J2ME ENGLISH TO ENGLISH DICTIONARY USING INDEXED BINARY SEARCH

A Project paper submitted to
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DEDICATED TO -

EVERYONE WHO TRY TO NEVER COME IN FRONT OF THE PEOPLE.
IF THE PERSON BE PRESENT IN A CEREMONEY, NEVER BEEN TOLD TO SIT IN THE FIRST ROW.
IF THE PERSON BE ABSENT, NOBODY ASKS FOR.

Faculty of Computer Science and Engineering
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Dinajpur-5200, Bangladesh.

CERTIFICATE

This is to certify that, the project paper entitled **"J2ME ENGLISH TO ENGLISH DICTIONARY USING INDEXED BINARY SEARCH"** submitted by **EMRAN ALI**, Student ID: **0702008**, has been carried out under the Department of **Computer Science and Information Technology (CIT)** and under the supervision of **Md. Abdulla Al Mamun, Assistant Professor, Department of Computer Engineering (CEN)**. This project and thesis has been prepared under the Department of **Computer Science and Information Technology** in **Hajee Mohammad Danesh Science and Technology University (HSTU)** as a 4.5 Credit Hour course (CIT-402, Project and Thesis) in partial fulfillment of the requirement for the Degree of **Bachelor of Science in Computer Science and Engineering**.

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ABSTRACT

In this era of modern technology life is becoming very easier. To make all activity of the human life easier and convenient, one of the major facts must be considered – device size. With the growth of technology the size of everything is becoming smaller. We everyone wants to get very powerful and effective services from a single, small thing. As an example, a Cell Phone. In present days, Cell Phones or Mobile Phones are not used only in voice or text communications, it provides multimedia, analytical etc functionality as well. Even the powers and working abilities of Cell Phones are becoming higher so that they are called smart phones or some times pocket PCs.

In the other hand, English is the de-facto International Language to communicate with the people of different community and different country. Hence, English to English Dictionary can help to learn English in an easy way. As well as various dictionaries as paper copy and software are available for Personal Computers online and offline to learn a language. A few software or application is available for Cell Phones.

In this Project English to English Dictionary application software has been developed for Java supported Cell Phones which are widely used in developing countries as Bangladesh. There are some English to English Dictionary applications available for Cell Phones. In this project, a simplified, user-friendly and efficient application has been tried to develop.

This Project allows user to search for a specific word and navigate through a list of words and provides the word finder suggestion, selects a word, auto-navigates through the word list, corresponding meaning and synonym finding etc services. To make this application efficient and user-friendly Custom Item to create customized user interface and event handler, separate file-groups or file fragmentation to store the dictionary data and an especial customized searching technique called Indexed Binary Search for finding words from the list quickly have been used.

In this paper the requirement, system analysis, system design, implementation, operation process of the system and other things are described very carefully. It is a hope that, this application will help the users to learn English in very different and easier way.

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CHAPTER 1: INTRODUCTION

1.1 Overview

"A dictionary is a list of words with their definitions, a list of characters with their glyphs or a list of words with corresponding words in other languages." [1]

"A dictionary (also called a wordbook, lexicon or vocabulary) is a collection of words in one or more specific languages, often listed alphabetically, with usage information, definition, etymologies, phonetics, pronunciations, and other information; or a book of words in one language with their equivalents in another, also known as a lexicon." [2]

There are different kinds of dictionaries available online, offline (printed version, Desktop) and for Cell phone. Some of the dictionaries deal with the mapping of words from one language to other language. There are also dictionaries that work with in the same language that gives the meaning of a word with another simplified word expression. There are many countries that have their own dictionary to translate foreign language to their local language and vice versa. It helps them to learn and understand the foreign language in an easy way. Therefore, English to English dictionary plays the biggest role in understanding and learning the international language to all the people of any nationality and language.

In this age of technology everyone wants to gate a great service from smaller and mobile devices. This is why the size of PCs are becoming smaller and cell phones are becoming powerful almost a PCs. A J2ME mobile dictionary is a process that facilitates translation service using a JVM enabled cell phone. It is typically managed searching environment with a navigation menu and icons giving access to automated tools and content pages. The only thing a J2ME mobile dictionary needs is a JVM enabled cell phone. Therefore, as long as we can get the translation of a word any time any where, there is no need to buy different dictionaries or ask somebody to translate a word.

The printed version of the dictionary has the following drawbacks:

- It is time consuming - locating the required word takes a lot of time and the user has to pass different stages i.e. first he/she has to locate the first letter of the word and then to locate the second, the third till the last letter of the word.

- Users should have the dictionary at hand; the users should have to carry the dictionary with them. Many people don't feel comfortable time and place to have the dictionary with them.
- User should have a means to get the dictionary, buy or lend.
- The dictionary is not available any time any where; availability of the dictionary is limited.
- May be damaged and unable to find the required word.
- Some of the page may not be available because of different reason.

Using the printed version of the dictionary has been only means of getting word translation, but now it is not convenient means especially in today's rashly world and due to the above mentioned drawbacks.

The desktop and online version of the dictionary has the following drawbacks:

- User must have a PC.
- For online dictionary user must have an internet connection.
- Offline or online dictionary software are expensive.
- The operation speed depends on PC capability and internet connection.
- These systems are not always mobile (Movable).

The other means of getting word translation is using Java based Mobile (for Cell Phone) dictionaries. This dictionary solves some of the drawbacks of the printed and online version dictionaries.

J2ME dictionaries for cell phone provide the following advantages:

- Fast searching facility.
- It is available any time any where.
- Users don't need to buy; most of the applications are free of cost.
- Free from damage unless the system is down.
- Different means of displaying the meaning of the word.

1.2 Problem Statement

There are many dictionaries available for Java supported Mobile Phones for the translation from English to English. The method of displaying the result of a search word is only using its corresponding meaning text. Most of those have some problems such as searching response time and no result about its similar words. Such kind of problem can be solved if the dictionary has a special searching technique and option of indicating the synonym of the words.

Therefore, a dictionary must have the options to solve the problem of the existing dictionaries and helps the user to understand the word and its meaning very easily. The dictionary will have an improved search technique and synonym showing capability in addition with it meaning.

1.3 Objective of the Project

A system is developed to meet some requirement. The system has some general and some specific objective. The objectives are described bellow-

1.3.1 General Objective

The objective of this project is to analyze, design and develop enhanced English to English dictionary for Java supported Mobile Phone.

1.3.2 Specific Objectives

- To make searching and displaying mechanism different.
- To make the system effective and efficient.
- To make the system friendly to the users.
- To enhance English to English dictionary by adding "Indexed Binary Search" technique.
- To provide the corresponding synonym of the word.
- Optimum utilization of Mobile Phone resources.

1.4 Significance of the Project

Since English is the de-facto international language and Mobile Phone is widely and very commonly used device. This Mobile Dictionary will help everyone from every

country especially non English speakers to learn the International Language in an easy way. The dictionary will help users who want to get the illustrated meaning of a specific English word and its alternative words those can be used instead of it. The searching feature of the dictionary helps to search the words effectively.

Forasmuch-as it is mentioned that, this dictionary helps every user to learn the unique international language. The outcome of this project is that, any people can make use of this dictionary to learn international language very easily and able to communicate with each other world wide.

1.5 Scope of the Project

The scope of this project will include the following activities related to the searching, navigating through word list and retrieving the corresponding meaning and synonym.

That is, its scope covers:

- Navigating through a large list of all words sorted in alphabetical order.
- Searching for a specific word by taking input from the user.
- Word searching suggestion.
- Retrieving corresponding information about the specified word as meaning and synonym etc.

For this project, an "Oxford English-English Dictionary for Java supported Mobile" is used as the source of our dictionary data because it has as many words as 17,700. Word categorization and structuring will be adapted from this dictionary. Due to budget and time limitation, only representative words will be encoded to test the functionalities of the system.

1.6 Document Organization

This project report is outlined as follows: Chapter 2, system analysis of the project is discussed. Chapter 3 discusses the system design of the system, and the proposed system architecture. The tools/technologies used to implement the prototype of the project are discussed in chapter 4. Chapter 5 contains the techniques used in this project. Chapter 6 presents the conclusion, recommendation and future works.

CHAPTER 2: SYSTEM ANALYSIS

2.1 Current System

One means of getting translation of English to English word is using the print versions of the Dictionary. Using the printed version of the dictionary has been only means of getting word translation, but now it is not convenient means especially in today's rashly world and due to the drawbacks mentioned in the previous chapter. The other means of getting word translation is using online dictionaries. Online dictionaries solve some of the drawbacks of the printed version dictionaries. One of the limitation of online dictionaries is one has to have a computer and an internet connection other wise it is unable to do the translation of the word. Despite the fact that online dictionaries are better means of getting the translation of the word than the printed version of dictionaries, most of the online dictionaries and some J2ME Mobile dictionaries have the following draw backs:

- Relatively long searching and response time.
- Poorer search technique.
- Absence of synonym presentation.

Even if the existing J2ME Mobile dictionaries have some drawbacks, it solves the problem existed in the printed version of dictionaries. The J2ME Mobile dictionary is convenient to many people since it is accessible any time any where, many people would like to use Mobile dictionary.

This project tries to solve the above mentioned problems of an online dictionary and others to make more convenient to the users and efficient working.

2.2 Proposed System

2.2.1 Overview

The proposed system of a J2ME Mobile English-English dictionary will be available at any time any where and display the meaning of the word with the mentioned facilities.

The proposed system will:

1. Do the translation of the word from English to English.
2. Have different means of searching the word.
3. Provide a way to navigate through the list of words.
4. Provide the related word if the searched word is not available in the dictionary.
5. Available anytime, anywhere in Cell Phones.
6. Has an easy interface to make a search.
7. Uses a convenient and efficient search technique for searching the word and meaning.
8. Shows all possible meaning and synonym available.

2.2.2 Functional Requirements

Functional requirements describe the interactions between the system and the users independent of its implementation. The functional requirements of the proposed system are listed as follows:

- The system should provide searching facility.
- The system should have the facility to navigate through the list of English words.
- The system should provide the facility to write English word.
- The system should provide the related search result of searched word.
- The system should provide an appropriate error message.

2.2.3 Non-Functional Requirements

Nonfunctional requirements describe user-visible aspects of the system that are not directly related with the functional behavior of the system that are listed above. Non functional requirements of the proposed systems are listed as follows:

- **User Interface and Human Factors:** The system interface shall be able to run on a variety of Cell Phone regardless of their screen size, memory etc. The system shall have a user friendly menu driven interface that is easy to navigate with. The greatest degree of user system interface consistency and standard shall be provided for all user interfaces.
- **Documentation:** The activities and outputs of each system development stage in the project workflow shall be properly documented for the successful completion of the project. These documents produced at the end of each stage shall be

organized and compiled together at the end of the project for future reference, system maintenance, and system support. All supporting documentation or help file for managing the dictionary must have to be provided to the user inside the application.

- **Hardware/Software Consideration:** The system is expected to be implemented using J2ME (Java 2 Micro Edition), therefore it has to be loaded on a Cell Phone with Java for mobile phone that is KVM (Kilobyte Virtual Machine) support. And the application should be developed with appropriate CLDC (Connected Limited Device Configuration) and MIDP (Mobile Information Device Profile) so that it is supported by almost all available cell phones.
- **Performance Characteristics:** The system shall perform operations within a minimum amount of time. The system shall be interactive and the user shall get the expected result with in few seconds or the system must enable users to do something else while fetching result for their request to hide response latency.
- **Training:** After the completion of the development of this system, we must consider that a minimum and almost no training have to be taken for operating the system.
- **Reliability:** The system shall be uploaded on a reliable machine and there shall be a frequent and reliable.

2.3 Analysis Model

The aim of analysis model is to produce a model of the system that is correct, complete, consistent, unambiguous, realistic, and verifiable. In this section the system is described by showing its subsystems' functionality by use cases, its static behavior by activity diagram, and its dynamic behavior through sequence diagram.

2.3.1 Use Case Diagram

Use case diagrams overview the usage requirements for a system. "Use Case Diagrams (UCDs) are Behavior diagram used to describe a set of actions (Use Case) that some system or systems (Subject) should or can perform in collaboration with one or more external users of the system (Actors). Each use case should provide some observable and valuable result to the actors or other stakeholders of the system." [3]

This section presents functionality of the system in terms of actors and use cases. A use case describes a function provided by the system that yields a visible result for an actor. An actor describes any entity that interacts with the system (as User, Developer).

The following shows the use case diagram of the system.

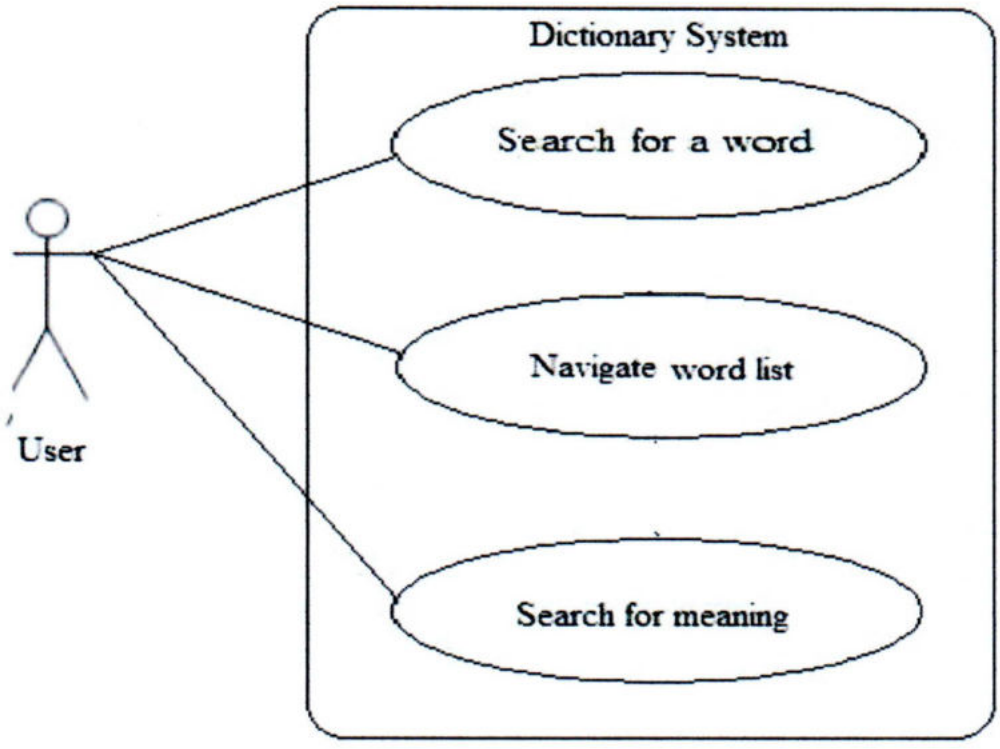

Figure 2.1: Use Case Diagram of the Dictionary System.

2.3.2 Sequence Diagram

"A sequence diagram in a Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. A sequence diagram shows object interactions arranged in time sequence. "[4]. "The sequence diagram is used primarily to show the interactions between objects in the sequential order that those interactions occur." [5]

Sequence diagram describe behavior of the system as a sequence of messages exchanged among a set of objects. It is used to formalize the behavior of the system and to visualize the communication among objects of the system.

Following figure depict sequence diagram for the use case.

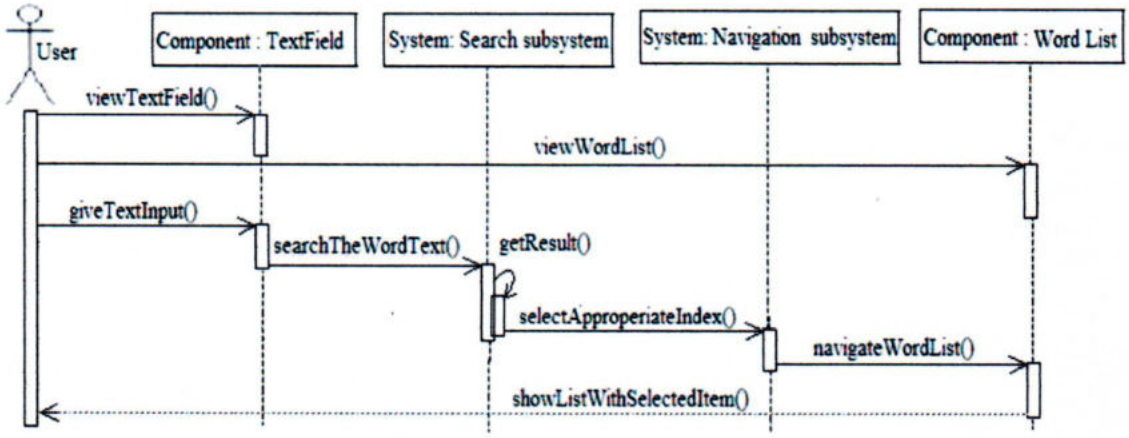

Figure 2.2: Sequence Diagram for "Search for a Word" Use Case.

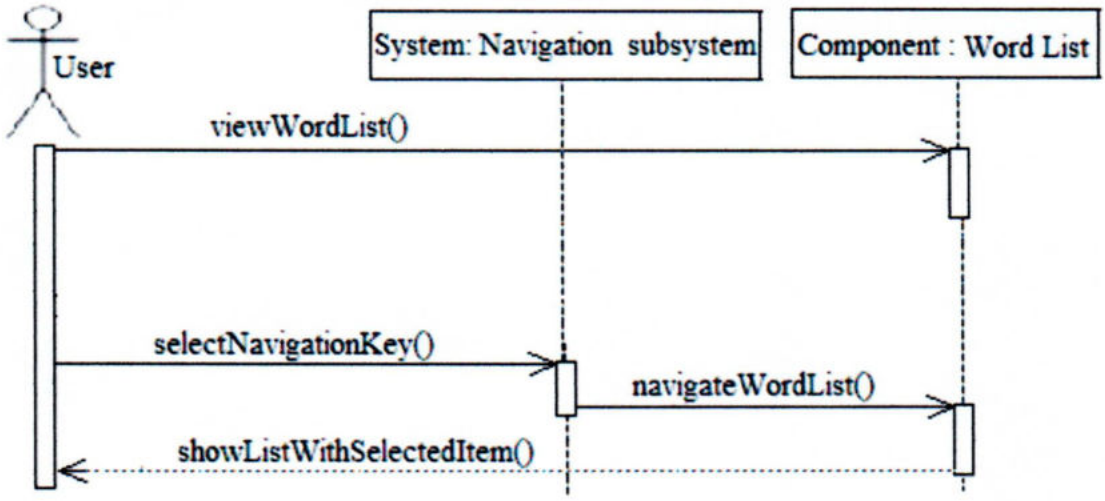

Figure 2.3: Sequence Diagram for "Navigate Word List" Use Case.

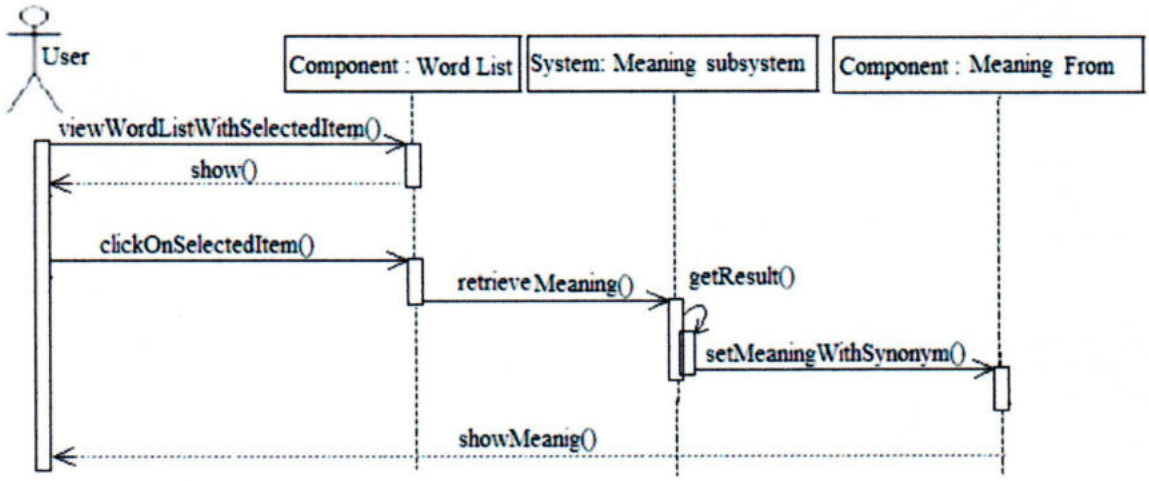

Figure 2.4: Sequence Diagram for "Search for Meaning" Use Case.

2.3.3 Activity Diagram

"Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modeling Language, activity diagrams can be used to describe the business and operational step-by-step workflows of components in a system. An activity diagram shows the overall flow of control." [6]

"In UML, an activity diagram is used to display the sequence of activities. Activity diagrams show the workflow from a start point to the finish point detailing the many decision paths that exist in the progression of events contained in the activity. They may be used to detail situations where parallel processing may occur in the execution of some activities. Activity diagrams are useful for business modeling where they are used for detailing the processes involved in business activities." [7]

An activity diagram describes a system in terms of activities. Activities are states that represent the execution of a set of operations. The completion of these operations triggers a transition to another activity. It is a flow diagram used to represent the data flow or the control flow through a system.

Figure 2.5 is an activity diagram representing activities related to searching Dictionary Words. Rounded rectangles represent activities; arrows represent transitions between activities; thick bars represent the forks of the control flow.

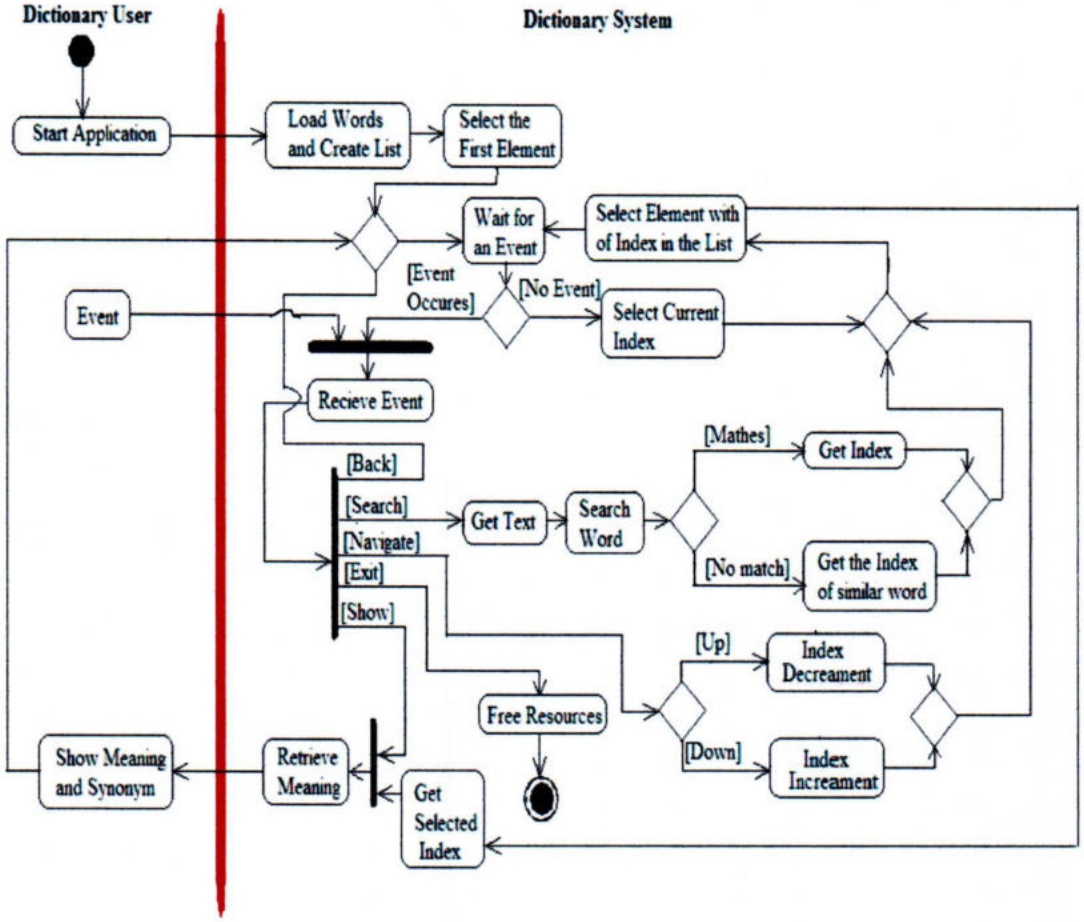

Figure 2.5: Activity Diagram for Searching Dictionary Words.

CHAPTER 3: SYSTEM DESIGN

3.1 Design Goals Criteria

The system is expected to run on a cell phone. Therefore, the design goals criteria stated in this section consider this fact to determine the performance, dependability, cost, maintenance and end user criteria.

3.1.1 Performance

- Response time: Since the allowed execution time (response time) on any cell phone is limited coding should follow simple, efficient and fast algorithms. Especially looping statements shall be avoided (if possible) or minimized.
- Throughput: As described above the system mainly runs at the cell phone, therefore the number of tasks it may perform belongs to not only to this system but also to other request coming from other processes.
- Memory: Memory is required mainly during running the application; because of the limited memory and other resources of the CLDC devices.

3.1.2 Dependability

- Robustness: All user input shall be verified and checked for it correctness and completeness before it is passed as a parameter for further execution, therefore the system can be protected from failures that may occur from invalid user inputs.
- Reliability: The system shall be tested after and during development process to meet the required services. And also it should give consistent and correct output for various type of input it is given.
- Fault Tolerance: Error handlers shall be used to handle and tolerate fault that may arise during execution.
- Security: In order to protect the system from malicious attack the system shall be well protected and secured.

3.1.3 Maintenance

- Modifiability: In order to make the system flexible and easy to modify its functionality some of its feature shall be modifiable.

- Adaptability: The system shall be implemented by avoiding constant information therefore some features shall be set any time.
- Portability: The system shall be developed to run on KVM- Java environment therefore it is not portable to run on any environment which is not KVM enabled.
- Readability: Coding shall incorporate significant and clear comments describing each part of the code what it does and what its purpose is.
- Traceability of Requirement: The system shall be developed according to the system analysis and the design specification and it shall not incorporate any thing beyond. Otherwise newly incorporated functionality shall be documented.

3.1.4 End User

- Usability: The system shall be developed to be easy for user understanding. Especially in developing the user interface it is better to keep the user dictionary in mind.

3.2 Proposed Software Architecture

3.2.1 Overview

J2ME English-English Dictionary is a dictionary system that gives dictionary searching and navigation facilities to the dictionary users. Therefore the system shall maintain a central data store which can be maintained and accessed by a user through the application. Thus the system mainly follows a special type of repository architecture called Local File Access architecture.

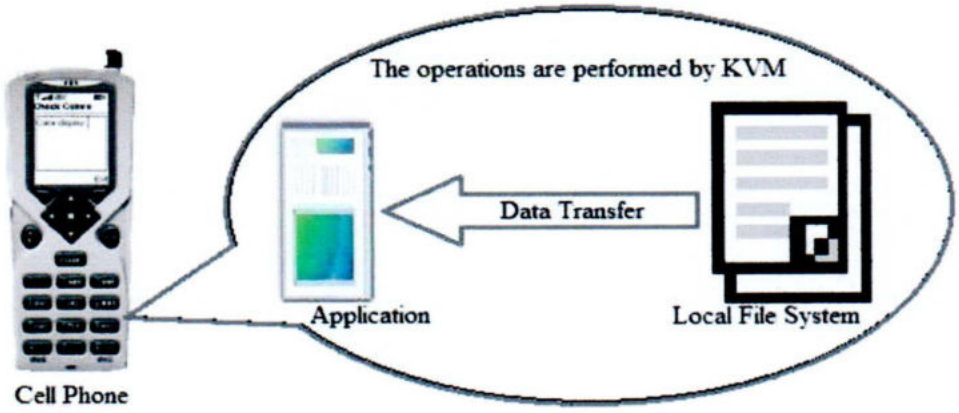

Figure 3.1: Local File Access Architecture.

In Java 2 Micro Edition (J2ME) Dictionary, user can access the service readily available on the cell phone. The services are requested from the cell phone via this application by accessing the cell phone's local file resource and which will be executed remotely by the Java Kilobyte Virtual Machine (KVM). Once the KVM is done with the execution of the request to access the resource it will return the result to the application who requests the service.

3.2.2 System Architecture

The proposed software architecture is a Local File Access architecture on which all the operations are performed inside the cell phone. The application requests service from the KVM. The proposed system is decomposed in to four main subsystems, namely, the Word-Retrieval subsystem, the Display subsystem, the Search and Navigation subsystem and the Meaning and Synonym Retrieval subsystem.

Each subsystem has its own function and there is also communication among them to exchange information. The system is decomposed according to the specialized task it performs to ensure high coherence. The level of coupling is relatively low because the interactions between subsystems are only exchange of data. The major tasks of the dictionary shall be handled by these four subsystems.

3.2.2.1 Word-Retrieval Subsystem

Word-Retrieval subsystem deals with the automated and efficient population of the Word-List and activation of Display subsystem facilities of the system during the start of the application. It populates the word-list with all available words sorted by alphabetical order and visible the word-list to the user for search and navigate.

Therefore, the Word-Retrieval subsystem provides the facilities-

- Retrieve all words serially from all the word files alphabetically.
- Populate the Word-List or Word-Manu available for navigation and search.
- Activate Display subsystem.

3.2.4 Persistent Data Management

This part of the document depicts the persistent data management process of this Dictionary project. As described in the previous sections that Local File Access architecture will be used in this Dictionary System. That is, all the data used in this system will be stored in local resource files.

For the simplicity of the project and faster accessing process, different file sets are used for storing words and their corresponding meanings and synonym indexes. To improve efficiency of the system each of the word, meaning and synonym file sets are fragmented into 26 (twenty six) files each of which will store the information of the words those starts with the corresponding letter of the alphabet. That is, the word files named wa, wb, wc... wz will store the words those starts with a, b, c... z respectively in an alphabetical order.

Similarly the meaning files ma, mb, mc... mz will store the meanings and synonym files sa, sb, sc... sz will store the indexes of the corresponding words in the corresponding word files.

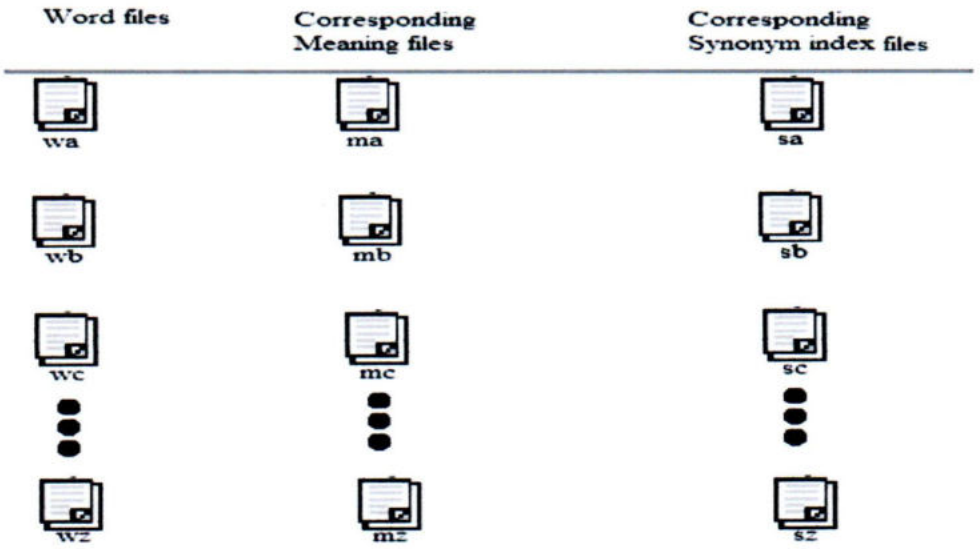

Figure 3.4: Storage Structure of the Dictionary Data Files Inside Application.

The data inside each file is stored separated by a new line character. When there are more then one meaning or synonym for a word are separated by a Slash Mark (/) inside the file and left blank when there is no information about the word. And inside the files

how data is stored is shown bellow for wa, ma and sa files only (all other files will be like this)-

Word files	Corresponding Meaning files	Corresponding Synonym index files
a	something xx/jhgd/jhg/ttt	21/75/925
aa	something xxwf	45
ab	something xxjh/hgfhg	21/42
aba	something fgh/hg/rst	
abd	something ng	124
...	...	...
...	..	...
...	..	...
az	something yt/trg	124/24/433

Figure 3.5: Storage Structure of the Dictionary Data Inside Files.

3.2.5 How Persistent Data are Used in Application

When the application starts it accesses all the word files (wa, wb, wc... wz) and stores all the available words in a collection framework of Java called Vector and also records the index of the first word of each file in another Vector for the simplification of the application and to speed up. After storing in vector it populates the word list and makes visible on screen.

When user searches or navigates through the word list, one of the words from the list is selected and when the user wants to see its meaning and presses show button. Then it scans the first letter of the word and retrieve the corresponding meanings and synonyms from the files named with the starting letter. And it uses the word count vector elements and the index of the searched word in the list to retrieve the specified position of meanings and synonyms in the files.

3.3 Services of the Subsystems

The system is decomposed into four main subsystems as shown in the system decomposition section of this document. In this section the detailed service of these subsystems and their preliminary interface is presented.

3.3.1 Word-Retrieval Subsystem

As it is mentioned before that, at starting time of the application the Word-Retrieval subsystem provides the facilities such as activation of Display Subsystem, accessing of local resource word file, retrieving all the words from the files and sorts those alphabetically and populates one of a collection framework element to store those word data to use in the application.

At the starting of the application when the "Welcome Screen" is shown during that time all the word data is retrieved and made ready for use in the application. As shown in the following screen shot.

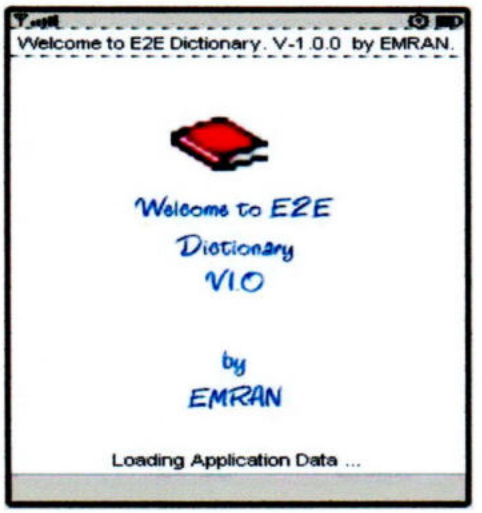

Figure 3.6: Word-Retrieval Subsystem When the Application is Loading Word Data.

3.3.2 Display Subsystem

Similarly as mentioned that, Display Subsystem is responsible for managing, maintaining and visualizing all the dictionary text presenting the word, meaning and synonym etc and all the components those contains those texts such as J2ME Forms, Text Field, Word-List, Alerts etc.

Especially a thing is emphasized in this system's display design that, there is no convenient way to show the Text Field (with which text inputs are taken) and List (with which a set of text are shown serially) on the same screen using J2ME technology. To solve this problem "Custom Item" component is used to create and customize the user interface so that, Text Field and List be shown on the same screen. This is described in detail in the next chapter.

The screen shot images of the display components are shown bellow-

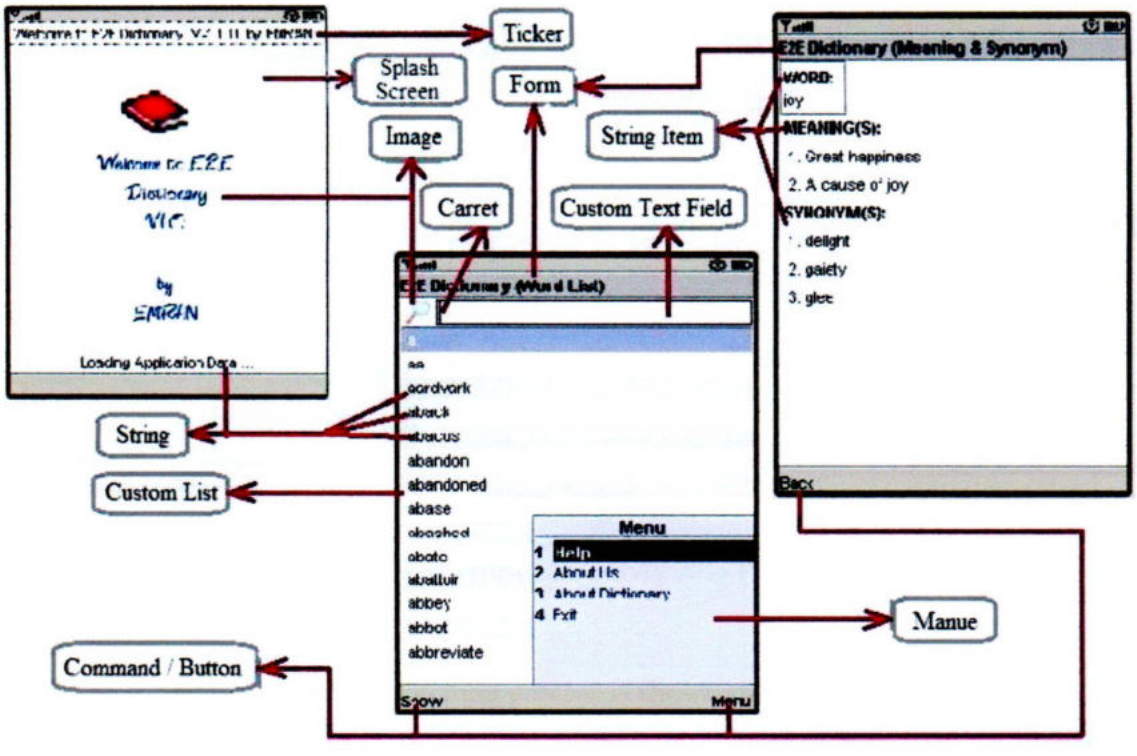

Figure 3.7: Display Components of the Display Subsystem.

3.3.3 Search and Navigation Subsystem

Search and Navigation subsystem provides the facility to give input and also give the opportunity to navigate through the word list to find user's desired word. It allows the user to give input using the traditional key-pad of cell phone, auto navigation facility when user gives input from key-pad and also manual navigation facility to navigate through the word list.

When user navigating the word list manually then it manages the serial and appearance of the word list from sorted word collection. But when user searches through key-pad; after every successful key stroke the dictionary uses an especial search technique name "Indexed-Binary Search" to fine the accurate or approximate word and navigates the selection of the list right there. When the user input is not exactly as the word then it selects an approximate word that starts with the user's input word or next to it. The searching technique is described in the later chapter.

The screen image of navigating process is shown step by step bellow-

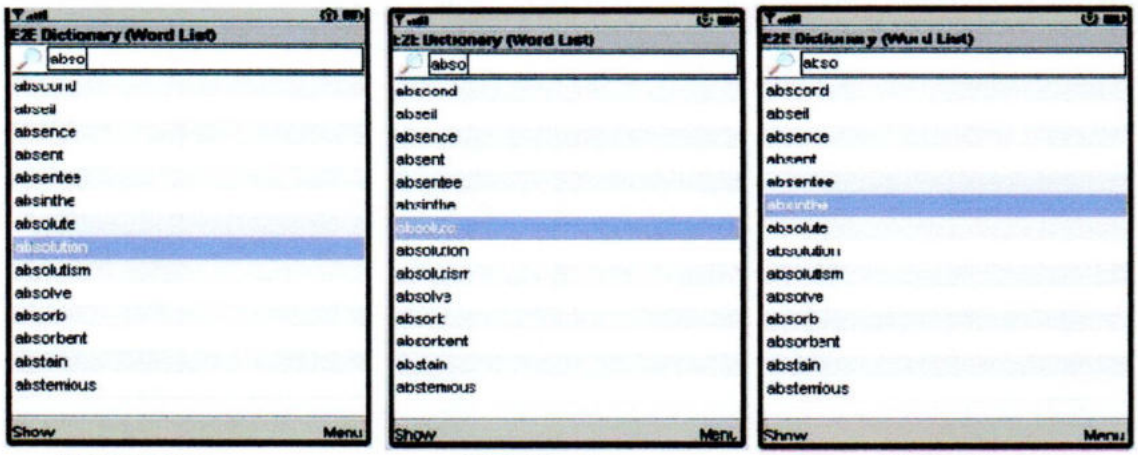

Figure 3.8: Word-List Navigation Process.

Similarly the screen image of searching process is shown step by step bellow-

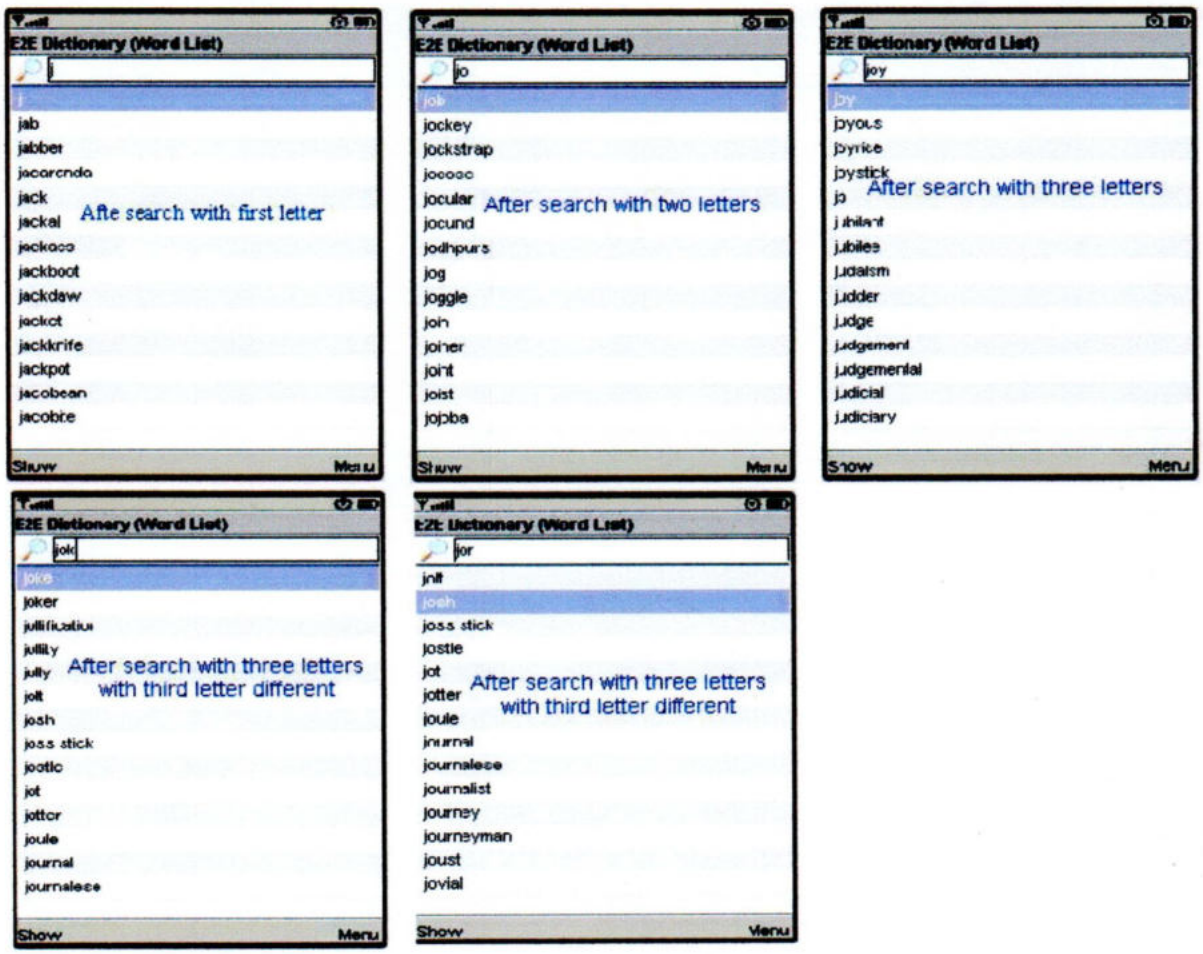

Figure 3.9: Screen Shot of Searching for a Word.

3.3.4 Meaning and Synonym Subsystem

Meaning and Synonym subsystem deals with the retrieval and presentation of all the available meaning and synonym of the corresponding word in the system. It involves accessing of local file resources; as- meaning file and synonym file and identification of the corresponding synonym words.

When user wants to see the meaning of the selected word then only from one of meaning files is read and after some calculation it retrieves the specified meaning word or words and same way retrieves the synonym indexes. When the synonym indexes are obtained then after calculation from the word list the corresponding synonym word or words are along with their meaning are shown. If there is no synonym available for the word then only meanings are shown.

The interface of this operating subsystem is shown bellow with its screen images-

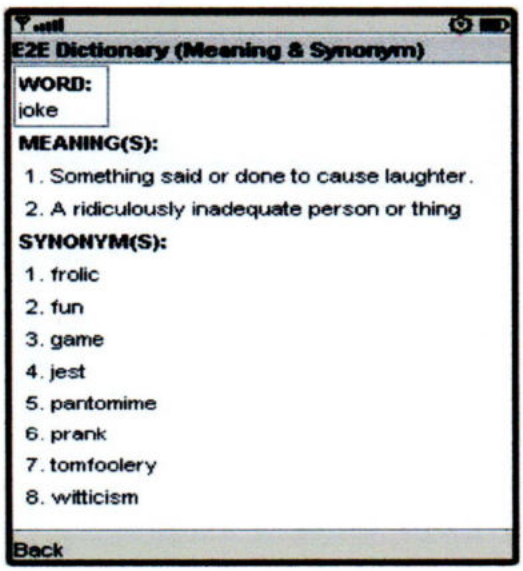

Figure 3.10: Meaning and Synonym Subsystem Display.

CHAPTER 4: SOFTWARE DEVELOPMENT

4.1 Development Environment

To understand the development environment of J2ME application; it is needed to understand various Java editions or Java platform first. Here various editions of Java is described briefly-

4.1.1 Java Editions

Here the Java Editions or Java platforms currently available for various types of devices [8]:

- **Standard Edition (J2SE):** Designed to run on desktop and workstations computers.
- **Enterprise Edition (J2EE):** With built-in support for Servlets, JSP, and XML, this edition is aimed at server-based applications.
- **Micro Edition (J2ME):** Designed for devices with limited memory, display and processing power.

The following figure shows, the editions of Java 2 with types of device those can be programmed using these editions-

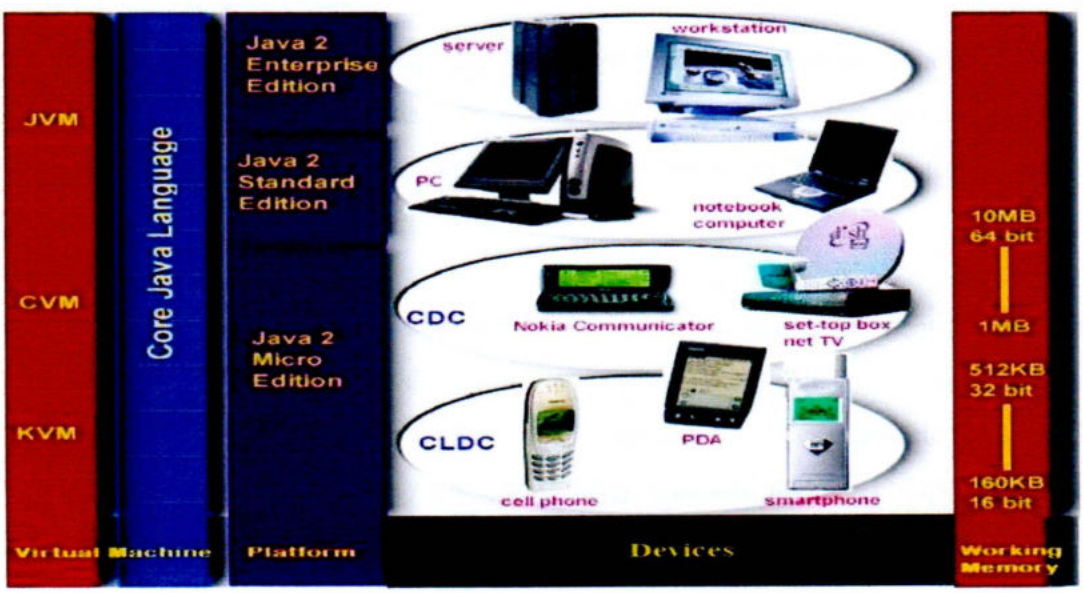

Figure 4.1: Java Editions (Platforms) and Respective Devices. [9]

4.1.2.1 Virtual Machines:

Once we've compiled our Java source code into a class file(s), and optionally included them in a Java Archive (JAR) file, the JVM translates the class files (more accurately, the byte code in the class files) into machine code for the platform running the JVM. The JVM is also responsible for providing security, allocating and freeing memory and managing threads of execution. [11]. The JVM that run on small devices, that is CLDC devices are usually called as Kilobyte Virtual Machine (KVM).

4.1.2.2 Configurations:

A Configuration defines a Java platform and software environment for a broad range of devices. [12] A Configuration is closely tied to a Kilobyte Java Virtual Machine (KVM). In fact, a Configuration defines the Java language features and the core Java libraries of the JVM for that particular Configuration.

4.1.2.3 Profiles:

A profile consists of Java classes that enable implementation of features for either a particular small computing device or for a class of small computing devices. It provides the libraries for a developer to write applications for a particular type of device. [13]. For example, the Mobile Information Device Profile (MIDP) defines APIs for user interface components, input and event handling, persistent storage, networking and timers, taking into consideration the screen and memory limitations of mobile devices.

As it is said before that, J2ME inherits some features and classes from the Java standard edition (J2SE). The inheritance of packages is shown bellow-

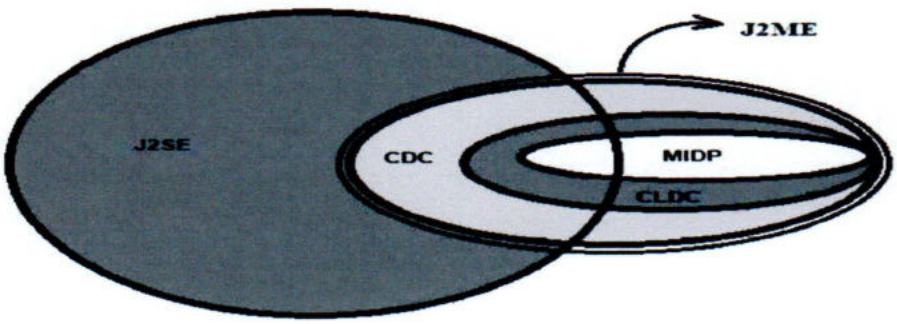

Figure 4.2: Venn Diagram Indicating Package / Class Inheritance of CDC, CLDC and MIDP from J2SE.

4.1.3 Beneficial Features of Java (J2ME)

As a development environment J2ME is chosen; because, Java has a lot to offer. Beyond Java's platform independence, it has a number of features that make it an attractive programming language.

a) **Security:** Security was a concern to the designers and developers of Java from the beginning. Even in the development of a programming language initially intended for consumer electronic devices, the developers knew that these devices were going to be networked and therefore vulnerable to malicious attacks from other systems on the network.

b) **Reliability:** Java's reliability stems from not having to manage some of the lower-level resources such as memory and pointers. Developers are then able to manage information as an object or set of objects, in a manner more akin to how it is done in the real world.

c) **Object-oriented:** Java is considered a true object-oriented language. And object-oriented programming structures actively encourage developers to organize applications into easy-to-understand, manageable pieces.

d) **Free:** Everyone likes free stuff. Programmers and managers of programmers are no exception. The basic Java development and runtime environments are free.

e) **Simple:** Java is simple if you are familiar with almost any other object-oriented programming language, Java's syntax will seem relatively straightforward and easy to learn.

f) **Other useful features:** There are many features that make Java an ideal programming language. As, multi-threading, exception/error handling, dynamic binding, and performance are just some of the additional reasons why Java is a good programming environment.

4.1.4 Limitations of J2ME for Mobile Application

Although Java has a number of advantages; due to the limitations in the capability of small device J2ME omits some features of Standard Java.

The CLDC specification omits support for the following features of the Java language:

- Floating point calculations
- Object finalization
- The java.lang.Error class hierarchy in its entirety

The features in this list have been omitted because of either changes to libraries or security concerns:

- Java Native Interface (JNI)
- User-defined class loaders
- Reflection
- Thread groups and thread daemons
- Finalization (no Object.finalize() method in CLDC libraries)
- Weak references
- Errors (a small subset of J2SE errors is supported)
- Class file verification

4.2 Programming Tool

Some available software tools are used to develop this system. In the development of this system a well known IDE (Integrated Development Environment) for Java application "Net Beans 7.0" and a specific tool kit for mobile application development by Sun Microsystems named "Sun Java WTK 2.5.2" are used. Here is some about these software and their capabilities described briefly.

4.2.1 Net Beans 7.0

Net Beans is an IDE (Integrated Development Environment) from Net Beans Organization. It provides the facility to develop almost every type of Java Applications. Such as- Java Console Application, Java Desktop Application, Java Web Application, Java Mobile Application and many more. It also supplies all the environments, modules, simulator etc to develop a complete application.

In this J2ME Mobile Dictionary application development Net Beans IDE version 7.0.0 with its corresponding embedded environment and SDK (Software Development Kit) versions is used with its embedded Mobility SDK version 3.0 to develop the Mobile

dictionary application/system. This Net Beans mobility SDK 3.0 provides Packages for mobile application development, APIs, Mobile device Emulators (A software simulation module to simulate mobile applications and shows to observe how the mobile applications run on the Cell Phones / Mobile Phones). In mobility module of J2ME the device configuration and device profile for Cell Phone CLDC (Connected Limited Device Configuration) version 1.0 and MIDP (Mobile Information Device Profile) version 2.0 is used.

With Net Beans Mobility module Net Beans Java FX module is also used to test with its runtime characteristics and Emulators.

4.2.2 Sun Java WTK (Wireless Tool Kit) 2.5.2

Along with the Net Beans 7.0 IDE, Sun Java WTK (Wireless Tool Kit) is also used as third party development software for application development. It an application development tool kit from Sun Microsystems for developing Mobile applications using Java. Mainly to run and check applicability of the system, Sun Java Emulators are used as a third party emulator by attaching it with Net Beans IDE.

4.2.3 Sony Ericsson ME SDK 3.0.1

Along with the Net Beans 7.0 IDE and Sun Java WTK (Wireless Tool Kit)- Sony Ericsson ME SDK is also used as third party development software for application development. It has a huge collection of emulators with various screen size and capabilities. So, to run and check applicability of the system, these Emulators are also used as a third party emulator by attaching it with Net Beans IDE.

CHAPTER 5: DISPLAY, STORAGE AND SEARCHING

5.1 Customized Screen

As it is mentioned before briefly that, in J2ME platform it is not possible to show a List component and a Text Field component on the same screen. But, in this project to make the application more user-friendly such a thing is needed; so that user can give input using key-pad and can see the list of words at the same time.

To achieve this goal, Custom Item is used in this project. Custom Item is not a component rather then a way to achieve components as users require and developers needed. Custom Item component provides developer some geometric shape drawing methods such as methods for drawing Characters, Strings, Images, Points, Lines, Triangles, Rectangles, Round Rectangles, Circles, and Ellipses etc. And also provides some methods for event handling using key strokes.

Using these methods, the dictionary main form is crated to provide the users the facility to give input, navigate through the word-list and see the status at the same time. In this form the Text Field users can see is not a text field really, it is a Round Rectangle with a string (Input text) is drawn inside it very carefully and the blinking carret is a "|" mark. Similarly, the list users can see is also false, it is just a set of Rounded Rectangle with the word text is drawn inside these very carefully after a set of complex pixel based calculations.

Most of the events handling as navigating the word-list, giving text input, moving carret position and query for meaning are done using the event handling methods provided by the Custom Item Class in a customized fashion.

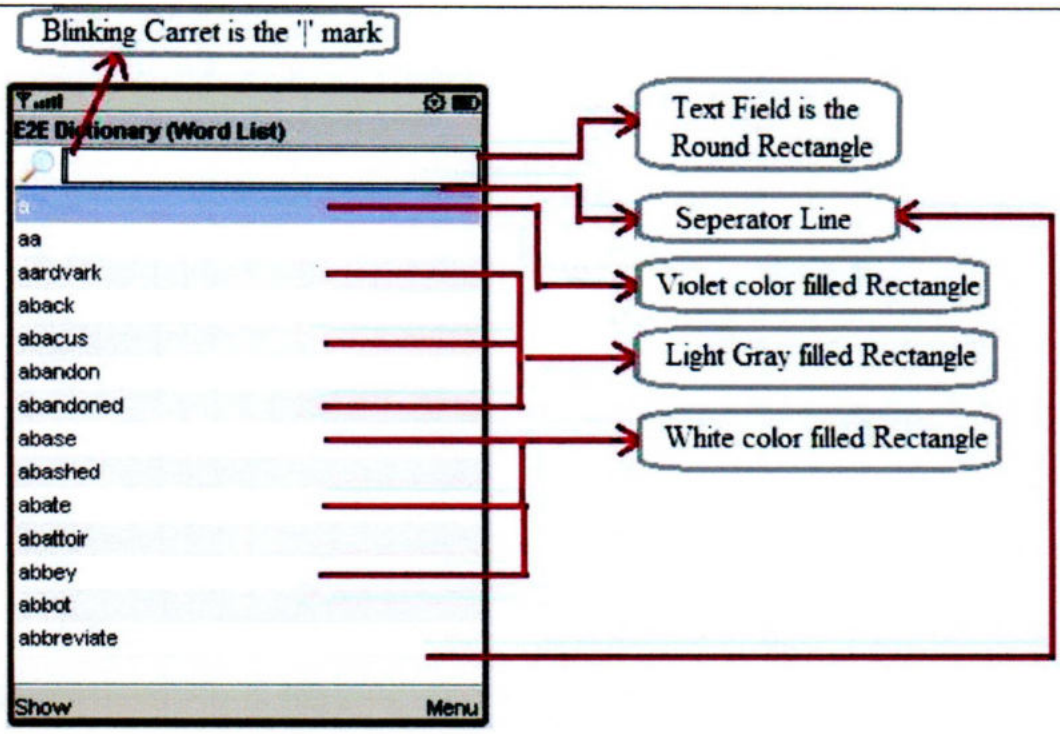

Figure 5.1: Custom Text Field and Custom List Made up of Geometric Shapes.

5.2 File Fragmentation

As described before in the system architecture section that the persistent data for this dictionary application will be stored in local resource files. And it is also shown that a set of separate file groups are used to store words, meanings and synonyms. This is advantageous in a way of accessing the files to retrieve the information from these files. That is, we do not need to retrieve all the data from all the files. As, when we are about to search the word-meaning of the word "fortune" then we do not need to search all the files.

According to our storage structures the word "fortune" must be in "wf" file as it starts with the character "f" and its meaning and synonym will be "mf" and "sf" files respectively. And also the meaning and synonym will be at the same position of the word in the word file. Then we have to search only up to that position to retrieve the meaning and synonym. This technique will reduce the search time and make application faster.

5.3 Indexed Binary Search

Indexed binary search is modified version of the traditional binary search where some indexes are used to search the words instead of searching the entire collection of data. In this search technique system searches using binary search within a range indicated by two indexes. As in our dictionary project all data are stored inside the file in an ascending sorted order and we are reading the files in alphabetical order so our entire word list will be a sorted list. We know that, Binary search is efficient for sorted collection. So, we will use this binary search in our application in a different fission that is we will use Indexed Binary search. The searching process is shown bellow with flowchart-

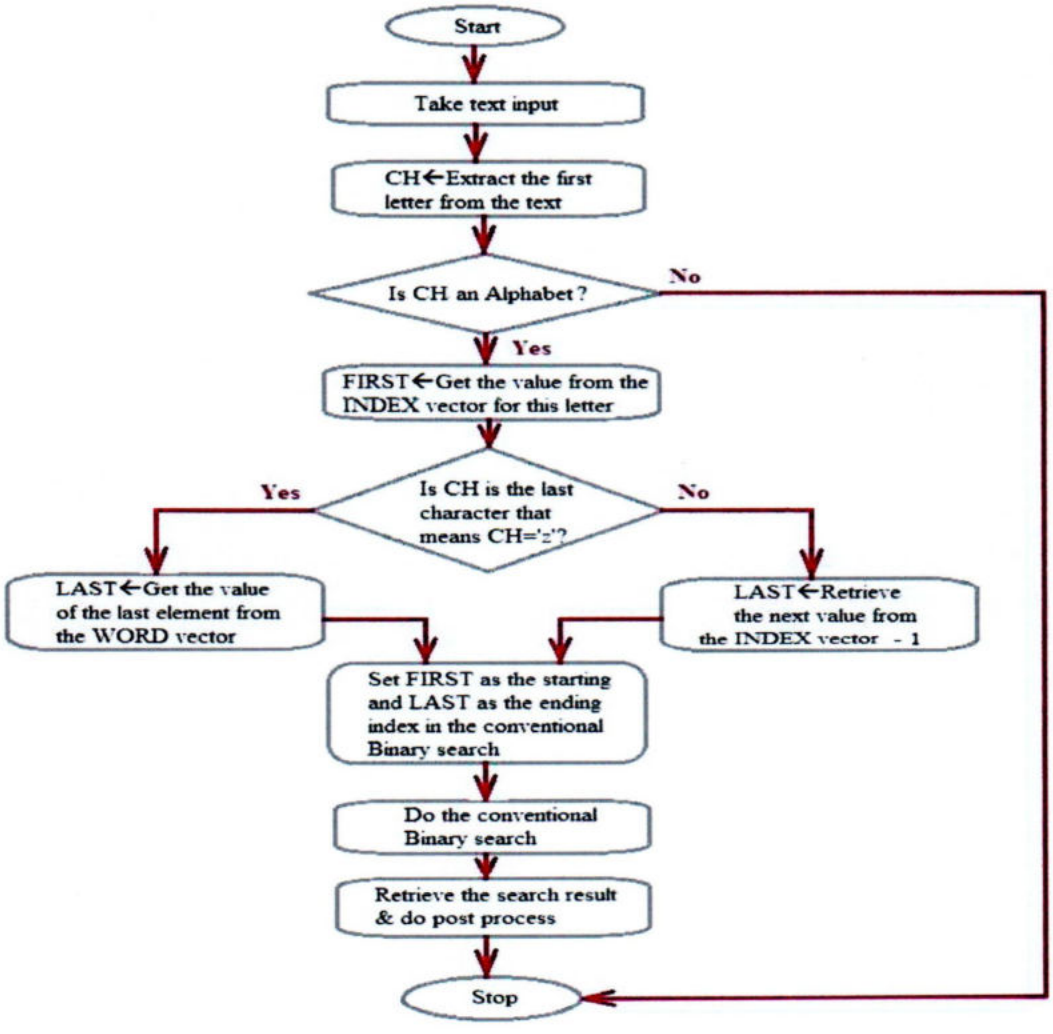

Figure 5.2: Flowchart of the Indexed-Binary Search.

In this dictionary project, at the starting of the application when the word data to be loaded from the word files in alphabetical orderly and storing in Java collection framework called Vector named "Word-Vector" then the index of each first word of the

file is recorded in another Vector named "Index-Vector". The "Word-Vector" is used to populate the word list to visualize to the users and this "Index-Vector" is used for this searching purpose.

Here the searching strategy of the word "joy" is shown with the following figure-

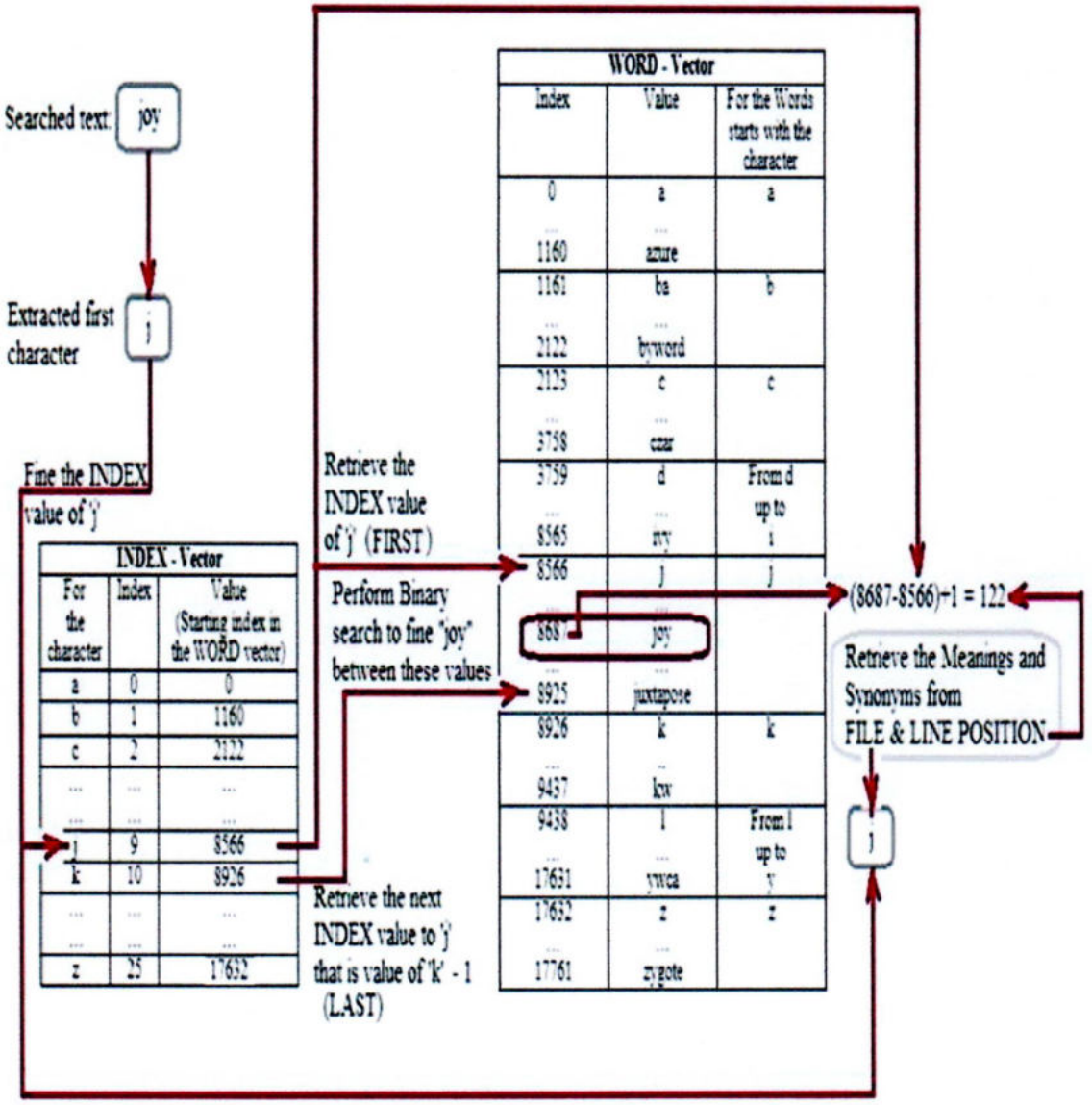

Figure 5.3: Step-by-Step Searching Process for the Word "joy".

When user types something for searching, then in this searching process it extracts the first letter of the word and retrieves its value from the "Index-Vector" that is the index in the "Word-Vector" and the next the next value from the "Index-Vector" if any otherwise the last index of the "Word-Vector".

These two values are used as the FIRST and LAST index in traditional Binary search. This feature helps us to find a word in a shorter time then Simple Binary search. And then using the file fragmentation feature (described bellow) and the "Index-Vector"; that is subtracting the index of the word in the "Word-Vector" to the FIRST we get the position of the word in the word file and so in the meaning and synonym files. Then searching up to this position from meaning and synonym file we can retrieve the meaning and synonym easily.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

In this project, a J2ME Mobile dictionary has been developed that provides translation service from English to English language for Java supported Mobile Phones. It provides the facility to see all available alternative meanings and all available synonyms using a faster searching technique. In this project some especial features are used to develop an experience-class mobile application.

For user interface design to meet user's desired and convenient interface requirement Custom Item is used. The event handler to interact with the system for each interface is mapped so that it is easy and friendly to the user. The mapping is done for conventional mobile key-pads available almost on every Cell Phone.

For data storage and retrieval the Local Resource File Access Method is used. According to this method data is stored as resource text files inside the application locally and retrieved in similar way. File fragmentation technique is used to store the data and for faster access and retrieval. To improve the efficiency of the application words, meanings and synonyms are stored in separate sets of files according to the alphabetical sequence.

The main feature of this project is to get the advantage of faster searching using a modified Binary search method called Indexed Binary Search. In this modified searching technique the word-count index is used in alphabetical order or sequence with the conventional Binary search. This searching method provides the result about 10 times faster then conventional searching.

6.2 Recommendations and Future work

Forasmuch-as this project solves some problems of the Paper, Desktop, Online and Mobile dictionaries, it also has some drawbacks. To provide better services of the dictionary, it should be rich in data content. Therefore, an extended work towards entering more data content into the dictionary data storage is recommended. This will make the dictionary to be complete and provide a better service to the users. To operate the system, user must be carefully read the help section provided with the application.

As it is admitted that, this project is not absolute. It may have some problem still exist; but the careful steps will be taken to recover all problems as possible in the next version. Currently I am working with J2ME English to Bengali Dictionary.

I have some future contrivances:

- To improve the efficiency of this application.
- To minimize data size of the application.
- To add pronunciation of the words.
- To work with Bengali fonts in Mobile phone.

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