commercial purpose only.

MySQL is a relational database management system, which stores data in separate tables rather than putting all the data in one big storeroom. This adds speed and flexibility. The linking between the tables makes it possible to combine data from several tables on request.

Nowadays, a lot of language bindings now available such as Perl, PHP, Java, C, C++, Eiffel, Python and Tcl. But the increasingly popular combination for MySQL is PHP.

MySQL handles large databases, which can contain up to 50,000,000 records. From the graphics aspect, MySQL does not allow the storage of graphical data. Anyway, the advantages of MySQL are it is very fast, reliable, and easy to use. The connectivity, speed, and security make MySQL highly suited for accessing databases on the Internet.

2.6.3 Microsoft SQL Server

Microsoft SQL Server 7.0 is a single process, multithreaded relational database server primarily intent for transactional processing. It is based on the client/server architecture, which divides processing into two components: a front-end, or client component, that run on a local workstation and a back-end, or server component, that runs on a remote computer.

2.7 Data Access Technology

Access technology is needed to enable communication and access to various databases.

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2.7.1   JDBC (Java Database Connectivity)

The JDBC specification is similar to Microsoft's Open Database Connectivity (ODBC) driver, where both provide a standard interface between you and the database server. JDBC provides a standard API, which you can use regardless of what database is being used in the backend.
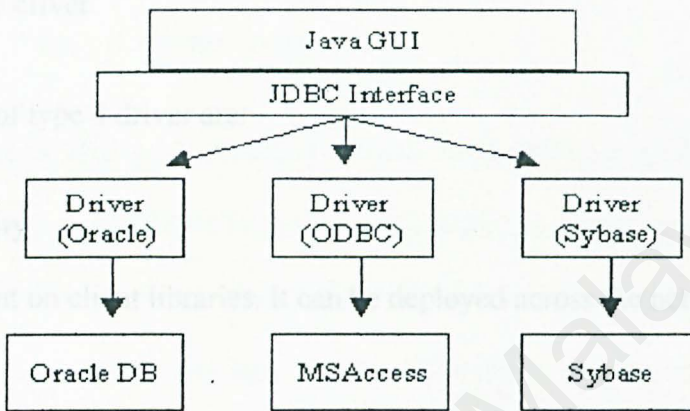
Figure 2.10 : JDBC

Types of JDBC Drivers

There are four categories of JDBC drivers, type 1 driver, type 2 driver, type 3 driver and type 4 driver. All of it implements the same database connectivity functionality. The first three types of drivers are based on bridge architectures. The bridge is implemented as a process between the Java-based client and C-based database server, and translates Java methods and objects into the C functions and data types understood by C-based database servers. Thus, any of the first three types of drivers turn a traditional 2-tier (client/server) architecture into a 3-tier architecture, and a N-tier architecture into an N+1-tier architecture. The disadvantages of these drivers are it results additional translation overhead and performance overhead process to administer.

A type 4 driver is a pure Java driver that uses a native protocol to convert JDBC calls into the database server network protocol. Using this type of driver, the application can make direct calls from a Java client to the database. The database vendor typically offers a type 4 driver. Because the driver is written purely in Java, it requires no configuration on the client machine other than telling the application where to find the driver.

The advantages of type 4 driver are:

i.   **Portability**
-    Not reliant on client libraries. It can be deployed across the network.

ii. **Performance**
-    No translation to ODBC or to a DBMS networking API, which should improve connection throughput.

iii. **Configuration**
-    It requires no configuration on the client machine.

iv. **Overhead**
-    It eliminates the additional translation and administration overhead of the bridge process.

JDBC technology lets Java programmer connect to a database, query it or update it. It provides cross-DBMS connectivity to a wide range of SQL databases, and now, with the new JDBC API, it also provides access to other tabular data sources, such as spreadsheets or flat files.

The JDBC API allows developers to take advantage of the Java platform's "Write Once, Run Anywhere" capabilities for industrial strength, cross-platform applications that require access to enterprise data. With a JDBC technology-enabled driver, a developer can easily connect all corporate data even in a heterogeneous environment.

2.7.2 ODBC (Open Database Connectivity)

ODBC is a standard database access method developed by Microsoft Corporation. The goal of ODBC is to make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data. ODBC manages this by inserting a middle layer, called a database *driver* , between an application and the DBMS. The function of database driver is to translate the application's data queries into commands that the DBMS understands. For this to work, both the application and the DBMS must be *ODBC-compliant* -- that is, the application must be capable of issuing ODBC commands and the DBMS must be capable of responding to them. Since version 2.0, the standard supports SAG SQL.

2.8 Language

2.8.1 C++

Released in 1985, C++ is an object-oriented programming language created by Bjarne Stroustrup. The C++ programming language is one of the most powerful and widely used computer programming languages. It maintains almost all aspects of the C language, while simplifying memory management. In addition, Stroustrup added classes and several other features to allow object-oriented programming.

While having features allowing low-level access to memory, it also containing high level features which simplify programming.

C++ is a general-purpose programming language. It can be used to create small programs or powerful applications. It also supports generic programming. It can be used to make cgi scripts or console-only DOS programs. In short, using C++, you can write programs that do almost anything.

In order to make usable programs in C++ you will need a compiler. A compiler converts source code, the actual instructions typed by the programmer, into an executable file. Numerous compilers are available for C and C++.

C++ includes everything that is part of C. In addition, C++ also contains many improvements and features that make it a "better C", independent of object-oriented programming. C++ is actually an extendible language since we can define new types in such a way that they act just like the predefined types which are part of the standard language.

Some of the new features in C++ include encapsulation, inline function calls, overloading operators, inheritance (derive new classes from existing ones) and polymorphism (create many definitions for the same operators).

Beside that, C++ support data hiding (protect the data by using private feature of classes).

2.8.2   Visual Basic (VB)

Visual Basic is an object-oriented, event-driven GUI programming language developed by Microsoft Corporation for Windows application development. It derived from the DOS versions of Basic, QBasic, QuickBasic, and most of the language is still supported, as well as a great amount of extensions.

Visual Basic allows the common person to easily make full featured and powerful Windows Programs. Database programs, ActiveX controls, fully Network Capable Client/Server programs, almost anything.

Visual Basic is not only a programming language, but also a complete graphical development environment. This environment allows users with little programming experience to quickly develop useful Microsoft Windows applications which have the ability to use OLE (Object Linking and Embedding) objects, such as an Excel spreadsheet. Therefore, Visual Basic is a RAD (Rapid Application Development) tool. Visual Basic also has the ability to develop programs that can be used as a front end application to a database system, serving as the user interface which collects user input and displays formatted output in a more appealing and useful form than many SQL versions are capable of.

Visual Basic allows the user to create nice looking, graphical programs with little coding by the programmer, unlike many other languages that may take hundreds of lines of programmer keyed code. As the programmer works in the graphical environment, much of the program code is automatically generated by the Visual Basic program.

Visual Basic can and is used in a number of different areas, for example:

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- Education

- Research

- Medicine

- Business

- Commerce

- Marketing and Sales

- Accounting

- Consulting

- Law

- Science

2.8.3 Java

Java was developed at Sun Microsystems. Work on Java originally began with the goal of creating a platform-independent language and operating system for consumer electronics. What we know today, as Java is both a programming language and an environment for executing programs written in the Java language. Unlike traditional compilers, which convert source code into machine-level instructions, the Java compiler translates Java source code into instructions that are interpreted by the runtime Java Virtual Machine. So, unlike languages like C and C++, on which Java is based, Java is an interpreted language.

Java is a general-purpose development language. Java is completely portable to a variety of hardware platforms and operating systems. Beside that, it also supports interactive content on Web pages.

Java is a simple, object-oriented, distributed, interpreted, robust, secure, architecture-neutral, portable, high-performance, multithreaded, and dynamic language.

By using Java, you can add animation to a World Wide Web page, write games and useful utilities, create programs that sport a graphical user interface, and design software that makes the most of the Internet

Java is exceptionally well suited to distribute networking applications because of its built-in networking support and the runtime system's capability to dynamically load Java byte code across the network. Java also provides the capability to dynamically utilize new content and protocol handling software.

Java is a sound choice for developing software where reliability is of utmost concern, such as mission-critical applications. Java's object-oriented nature combined with numerous, compile-time and runtime integrity checks eliminate many difficult-to-find programming errors. The Java language has removed many of the dangerous programming capabilities, such as modifiable pointers, unchecked type conversion, and relaxed bounds checking, that are commonly found in other programming languages, such as C and C++.

The Java API provides full support of multithreaded programming. Multithreaded programs can be developed in a single, consistent manner, independent of the vagaries of the host operating system interface.

Java classes and objects directly support the object-oriented concepts of encapsulation, inheritance, messages and methods, and data hiding. Java interfaces provide support for multiple inheritance and polymorphism. The Java language

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retains all the benefits of object-oriented programming without the performance impacts associated with pure object languages, such as Smalltalk.

The Java API provides extensive support of windowing and graphical user interface development without the complexities associated with maintaining multiple window class libraries. Several visual programming tools have been developed for Java.

Java Development Kit (JDK) is to provide a complete set of tools for the development, testing, documentation, and execution of Java programs and applets.

The following are the four types of applications you can build in Java:

- Applets (mini applications)
- GUI applications
- Command line applications
- Packages (libraries)

2.8.4 JSP (Java Server Pages)

Java Server Pages (JSP) is a technology that enables web developers to mix regular, static HTML with the dynamically generated content from servlets. As part of the Java^{TM} family, the JSP technology not only enables fast development of web-based applications that are platform independent and cross-Web-server support, but also effectively melds the power of server-side Java technology with the WYSIWYG features of static HTML pages.

JSP pages typically comprise of static HTML/XML components, special JSP tags and snippets of code written in the Java programming language called

"scriptlets". JSP separate the user interface from the content generation to enables developers to change the overall page layout without modifying the underlying dynamic content. Besides, this is also facilitated by reusable component technologies such as JavaBeans^{TM} component architecture and Enterprise JavaBeans^{TM} technology. By separating the page logic from its design and display, plus supporting a reusable component, JSP technology makes it faster and easier than ever to build web-based applications.

JSP technology provide an attractive alternative to other types of dynamic web scripting/programming, which the dynamic part is written in Java, a powerful language that already has an extensive API for networking, database access, distributed object and the like. This is best suited to complex applications. Moreover, JSP technology brings the "Write Once, Run Anywhere" paradigm to interactive web pages which means that JSP pages can be moved easily across platforms, and across web servers without any changes.

JSP has a number of advantages over many of its alternatives as listed below :

- **JSP versus Active Server Pages (ASP)**

ASP is a competing technology from Microsoft. The advantages of JSP are twofold. First, the dynamic part is written in Java, not Visual Basic or other ASP-specific language, so it is more powerful and better suited to complex applications that require reusable components. Second, it is portable to other operating systems and Web servers.

- **JSP versus Pure Servlets**

JSP doesn't provide any capabilities that couldn't in principle accomplished with a servlets. In fact, JSP documents are automatically translated into servlets behind the scenes. But it is more convenient to write and modify regular HTML than to have a zillion println statements that generate the HTML.

- **JSP versus PHP**

PHP is a free, open-source HTML-embedded scripting language that is somewhat similar to both ASP and JSP. The advantage of JSP is that the dynamic part is written in Java, which already has an extensive API for networking, database access, distributed objects and the like whereas PHP requires learning an entirely new language.

- **JSP versus JavaScript**

JavaScript can generate HTML dynamically on the client. This is a useful capability, but only handles situations where the dynamic information is based on the client's environment. With the exception of cookies, HTTP and form submission data is not available to JavaScript. And, since it runs on the client, JavaScript can't access server-side resources like databases, catalogs, pricing information, and the like.

- **JSP versus Static HTML**

Regular HTML, of course, cannot contain dynamic information. JSP is so easy and convenient that it is quite feasible to augment HTML pages that only benefit marginally by the insertion of small amounts of dynamic data. Previously, the

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CHAPTER 3

METHODOLOGY

Chapter 3 - Methodology

3.1   Methodology

Methodology represents a particular approach or philosophy for building

system. One is not better than other; each has its advantages and disadvantages, and

there may be situations when one is more appropriate than another.

There are several process models in system development:

1.   Waterfall Model with prototyping

2.   V Model

3.   Incremental Model

4.   Spiral Model

Waterfall Model with prototyping is chosen for Literati because:

o   Easy to identify milestones

o   Easy to separate one stage from another

o   Systematic

o   Scope of project well understand

o   Project risks have been accessed and are considered to be low.

3.1.1   Waterfall Model with Prototyping

Waterfall Model with prototyping consists of eight stages that are depicted as

cascading from one to another, which implies each development stage should be

completed before the next begins. This model presents a very high level view of what

goes on during development and it suggests to developers the sequence of events

they should expect to encounter. Associated with each process activity were deliverables, thus it can be used to gauge how close the project was to completion at a given point in time.

The Waterfall Model is helpful in laying out the development processes. It makes explicit which intermediate output is necessary in order to begin next stage of development. However, there are some disadvantages of this model as listed below:

- Does not reflect the way code is actually developed.
- No insights into how each activity transforms one artifact to another, such as requirements to design.
- Provides no guidance to developers on how to handle changes to products and activities that are likely to occur during development. This will cause the thrashing of development activities.
- Failure to treat software as a problem-solving process as it is derived from hardware world, which presenting a manufacturing view of software development.

The eight stages of the Waterfall Model are:

1. Requirements Analysis

Understand and determine users requirements by having requirements elicitation. Analyze user requirements by having interview or survey, collect and specify all the user requirements and validate user requirements.

2. System Design

Once the requirements are defined, a system design has to be created. It establishes an overall system architecture. System design involves describing the software system appearance and functionality from the user's perspective.

3. Program Design

When users approve the system design, the overall system design is used to generate the designs of the individual programs involved.

4. Coding

The programmer will write the programs based on the approved program design.

5. Unit and Integration Testing

When the programs have been written, test each units individually and integrate the tested units. Then, test the integrated units.

6. System Testing

Combine all the integrated units into a system and test the whole system to ensure the system has implemented all of the requirements, which called validation. Besides, the verification process has to be carried out to make sure that the functions and interactions specified initially have been implemented properly. After testing, the software is available for the user.

7. Acceptance Testing

User evaluate the system.

8.   Operation and Maintenance

Control, maintain the system and revalidate of system.

The system has to be validated and verified during the stage of system testing. The verification is to make sure that the function in the Literati works correctly and to check the quality of the implementation. The validation is to ensure that Literati has implemented all the requirements in the specification.

Prototyping is a sub-process to develop a prototype, a partially developed product or a simple simulator of the actual system to enable the user to examine some aspect of the proposed system and decide if it is appropriate for the final product.

A prototype of Literati will be built regarding to the project scope and the analysis of the system before start to built the actual system.

Prototyping is very important because:

•   To ensure the system meet the performance goals or constraints.

•   To ensure the system are practical and flexible.

•   To ensure the system fulfill the users' requirement.

•   To have an insight of how the module and sub-modules interact with each other.

Requirement Analysis

validate

System Design

verify

Program Design

Coding

Unit Integration & Testing

System Testing

Acceptance Testing

Operation & Maintenance
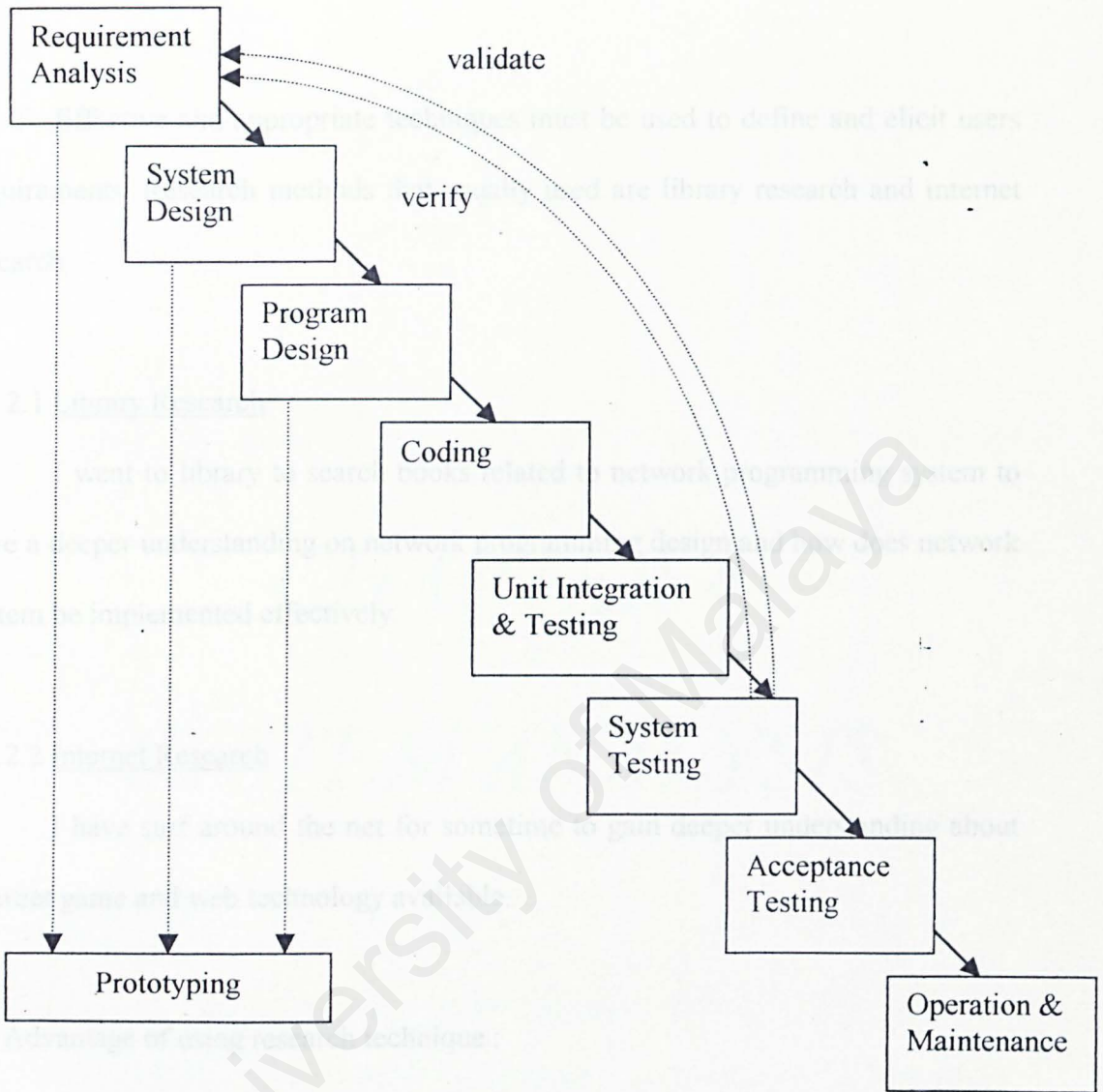
Prototyping

Figure 3.1 : Waterfall Model with Prototyping

3.1.2   Techniques Used To Define Requirements

Effective and appropriate techniques must be used to define and elicit users requirements. Research methods that usually used are library research and internet research.

3.1.2.1 Library Research

I went to library to search books related to network programming system to have a deeper understanding on network programming design and how does network system be implemented effectively.

3.1.2.2 Internet Research

I have surf around the net for sometime to gain deeper understanding about internet game and web technology available.

Advantage of using research technique :

i.   able to obtain a vast amount of up-to-date information from all around the world.

ii.   By understanding the existing system, we able to know the strengths and weakness and thus help us to design a better system.

CHAPTER 4
SYSTEM ANALYSIS

Chapter 4 - System Analysis

4.1 Functional Requirements

Functional requirement is a statement of the service or functions that a system should provide how the system reacts to particular inputs, and how the system should behave in particular situations. **(Sommerville, 2001)**

4.1.1 Authentication Module

Before the user can start to play the game, user should register to be a player. The login system and player profile are categorized in this module. If the player is new to this game, he have to register first before can play. This module check for the user's level when one login to the system and bring him to the control that he had access to. User needs to key in a valid user name and password to be able to use the system.

4.1.2 Interface Module

When the game is built as a web-based system it easier to have the feature that can be seen and easier to be used. The medium of communication between the player and the system is the interface, which also plays an important role in order to reach the objectives and make the game more interesting. It has text and graphics which easier for user to read and understand the game.

4.1.3 Engine Module

This is the core of all the system where all the logical execution happened. The module contains algorithm, which are encoded with a program language. This

module also contains the progress of the game. Besides that, this module also access to database to determine the validation of the words.

4.2 Non-Functional Requirements Analysis

Non-functional specifications are the constraints under which a system must operate and the standards which must be met by the delivered system **(Sommerwille, 2001)**. The literati in Bahasa Malaysia must ensures certain web application qualities like user-friendliness, correctness, functionality, reliability, flexibility, efficiency as well as maintainability.

4.2.1 User-Friendliness

User interfaces design creates an effective communication medium between a user and a computer. Therefore, it is very important to make sure that the interfaces fulfill user-friendliness so that it would not cause trouble to users. The Literati game system utilizes the Graphical User Interface (GUI). The usage of suitable and meaningful icons will help ensure that users use the system with more confidence and avoid mistakes made by user unintentionally.

The Golden Rules **(Mandel, 1997)** coins three rules:

• Place the user in control

This will define interaction modes in a way that does not force a user into unnecessary or undesired actions. Besides, it also provides flexible interaction for different users for instance via mouse movement and keyboard commands.

• Reduce the user's memory load

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One of the principles that enable an interface to reduce the user's memory load is by reducing demand on short-term memory. The interface should be designed to reduce the requirements to remember past actions and results.

- Make the interface consistent

The interface design should apply to consistent fashion where all visual information must be organized according to a design standard that is maintained throughout all screen displays. Apart from that, input mechanisms are constrained to a limited set that are used consistently throughout the application. Lastly, mechanisms for navigating from task to task are consistently defined and implemented.

4.2.2 Correctness

A program or system must operate correctly or it provides little value to its users. Correctness is the degree to which the software performs its required function. To ensure this application quality, lots of testing and trial-and-errors will be carried out.

4.2.3 Reliability

Reliability is the extent to which a program can be expected to perform its intended function with required precision (**Pressman, 2001**). A system is said to have reliability if it does not produce dangerous or costly failures when it is used in a reasonable manner, that is in a manner that instructed by the system. Assumptions were encountered by the system design in order to prevent user acts in an unusual pattern.

It is closely related to correct link processing, error recovery and user input validation. This quality is essential as it indicates how far users will be confident in the implementation of the game system.

4.2.4 Flexibility

For the Literati, flexibility of the system is stress on the Java-based system, which is able to receive user request from multi-platform. In other words, whether a user makes request from Windows-platform computer or Linux-platform computer, the user is able to retrieve the appropriate output. This is indeed the strength of the technology used in developing the Literati.

4.2.5 Efficiency

Efficiency is understood as the ability of a process procedure to be called or accessed unlimitedly to produce similar performance outcomes at an acceptable or credible speed **(Sommerwille, 2001)**. Efficiency is measured base on response time performance, page generation speed and graphics generation speed.

4.2.6 Robustness

The system module will be completely tested to ensure each module achieve its expectation. The modules will be integrated into system and system testing will be started after process integration. Any error that discovered during system testing will be solved immediately. This is to make sure the system is as robust as what had been expected before.

4.2.7 Maintainability

System maintenance accounts would require more effort if the system is not designed according to good programming practices. Maintainability is the ease with which a program can be corrected if an error is encountered, adapted if its environment changes, or enhanced if the customer desires a change in requirements **(Pressman, 2001)**. As the to-be-developed Literati will be built by using Java applet that is Java-based programming that enhances object-oriented concept, therefore, it is strongly believed that bugs or system faults can be detected and fixed in the shortest time. This is because object-oriented design makes sure that each class or object will only strictly handle one particular task or functionality.

4.3 Chosen Platform, DBMS, Web Server, Data Access Technology and Tools

4.3.1 Chosen Development Platform

For the Literati game, Windows 2000 is chosen as the development platform. Microsoft's Windows 2000 is built to work with a series of microprocessors from the Intel Corporation that share the same or similar sets of instructions.

The reason for choosing Microsoft's Windows 2000 as the development operating system is because Windows 2000 is still the most popular and widely use operating system.

4.3.2 Chosen Database Management System

Since SQL Server incorporates a world-class feature set for distributed client-server computing, therefore it is still chosen as database management system as it is

strongly believed that users who use SQL Server will enjoy benefits in these key areas **(Wynkoop, 1997):**

i)   Reliable distributed data and transactions

ii)   Centralized control of distributed servers

iii)   Very high performance and scalability

iv)   Support for very large databases

Advantages of SQL Server 7.0:

i.   Scalability

SQL Server provides powerful support for large database and complex queries. It is scalable from laptop to multiprocessor clusters to accommodate terabytes of data and thousands of users.

ii.   Internet, Intranet and Commerce

SQL Server is very important in Internet, Intranet and electronic commerce strategy due to its cutting-edge features and seamless integration with Microsoft Windows NT and Microsoft BackOffice. Furthermore, the Web Assistant enhances the SQL Server Assistant to easily generate HTML and WML files from SQL Server data. It also supports Internet database integration and allows the users to automate the publishing of database information in the HTML documents, built active web sites and conduct the processes on the Internet.

iii.   **Desktop, Mobile and Distributed System**

A single code base for all platforms, which from a laptop running Windows 95 to clustered systems running Windows NT Server is provided by SQL Server. It enables employees and customers the ability to work with data reliably from everywhere.

iv.   **Ease of Use**

Features provided by SQL Server ensure easy-to-use for database administrators in building, managing and deploying business applications. For example, the Dynamic Self-Management automates many routine tasks. Beside that, the profiling and tuning tools also help to simplify the process of finding the process of finding and fixing database problems by capturing and replaying server activity.

4.3.3   Chosen Development Data Access Technology

JDBC is chosen as the data access technology because of the features below:

i)   JNDI support

•   Ease of deployment (gives JDBC driver independence, makes JDBC applications easier to manage)

ii)   Connection pooling

•   Performance improvement (a connection pool is a cache of database connections that is maintained in memory, so that the connections may be reused)

•   Important for implementing a distributed transaction processing system

iii)   JavaBeans™ (RowSet objects)

•   Send data across a network to thin clients, such as web browsers, laptops, PDAs, and so on

•   Access any tabular data source, even spreadsheets or flat files

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- Make results sets scrollable or updatable when the JDBC driver does not support scrollability and updatability

- Encapsulate a driver as a JavaBeans component for use in a GUI

4.3.4 Chosen Development Language

There are two development languages chosen to use in this project.

4.3.4.1 Java applet

The first language to use is Java applet that is use to develop the applet to run the literati.

Java applet is chosen because of the features below:

- Simple

Java is simpler than other high-level language such as C++.

Java has simplified C++ programming by both adding features beyond those found in C++ and by removing some of the features that make C++ a complicated and difficult language to master. Java is simple because it consists of only three primitive data types - numbers, Boolean types, and arrays. Everything else in Java is a class. For example, strings are true objects, not just arrays of characters. Similarly, arrays in the Java language are first-class objects, not just memory allocations and runtime representations.

The most important C++ feature left out of Java is the capability to directly manipulate memory addresses through the use of pointers. Pointers are one of the cornerstones of the C and C++ languages, and it would be difficult to write many programs in these languages without using pointers. However, as any C or C++

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programmer will admit, pointers are also a significant source of problems and debugging time in C and C++ programs. Pointers can accidentally be set to point to the wrong thing, causing unexpected behavior including crashes. Pointers also can be used to store allocated memory. If the allocated memory isn't freed, or released back to the operating system, then the program will gradually leak memory, until it eventually runs out. An entire set of commercial products, such as the Bounds Checker products, has come into existence to help programmers identify these types of pointer-related problems. Java simplifies this by completely removing pointers from the language and using a handle-based solution instead.

One of the most important features is automatic memory management, usually known as *garbage collection*. Garbage collection is really just a blue-collar term that means that you don't need to free memory that you allocate-the Java Virtual Machine takes care of doing this for you.

- Object-oriented

Except for Java's primitive data types, everything in Java is an object. Java's support for object-orientation does not include multiple inheritance. The designers of the language felt that the complexity introduced by multiple inheritance was not justified by its benefits.

- Distributed

Java facilitates the building of distributed applications by a collection of classes for use in networked applications. By using Java's URL (Uniform Resource Locator) class, an application can easily access a remote server. Classes also are provided for establishing socket-level connections.

- Interpreted

Because Java is interpreted, once the Java interpreter has been ported to a specific machine, that machine can instantly run the growing body of Java applications. Also, when using an interpreter, programmers are freed from some of the concerns of intermodule dependencies. You no longer have to maintain a "make" file that is sometimes as complicated as the hardest part of your program.

Another advantage is that the time-consuming edit-compile-link-test cycle is broken. Without the compile and link steps, working in an interpreted environment is a much simpler edit-test cycle.

- Robust

Java was created as a strongly typed language. Data type issues and problems are resolved at compile-time, and implicit casts of a variable from one type to another are not allowed.

Memory management has been simplified in Java in two ways. First, Java does not support direct pointer manipulation or arithmetic. This makes it impossible for a Java program to overwrite memory or corrupt data. Second, Java uses runtime garbage collection instead of explicit freeing of memory.

- Secure

Closely related to Java's robustness is its focus on security. Because Java does not use pointers to directly reference memory locations, as is prevalent in C and C++, Java has a great deal of control over the code that exists within the Java environment. It was anticipated that Java applications would run on the Internet and that they could dynamically incorporate or execute code found at remote locations on the

Internet. Because of this, the developers of Java hypothesized the existence of a hostile Java compiler that would generate Java byte codes with the intent of bypassing Java's runtime security. This led to the concept of a byte-code verifier. The byte-code verifier examines all incoming code to ensure that the code plays by the rules and is safe to execute. In addition to other properties, the byte code verifier ensures the following:

➢ No pointers are forged.

➢ No illegal object casts are performed.

➢ There will be no operand stack overflows or underflows.

➢ All parameters passed to functions are of the proper types.

➢ Rules regarding private, protected, and public class membership are followed.

• Architecture-Neutral

Because the Java compiler creates byte code instructions that are subsequently interpreted by the Java interpreter, architecture neutrality is achieved in the implementation of the Java interpreter for each new architecture.

• Portable

In addition to being architecture-neutral, Java code is also portable. It was an important design goal of Java that it be portable so that as new architectures (due to hardware, operating system, or both) are developed, the Java environment could be ported to them.

In Java, all primitive types (integers, longs, floats, doubles, and so on) are of defined sizes, regardless of the machine or operating system on which the program is run.

This is in direct contrast to languages like C and C++ that leave the sizes of primitive types up to the compiler and developer.

Additionally, Java is portable because the compiler itself is written in Java and the runtime environment is written in POSIX-compliant C.

• High-performance

For all but the simplest or most infrequently used applications, performance is always a consideration. It is no surprise, then, to discover that achieving high performance was one of the initial design goals of the Java developers. A Java application will not achieve the performance of a fully compiled language such as C or C++. However, for most applications, including graphics-intensive ones such as are commonly found on the World Wide Web, the performance of Java is more than adequate. For some applications, there may be no discernible difference in performance between C++ and Java.

• Multithreaded

Writing a computer program that only does a single thing at a time is an artificial constraint that we've lived with in most programming languages. With Java, we no longer have to live with this limitation. Support for multiple, synchronized threads is built directly into the Java language and runtime environment.

Synchronized threads are extremely useful in creating distributed, network-aware applications. Such an application may be communicating with a remote server in one thread while interacting with a user in a different thread.

• Dynamic

Because it is interpreted, Java is an extremely dynamic language. At runtime, the Java environment can extend itself by linking in classes that may be located on remote servers on a network (for example, the Internet). This is a tremendous advantage over a language like C++ that links classes in prior to runtime.

In C++, every time member variables or functions are added to a class, it is necessary to recompile that class and then all additional code that references that class. Of course, the problem is exacerbated by the fact that you need to remember to recompile the files that reference the changed class. Using make files reduces the problem, but for large, complex systems, it doesn't eliminate it.

Java addresses this problem by deferring it to runtime. At runtime, the Java interpreter performs name resolution while linking in the necessary classes. The Java interpreter is also responsible for determining the placement of objects in memory. These two features of the Java interpreter solve the problem of changing the definition of a class used by other classes. Because name lookup and resolution are performed only the first time a name is encountered, only minimal performance overhead is added.

4.3.4.2 JSP

The second language chosen to develop the user login interface and game ending interface is JSP.

JSP has been selected as the web development language for the Literati system. The reasons of choosing JSP are as follows:

a. **Separation of static from dynamic content**

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- With JSP, the logic to generate the dynamic content is kept separate from the static presentation templates by encapsulating it with external JavaBeans components.

- These are then used by JSP page using special tags.

- When a page designer makes any changes to the presentation templates, the JSP page is automatically recompiled and reloaded into the web server by the JSP engine.

b. Write Once Run Anywhere

- JSP technology brings the "Write Once, Run Anywhere" paradigm to interactive Web pages.

- JSP pages can be moved easily across platforms, and across web servers, without any changes.

c. Ease of development

- JSP provides a way to generate dynamic web pages that are both easier to write and faster to run.

- No need to code client and server side programs separately, which made up of two files instead of only one JSP file.

d. Allowing collaboration between people

- A JSP can handle multiple requests concurrently, and can synchronize each of the requests.

- Synchronizing means multi-tasking where different user's requests are being handled in a different way.

e. Forwarding requests

- JSP can forward requests to other servers and servlets. So, JSP can be used to balance load among several servers that mirror the same content and to partition a single logical service over several servers, according to task type or organizational boundaries.

f. Speed and Scalability

Although ASP pages are cached, they are always interpreted. By contrast, JSP pages are compiled into Java servlets and loaded into memory the first time they are called, and executed for all subsequent calls. This gives JSP pages speed and scalability advantage over ASP pages.

g. Freedom of Choice

Unless you install *Chili! Soft ASP*, ASP pages work only with Microsoft IIS and Personal Web Server. Using ASP pages requires a commitment to Microsoft products, while JSP pages do not tie you to any specific web server or operating system. JSP pages are becoming a widely supported standard.

4.3.5 Chosen Authoring Tool

JCreator is chosen as the authoring tool to develop this game.

The main reasons for chosen JCreator are :

- More easy to use and more user-friendly compare to Notepad

- Can directly compile or run your Java program

- Editor with syntax highlighting

4.3.6 Chosen Development Web server

JSP is web server-independent, which means it can be developed in IIS, Apache Web Server or any other web server. Apache Tomcat version 4.0.6 is chosen to be the development web server. We only have to start the Apache Tomcat when we want to run the jsp file.

CHAPTER 5

SYSTEM DESIGN

Chapter 5 – System Design

5.1 Introduction

System Design is a phase in the waterfall model where the entire requirements for the system are translated into system characteristics. The requirements for system are regarding to the analysis that had been defined. System design includes the following issues:

- System Architecture Design
- System Functionality Design
- User Interface Design
- Database Design

5.2 Overview of System Architecture

1st Tier   **2nd Tier**   **3rd Tier**
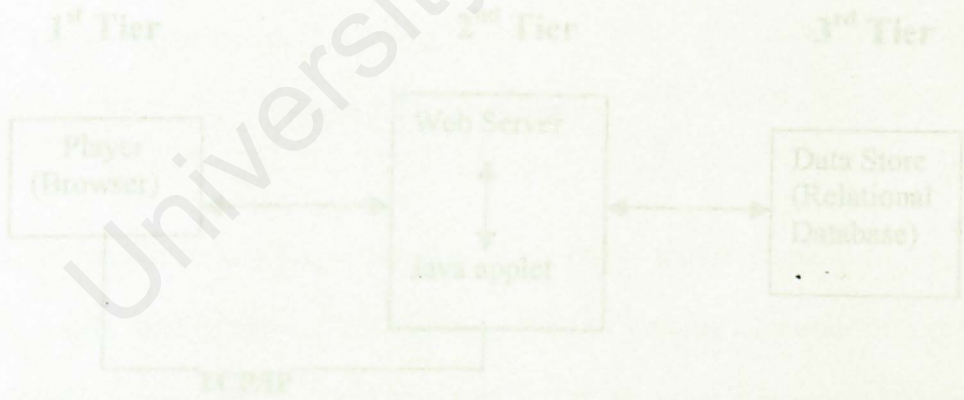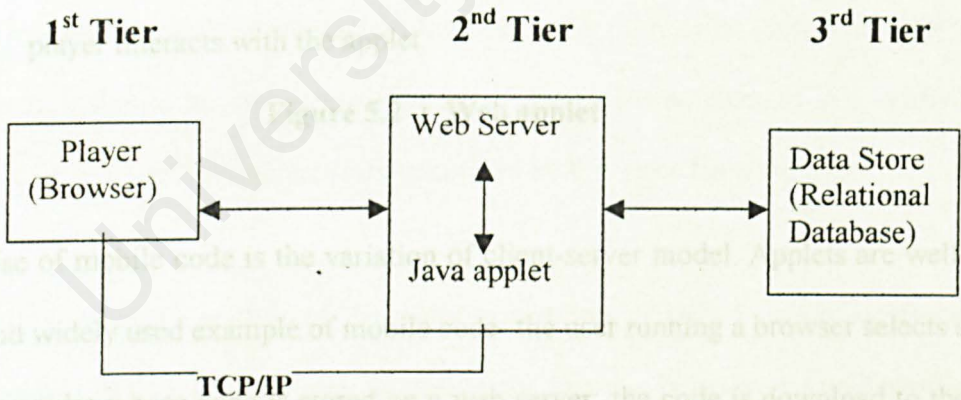

Figure 5.1 : 3-Tier Architecture of Literati

The conceptual architecture of the three-tier application applies when we split an application into three logical components of the application: user interface, computational logic and data storage. In reality, the three-tier Web applications generally consist of a Web browser for the user interface, a Web server connected to

a "middle tier" application, and a persistent store that is frequently a relational database.

The main purpose of having a three-tier architecture is to assign main functionality to each tier to ensure no function overlapped. Different people could handle each tier using different languages. Therefore, whenever there is error or system fault occurs, the problems can be detected and fixed easily without interfering other tier.

Player → Web server

Applet code
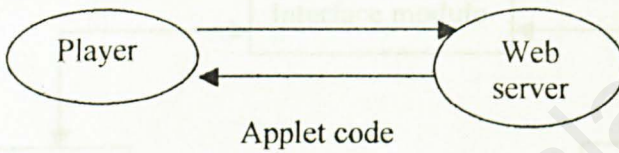
a) player request results in the downloading of applet literati

player → Applet   Web server
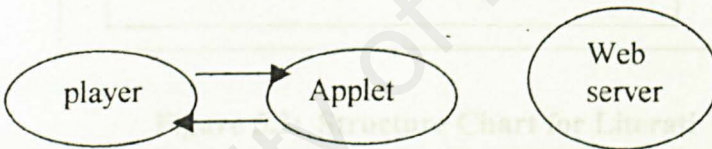
b) player interacts with the applet

Figure 5.2 : Web applet

Use of mobile code is the variation of client-server model. Applets are well-known and widely used example of mobile code- the user running a browser selects a link to an applet whose code is stored on a web server; the code is download to the browser and runs there, as shown in Figure 4.2. Advantage of running the downloaded code locally is that it can give good interactive response since it does not suffer from the delays or variability of bandwidth associated with network communication.

5.3   System Functionality Design

5.3.1   System Structure Charts

The objective of system structure chart is to show how the modules in Literati are related to each other.

The literati game can be divided into four main modules: Authentication module, Interface module, Play module and Engine module.
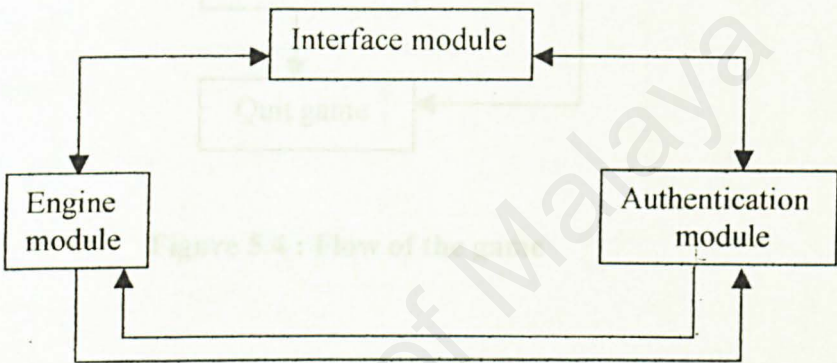
Figure 5.3: Structure Chart for Literati

The entire module is interactive between each other. The system is a game system, which should be interactive because of the real time changes and it affect other components work simultaneously generated by the input from the user.

Although every module of the game system has its own levels of operation and execution but their process is generated by the reaction between the user and the system itself. So all the components should combine together to react in other to produce a logical and possible input.

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```
            ┌─────────────┐
            │   Login     │
            └──────┬──────┘
                   │
                   ▼
            ┌──────────────────┐
            │ Interface feature│
            └──────┬───────────┘
                   │
                   ▼
            ┌──────────────┐
            │  Start game  │
            └──────┬───────┘
                   │
                   ▼
            ┌──────────────┐
            │  End game    │
            └──────┬───────┘
                   │
                   ▼
            ┌──────────────┐
            │  Quit game   │◄──────
            └──────────────┘
```
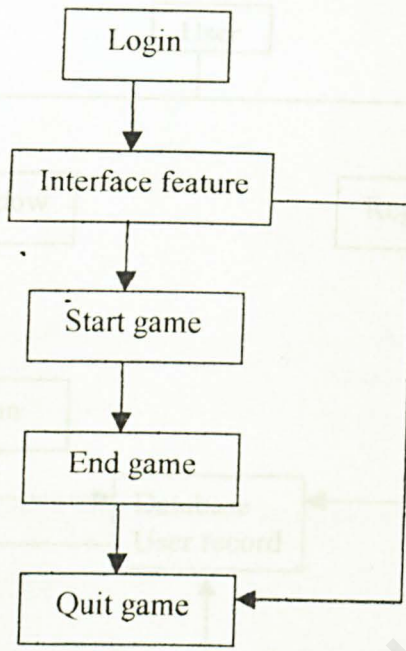
Figure 5.4 : Flow of the game

5.3.1.1 Design of authentication module

The authentication module is a module where the record is kept in the database. The module is designed as the door to the game because before user can use the features or the utility provided on the internet, user should login first. If the user is new to the database, the user should register to become player. The login features are the gate to the game. The gate is for the system to know who is using the system and retrieve the internet or record from database. It is important when the game is playing over the internet, the user will have its own identity. When playing the game, any moves made by the player will be recorded in the database. So the players can see the steps that he or she made for each game that played.

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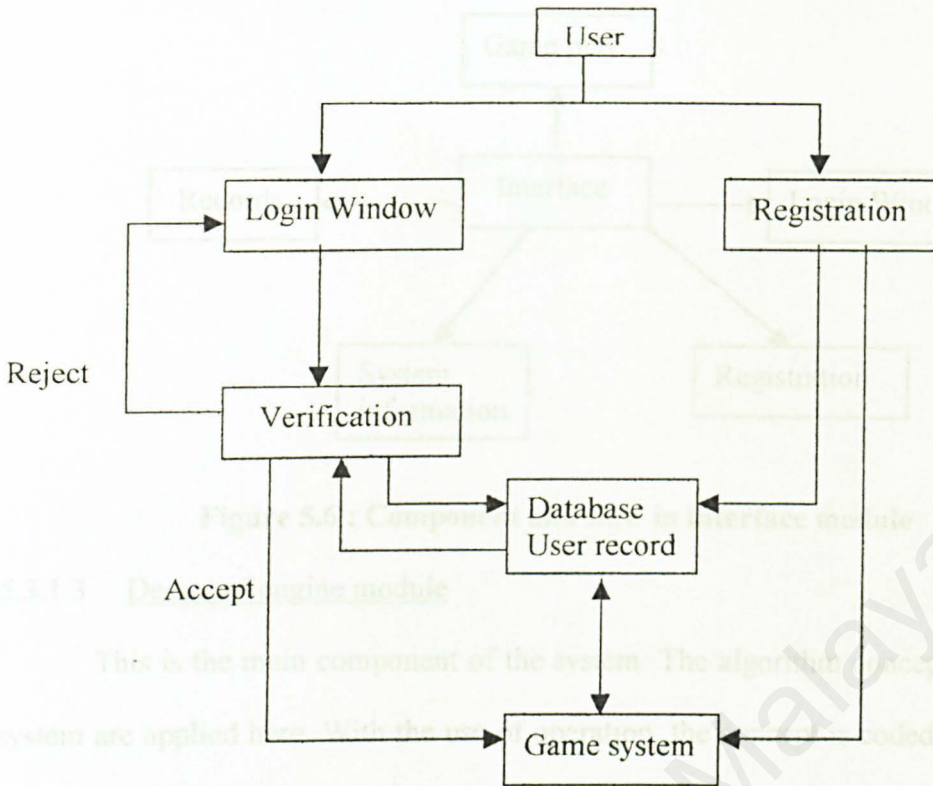
Figure 5.5: Component and flow in user module

5.3.1.2 <u>Design of interface module</u>

This module is the medium for communication and to exchange the information between user and system. It is a two way interaction. Information is delivered using the module handler, which are all the buttons, text fields and other utilities are provided to facilitate user.
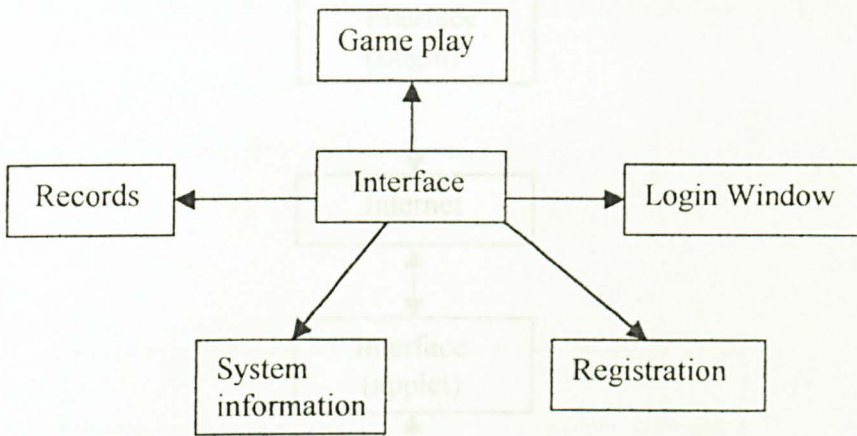
Figure 5.6 : Component and flow in interface module

5.3.1.3   Design of engine module

This is the main component of the system. The algorithm concept and game system are applied here. With the use of operation, the concept is coded and should be easily reached by the system. The module also contains the system for networking and internet purposes.

When a game started, which is all the necessary setting has been initialized, the system for the game's engine started its operation. The logical instrument is used to process and compare the action made by users.

```
          ┌─────────────┐
          │  Interface  │
          │   (Login)   │
          └─────────────┘
                 ↕
          ┌─────────────┐
          │  Internet   │
          └─────────────┘
                 ↕
          ┌─────────────┐
          │  Interface  │
          │   (applet)  │
          └─────────────┘
                 ↕
     ┌────────────────────────┐
     │  Web server            │
     │  Database Server       │
     │  Game system           │
     │  Logical functions     │
     └────────────────────────┘
```

Figure 5.7 : Component and flow in engine module

5.3.2   Data Flow Diagram (DFD)

Data Flow Diagram (DFD) is a technique used to show graphically the flow of data through a business system and the process performed by the system. DFD give an overview of the system inputs and output, processes and the flow of data through each process.
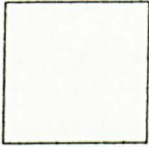
The advantages of using DFD are:

- Enable the system to be structured into independent units of a desired size

- Better understanding of the relationships between the system and their subsystem.

- Analysis to identify the required data and processes of the proposed system and make sure that they have been defined.

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- DFD is easy to use and understand as it has symbols that specify the physical aspects of implementation.

There four basic symbols in DFD: entity, flow of data, process and data stores.

Table 5.1: DFD Symbols

Symbols	Attribute
	Entity
→	Flow of Data
	Process
	Data Store

The convention, which is used to design DFD are based on the work by C.Gane and T.Sarson. The data flow is conceptualized with a top-down perspective. So, the Context Level Diagram will be drawn, followed by the Diagram 0. Diagram 0 is an overview process of all the major modules in Literati that includes all the data stores, entities and process involved.
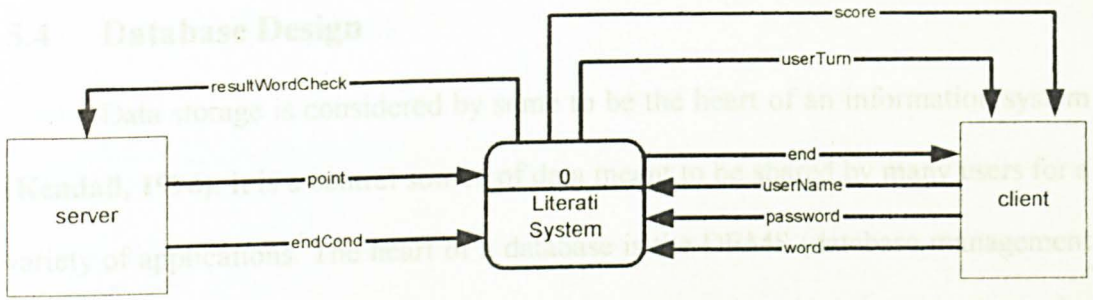
Figure 5.8 : Context Level Diagram of Literati
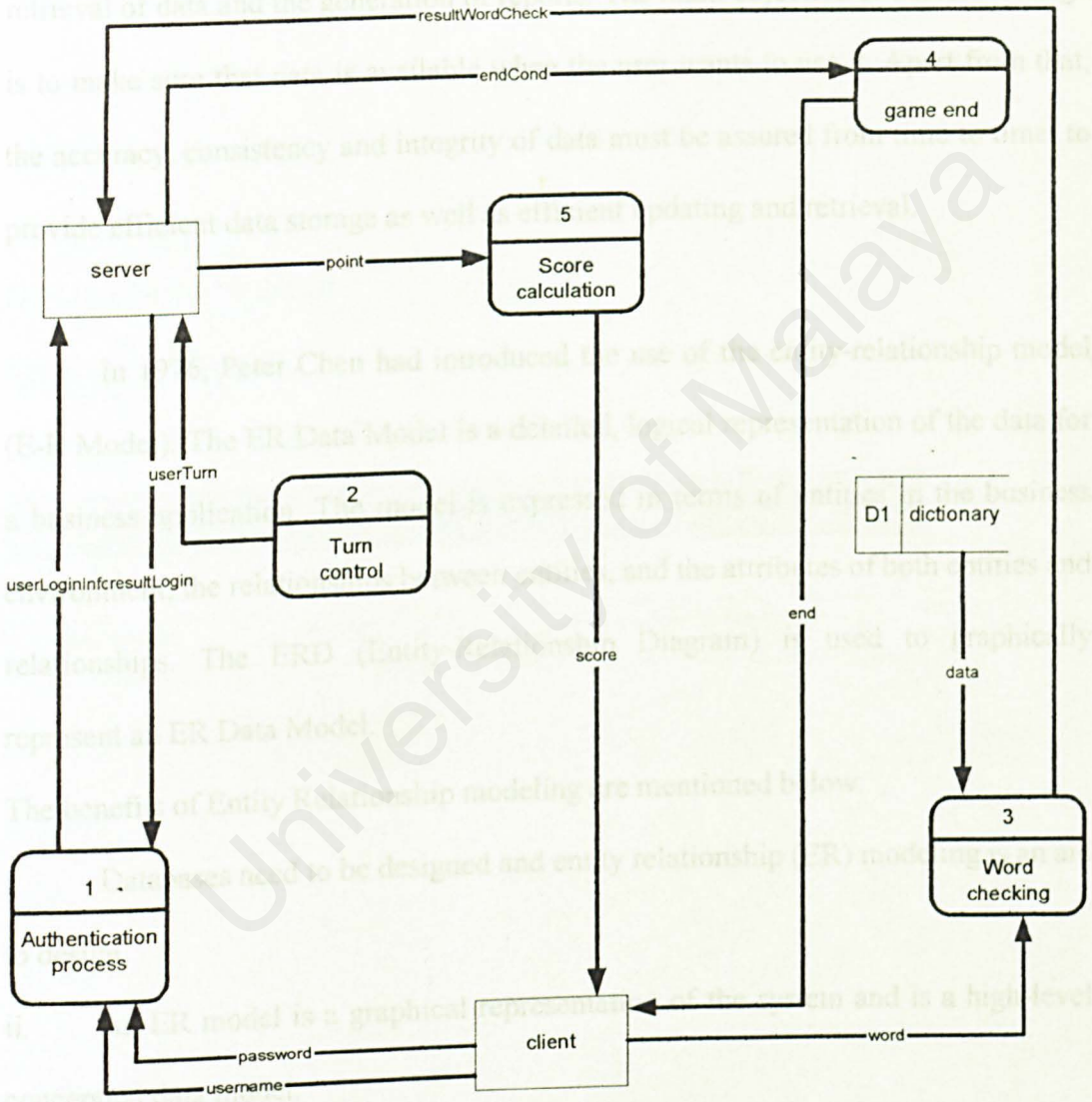
Figure 5.9 : Diagram 0 of Literati

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5.4   Database Design

Data storage is considered by some to be the heart of an information system **(Kendall, 1996)**. It is a central source of data meant to be shared by many users for a variety of applications. The heart of a database is the DBMS (database management system), which allows the creation, modification and updating of the database, the retrieval of data and the generation of reports. The main objective of database design is to make sure that data is available when the user wants to use it. Apart from that, the accuracy, consistency and integrity of data must be assured from time to time, to provide efficient data storage as well as efficient updating and retrieval.

In 1976, Peter Chen had introduced the use of the entity-relationship model (E-R Model). The ER Data Model is a detailed, logical representation of the data for a business application. The model is expressed in terms of entities in the business environment, the relationships between entities, and the attributes of both entities and relationships. The ERD (Entity-Relationship Diagram) is used to graphically represent an ER Data Model.

The benefits of Entity Relationship modeling are mentioned below:

i.   Databases need to be designed and entity relationship (ER) modeling is an aid to design.

ii.   An ER model is a graphical representation of the system and is a high-level conceptual data model.

iii.   Supports a user's perception of data and is independent of the particular DBMS and hardware platform.

5.4.1 Data Dictionary (DD)

Data dictionary or Catalog or Repository stores the metadata of a business information system. Metadata is data about data. The DD stores information about entities and their relationships with one another, attributes of entities, primary and foreign key. Data dictionary defines the field, field type and descriptions of each table.

In Literati, one database had been defined namely Literati and contained 2 tables, which are Literati_Dictionary and Literati_Info.

Database Name : **Literati**

Table name : **Literati**

Table 5.2 : Table of Literati

Field Name	Data Type	Length	Description
ID	int		ID of word
perkataan	varchar	255	Bahasa Malaysia word

Table name : **game**

Table 5.3 : Table of game

Field Name	Data Type	Length	Note
userID	varchar	255	user name
password	varchar	255	user password
fullName	varchar	255	user fullname
age	int	4	age of the user
sex	varchar	255	sex
email	varchar	255	email address of the user

5.5 User Interface Design

User interface is an integral part of an application, since a user has to interact with the application through the interface. Designing of the interface consists of designing the display on the computer screen and internet presentation. A simple but interesting user design is targeted for the system because this would attract many users to ease the played from uncontrollable situation.

There are several types of user interface – natural language interfaces, question-and-answer interfaces, menus, form-fill interfaces, command-language interfaces and graphical user interfaces (GUIs).

Graphical user interfaces (GUIs) is chosen to design user interface. The advantages of using GUI are :

i.   ease of using and learning the system

ii.   the window may contain processing option or data entry option or both

Some of the characteristics that are considered important to produced interesting interface are:

✓   The design should have the theme for the choice of colors, shape of buttons and other components

✓   Background displays which is nice to see and can be accepted suitable for the game

✓   Screen display presentation which is easy to understand and utilize

✓   Good arrangement of objects and not crowded

✓   Buttons, text fields are provided according to the wage and suitable needs

✓   Quick respond from system

✓   Suitable graphic and font, which include size, type and style

   The text fields are for user input data such as user identity and password. The buttons are for user to choose the designated utilities as labeled on it. The label is used to display the message.
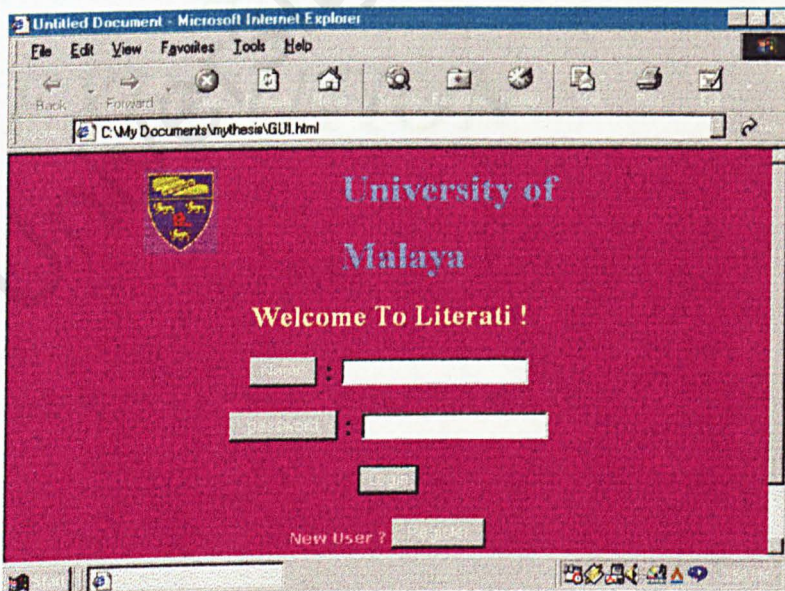
Figure 5.10 : User Interface Design

CHAPTER 6

SYSTEM DEVELOPMENT AND EXECUTION

Chapter 6   System Development and Execution

6.1   Introduction

The system development and execution stages resolve around stages in the development environment that are program coding and database development .In this phase, the system requirements and design are being implemented and converted into program code. However due to certain limitations on the programming language, certain modifications are needed in order to develop the system in accordance to the limitations of the development tools chosen to develop the system.

Each module in the game system is initially being developed and tested phase-by-phase until it is fully become functional system and after each of the module is able to run smoothly as an integrated. The system involves code generation using different programming languages ranging from JSP, Java and Structured Query Language (SQL).

6.2   Development Environment

6.2.1   Hardware Requirement

Table 6.1 : System hardware description

Processor	Pentium2 or above
Memory	64.0MB of RAM or above
Hardisk	10GB or above

6.2.2 Software Requirement

Table 6.2 : System Software Description

Operating System	Microsoft Windows 2000 Professional
Web Server	Apache Tomcat Ver4.0.6
Database Server	Microsoft SQL 2000
Driver	Microsoft SQL JDBC Driver
Java Development Kit	JDK 1.4.0
Browser	Microsoft Internet Explorer
Authoring tool	JCreator version 2.0

6.3 Database Management System

Microsoft SQL 2000 facilitates the various data retrieving, storing, deleting and other information manipulation activities. Majority of SQL statements use four basic commands : SELECT, INSERT, UPDATE and DELETE.

6.4 Development Tool Implementation

JCreator version 2.0 is the software used to develop the game system. Based on its object-oriented nature, JCreator is used to code the entire system. This Java programming tool provides the basic development environment such as graphical editor and debugger. This had helped in reducing and streamlining a certain degree of organization work in developing the class hierarchy for the applet.

6.5   Program Development

Program development is the process of creating the programs needed to satisfy the information system's processing requirement. Program development consists of the following five steps.

Review the program document

             → Design the program

                     → Code the program

                              → Test the program

                                      → Completion the program code
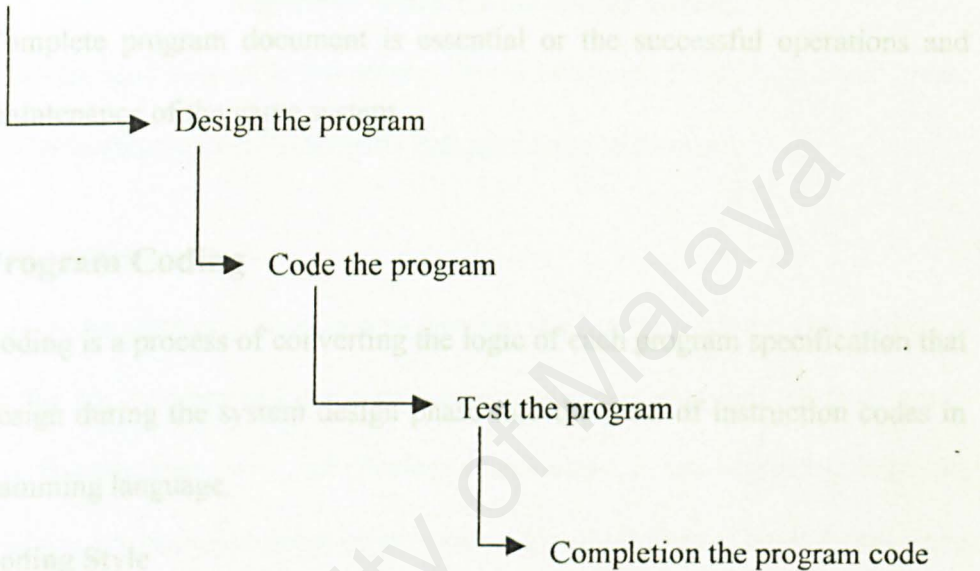
Figure 6.1 : The steps of program development

i.   Review the program document

The first step in the program development is to review the program document that was prepared. during the previous phases. The program document of literati game consists of data flow of game and data dictionary.

ii.   Design the program

For the second level of program development, decisions have to be made on how the program can accomplish its tasks by developing a logical game solution to those programming problems. The logical solution for the game is a step by step solution to a programming problem.

iii.   Code the program

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Coding the program is a process of writing the program instruction that implements the program design. Design specification must be translated into a machine reachable format. The coding step performs this.

iv. Test the program

During this level, all programs must be tested to ensure it functions correctly.

v. Document the program

Complete program document is essential or the successful operations and maintenance of the game system.

6.6   Program Coding

Coding is a process of converting the logic of each program specification that had be design during the system design phase into the form of instruction codes in the programming language.

6.6.1   Coding Style

Coding style is an important attribute of source code and it determines yhe intelligibility of a program. The readability of the source code makes the system easier to be maintained and enhanced.

The JSP specification provides web developing with a framework to create dynamic content on the server using HTML Java. The basic concept is presented as Figure 6.2.

Browser		Server
User enter values	Send request to server for java applet →	Interprets JSP and user data from form to generate response
Response displayed in browser in browser window	← Send response to browser containing HTML code	
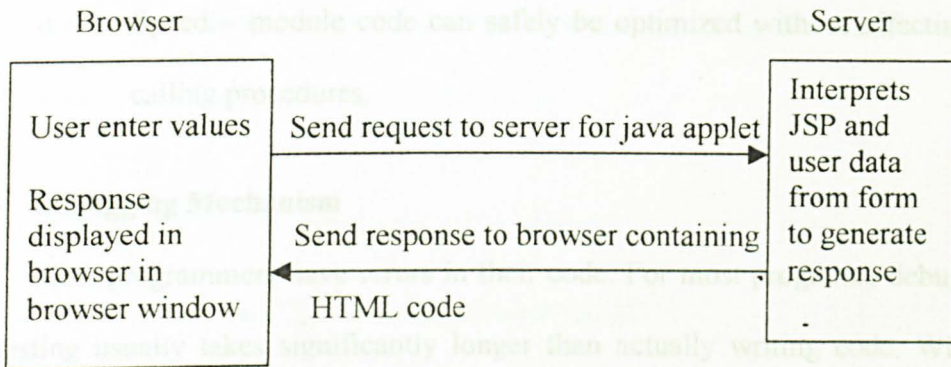
Figure 6.2 : Basic Concept for coding

Browser send request to the server. Server interprets the JSP code and create a response by loading applet of the game and send back to browser.

6.6.2 Coding Approach

Top-down approach is chosen to develop the Literati system. This approach will break the big modules of Literati into functions and procedures. All these small modules or functions are built and developed separately. In the beginning stage, all the java classes are designed using object-oriented methodology. These classes were created, compiled and run and each of them perform only a specific role.

The coding paradigm adopted by the system is oriented at giving reliability and performance a balance. Listed below are the coding approaches, which have been adopted for the game system.

    o   Maintainability – codes are well organized usage of systematic variables coding

    o   Reusability – object-oriented codes are easily developed for reuse in other part of the system which needs loping and recursive methods

    o   Testability – modules can be tested easily by naming small changes upon several parts of the system

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○　Speed – module code can safely be optimized without affecting the calling procedures.

6.6.3　Debugging Mechanism

Most programmers have errors in their code. For most programs, debugging and testing usually takes significantly longer than actually writing code. When a program is broken, fixing it can seem like a really confusing and intimidating task.

6.6.3.1 Compilation Error

The first problem need to fix first is the compile errors.

6.6.3.2 Runtime Error

The program does something, but not as expected.

- A great way to make sure the code is getting executed is to put System.out.printIn() statement at strategic places in the code to find out what is getting executed and what is not.

- Comment out blocks of code that are suspected causing problem by using /*...*/

6.6.3.3 Debugger

JCreator is an ultimate tool for debugging. It will display the values of variables in memory, which line make the programs crash.

6.6.3.4 Exception Handling

Exception Handling is one of the debugging mechanism. This technology focus on detecting and responding to unexpected events at runtime. To handle exception in the program code, some potentially troublesome codes are enclosed within a try clause. A try clause is a special Java construct that tells the runtime that a section of code could cause trouble. Another piece of code(a handle) is needed in a corresponding catch clause that responds to errors caused by the code in the try

clause. That error event itself is the exception and the code in the catch clause is known as an exception handler.

```
try {
displayArea.append("\nAttempting connection\n");
socket = new Socket(InetAddress.getByName("127.0.0.1"), 6000);
displayArea.append("connected to"+socket.getInetAddress().getHostName());
output = new DataOutputStream(socket.getOutputStream());
output.flush();
input = new DataInputStream(socket.getInputStream());
displayArea.append("\nGot I/O streams\n");
} catch (EOFException eofexception) {
} catch(IOException ioException) {

}
```

Figure 6.3 : Example of Exception Handling

6.6.4   Code document

Code document begins with the selection of identifier (variables) names, continues with the composition of connectivity and end with the organization of the program. Indentation can also be used to increase the readability of source code.

The elements of code document include :

o   Internal document

Internal document contains information directed at someone who will be reaching the source code. Thus, statements of purpose indicating the function of the module and a descriptive comment that

is embedded within the body of the source code ids needed to describe processing functions.

o   Naming convention

Naming convention provides easy identification for the programmer, the naming convention have to be created with coding consistency and standardization in mind.

o   Modularity

In order to reduce complexity, facilitate change results in easier implementation by encouraging parallel development of different parts of systems.

Introduction

The main function of testing is to establish the presence of defects in a program and to judge whether the program is usable in real application. Nevertheless, testing can only demonstrate the presence of errors. It cannot show that there is no error in the program. Therefore, a more suitable approach must be chosen reduce the possibility of errors in a program.

Bottom-up approach is adopted in system testing for Literati. Each module at the lowest level of the system hierarchy is tested individually. Then all the tested modules would be related... the process is repeated until all the modules are tested successfully.

CHAPTER 7

TESTING

Testing Process

In general, the testing process of Literati can be shown in the following figure. All the details will be further explained in subsequent sub-sections.

| Unit Testing | | Integration Testing | System Testing |

Figure 7.1 Testing Process

Types of Testing

Unit Testing

Unit test is the process to test the individual component to ensure that they function properly. Each component is tested independently without the

Chapter 7 TESTING

7.1 Introduction

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Bottom-up approach is adopted in system testing for Literati. Each module at the lowest level of the system hierarchy is tested individually. Then, all the tested modules would be related to the next module testing. This approach is repeated until all the modules are tested successfully.

7.2 Testing Process

In general, the testing process of Literati can be shown in the following figure. All the details will be further explained in subsequent sub-sections.
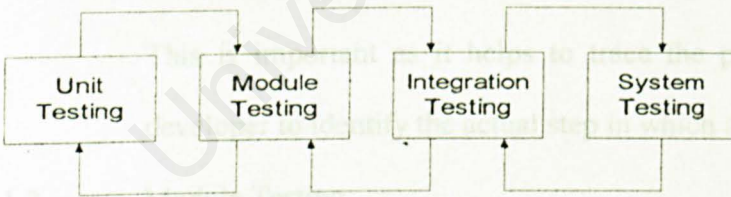

Figure 7.1 Testing Process

7.2.1 Types of Testing

7.2.1.1 Unit Testing

- Unit test is the process to test the individual component to ensure that they function properly. Each component is tested independently without the

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interference from other system components. Unit test is performed concurrently with the development process.

- Techniques used during the process of performing unit testing are as follows:
    o Code Review

        Before a .java file is compiled into java class, codes are reviewed line by line to discover any syntax error as well as semantic error. If errors are discovered, they are corrected immediately.

    o Compilation of Java Class

        This method is faster compared to code review techniques and it is efficient in discovering errors. During the compilation, the Java compiler will detect type of errors in a program and display the error type as well as the line number in which the error occurs.

    o Other techniques

        If the error occurs during the loop of a function, then it will be difficult to identify the actual error. Therefore, for each loop of a function, a value is output using the command "System.out.ptintIn()". This is important as it helps to trace the program and allows the developer to identify the actual step in which an error has occurred.

7.2.1.2   Module Testing

Module testing is performed without other system modules. A module consists of a collection of dependent components to perform a particular task or function. Different possible test cases are applied to the module and the test results would be verified. Unusual results will be analyzed and they would help in debugging sub-modules in order to produce the desired output.

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7.2.1.3   Integration Test

Integration test is needed when all modules are integrated. Several important aspects are checked to ensure that the flow of the data in Literati is well organized and are user friendly to all the system users.

7.2.1.4 System Test

The sub-systems are integrated to make the entire system. Therefore, the main purpose in system testing is to find errors that result from unanticipated interactions between sub-systems. Besides, it is used to validate whether the system meets its functional and non-functional requirement.

Finally, a performance test is performed to compare the integrated modules with the non-functional system requirements. These requirements include security, interoperability, flexibility and reliability.

Chapter 8 System Evaluation and Conclusion

8.1 Introduction

Evaluation is the ultimate phase of developing a system and an important phase before delivery the system to the end users. Evaluation was related to user environment, attitudes, information priorities and several other concerns that are to be considered carefully before effectiveness can be concluded. At all phases of the system approaches, evaluation is a process that occurs continuously, drawing on a variety of sources and information.

8.2 System Strengths

Before really thinking right into the heart of development in coding, choosing the right tools and programming language are very important factors. The following will discuss regarding the reasons why the following selected as strengths.

i. System Strengths

Every user has to login before entering the system. The game only allows authorised users to access the system.

ii. Future Extensibility

The game was coded using the Java's latest standard J2EE (Java 2 Enterprise Edition). Thus, it guarantees future extensibility and enhancement such as servlets and JavaBeans. Besides that, the advantage across multiple operating system has enabled this system to reside in almost any operating system in future.

iii. Simple and user-friendly interface

Chapter 8 System Evaluation and Conclusion

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Evaluation is the ultimate phase of developing a system and an important phase before delivery the system to the end users. Evaluation was related to user environment, attitudes, information priorities and several other concerns that are to be considered carefully before effectiveness can be concluded. At all phases of the system approaches, evaluation is a process that occurs continuously, drawing on a variety of sources and information.

8.2   System Strengths

Before really thinking right into the heart of development in coding, choosing the right tools and programming languages are very important factors. The following will discussed some justifications on a few points being selected as strengths :

i.   System Strengths

Every user has their login name and password. Literati game only allows authorized users to access the system.

ii.   Future Extensibility

The game was coded using the Java's latest standard J2EE (Java 2 Enterprise Edition). Thus, it guarantees future extensibility and enhancement such as servlets and JavaBeans. Besides that, the advantage across multiple operating system has enabled this system to reside in almost any operating system in future.

iii.   Simple and user-friendly interface

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User interface in the system is easy to understand and user-friendly. It is developed by using GUI based development tools. Therefore all function interfaces are kept simple and well arranged. Command button, text box and other control objects are used to allow the user to execute command with case. An action is just a click away and the user just needs minimal knowledge of mouse and keyboard to use this system.

iv. Easy Accessibility

This system is a we-based application and can be accessed easily using the web browser. The web browser needed such as Internet Explorer and Netscape Navigator could be download free from the internet.

v. System Transparency

System transparency refers to the condition where the players do not need to know where the database resides, how is the system structure and its database management system.

8.3 Limitation, Constraints and Future Enchancements

Due to time constraints, some feature of the game system is not including in the game. So, there are still places for future enhancements on the system.

1. Limited user

This game system only allows two players to play at one time. However it can be extends to multiplayer game in future.

2. Database Editing

There are around 7000 words reside in the database. The number of words can be added in future.

3. A user friendly way to edit database

A graphical user interface module can be developed to help user to add the new words into the database. This is to facilitate the user that is not familiar with the SQL database.

4. Replace the unwanted tile

When the user click "pass" button, the system should allow user to change the tile that he or she wants to get rid of and replace them with the new tiles.

8.4 Problem Faced

While developing the system, there are several problems being faced. Some due to the tools limitation and some are the result of lacking knowledge and experience. The following discussed some of these problems and the solutions I have took:

i. Debugging Java code

During the compilation time, the error for the compilation will be display in the configuration window. During the early stage of program development, I was not use to the name of the error and why it occurred. So, I took a lot of time to get myself familiar with the error by referring to the Java2 SDK Documentation.

For the runtime error, I tried to debug the runtime error by putting "System.out.printIn()". This code help me a lot to trace the execution of the program whether the program is running correctly. If bug is found during the program execution, I also knew where the bug is by putting this code.

ii. Get the functions of each component

There are many components and functions provided for the Java programmers to develop their program. However, the functions should be used correctly and some of

the functions allow overridden by Java programmers but some do not. So, I refer to the documentation and books in order to help me use the functions correctly. Beside that, I also used extra debugging tool, NetBeans to help me to use the function correctly.

iii.   GUI components organization

It is hard to organize the position of each of the components in the GUI. I have change a few times of my components layout in the process of my GUI development. The position and the size of the components have to be calculated precisely in order to place it nicely in the interface.

8.5   Knowledge and Experience Gained

There was a lot of knowledge gained throughout the development of this system. This includes knowledge in web application development, computing environment, internet technologies, programming languages and concepts as well as database server.

Overall, this project gives a lot of benefit and knowledge.

i.   SDLC (Software Development Life Cycle)

Even through programming skills and techniques are important in system development, good software technique must also be applied. Here, theories and knowledge gained throughout the course of computer science studies like system analysis were literally put in practice.

ii.   Writing code and good programming practice

Before this, I only gain practice in writing simple program. This thesis is the biggest project I have ever did so far. Because this is a gaming system, the logic of the game should be strictly maintained. I have gain experience how to organized the program

development and ensure that the logic of the system flow correctly. Besides that, I learnt in detail how the object-oriented concept is being implemented. There are different rules to apply for developing program in object-oriented way and structural way. Apart from that, I also learnt many of the good programming practice to apply when writing code especially in the environment of object-oriented.

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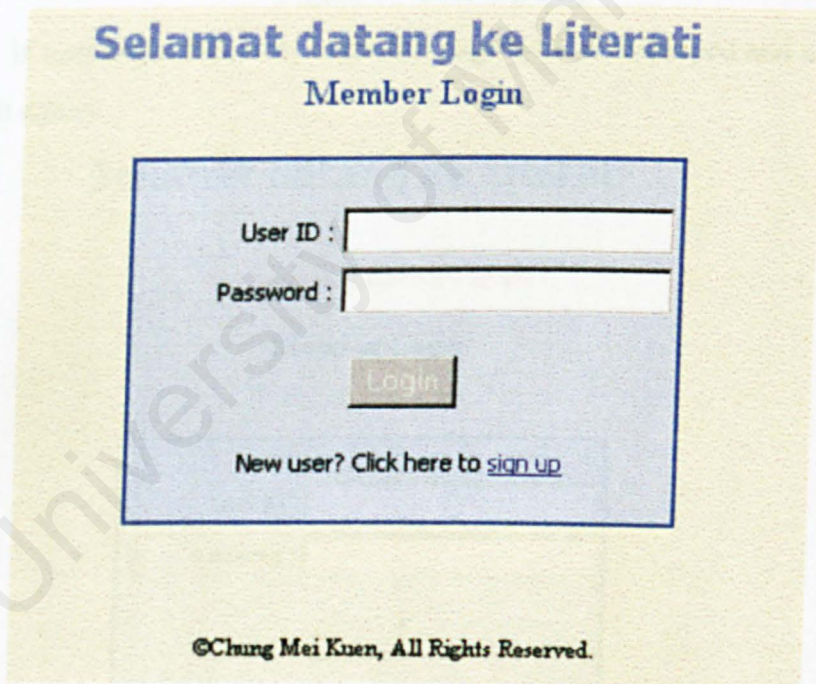
APPENDIX

Prerequisite to game download

Intro: The game is meant for those who want to play the game online. This game ... the person who likes playing strategies. This manual will guide the players on how to play the game.

You need an account either server to play the game.

... the game as upon the begin of the ...

Still, a player needs an account upon ... Using the username and the password during registration. If you do not have an account, click on the link which says "click here to sign up at the bottom of the page to apply for an account.

APPENDIX

Figure 1 : Login Page

Appendix A User Manual

Literati is a network game that allow user to play the game online. This game needs two players to start playing the game. This manual will guide the players on how to play the game.

The following are the steps taken to play the game.

1.   Start playing the game by login at the http://<domain name or ip>/userLogin.jsp. Using the username and the password during registration. If you do not have an account, click on the link *New user ? Click here to sign up* at the bottom of the page to apply for an account.

Figure 1 : Login Page

Selamat datang ke Literati

Sign Up

User ID :
Password :
Full Name :
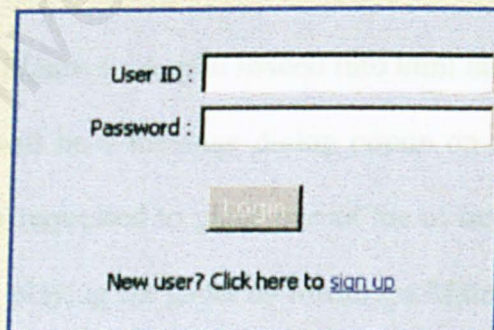Age :
Sex :
EMail :

Submit

Figure 2 : User Sign Up

2.   If user login fail, user login fail page will be displayed and user need to login again.

Selamat datang ke Literati

Invalid login. Please try again.

Member Login

User ID :
Password :

Login

New user? Click here to sign up

Figure 3 : User Login fail

3.   After login successfully, the applet will load into the html page. If you are the first player, you have to wait for the second player in order to play the

game. You can get knew of whether your are the first player or second player by looking at the message displayed in the text area on your right hand site of the applet. If you are the second player, you have to wait for your turn. The text field on the upper right hand side of the applet display the total tile left. The value will decrease each time the player successfully forming a word.
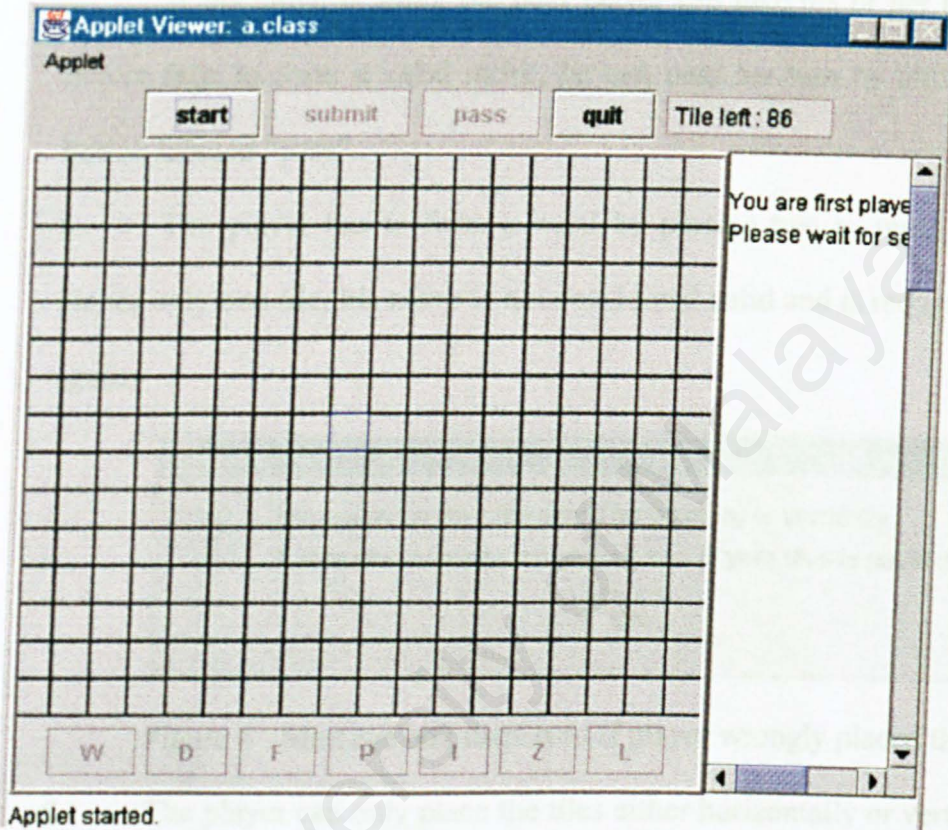

Figure 4 : Applet loaded into html interface

4.   There will be a message dialog popup on the screen of first player. The first player requested to place one of his or her tile in the blue cell. The player can start playing the game by forming a Malay word and place the tiles on the board. If he or her does not place one of his or her tile in the blue cell, his or her move is considered not valid and is asked to play again.
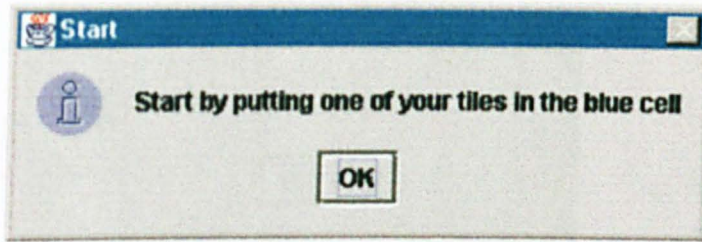
Figure 5 : Starting message

5.   If his move is valid, the next player can take his or her move. If the player fails to form a valid move, he can pass his turn by clicking on the button labeled "pass".

6.   The player has to form a word by placing two or more tiles. If he places only one tile, his move is not considered valid and is requested to play again.
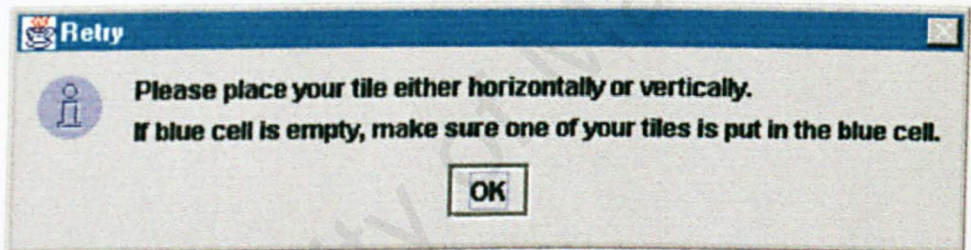

Figure 6 : Message box displayed if player wrongly placed the word

5.   The player can only place the tiles either horizontally or vertically. He cannot place the tile diagonally. By doing so, the system will request the player to play again.

6.   If the player's word is valid, he can view his point on the message display on the text area. The point is the accumulated point. It means that the point is added up with the previous point.

7.   If the player does not want to play any more, he can call quit by clicking on the button labeled "quit". Then, a message dialog box will send to another player to inform him or her that his opponent has quit. This also marks the end of the game.
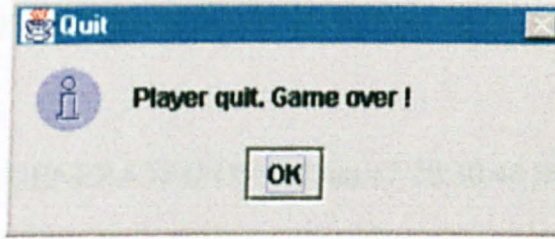
Figure 7 : Message displayed when game is over

8. If the players reach the end of the game when no more tile left, the players will receive a message dialog box displayed their point and this also marks the end of the game.

Appendix B   Policy File

```
/* AUTOMATICALLY GENERATED ON Fri Jan 17 20:30:46 SGT 2003*/

/* DO NOT EDIT */


grant {

 permission java.net.SocketPermission "*:1024-", "connect, accept, resolve, listen";

};
```