VOICE-BASED DATA ENTRY THROUGH ANDROID PHONE

BY

FAN CHEE KHUEN

10ACB06681

A PROPOSAL

SUBMITTED TO

Universiti Tunku Abdul Rahman

In partial fulfillment of the requirements

for the degree of

BACHELOR OF INFORMATION SYSTEM (HONS)

INFORMATION SYSTEM ENGINEERING

Faculty of Information and Communication Technology

(Perak Campus)

JANUARY 2014

DECLARATION OF ORIGINALITY

I declare that this report entitled "**VOICE-BASED DATA ENTRY THROUGH ANDROID PHONE**" is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

Signature : _____

Name : _____

Date : _____

ACKNOWLEDGEMENTS

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals. I would like to extend my sincere thanks to all of them.

I would like to express my sincere thanks and appreciation to my supervisor, Mr. Goh Hock Guan for his guidance and constant supervision as well as for providing necessary information regarding the project & also for he support in completing the project. Besides provides me with necessary information and suggestion, Mr. Goh also correcting me in report written with a clear objective and scope.

Lastly, my thanks and appreciations also go to my family and friends for giving me support in developing the project and people who have willingly helped me out with their abilities. In addition, I would like to thank to some UTAR lecturer who provides me with necessary information about this project needed. Lastly, I am appreciating that given a chance to work on this project.

ABSTRACTS

The purpose of this project is to develop an Android application, which provides the voice recognition services. The system's main target user is those people with Android phone, who want to do data entry through his/her phone. This system will help the users for doing data entry by speaking to the device; it will bring the convenience to the user.

The development language use to develop the voice recognition system is Java programming language. The software involves major are the Android software development kit and the Eclipse IDE Compiler. The system development model used to conduct this voice recognition application is prototyping model, which is more suitable in developed the voice recognition.

At the end of this project, there will an Android application which using the offline voice recognition system (Voice Recognition API by Google). The application able to receive the user voice as input and identify the phase then search it for the recipe whether it exists or not or perform some specific action, if it exists then the application will display it, else the application will prompt an error message to the user.

Besides that, this application also can serve as an e-memo for the user. User can mark down what they want to buy with this application. In addition, user also able to precisely to buy the ingredient without any redundancy, which this application provide an inventory function for user to save the ingredient they got in the house.

TABLE OF CONTENTS

Chapter 2: LITERATURE REVIEW

Chapter 3: SYSTEM METHODOLOGY

LIST OF FIGURE

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Motivation

In the year of 2009, it was marked as the year that many people accessed the Internet for the first time by using a mobile phone rather than a PC. Many people believe that, within the next 5 years there will be more people access the Internet by using mobile phone rather than using personal computer. There is still some reason, why I want to develop a Smartphone application and why it is only Android Operating System based Smartphone.

Firstly, according to a study of the global information and measurement company Nielsen, the Smartphone ownership in Malaysia in term of Operating System, Google Android Operating System placed number two which has 28% and the follow up is the IOS by apple which has 18%. There will be more Android Operating System Smartphone user for the future, this is because of in the market there are many Smartphone are now using the Android Operating System. The trend of the Smartphone market in Malaysia is more on the Android Operating System. Besides that, there are also various kind of tablet are using Android Operating System also, for example the Samsung Galaxy Tab, Macsonic S7A7 and etc.

Secondly, many available Smartphone applications no matter in the Google Play Store or Apple Store has changed the way people use their Smartphone, for example the

GPS map navigation application had just replaced the ordinary GPS devices which only provide user navigation and the Voice Recognition application enable the mobile phone user not only input data from a keyboard, voice recognition application like Google Talk provide various functions from simply send a text message to open some other application, all the interaction between user and the phone just used the voice recognition, sometime the Google Talk also will provide feedback to the user as well. People no longer use their phone for only making phone call, text messaging, serve as an alarm, playing game or doing some other basic Smartphone applications. furthermore, those existing application in the Google Play Store less dealing with the voice recognition area, this give the application developer a unique opportunity to create dynamic, compelling new application. This will be actually something different and it will bring convenience and ease to life for an Android Smartphone user.

Finally, the barrier to entry for new Android developers is very low. New Android developers no need to acquire a "certificate" to become Android developer. Google Play actually did provide various kind of service for the developer, like free and up-front purchase, and in-application billing options for distribution and monetization for developer application. The most important, there is no approval process for developer before distributes an application to the Google Play Store. Google Play Store is different from the Apple Store, at least the Apple store require user to purchase an account before to distribute an application. Besides, in term of programming, developer required to use a IOS computer to do coding and debugging with an IOS Smartphone, these will actually spend developer lot of money before to distribute an application to Apple Store. For a developer to develop an application, he just need a whatever operating system computer

installed with JAVA and the android SDK and debug with any brand of Smartphone, this is far cheaper if compare with to develop an IOS application.

1.2 Project Objective

The objective of this project basically is to create a speech recognition program to recognize user voice as an input. The user voice input will be processed by the program and the program will use it to search for the keywords in the predefined database.

To apply the offline speech recognition API from Google, system designed to make use of the offline speech recognition to perform voice data entry rather than using a keyboard. There is no limitation on the total number of words to be recognized by the system, this will give the user the better using experience as it can input more complicated phrases.

To ensure the performance by using a pop-up confirmation dialog, this action will increase the probability of the user spoken data to be recognized by the system before start performing any task and minimize the user hand contact with the Android phone

1.3 Project Scope

The main system consists of 2 modules, which are the inventory module and voice based data entry module. This voice based data entry module will be delivered as a prototype. The scope will be narrowed down to some food recipe name and the ingredients they need such as salt, sugar, oil and etc. The target user will be housewife and somebody who needs to prepare meal frequently. The targeted language for this

project will be English. As the project title stated, an Android operating system phone device will be used to capture user's voice as data input.

1.4 Main contribution of the project

Purpose of the speech recognition system is to let user more convenience, effective and efficiency to experience the voice based data entry. As we know that, keyboard based data entry can be very inconvenience and inefficiency in some of the time. Making data entry through voice recognition system bring the convenience to the user as the user just press the predefined virtual button on the Android phone screen and talk, than the voice recognition system will recognize the speech and convert it into text.

Beside, this project also can use as an e-memo. User can mark down the items that they wanted to buy, without using any extra devices. As we knew that, nowadays people also got a smart phone with them, it will be a value added service for the user.

Furthermore, with this application, user can precisely purchase the items that they want without having redundancy with the inventory at home. This will help user to avoid the item in the inventory being wasted.

1.5 Organization of the report

The chapter 2 is about the literature review. This chapter contains the review of the technology of the smart phone operating system like Apple's iPhone operating system, Google's Android operating system and Window's phone operating system. Besides, it also contained 4 internet journal articles which related to voice recognition. At last, it summarized all the internet journal articles into the concluding remarks.

The chapter 3 is about the system methodology. This chapter is about the system development model which applied for the project. Before that, there is some briefly explanation of few model like, spiral, prototype and waterfall. The system and user requirement specification also stated clearly at here. Besides, the implementation issues and challenge, project milestone also included in this chapter. The budget allocation for this final year project placed at the end of this chapter.

The chapter 4 is about system design. This chapter will show the system architecture. The application interface design also shows at here. Besides, there is a system flow diagram and a UML use case diagram will be included in this chapter.

The chapter 5 is system implementation. This chapter shows, how to setting and configure the application to work offline. Besides, it also teaches user how to use this application with screen shoots of the application in a very detailed way.

The chapter 6 is system evaluation and discussion. This chapter is trying to evaluate the objective whether it achieved or not. Some testing has been conducted to test the performance of this application. Deployment challenges also have been included inside this chapter as well.

The Chapter 7 is the conclusion; this chapter concludes everything of this documentation. Some recommendation to the next developer who wish to enhance this project application has been included in here as well.

Chapter 2

Literature Review

2.1 Review of the technology

2.1.1 Android Operating System

2.1.1.1 Strengths

The brand of Google is well known and respected by the technology companies all around the world. This is mainly due to the Android platform that gives it credibility and viability to the potential partners, developers and vendors. Google also in collaboration with the Open Handset Alliance (OHA) which is a group of technology companies that work together and developing an open and free Android mobile platform. For addition, the Android platform also integrated with a number of the Google application and services like GMAIL, GPS, Maps, Read and many others which able to reinforce Android platform capability and effectiveness. Besides, as the leader in the internet search and the YouTube, an online video browsing service, provide Android platform more competitive advantages.

Firstly, Android operating system is open-source software, it is different with the Apple IPhone where you only can get the hardware only from the Apple, for those hardware manufacturer chooses the Android operating system, they can apply it on their

handset. Therefore, consumer can choose from various brands of mobile phone manufacture, for example Samsung, HTC and etc.

Secondly, Android operating system is more cost effective and high transparency in licensing agreements. Therefore, mobile phone manufacture able to utilizing the Android operating system and tend to able price the smart phone far more cheaper compare to the Apple Iphone. This will allow the increase population of the Android operating system user.

Lastly, there are just few steps then a single people become an Android application developer. The people just need to download a JAVA compiler and the Android SDK then he/she can start to developer application. Google also provide tutorials how to getting started to develop an application and there is many available source code at the website. Besides, there are many people discussing about the Android application on the internet, developer can simply sharing their experience with each other. This is the main reason that, Google Play Store got many powerful applications.

2.1.1.2 Weaknesses

Android operating system is just less mature compare to the iPhone operating system since Android operating system launched time is just so short. Thus, the level or overall user friendliness that Apple iPhone operating system has achieved, the Android operating system yet still need keep improving to achieve that.

The multimedia support is another weakness of the Android operating system. Google just unlike the Apple, which Apple has a very popular application called as iTunes and marketplace, but Google does not have a centralized multimedia material and the multimedia player. This makes the Android operating system user having difficulty in downloading the multimedia or playing it. Some of the user might go to unauthorized site to download, it might cause of infection of the viruses and etc.

Android phone always prone to external threats, this is because the friendliness of application development and the manipulation of source code by somebody that means to do something bad. Besides, many available applications in the Google Store, whether it is free or not, it require a constant internet connection to run. This will bring a problem for country that did not provide internet connectivity in public place, like Malaysia.

Android operating system got such many brands of hardware manufacturer, whenever Google releases a new version of Android operating system, Google has to wait for the hardware manufacturer to test and modify code to ensure that their specific hardware configuration works with no error. This is unlike which the Apple, because Apple having the full control of when and how the iPhone user get the new hardware and the latest version of the operating system and core functionality. To overcome this, Google had planned to slow down the release of the operating system, by implement more core feature of its services into the Android operating system instead of as application.

2.1.1.3 Opportunities

The tablet market nowadays is getting bigger; the Android operating system has the great opportunity to get into it. With the currently successful of the Android operating system on the smart phone, hardware manufacturer should come out with the Android operating system based table, it will be great opportunity if they able to execute properly. With all the core features of the Android operating system, it is able competitive with the Apple iPad and attract the user to consider the Android tablet.

The current smart phone market is still immature and there is still many kind of phone inventing and keeps improving. Google need to keep improving the Android operating system and positioning itself with the cloud computing application and service in support of the Android operating system. By this way, Android platform able to maintain the growth rate and increase market share.

Android application developing is open and very developer friendly. It is unlike the Apple which had ticked down many of the developer community. Besides, those development tools for iPhone application are difficult to and the application store publishing approval takes a long time to process. On the other hand, development of Android application is free and easier. The Android development tools using the Java programming language which is widely known and use. Besides, the Android Software development kit (SDK) built in with an emulator which allow developers to test their application virtually, and not necessary must need a physical Android Phone.

2.1.1.4 Threats

The increasing of the competitor is one of the threats for Android. Those companies such as Blackberry and Microsoft are going to do their best to get their market share. The Blackberry platform which having regularly support from the enterprise market, and the Microsoft's Window 8 just make them more competitive in the phone market. There is still a mobile phone platform which having very strong foundation, Symbian platform by Nokia, also will not giving up easily.

The Android phone prone to security threats like malwares and viruses, as the Android platform is open, everybody can easily create an application, if a user download an application from unauthorized sites, it might lead to infect of virus or crashing the entire system.

2.1.2 iPhone operating system

2.1.2.1 Strengths

The Apple iPhone operating system is a mature operating system compare to the other smart phone operating system, since Apple first iPohne was invented at year 1983. Apple iPhone just accumulated enough knowledge in the smart phone field until today; it is around 30 years of experience. All the features that Apple iPhone provide and all the achievement they had done, helping them position in the market and get the loyalty from the iPhone users. Besides, many of the iPhone users not only occupy an iPhone product, basically they might still own other Apple product like, iPod, Mac book, iPad and etc.

This is because normally the Apple's first time customer buying iPhone, they will buy the other Apple products as well.

The iTunes application which from the Apple Company, provide the centralized multimedia services for the all Apple product user, which unlike with other smart phone operating system. With the iTunes, Apple user can synchronize their multimedia file with the computer, and then can easily transfer some multimedia file to other Apple product. Besides, iTunes also provide the service for multimedia online downloading, which can provide the Apple user a safe download path without infection of the viruses.

The user interface of the iPhone is very user friendly, even a small child or a people who never use a smart phone before also manages to use the iPhone. Besides, their user interface has been extends into the cloud computing. Apple integrated their iCloud service and it is almost transparent to the end user. For example, a user take a photo using the iPhone, immediately the photo will be synchronized to the iCloud, and it will shown at the users' other devices like computer, iPod, iPad and etc. Besides, the users can also share the photo to specified user in a shared folder.

The Apple Apps Store provides a higher security and safer market for Apple users. This is because when a developer wants to publish an application, he/she must wait for approval from the Apps Store administrator. The Administrator will seriously investigate the application whether it contains any virus or malware or not, therefore it take some period of time.

2.1.2.2 Weaknesses

When talking about iPhone, for those who are not affordable to buy 1, first thing comes out in their mind is “expensive”. Due to all advanced features, amazing design of the hardware and other reasons, Apple had priced the iPhone at such higher than other operating system smart phone. For example, a iPhone 5 normally need at least of RM 2,000 but there is only need around RM 800 then a user can get an Android phone or Window phone. Besides, the Apple Apps Store there are less free useful application for iPhone user to download, unlike Google Android, their market are big and many available free useful application for their Android phone user.

Although the outlook of the design is amazing and incredible, but inside of the hardware design is not really flexible for some iPhone users in term of the phone memory, this is because the iPhone comes without expandable memory. Besides, the battery of the iPhone is fixed, it very inconvenience for the situation when the iPhone battery is broken, and the user forced the send the iPhone to some specialist to change in the battery. It is unlike some other smart phone like Samsung, HTC, Nokia and etc.

The Apple products are commonly well known for weak integration with other brand product. They will provide user the only alternative choose of application for their products, which is all the application from their company such as, Safari web browser, iTune multimedia player and etc. This will bring the inconvenience to the user. For example, a user just familiar with the Microsoft Office tools, but the Apple did not provide this application, this make the user had to pay extra money to download from the Apple Apps Store.

2.1.2.3 Opportunities

Although the increasing number of fierce competitors in the smart phone and tablet industries such as Google and Window, Apple still able to deal well with the competitors. The trust and loyalty of Apple customer still there, they willing to pay the high price to get an iPhone rather than that cheaper price phone like Android phone. This is because they still appreciate what an iPhone brings to them. Apple should take this opportunity, to keep work harder to maintain the trust and loyalty of their customer and the other side grab more customer from the other operating system smart phone.

Apple's direct online sales channel is keep on growing, it help Apple keep at stand in the smart phone mobile market. Apple should have to make the direct online sale channel available to as many countries as possible, because when there is a new launch of iPhone, everybody also feel exciting to get it as fast as possible. Besides, Apple also could make the new launch of iPhone at the same time in every country which no need some of the customer to wait for long time in their country for the official launch of new iPhone.

The Apple iTunes is the most successful application, many iPhone user also download multimedia and application from there. Apple should then take the chance and get latest multimedia ready for their user to download, or come out with new policies that can benefit their user. For example, provide promotion for the download of the same singer or the same music production company.

2.1.2.4 Threats

That smart phone with different operating system like Google's Android operating system and the Microsoft's window operating system is Apple major threats in the smart phone market, although most of them unable to come out with a smart phone which better than iPhone, but they still occupy quite some of the smart phone market share.

The global downturn of the economic affect the sales of iPhone, many of the customers tend to substitute with the cheaper phone like Android operating system which also provides them many functions as well.

2.1.3 Window operating system

2.1.3.1 Strengths

For the year Microsoft established, Microsoft is the leading operating system for the computer, which resulted the rate of higher then 90% market share of PC OS. Many people also heard and used the computer operating system of the Microsoft before. Microsoft window operating system is just easy to use and user friendly. Many people start using the window operating system like Window 95 from long time ago until currently the Window 8, user are just too familiar with it. Therefore here come the brand loyalty and the brand reputation.

The biggest strength of the window phone operating system which is they are fully compatible with the Microsoft products lines, such as the Microsoft Sharepoint and

the Microsoft Office. Besides, since all of the software is from the Microsoft Company, it is easier for the window phone developers who have the internal knowledge to implement data exchange interfaces between the window phone and the Microsoft software if compare with those external developers. For addition, since many computer users also have the experience of using the computer window operating system and some of their software like Microsoft Office, user already familiar with the software, this will shorten the time for a adopter of a window phone to learn the functionality of the smart phone.

The connection to the Xbox Live is a major competitive advantage for the Microsoft window phone and most important is that this it cannot be copied by the other competitors easily. Besides, the strong financial fundamental of the Microsoft Company allows them to face a short period of financial losses in the smart phone market. Microsoft Company got the ability to handle the financial losses and push the window operating system into the smart phone market.

2.1.3.2 Weaknesses

Although the Microsoft having the strong financial fundamental, and the budget for the research and development is around 7 billion US dollar but with the past experience show that they are inability to market their innovations successfully. In This regard, the further enhancement of the window operating system phone although had been developed, but it possible have been held back. Right after the introduction of their new operating system, Microsoft just tightened control over the applications that can be executed on the window phone, those applications that can be execute normally are those applications that have been received through their marketplace.

Although Microsoft window operating system for computer is a long establish and stable operating system. When comes to the smart phone, there will be a different story. In short, Microsoft window operating system stills an immature operating system for smart phone. Many of the new application developer rather than choose the iPhone operating system application or Android operating system to start till first application, since there is bigger market for the application. This make the window phone application market lack of available application. Although some of the developer willing to develop the window phone application, but they will still develop for the iPhone and Android version first, only they develop for the window phone.

Window phone just like the Android phones which are got no centralized multimedia material, unlike with the Apple having the well established centralize multimedia material which is the iTunes. Window phone user got no a trusted site to purchase and download the multimedia, until their user go download from other site that might contain of the viruses or malware. At last it may lead to the infection of viruses or malware.

2.1.3.3 Opportunities

The smart phone and the tablets markets will still grow steadily over the few years, as long as the window operating system phone not yet totally dropped out from the competition with the Apple iPhone operating system and Google Android operating system, the investment of Microsoft on the window operating system phone might be profitable if they keep on working hard.

The biggest opportunity is that Microsoft is the first-mover for tapping into the Mobile Game Market. Being the first-mover, there will very lead to a very high competitive advantage. Although the Apple iPhone and Google Android both phone also support for the online game, but neither Apple nor Goole have a thorough integration of the Mobile Gaming business like Window.

Since everyone also talking about the cloud computing. Window operating system phone should be come out with some core function which related to the cloud computing and providing cloud service like what Apple had done, iCloud. Mobile advertising markets are grow rapidly these few years, Microsoft has a great opportunity to step into the market with the window mobile phone.

2.1.3.4 Threats

The bad reputation in smart phone market is the main threat for the Microsoft window phone. Besides that, the bad marketing effort that Microsoft conducted is another problem that they need to solve. Even though the Microsoft having best technology and the huge budget for marketing, but they still unable to get the attention from the customer.

There is another potential competitor join the competition and challenge the share of the Mobile Gaming Market of the Microsoft, which is the Nintendo. Nintendo start to step into the Mobile Gaming market as they announced they will develop themselves a brand new mobile gaming device. This could be a threat for Microsoft in the market as the Nintendo is well known of producing quality gaming device.

The last major threat of the window phone that is, the smart phone market is highly competitive. While the Microsoft keeps on improving their window phone

operating system, they must be innovative enough. This is because in the smart phone market, in average of few months, there will be a new phone will be released.

2.1.4 The Selected operating system

This project is going to use the Android operating system phone; this is because the Google Android is basically supported by the Open Handsets Alliances. Besides, those tools needed for develop the Android application can be found easily, and it is also user friendly, the most important is those software are free of charge. This can reduce the budget for the project. During the development, it is using the Java language programming which is the programming language that I far more familiar with if compare to the C/C++ programming language. The Android software development kit also provide function of testing the program virtually, they will provide a emulator for the developer.

Nowadays the developing the mobile application is a hot issue especially for the Android application. Therefore, there are many website and forum available for the discussion and experience sharing, which I can learn a lot from there and this will help in the project. There are also available of the source code and tutorial for the new developer like me to learn. Besides, if there is a problem during the application developing, I can ask the expertise in the website and forum, and there are always happy to provide.

2.2 Review of existing work

2.2.1 Method and Apparatus for effectively receiving voice input to a voice recognition system

The researcher introduces a method and apparatus for effective receiving voice input to a voice recognition system. According to the research, researcher provides a method and apparatus to complete the voice recognition task with minimal contact with the user. First of all, the system will record down the spoken information before to perform the voice recognition, if the system cannot recognize the spoken information, then a human attendant will intervene to assist the system to recognize the spoken information by choosing the possible "solution" that provide by the system or playback the recorded spoken information.

The advantages of the research is, no matter the user's spoken information able to be recognizable by the voice recognition system or not, at the end the system still able to get spoken information from the user. This is because when the voice recognition system unable to recognize the spoken information, there will be a human attendant intervene and help the system identify the spoken information, if the system and the human attendant this both method also unable identify the spoken information, at last the human attendant will reply the user to repeat the spoken information.

The limitation of the research will be the human attendant, the company need to hire an extra employee to serve the user. The company need to spend more money this will directly affect the profit of the company. Besides, the human attendant sometime also will make mistake, they might listen wrongly from the playback of the recorded

spoken information. With the wrong input of spoken information to the voice recognition system, it will affect the accuracy and performance of the system.

To overcome the limitation, the researcher can just ignore the human attendant part. When comes to the situation the voice recognition system can't recognize the spoken information, then the system prompt the user the possible "solution" and let the user choose, if the none of them is the answer, only the system request user to repeat the spoken information.

2.2.2 Voice Recognition System Having Articulated Talk-Back Feature

The researcher a voice recognition system is provided that outputs a talk-back voice in a manner such that a user can distinguish the accuracy of a voice-recognized character string more easily. The system basically work like this, a voice recognition unit perform the voice recognition on a user's articulation in which character string such as the telephone number "024 636 0123" is captured via a microphone. Based on the "sound existing period delimited by silent intervals", partial character string "024","636","0123" will be obtained. Then a talk-back voice data will connect back those partial character strings by insert a space between and then generate a character string "024 636 0123". At last, a voice signal to be produced by the speaker is generated in the form of the talk-back voice.

The strengths of this research are that the voice recognition system captures the user input partially by using the "sound existing period delimited by silent intervals". With this method, it actually can increase the accuracy rate of the voice recognition.

Because the system capture the user input partially, it means the system capture a "shorter" of voice input, if compare with capture the whole "long" voice input the accuracy rate surely will be higher. Besides, the system will produce a talk-back voice, it can let user to confirm with the voice input. If user found out the voice input was wrong, he still can change the voice input before the system process it.

There will be need more processing time is the main limitation of this research. Since the system capture user voice input partially, that mean if user provide a character string consists of 5 part, the system need to process 5 times then only can fully capture the character strings that user want to input. And the character string scope seems like limited at some password or integer that to be converted into character string. Besides, nowadays voice recognition system, just need to capture few phrases or word as command, then it can process the command already, which mean it may be not necessary to separate a character string partially.

2.2.3 Designing Android Applications with both Online and Offline Voice Control of Household Devices

The purpose of the project is to use the assistive technology (AT) to help persons who are disabilities. The authors develop two Android applications with offline (PocketSphinx) and online (Google Voice Recognition Technology) voice recognition on the same smart phone to operate a television remote through an input-output (IOIO) Board. The purpose to implement the offline voice recognition is to provide flexibility to those smart phones which are without Wifi connectivity or data plan. There are 7 specific

keywords for the testing, which are channel increase, channel down, volume increase, volume down, power, on and off. These 7 specific keywords used to test the both online and offline application response accuracy with respect to distance between user and devices as well as the level of ambient noise.

At the testing result, the Online voice recognition which is by the Google, providing the higher accuracy compare to the offline voice recognition which is by the PocketSphinx. In general, the both online and offline voice recognition provide the higher accuracy when the distance between user and the devices, but the accuracy obviously dropped when the level of ambient noise increased.

The testing result is done by the specific group of people and with specific condition which are, the seven command is done by the female of Caucasians who between ages 20 to 23, besides, they perform 10 trails of the testing. The criteria and condition for choose people to perform a testing can affect the result. There will be some other question coming out like, will the result got a big different if the number of trial change to 50, why the testing is not perform by male in Caucasians with other age range? But anyhow, we can know that the both application provide quality recognition with the defined condition by the authors.

Google recently updated their Android Operating System, which also support offline voice recognition, it will be used to implement the application and it is nothing related with the online voice recognition. The seven commands in the research paper got the similarity with keywords in the application. The testing criteria like range between user and the device, and the level of ambient noise can be applied to testing for my application once the prototype is done.

2.2.4 Voice Control System with Advanced Recognition

This paper explains the process of realization of voice control system based on the cloud processing. This project used the Google speech to text STT API and developed two Android applications with two different algorithms. The first application is a TV remote controller simulator; this application applied the Levenshtein distance algorithm while the second application is to moves the graphical elements; this application applied the longest common subsequence (LCS) algorithm. The testing and verification is done by the help of 20 different people, who individually spoken 10 sentences with 10 input commands each. As a result, the both researcher proposed approach achieved a higher rate up to 50% compare to the Google speech to text.

The cloud model processing got the higher probability come out with a more accuracy result while dealing with the very demanding and complex processing like the speech processing, which that not a normal hardware architectures that can simply support such complexity natively. Besides, this paper also showed that the usefulness of applying the advanced recognition module for the application like voice control or voice recognition will resulting for a better precision and accuracy on recognition of a set of predefined voice input commands.

Although there are many well-established algorithm, but there are still no 1 algorithms able confidently provide the 100% accuracy for all the voice recognition. This is mainly due to the some environmental problem, like the background noise during the recording time, the volume of the speech, informal pronunciation of a words or different accent and etc. It is the general problem for all type of algorithms for the detection and treatment of speech.

The cloud processing model is a good approach with dealing to the certain set of command; it can definitely improve the accuracy up to 50%, but it processing the voice recognition at the cloud, which means need to make use of the internet.

2.3 Summarized review of existing work

Table 2.1 Summarize of review existing work

No	Title	Introduction	Strengths	Weaknesses	Comments
1.	Designing android application with both online and offline voice control of household devices	A smart phone recognition system with both online (Google Voice Recognition technology) and offline (Carnegie Mellon's PocketSphinx) was developed to operate a television remote control with simple voice commands (channel increase, channel down, volume increase, volume down,	Both online and offline application were tested for response accuracy with respect to distance from the user's mouth and surrounding noise. The testing perform under those factors that will affect the accuracy of voice recognition	The testing was done by female Caucasians between the ages of 20 to 23. They didn't include the male and the other age range as the testing target.	For my application will not related with online voice recognition, it will just use the offline voice recognition The seven commands just similar like the command for my application

		power, on and off) and tested with different ambient noise level and distance from subject.			
2.	Voice control system with advanced recognition	This paper explains the process of realization of voice control system based on the cloud processing. Two applications were developed, first is the TV remote controller simulator which use Levenshtein distance algorithm, and second is an application that moves the graphical elements which uses Longest Common Subsequence algorithm. As results show that, the	The cloud model processing provides the possibility of using the results of a very demanding and complex processing like the speech processing that on the hardware architectures that can't support so a complex processing. Besides, the accuracy will be probably increased up to 50% by using the advanced processing.	For all types of algorithms for the detection and treatment of speech, still the general problem like background noise during recording, volume of speech, irregular pronunciation of words or a different accent unable totally solved.	The cloud model although is a good approach for doing advanced speech processing, but it is not suitable for my application, since my application just receive few command or phase as voice input. The offline voice recognition system can solve the problem.

		researcher proposed approach with additional processing the accuracy is higher up to 50%.			
3.	Method and apparatus for effectively receiving voice input to a voice recognition system	Researcher provides a method and apparatus to complete the voice recognition task with minimal contact with the user. Firstly, the system will record down the spoken information before to perform the voice recognition, if the system cannot recognize the spoken information, then a human attendant will intervene to assist the system to	The system surely can get the spoken information from the user. System will firstly perform voice recognition, if it failed to so, it will provide the human attendant the "possible solution" to choose. If the human attendant still unable to identify, then he will reply the user to repeat.	Company need to hire an extra employee to serve the user, this will directly affect company profit. Besides, the voice recognition system do not guarantee the accuracy or correctness of the voice recognition, the voice recognition system still will wrongly recognize the user spoken information.	Since my application is offline voice recognition, for sure there will not a human attendant to assist the system or user, but the method of providing "possible solution" and request to repeat seems to be able to apply on my application, since this will help the system to receive the command or phase from user.

		recognize the spoken information by choosing the possible "solution" that provide by the system or playback the recorded spoken information			
4.	Voice recognition system having articulated talk-back feature	The researcher introduce a voice recognition system is provided that outputs a talk-back voice in a manner such that a user can distinguish the accuracy of a voice-recognized character string more easily. The system will partially capture the voice which delimited by silent intervals, when finish capture, system will combine all of them and	The system captures the user voice input partially which able to increase the accuracy rate. Beside the talk-back voice allows the user to identify weather the system recognizes the voice input correctly.	In terms of user and system, there will be need more processing time for this method, since the whole string chopped into partial and being capture by the system. Besides, this method seems like not a feasible approach, it only applicable at some area like phone number or some command with 2 -3 words.	The strength of this research will be a good method for increasing the accuracy rate for my application. Besides, the talk-back voice service will help my application to achieve my project title, which is voice-based data entry. The talk-back voice service will let the user identify if the system had captured

		generate back the character string. At last the system will have the talk-back voice for the captured information.			the correct information. If user says yes, then the system will proceed, if not the system will not proceed

2.4 Concluding remarks

After reviewing the 3 smart phone operating system, in the term of cost effective, Google Android has the competitive advantages over the other 2 operating system. When comes to the user friendliness and great interface, iPhone operating system then has the competitive advantages in it. For the Window phone operating system, they are the first mover to the mobile gaming business, which is never done by the Apple and Google.

Summarize the existing work; there are many applications implemented the online voice recognition by Google. The developer lesser implement the offline voice recognition, developing offline voice recognition could be benefits quite a huge population of Android phone user. All the paper conducted with the only purpose which is implement different algorithms and shows the accuracy of the voice recognition in different condition and situation.

Chapter 3

System Methodology

3.1 System development

3.1.1 Waterfall model

The waterfall model is the first software development methodology introduced. Some of the people also named it as a linear-sequential life cycle model, because it illustrates the software development process in linear sequential flow. This model is easy to be understood and use. Waterfall model basically separate project into phases, for example like requirement gathering and analysis, system design, implementation, testing, deployment of system and maintenance. Each of tasks of a phase must be fully done before the start of another new phase. When a phase is done, there will be a review and determine whether the project is still on the right path and a decision on if to continue or discard to project. All the phases in the waterfall model do not overlap, because it is hardly go back to previous phase to start over again.

The advantages of waterfall model are which it allows for control and departmentalization. For example, a single project manager can schedule a deadline for each phase of the development, after through the waterfall model process the phase by phase then a product is done. Besides, the waterfall model is simple and easy to be understood and use. For example, the waterfall model processes each phase step by step,

after a phase done only another start. Basically the development moves from the concept of idea, to design, implementation, testing, installation, troubleshooting, and finally the operation and maintenance. All the phases must be strictly following the order.

The disadvantages of waterfall model are that it is not a good model to be used when dealing with complex and object-oriented projects. It is because the waterfall model it does not allow for much reflection or revision. For example, after an application is in the testing stages, it is hardly to go back to the first phase to change something that was not nicely documented. Besides, by using waterfall model, there will be no workable software produced until about the end of the software development life cycle.

3.1.2 Prototype model

Prototyping refers to developing software application prototypes, which are only displaying parts of the functionality of the software under development. Basically the prototypes are usually systems which there are many detailed function are not built in and its goal is to provide the system with overall functionality. Prototype model is very popular among the other software development model, because it enables to understand the client requirements at the early stage of development. By using the prototype, the client can actually first to use the system and get the experience on the system. With the prototype, client able to better understand the requirement of the desired system, therefore can provide precious feedback about the system. The feedback from the client helps software developers know about what the client exactly expected. In short, a software prototype is software with limited functionality which purposely to allow the client to evaluate developer proposal and test it before implementation. It also helps developer to understand the requirement which is the client had specified but the

developer forgot or have not been considered during the software design or development. The 4 major software prototyping used widely are throwaway/rapid prototyping, evolutionary prototyping, incremental prototyping and extreme prototyping.

The advantages of prototype model are the client are actively involved in the development, therefore the client can get a better understanding of the system which are being developed. Besides, since the client involved actively, precious feedback can be obtain from the client which may leading to a better solution to the system. In other words, those missing, confusing and difficult functionality can be identified easily and some errors can be detected much earlier.

The disadvantage of prototype model is may increase the complexity of the system that are going to develop. The scope of the system might expand beyond the original after a version of prototype has developed.

3.1.3 Spiral model

The spiral model is just similar with the incremental model and the waterfall model. It is a combination of the sequential linear development model and iterative development process. The different is spiral model emphasis on the risk analysis. Spiral model allows incremental release of the product and incremental refinement during iteration around the spiral. The spiral model has four phases, which are planning, risk analysis, engineering and evaluation. During the planning phase, system designer or developer start to gather the system requirement, then a risk analysis will be conducted. In the risk analysis phase, risk and the alternative solutions will be identified, and then a

system prototype will be built at the end of the phase. In the engineering phase, software application will be produced, before the end of the phase a testing will be conducted. At the final phase, which is evaluation phase, it allows client to evaluate the project before the project continue to the spiral. Based on the client evaluation, the software development process enters into the next iteration. It will follow the previous approach to implement the feedback that the client had suggested. The iteration of spiral is keep continues throughout the life of the software application.

The advantage of the spiral model is that it good for the large and mission-critical project. It is because it allows for different functionality added in during the software life cycle. Since there is risk analysis done before start of the project, the avoidance of risk is enhanced. The spiral model is a consistent method with approaches that have multiple versions of software builds and releases, which it allows client, conduct orderly maintenance activity. Furthermore, during starting of the software development, client is forced to involve in the system development, which can enhance the quality of the system.

The disadvantage of the spiral model is the project's success or not highly dependent on the risk analysis phase. Unfortunately, conducting the risk analysis required specific expertise to perform. Beside, hiring specific expertise to perform risk analysis can be very costly for the developer company.

3.2 The selected software development model

There are many kinds of software development model available, for example V-model, incremental model, agile model, iterative model and etc. The reason I only review for waterfall model, prototype model and spiral model because they seems like applicable for the project I going to developer. At the last, the software development model for this project is the prototype model.

The prototype model is more suitable for the project, after my consideration. Since my project is, "Voice-based data entry through Android Phone". The voice based data entry could be very broad scope and it also can be different kind of language, due to the time constraints, abilities, knowledge I have, it is impossible for me to develop a complete system. Therefore a prototype system will first to be developed, and it limit the system scope for only English language, and some food ingredient like sugar, salt, egg and onion. With the limited scope, it is easier for me to test and evaluate the system.

The spiral model is not suitable due to it is a costly model. The spiral model needs to perform the risk analysis only can develop a prototype. Unfortunately to perform risk analysis required specific expertise, which can be costly. Due to I am still a student, the price is not affordable, besides this is only for the Final Year Project purpose, it is difficult to pursue to some related IT company to sponsor me for the project.

The waterfall model is the far more economical if compare to the spiral model and it doing the project a phase after a phase seems like systematically, but it is not suitable for the project which is complex and object-oriented projects. This project basically is a highly interacted with the end users, therefore it require lot of feedback and revision.

Besides, the waterfall model is hardly to go back to previous phases to do correction. Due to those reason, waterfall model is not suitable.

Finally, after the consideration of the complexity and the budget of the project, the software development model will be used for this project is prototype model.

3.3 Software and hardware Involved

3.3.1 Software

3.3.1.1 Eclipse compiler software & Android Software Development Kit (SDK)

Both of the software will be used for developing the application. The Android SDK will provide developer the API libraries and developer tools necessary to build, test and debug applications for Android and then the Android SDK will patched onto the Eclipse compiler, then the developer can start do coding. We can download the software at http://developer.android.com/sdk/index.html for free. The SDK Android developer tools it includes everything a developer need to begin developing applications which are the Eclipse and ADT plug-in, Android SDK tools, Android Platform-tools, the latest Android Platform and the latest Android system image for the emulator.

3.3.2 Hardware

3.3.2.1 Computer

This computer can be any operating system; its purpose is to let the developer to install the Eclipse Compiler and Android Software Development Kit.

3.3.2.2 Android operating system Smartphone

We going to use the Android Smartphone built-in's microphone to recognize user voice as an input. Although the Android SDK provides the emulator for developer to perform debugging, unfortunately that emulator does not support the voice recognition. Therefore, developer is forced to test and debug the application by using the Android Smartphone.

3.3.2.3 USB Cable

This USB cable is used to connect the Android Smartphone to the computer, so that we can perform the testing and debugging work.

3.4 System/User requirement specification

3.4.1 User requirement

User requirement is a document usually used in software engineering that specifies the requirements the user expects from software to be constructed in a software project. The user requirement of the project voice based data entry through Android Phone shown at the table below:

- The microphone shall be able to receive the sound information from user
- The user shall be able to see result if the data entry found in the predefined database
- The user shall be prompt an error message if the data entry did not found in the predefined database
- The user shall be able perform various voice command.
- The user shall be able to delete the ingredient and to buy list from the android application file.

3.4.2 System requirement

System requirement is a structured document setting out detailed description of the system's function, services and operational constraints. What it defined should be implemented in the system. The system requirement of the project voice base data entry through Android Phone shown at the table below:

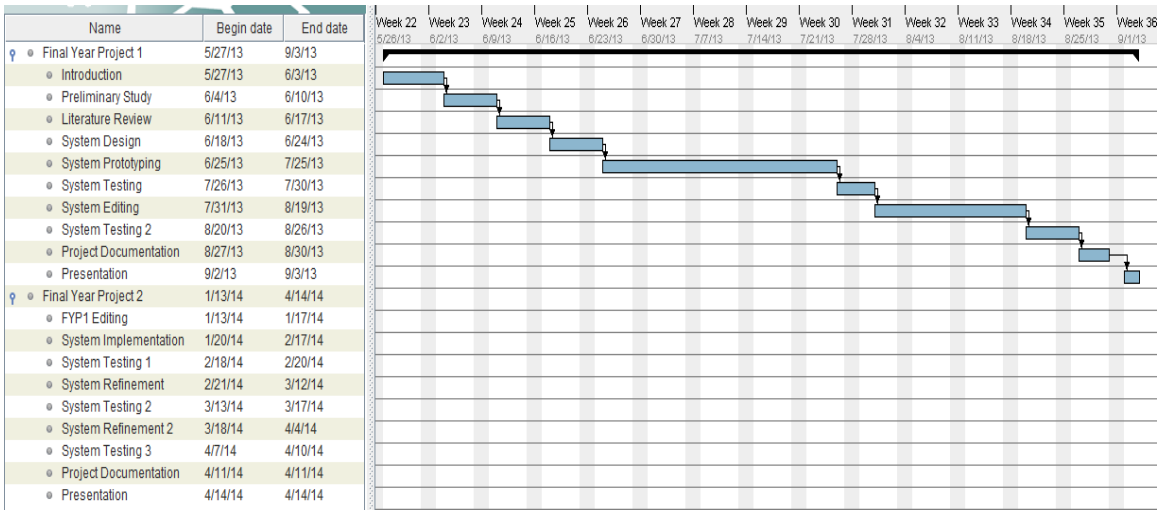
- The system shall be able to receive the sound information from microphone as data entry
- The voice recognition system shall be able to process the data entry from microphone
- The system shall be able to use the data entry from user to search for particular key words in the predefined database
- The system shall be able to display the result if the data entry from user found in the predefined database
- The system shall be able to prompt the user an error message if the data entry from user did not found in the predefined database.
- The system shall be able to save and read the ingredient and to buy list from the android application file.

3.5 Implementation Issues and Challenges

During the implementation of the project, there were some issues and challenges which delaying the project development process. Since this is a one person project, that's why only one person involved in this project. The critical and tough period comes during the process of development, due to there is no one can be discuss with, many problem and issues spend a lot of time only able to solve it. Moreover, due to the lack of familiarity of make use Google Android voice recognition API, the parallel process of learning while developing cause the longer time to finish the development process.

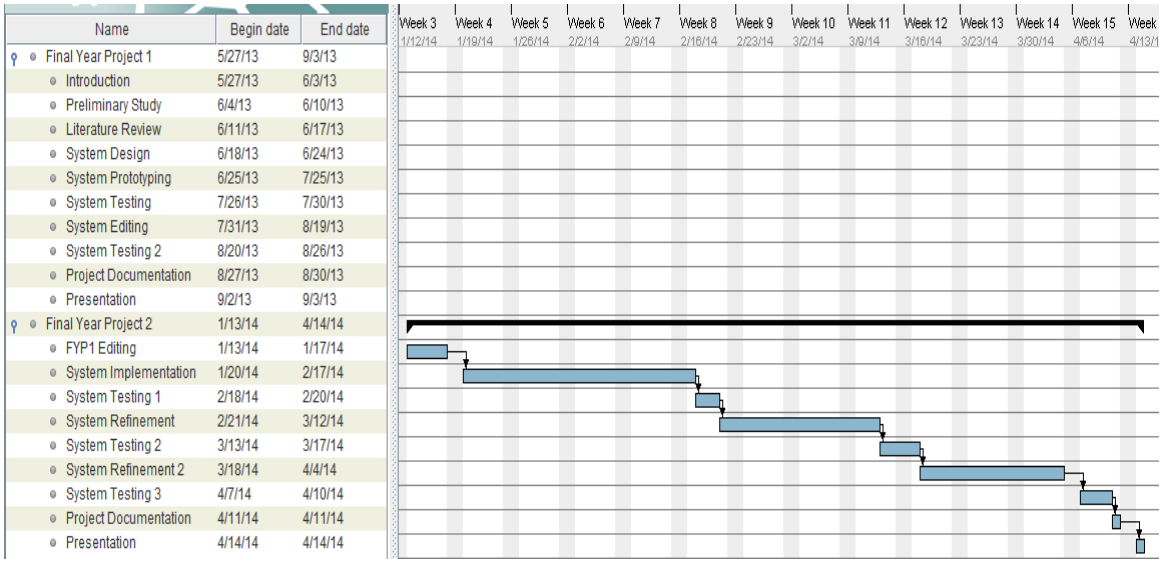
3.6 Project Milestone

Figure 3.1 Milestones and Gantt Charts 1



Name	Begin date	End date
Final Year Project 1	5/27/13	9/3/13
Introduction	5/27/13	6/3/13
Preliminary Study	6/4/13	6/10/13
Literature Review	6/11/13	6/17/13
System Design	6/18/13	6/24/13
System Prototyping	6/25/13	7/25/13
System Testing	7/26/13	7/30/13
System Editing	7/31/13	8/19/13
System Testing 2	8/20/13	8/26/13
Project Documentation	8/27/13	8/30/13
Presentation	9/2/13	9/3/13
Final Year Project 2	1/13/14	4/14/14
FYP1 Editing	1/13/14	1/17/14
System Implementation	1/20/14	2/17/14
System Testing 1	2/18/14	2/20/14
System Refinement	2/21/14	3/12/14
System Testing 2	3/13/14	3/17/14
System Refinement 2	3/18/14	4/4/14
System Testing 3	4/7/14	4/10/14
Project Documentation	4/11/14	4/11/14
Presentation	4/14/14	4/14/14

Figure 3.2 Milestones and Gantt Charts 2



Name	Begin date	End date
Final Year Project 1	5/27/13	9/3/13
Introduction	5/27/13	6/3/13
Preliminary Study	6/4/13	6/10/13
Literature Review	6/11/13	6/17/13
System Design	6/18/13	6/24/13
System Prototyping	6/25/13	7/25/13
System Testing	7/26/13	7/30/13
System Editing	7/31/13	8/19/13
System Testing 2	8/20/13	8/26/13
Project Documentation	8/27/13	8/30/13
Presentation	9/2/13	9/3/13
Final Year Project 2	1/13/14	4/14/14
FYP1 Editing	1/13/14	1/17/14
System Implementation	1/20/14	2/17/14
System Testing 1	2/18/14	2/20/14
System Refinement	2/21/14	3/12/14
System Testing 2	3/13/14	3/17/14
System Refinement 2	3/18/14	4/4/14
System Testing 3	4/7/14	4/10/14
Project Documentation	4/11/14	4/11/14
Presentation	4/14/14	4/14/14

3.7 Budget

Table 3.3 Budget Allocation

Item	Final Year Project	Commercial
Android Phone	Self owned	RM700-RM800
Computer	Self owned	--
Publish	--	25$ USD (RM 80)
Voice Recognition API	Open Source	--

According to the Table 3.1, basically there is need no budget going to allocate to this final year project, since the Android Phone used to do software testing and debugging are the smart phone that which is myself currently using, no need to spend money to get a new Android phone. Besides, the computer which currently I am using is enough for doing code and compile for this project. For addition, the voice recognition system engine that I used for this project is Google Android voice recognition API which is an open source toolkit for speech recognition. It can be downloaded from the website https://gitorious.org/freebroid/development/source/62e92d7a2a3fd2798901ec2e7c452ff0e4067163:samples/ApiDemos/src/com/example/android/apis/app/VoiceRecognition.java Coming to the commercialize, there will be need a Android smart phone which need a updated version of Android Operating System (Jelly Bean) to support the offline voice recognition, it cost around RM700 – RM800. Besides, there will going to need a Google account which it cost 25$ US Dollar it approximate to RM80 for that. As conclusion, the budget needed to be allocated is at the range of RM780 – RM880 for this project.

CHAPTER 4

SYSTEM DESIGN

4.1 System Architecture

System architecture is the conceptual model that defines the structure, behavior and more on the views of a system. It could comprise system components. It also provide the external visibile properties of those components and the relationship between them. Besides, system architecture give a plan from that products can be procured, system developed that will work together to implement the overall system.

Figure 4.1 Voice recognition system architecture

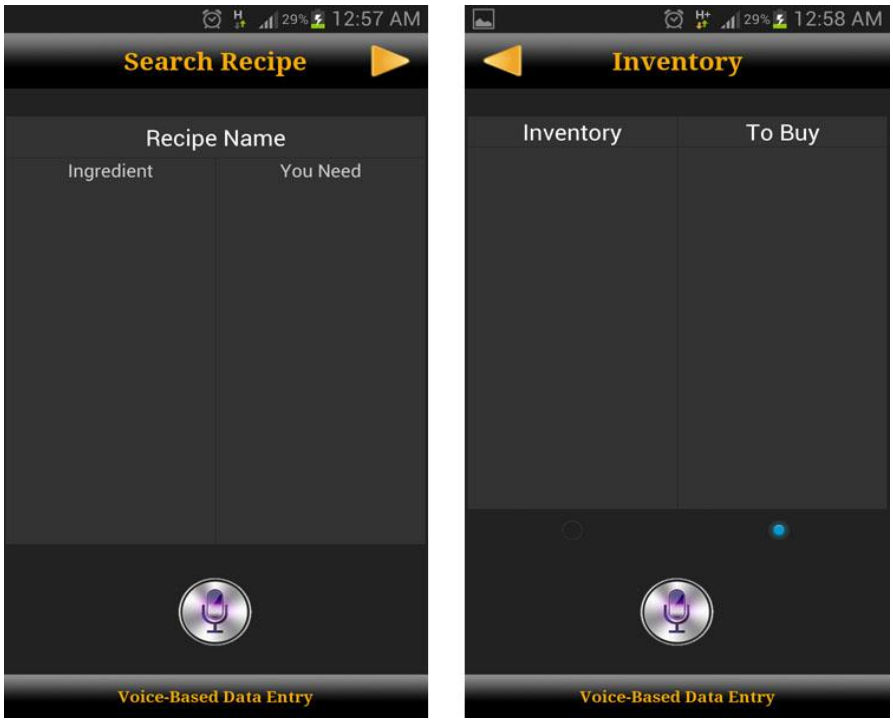
Basically, when Android phone users use the application, the user needs to push a virtual button on the Android phone screen to perform the data entry. The length of the voice data is not limited; this will provide the user a better using experience.

The voice data entry will send to the offline Google Speech-To-Text (Voice Recognition Engine) to be process. After the voice data being processed by the voice recognition engine, there will be a result of whether the voice data entry able being recognized by the system or not. If the voice data can be recognized by the system, then system will prompt the user the system most confident recognize result, once the user confirm with the recognize result, eventually the system will proceed to search in the predefined database see if it exists in the database or not or performing some specific command. If it is exist, a result will be displayed on the user Android phone screen or some specific action will be performed. If it did not exist, an error message will be prompt to user.

The predefined database consist of two type of storage, they are file storage and the binary 2 dimensional String array. The 2 dimensional String array is used to store the recipe name and all the ingredient needed to cook them, while the file storage consist of 4 file, they are ingredient, ingredient's quantity, to buy list and to buy list's quantity. These 4 files used to store ingredient that left in user's inventory and to buy list is for user to store the ingredient that wanted to buy.

4.2 Interface design

Figure 4.2 System interface



The figure 4.2 shows the interface of the application in the Android phone. For both page, the label with the text “Search Recipe” and “Inventory” is the header of the application, while footer is the label which with the text “Voice-Based Data Entry”. In the header, there is a direction arrow appeared at both page, their function is when user pressed them, the application will navigate to the other page. Which means when user pressed the direction arrow from the “Search Recipe”, the user will be navigated to the “Inventory” page.

The both image button doing the same function, which when user pressed the image button, the voice recognition will be triggered. User can then start to perform the voice-based data entry. In the “Search Recipe” page, there is a label with text “Recipe Name”, that is the place for the system to display the searching recipe name, and the recipe’s ingredient will be displayed at the column right below of it with the text labeled “ingredient”. For the column beside the “ingredient”, is used to display that, what ingredient the user still need only he can cook that food.

At the “Inventory” page, there is 2 radio buttons. It is used to indicate which column is choosing between “inventory” and “toBuy”. Different column will having the different function and action command. The “inventory” column is used to display the ingredient that the user remained while the “toBuy” is used to display the thing that user want to buy.

4.3 System Flow Diagram

Figure 4.3 System Flowchart

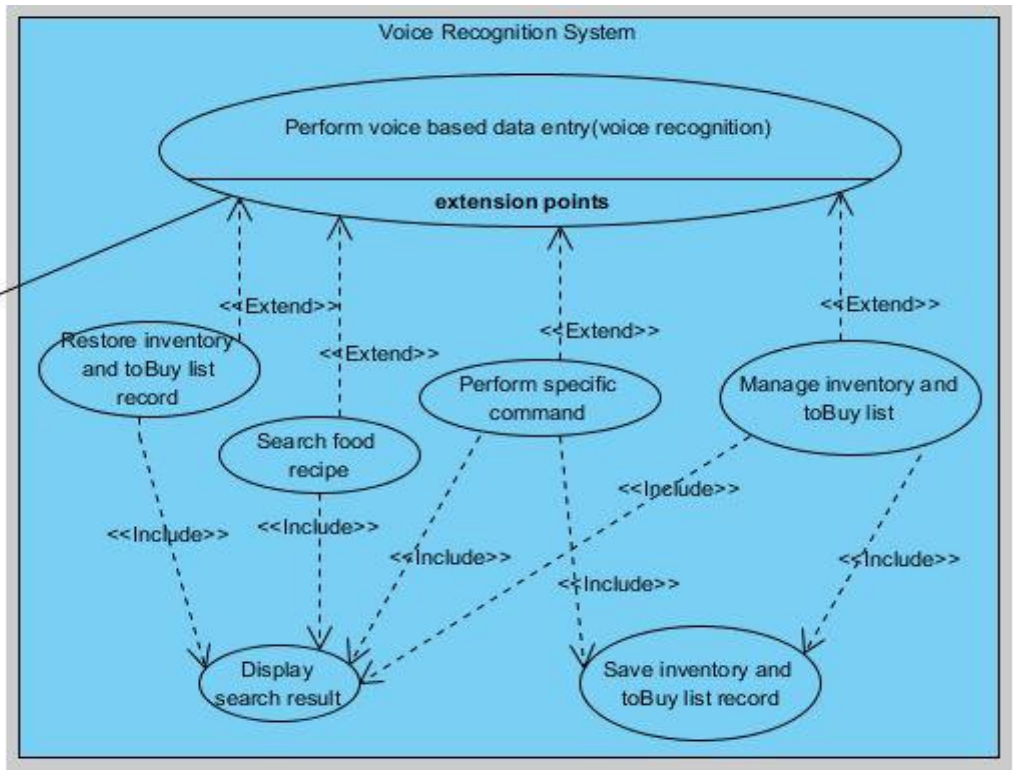
The figure 4.3 shows the system flow, which when start of the system, user got 2 choices, which are to stay on the current page ("Search Recipe Page") or go to the next page ("Inventory Page"). However, user also can navigate from the "Inventory Page" to "Search Recipe Page". Both pages also provide user the voice recognition function, when user pressed the virtual button, then it will trigger the voice recognition function. User can then speak out their voice data input; the system will start process the voice data after a second of the silent interval. If the voice recognition system unable to recognize what user spoke, it will prompt user an error message with either cancel the voice recognition or retry, if the voice recognition system able to recognize what the user spoke, it will prompt user a cancelable confirmation dialog with 3 seconds of countdown timer and the most confident recognized result, if the result provided by the voice recognition system is the user desired input data, he can just ignore the dialog box, because after 3 second it will proceed with the result. However, if the result is not the user desired input data, user may cancel the confirmation dialog and try again.

Whenever the user confirms with the result, the system will then continue to search in the predefined database, if the input data matches with the item in the predefined database, then the system will print out the result to the user or perform specific action according to the input data. If the input data do not matches with the item in the predefined database, it will prompt user an error message and return back to starting page and user may try again.

Basically, both pages also provide the similar function, which is the voice recognition function, the different between these both pages, is actually they will accept different action command and doing different task.

4.4 Unified modeling language (UML)

Figure 4.4 Use case of voice recognition system



The figure 4.4 shows the use case of the system. There is only a main function a user can perform, which is the voice based data entry (voice recognition). However, it consists of 4 optional functions, there are "restore inventory and toBuy list record", search food recipe, perform specific command and manage inventory and toBuy list. After performed any one of the 4 optional functions, a display result functions will be called. Save inventory and toBuy list function will be performed after the both optional functions perform specific command or manage inventory and toBuy list is performed.

4.5 Concluding Remark

This chapter started with the system architecture, it briefly explained how the system overall work like, which the system using the Google Offline voice recognition, system used 2 dimensional array to store the food recipe and file storage to permanently store the inventory ingredient and "toBuy" list item and etc.

Followed up by showing the interface of the application, which at the "Search Recipe" page consist of 2 labels for header and footer, a virtual button, and 3 text views for displaying the recipe name, recipe ingredient and "youNeed" list. For the "Inventory" page, it consists of 2 labels for header and footer as well, 2 ratio buttons for "inventory" column and "toBuy" column, a virtual button and 2 text views for displaying the item in the "Inventory" column and "toBuy" column. Then a system flow chart and a UML diagram will be used for detailed explain how the system works, and what functions the system consist of.

CHAPTER 5

SYSTEM IMPLEMENTATION

5.1 Software setup

There are two ways to setup for this application. The first way is for the developer who uses their Android smart phone to debug the application, in one condition which is the Android smart phone must enable the phone debug mode. When developer chooses to runs the Android project from the Eclipse compiler, the compiler will automatically install the application into the developer smart phone.

The second way is to install the application by using the Android project .apk file. The .apk extension is the Android application setup's extension; developer can get it from the Android project (Android project name/bin). After acquired the .apk setup file from the Android project file, developer can all the ways to transfer the setup file from the computer to the smart phone. Before the installation, developer needs to check the smart phone security option, which they need to allow the smart phone to install application from sources other than the Play Store. After this step, developer is free to install the application into the Android smart phone.

5.2 Setting and Configuration

After the installed the application into the smart phone, there are few steps that user need to configure only that the application work as it expected. First of all, user must ensure that their Android smart phone operating system version is up to date or at least at the version of Jelly Bean 4.1, because start from the Jelly Bean 4.1 version, supporting the Google offline voice recognition. User can update their Android smart phone operating system version with following steps, "setting –> about device -> software update -> update".

Figure 5.1 Steps for enabling offline voice recognition 1

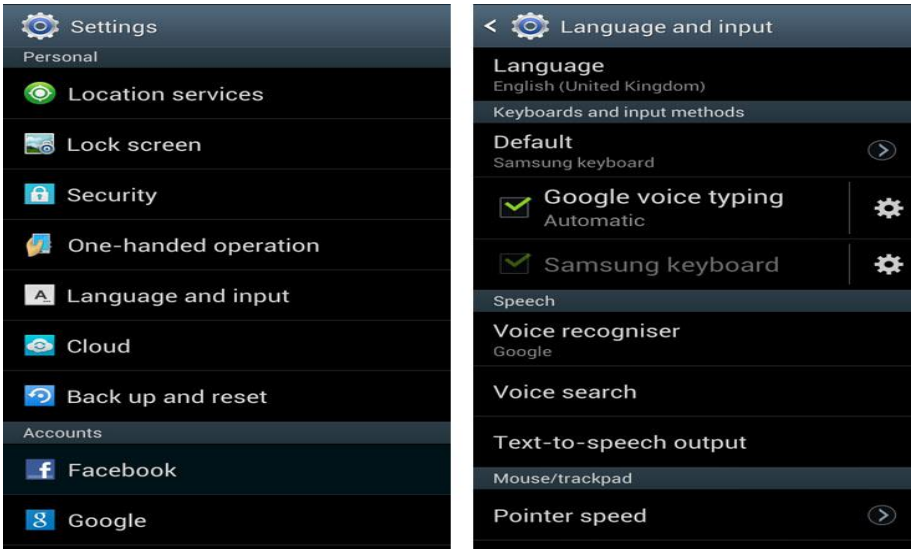


Figure 5.2 Steps for enabling offline voice recognition 2

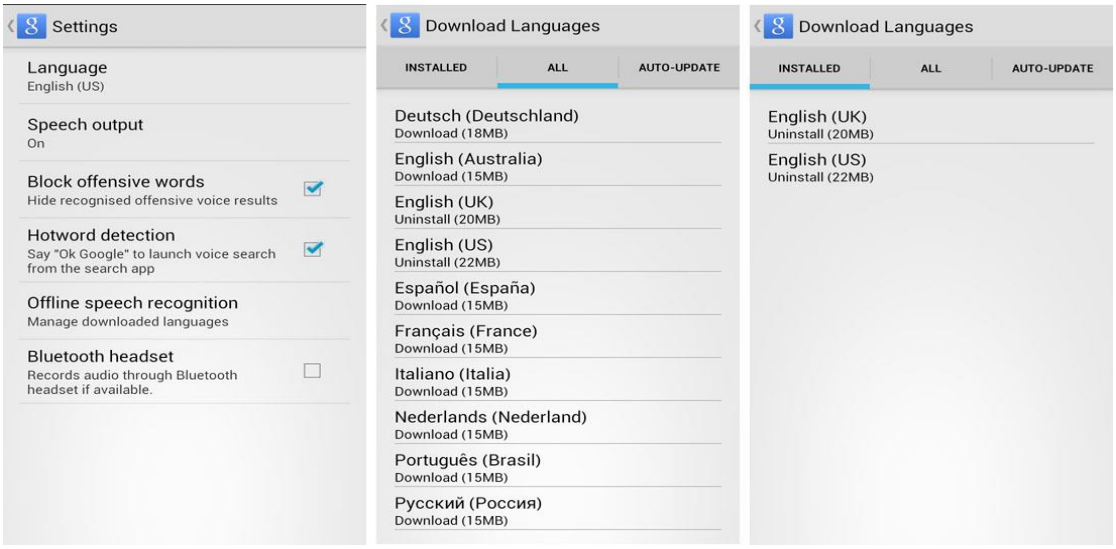
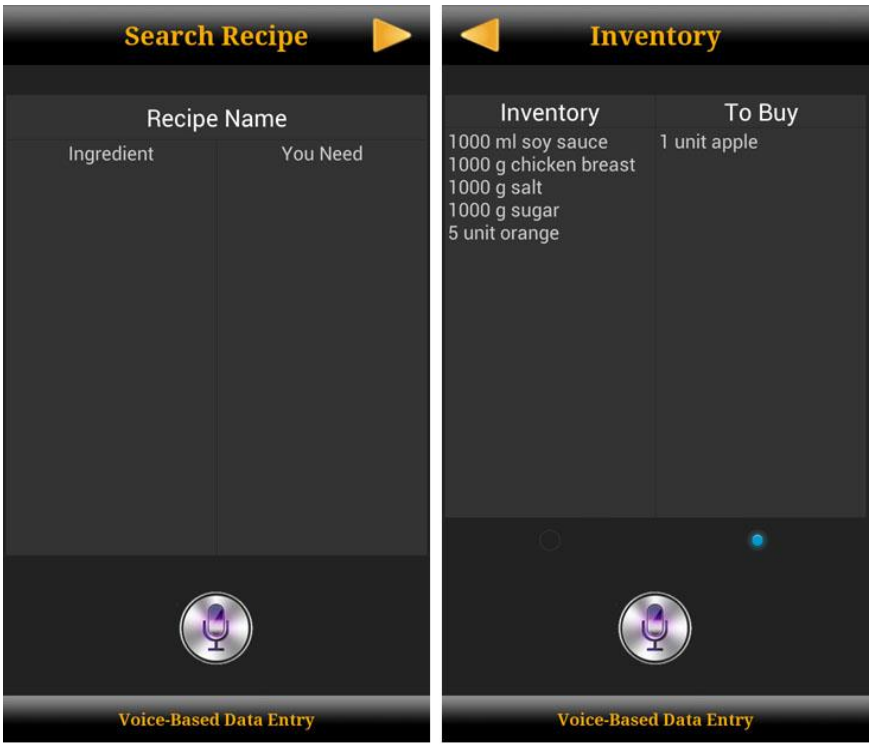


Figure 5.1 and 5.2 is showing the steps for enabling offline voice recognition. Once the user's Android phone operating system is Jelly Bean 4.1 or latest, then user can start the configuration, by go to the phone setting then search for the "Language and input" option. There will be an option of "Voice search", tap on it then user will see an option of "Offline speech recognition". User able to download various kind of language pack after tap on the "Offline speech recognition", however the application only support for the English language. After finish downloads the English language pack, the application is ready to use.

5.3 Modules implementation

Figure 5.3 Start up page of application



After done all the setting and configuration, the application is ready to use. Figure 5.3 is showing the start up page of the application. The "search recipe" page is for the user to search for the recipe and the "Inventory" page is for the user to check what ingredient they still left in their inventory and what they are planning to buy. After the installation, the application consist of few food recipe for user to search, some ingredient left and ingredient in the "toBuy" list, all of these data is purposely created for demonstration.

Figure 5.4 Application in use I

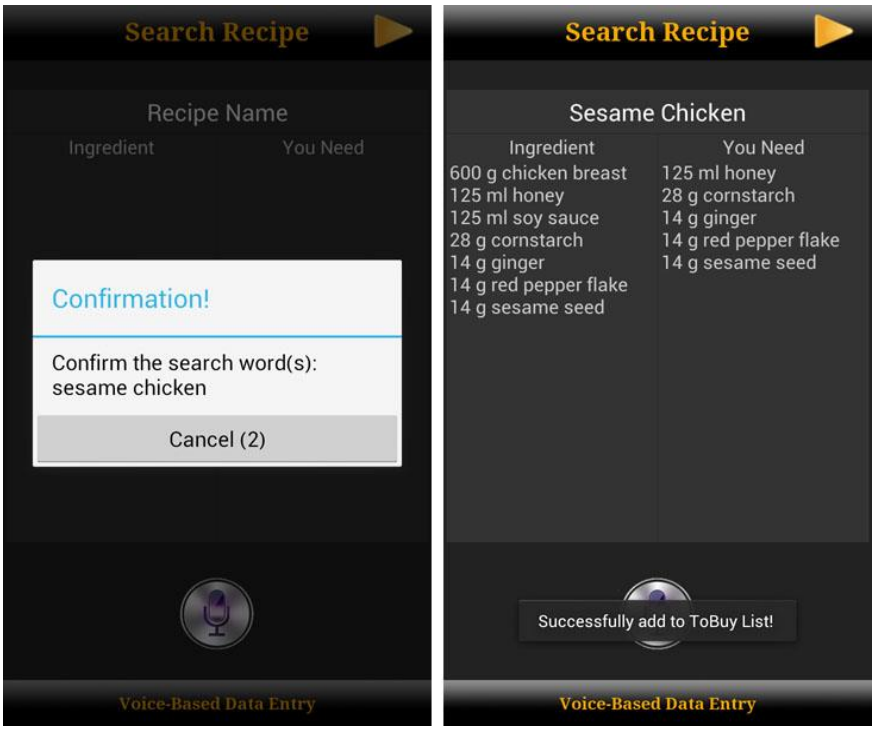


Figure 5.4 showing the application in use part 1. When the user pressed the virtual button (with microphone icon), user is allowed to speak something to let the application to recognize. Once the application recognized what user spoke, then it will prompt user with the most confident result to the user in the alert dialog box. The alert dialog box consist a button with a countdown timer. User is given 3 seconds to press the cancel button to cancel the searching, or after 3 seconds the application will continue and proceed to the searching process with the recognized result. If the recognized result found the recipe in the predefined database, it will display all the appropriate information on the corresponding field.

There are some special commands for this “search recipe” page. For example, “buy”,”next”,”inventory” and “exit”. The “buy” command, it is used to add the entire ingredient from “You Need” list to “toBuy” list. The “next” and “inventory” performing the same function, which is to navigate to “inventory” page while the “exit” is to exit application.

Figure 5.5 Application in use II

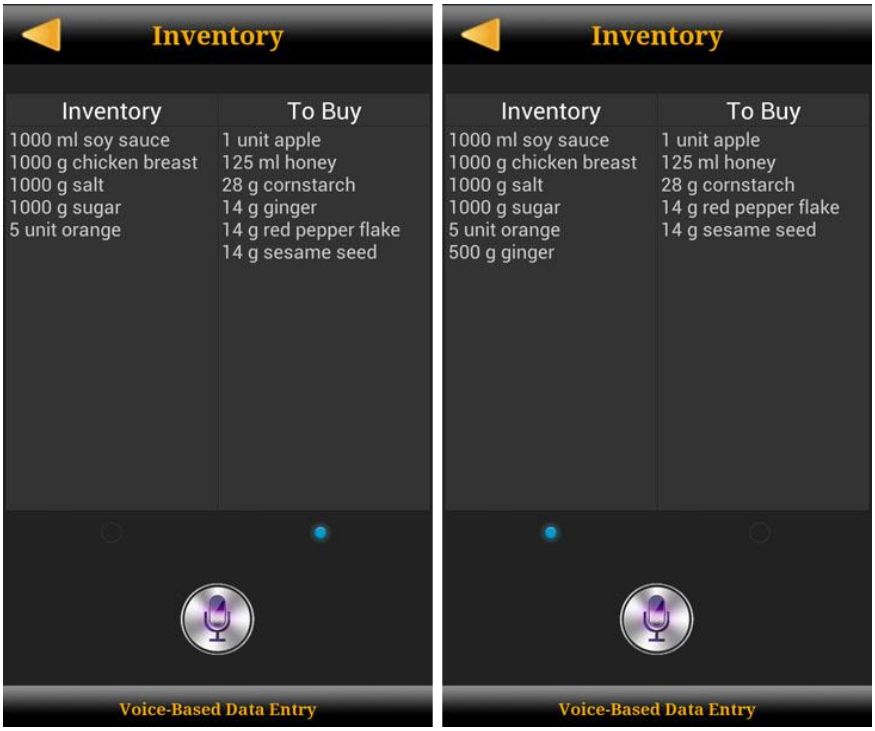


Figure 5.5 showing the application in use part 2. After a user used the “buy” command at the “search recipe” page, entire ingredient from the “You Need” list then will added into the “toBuy” list. In this “Inventory” page, there is 2 radio buttons. The

left radio button indicates the “Inventory” column and the right radio button indicates the “toBuy” column. Both of the columns basically are taking the same special command except the “transfer” command is accepted by the “toBuy” column.

Figure 5.6 Application in use III

Figure 5.6 showing the application in use part 3. User can choose to use the “transfer” command to transfer the entire ingredient from the “toBuy” column to the “inventory” column or just press the virtual button and speak “500 g ginger” then the system will then transfer only the ginger to the “inventory” and the ginger from the “toBuy” column will disappeared. There is syntax for the voice data input, user must

speak out the quantity, followed by the quantifier and the last is the ingredient name. In order to let system able to recognize what user is trying to do, user must follow the syntax.

Figure 5.7 Application in use IV

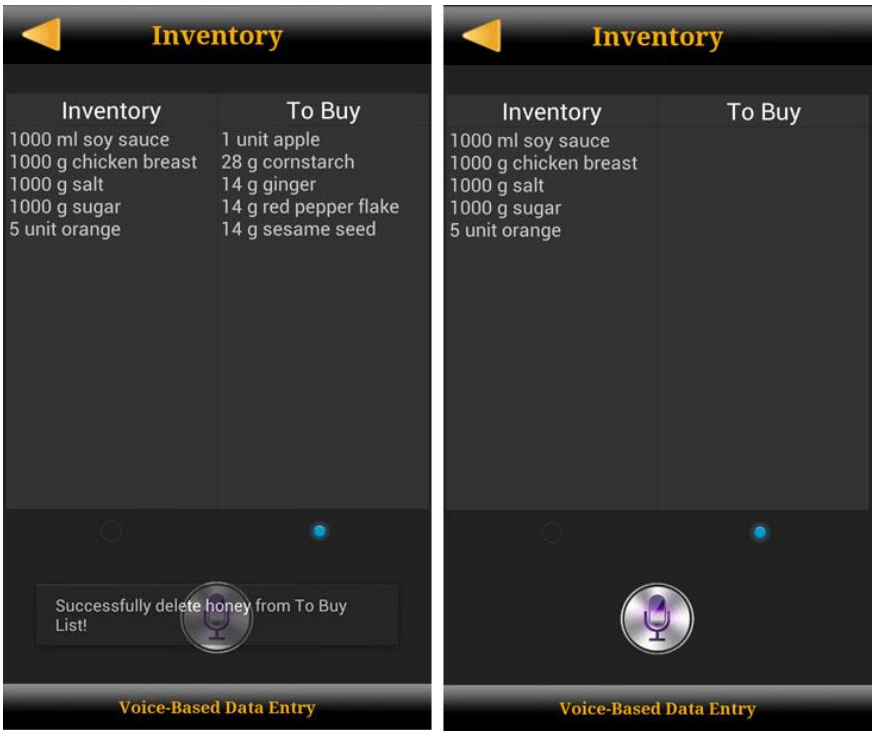


Figure 5.7 showing the application in use part 4. User can use the “delete” command to remove single ingredient from the “inventory” or “toBuy”. For example, if the user speaks “delete honey”, then the system will delete honey from the “toBuy” column and will prompt user a message. There is also syntax for the “delete” command, which is user must first to speak delete, follow up by the ingredient name (“delete honey”). Rather than remove ingredient one by one, user can remove the entire column

with the “clear” command. The “delete” and “clear” command make user easier to manage their “inventory” and “toBuy” column. However, user must use these 2 commands carefully, because those deleted ingredient, will permanently deleted from the application. Other than all the commands explained at above, the “inventory” page also able to receive the command like “back”, “previous” and “exit”.

5.4 Concluding remark

This chapter is more like a user manual. It tells the user where can get the .apk files and how to install this application. Before the application is ready to use, user Android smart phone operating system need to be at least is Jelly Bean 4.1 version or latest. After configuring their Android smart phone to support the offline voice recognition, the application is ready for use. The application can perform many kinds of functions, for example like, search recipe, add ingredient in “You need” list to “toBuy” list, manage the both “inventory” column and “toBuy” column in the “Inventory” page and etc. Besides, the application also able to receive the command like “next”, “previous”, “home” and “inventory” to let user navigate among the “search recipe” page and “Inventory” page.

CHAPTER 6

SYSTEM EVALUATION AND DISCUSSION

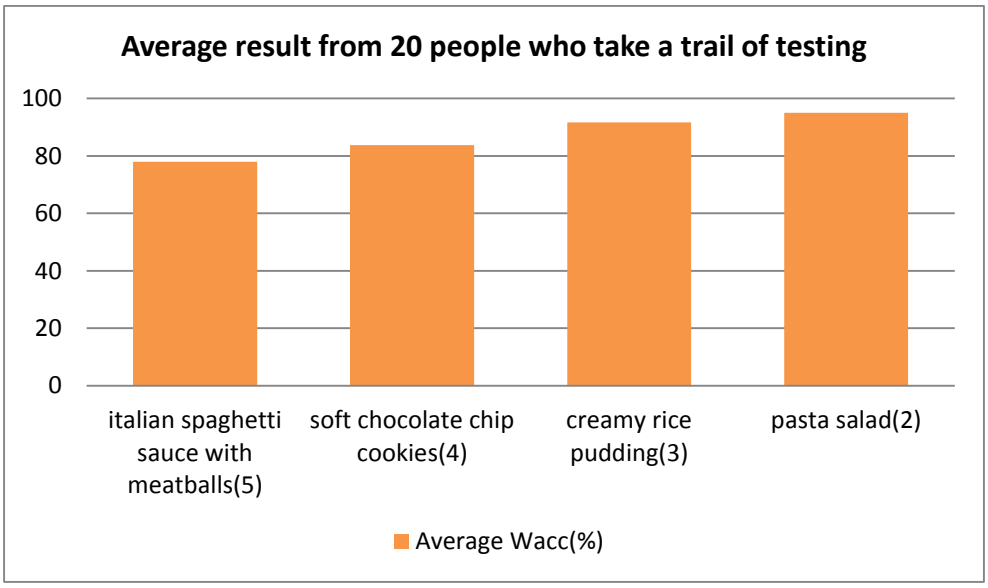
6.1 Performance Metrics

The performance metrics for voice recognition commonly is word error rate (WER). It is derived from the Levenshtein distance, which is working at the word level instead of phoneme level. The general difficulty of measure voice recognition performance lies in the recognized word sequences could have different length from the reference word. Voice recognition word error rate (WER) is a good tool for comparing different system and for evaluating improvements with a system. However, when evaluating performance of a voice recognition system, the word accuracy (WAcc) is used instead of word error rate (WER).

$$WAcc = 1 - WER = \frac{N - S - D - I}{N}$$

- S for the number of substitutions,
- D for the number of deletions,
- I for the number of insertions,
- N for the number of words in the reference.

Figure 6.1 Average word accuracy results



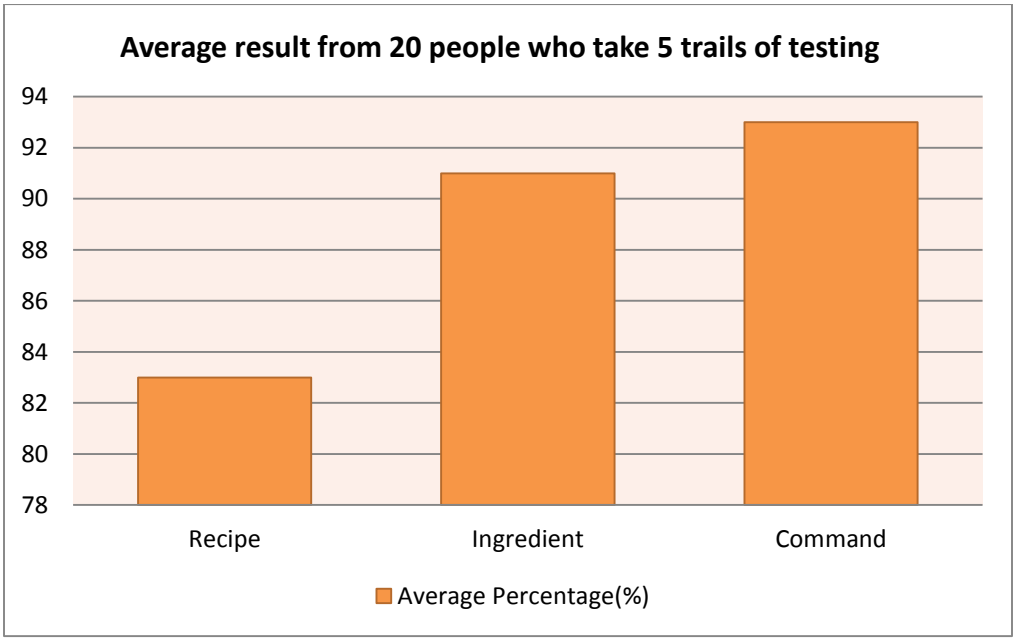
There are 20 people selected randomly to perform this voice recognition system performance measurement. They are given 4 set of food recipe which different length, which are from total length of 5 to 2. The trail process start from a people, speak out the 5 words' food recipe "Italian spaghetti sauce with meatballs", then is the 4 words' food recipe "soft chocolate chip cookies" and so on. Each time they finish a set of food recipe, the recognize result will be marked down, and the final result will be calculated.

Figure 6.1 showing the Average word accuracy result from 20 people who take a trail of testing. There is very obvious that, as the total number of word increased, the accuracy will drop. That is the reason why the "Italian spaghetti sauce with meatballs" having the average word accuracy less than 80% while the "pasta salad" having the average of 95%. Besides that, during the conduct of testing, there is another significant

phenomenon which is the voice recognition system take longer time while trying to recognize the 5 words' food recipe. Fortunately, this project application mainly having the 2 – 3 words of food recipe, therefore, the accuracy and the recognizing time can be guaranteed.

6.2 Performance Setup and Result

Figure 6.2 Average accuracy results



There is a testing conduct regarding to the main phrases of this project application. The testing data set is just as same as the Appendix. Figure 6.2 showing that average accuracy results from 20 people who take 5 trails of testing on 3 different areas, which

are recipe, ingredient and command. Having the highest average accuracy 93% is at the command area, basically the voice recognition able to recognize what the 20 participant speak, except the word “delete”.

The ingredient area having the 91%, the 9% missed accuracy basically fall on the word which needs to pronounce precisely, for example, egg. For some time, the recognized result is, eight. However, some of the participant repeat to try the word, “egg” few times, the voice recognition system still able to recognize the correct result.

There is only 83% average accuracy for the food recipe area; the main reason is those 20 participants choose the 3 words’ food recipe, which may cause the accuracy decrease. However, for those 2 words’ food recipe, the voice recognition system able provides the correct result to the participant.

6.3 Objective Evaluation

There are 3 objectives for this project. Firstly, is to create a speech recognition program to recognize user voice as an input and it is achieved. This project has successfully implemented the Google Voice Recognition API, with the only one virtual button, when user pressed on it then they can perform the voice recognition and use the recognized result to search through the predefined database or perform some specific action.

Secondly, is to apply offline speech recognition. This objective achieved as well. Originally, the Google Voice Recognition API was worked under online circumstance,

however operating system version Jelly Bean 4.1, it support offline voice recognition. The offline voice recognition work like the online voice recognition, no limitation on the total number of words to be recognize by the voice recognition engine, however as the number of words increase, the accuracy will be decreased.

Lastly, to ensure performance of the program, a pop-up confirmation dialog box has been implemented. This objective achieved also. The function of the confirmation dialog box is to reduce the unnecessary of process of undesired voice input data. For example, if user want to search for "egg roll" recipe, the voice recognition sometime might recognized it as "eight roll", then the confirmation dialog box is for the user cancel the searching with the recognized result. It surely will help user in the searching or input data.

6.4 Deployment Challenge

During the process of deployment, there are few challenges. Firstly, the quantifier of the ingredient for a recipe, sometime the ingredient of a recipe uses quantifier like, tablespoon, cup, ounces, pounds and etc. Non-standardized unit of measurement will bring difficulty to user on calculate the exactly amount they need. This problem has been solved by using the method of equivalent. For example, 1 ounce is equal to 29.57 grams and 1 pound equal 453.6 grams. However, "unit" will use to quantify those ingredient that without quantifier, for example 1 unit apple and 1 unit onion.

Secondly deployment challenge is pronunciation of the word "unit" that used to quantify those ingredient that without quantifier. During the testing, the voice recognition

engine usually recognizes the “unit” as “unique” or “uni”. This problem is unable to solve, however there is an alternative solution for this problem, since it is pronunciation problem, user is recommended to learn the exact pronunciation for this word. A testing has been conduct that, voice recognition engine is able recognize the “unit” word correctly after user learnt how to pronounce the “unit” word.

The last deployment challenge is, version of the Google Search will affect the Google voice recognition engine. Since this project is using the Google voice recognition API, any update of the Google Search will directly affect this project. However, sometime this project application will gain the advantages from the update of the Google Search, and sometime it will cause this project application work like not expected. This problem is out of the developer control; however, developer is encouraged to always check if there is release of the Google Search new version and update the version of the project application to ensure the application is work as expected.

6.5 Concluding Remark

After conducted testing at indoor and the result showing that the offline voice recognition system is able provide at least 83% of the accuracy. When the total number of words reduces, the accuracy can be increased up to 93%. With the offline voice recognition system and the pop-up confirmation dialog box, the project application’s performance is enhanced to a certain level, which will be lesser user undesired recognized result being processed.

CHAPTER 7

CONCLUSION

7.1 Conclusion

The voice recognition is bringing the convenience to the public, to make public have the chance to experience this awesome technology and gain the advantages from it; the "Voice-based data entry through Android phone" project is created. This project is using the Google Offline Voice Recognition and produced in the form of a mobile devices application.

Voice-based data entry always can be performed faster than entering data by a keyboard. In some critical moment, for example like someone is driving and he urgently wants to send a message, a voice-based data entry will help them finish the task without let their hand leave the steering, as we know that is very dangerous when typing a message when driving. Furthermore, the user friendly application interface, enable the user learn to how use the application easily, just a simply press on the virtual button, then voice recognition engine is triggered, and then user can perform any action they want. The process is just simple and easy.

Nowadays almost everyone occupied a smart phone, the idea of make use of the current devices to serve as an e-memo and to manage their home inventory is great. User

can get the benefit without spending extra money. I believe that, this project will benefit users and able to assist them in their busy daily life.

7.2 Recommendation

This project is using the Google voice recognition API or what it so called Google Search. Whenever Google developed a newer version of the Google Search application, this project main function which is the voice recognition will be affected as well. Therefore, to ensure this project work like it expected, developer should always check if there is a newer version of Google Search is available, it is important that for developer to check whether his current application is compatible with the newer version of Google Search or not. However, sometime the project may gain advantages from the Google Search up date. For example, a previous version of 3.2.17 updated to the latest version 3.3.11 which just released on 14 March 2014, it provides function "Personalized Recognition", which is a function that knowing a user said in the past allows Google Search build a specialized models that match user voice and words. At the end, the accuracy of the voice recognition will be improved according for the user. Besides, the offline speech recognition language package might also affect the voice recognition result, developer also need to take care with it as well. Therefore, developer is recommended to restrict the user to update both of the Google Search application and the offline speech recognition language package to avoid incompatible of the project application. However, developer also can revise the project application once there is an update of the Google Search to ensure the project application is work as expected.

In term of enhancement, there are few things recommended to developer. Firstly, Malaysia full of delicious food, if developer can include some Malaysia local food recipe for example “Nasi Lemak” or other Bahasa Malaysia terms, it will provide a better user experience. Unfortunately the Google offline voice recognition currently does not support Bahasa Malaysia, developer is recommended to pay attention latest news on the update of the offline speech recognition language package. Once there is available Bahasa Malaysia language package, developer should implement the Bahasa Malaysia into the project.

Secondly, to make the project application able to precisely measure the quantity of an ingredient that needed for certain food recipe, developer should use those commons quantifier in the field of food recipe. For example, cup, tablespoon, teaspoon and etc. Precisely measure the quantity of an ingredient needed is very important, as it will directly affect the taste of the food. Besides, developer should add a function that will calculate the quantifier such as cup, tablespoon, and teaspoon into ml, g, kg, or l. This will easier for the user when trying to purchase ingredient.

Lastly, since this project application purposely build for public, therefore developer must make this project application looks like more professional. Developer should include more special command that will helps user in daily life, to make this project application consist of competitive advantages compared to other available similar application. Besides, comes to the commercialize, this project application will uploaded to the Google Play Store, there will different Android smart phone or tablet user with different models and different screens resolution, developer must consider the resolutions issue and the different firmware from different manufacturer’s compatible issue.

BIBLIOGRAPHY

Tutorialspoint.com. 2013. *SDLC Waterfall Model*. [online] Available at: http://www.tutorialspoint.com/sdlc/sdlc_waterfall_model.htm [Accessed: 1 Aug 2013].

Istqbexamcertification.com. 2013. *What is Waterfall model- advantages, disadvantages and when to use it?*. [online] Available at: http://istqbexamcertification.com/what-is-waterfall-model-advantages-disadvantages-and-when-to-use-it/ [Accessed: 1 Aug 2013].

Tutorialspoint.com. 2013. *SDLC - Software Prototype Model*. [online] Available at: http://www.tutorialspoint.com/sdlc/sdlc_software_prototyping.htm [Accessed: 1 Aug 2013].

Istqbexamcertification.com. n.d.. *What is Prototype model- advantages, disadvantages and when to use it?*. [online] Available at: http://istqbexamcertification.com/what-is-prototype-model-advantages-disadvantages-and-when-to-use-it/ [Accessed: 1 Aug 2013].

Istqbexamcertification.com. n.d.. *What is Spiral model- advantages, disadvantages and when to use it?*. [online] Available at: http://istqbexamcertification.com/what-is-spiral-model-advantages-disadvantages-and-when-to-use-it/ [Accessed: 1 Aug 2013].

Tutorialspoint.com. 2013. *SDLC Spiral Model*. [online] Available at: http://www.tutorialspoint.com/sdlc/sdlc_spiral_model.htm [Accessed: 1 Aug 2013].

Harrer, J. 2012. *Apple SWOT*. [online] Available at: http://jimharrer.com/index.php/jim-harrer-ceo-blog/entry/ramblings/2012/03/01/apple-swot [Accessed: 4 Aug 2013].

Answers, U. 2011. *A Swot Analysis Of Google Android Computer Science Essay*. [online] Available at: http://www.ukessays.com/essays/computer-science/a-swot-analysis-of-google-android-computer-science-essay.php [Accessed: 3 Aug 2013].

Kumar, A. 2013. *Android SWOT Analysis*. [online] Available at: http://www.marketing91.com/android-swot-analysis/ [Accessed: 3 Aug 2013].

Parallelus. 2010. *Hylander's Android SWOT Analysis*. [online] Available at: http://hustedia.com/blog/2010/06/21/hylanders-android-swot-analysis/ [Accessed: 3 Aug 2013].

Zigu. 2013. *Apple iPhone | SWOT Analysis | BrandGuide | MBA Skool-Study.Learn.Share.*. [online] Available at: http://www.mbaskool.com/brandguide/mobile-handsets/446-apple-iphone.html [Accessed: 4 Aug 2013].

Beta.fool.com. 2012. *Understanding Apple – SWOT Analysis - AAPL, XOM, GOOG - Foolish Blogging Network*. [online] Available at: http://beta.fool.com/jaans/2012/11/27/understanding-apple-swot-analysis/17329/ [Accessed: 4 Aug 2013].

Jurevicius, B. 2013. *Microsoft SWOT analysis 2013 | Strategic Management Insight*. [online] Available at: http://www.strategicmanagementinsight.com/swot-analyses/microsoft-swot-analysis.html [Accessed: 5 Aug 2013].

RHerrmann. 2010. *The Microsoft Phone 7 - Microsoft's last stand in the Smartphone market: SWOT-Analysis*. [online] Available at: http://is620microsoft.blogspot.com/2010/04/swot-analysis.html [Accessed: 5 Aug 2013].

Barrena, S., Klotz, L., Landes, V., Page, A. and Sun, Y. n.d.. Designing Android Applications with both Online and Offline Voice Control of Household Devices. Available through: University Tunku Abdul Rahman Library <http://ieeexplore.ieee.org.libezp.utar.edu.my> [Accessed: 10th July 2013].

Developer.android.com. 2012. *Android SDK | Android Developers*. Available from: <http://developer.android.com/sdk/index.html>. [10 Jul 2013].

Meier, R. 2012. *Professional Android 4 Application Development*. Indianapolis: John Wiley & Sons.

Mysinchew.com. 2012. *Smartphone ownership, usage to reach critical mass in Malaysia: Nielsen | My Sinchew*. Available from: <http://www.mysinchew.com/node/73315>. [10 Jul 2013].

Samsung MY. 1995. *Galaxy Note*. Available from: <http://www.samsung.com/my/consumer/mobile-devices/galaxy-note/ >. [10 Jul 2013].

Stefanoviü, M., Ýetiü, N., Kovaþevic, M. and Jelena, J. 2012. Voice Control System with Advanced Recognition. Available through: University Tunku Abdul Rahman Library <http://ieeexplore.ieee.org.libezp.utar.edu.my> [Accessed: 10th July 2013].

Voice recognition system having articulated talk-back feature - Google Patents US 8209177. [ONLINE] Available at: http://www.google.com/patents/US8209177. [Accessed 10 July 2013].

Method and apparatus for effectively receiving voice input to a voice recognition system- *Google Patents US 5033088*. [ONLINE] Available at: http://www.google.com/patents/US5033088. [Accessed 10 July 2013].

Allrecipes.com. 2014. *Allrecipes - Recipes and cooking confidence for home cooks everywhere*. [online] Available at: http://allrecipes.com/ [Accessed: 3 Apr 2014].

Android Widget Center. 2013. *How to Use Offline Speech Recognition in Jelly Bean | AW Center*. [online] Available at: http://androidwidgetcenter.com/android-tips/how-to-use-offline-speech-recognition-in-jelly-bean/ [Accessed: 3 Apr 2014].

Wikipedia. 2014. *Word error rate*. [online] Available at: http://en.wikipedia.org/wiki/Word_error_rate [Accessed: 3 Apr 2014].

APPENDIX

Appendix A

FINAL YEAR PROJECT II BIWEEKLY REPORT

Trimester 3, Year 3	Study week no.: week 2
Student Name & ID: Fan Chee Khuen 100ACB6681	
Supervisor: Mr. Goh Hock Guan	
Project Title: Voice-based data entry through Android phone	

1. WORK DONE Revise back the FYP1, edit the content.
2. WORK TO BE DONE Make sure the voice recognition engine work
3. PROBLEMS ENCOUNTERED Since stopped a semester only continue FYP2, need to read back what I have done previously
4. SELF EVALUATION OF THE PROGRESS Feels like need rush for it

_____ _____

Supervisor's signature Student's signature

FINAL YEAR PROJECT II BIWEEKLY REPORT

Trimester 3, Year 3	Study week no.: week 4
Student Name & ID: Fan Chee Khuen 100ACB6681	
Supervisor: Mr. Goh Hock Guan	
Project Title: Voice-based data entry through Android phone	

1. WORK DONE Finish edit FYP1 according to the advise
2. WORK TO BE DONE Make sure the voice recognition engine work
3. PROBLEMS ENCOUNTERED Having problem on how to make use of the Google Voice Recognition API
4. SELF EVALUATION OF THE PROGRESS Need to done faster, this semester workload to heavy

_____ _____

Supervisor's signature Student's signature

FINAL YEAR PROJECT II BIWEEKLY REPORT

Trimester 3, Year 3	Study week no.: week 6
Student Name & ID: Fan Chee Khuen 100ACB6681	
Supervisor: Mr. Goh Hock Guan	
Project Title: Voice-based data entry through Android phone	

1. WORK DONE Successfully make the Google voice recognition work in the offline situation
2. WORK TO BE DONE -application interface -application's function
3. PROBLEMS ENCOUNTERED Need to learn how to create interface with Java code, but online providing less tutorial, mostly is using .XML
4. SELF EVALUATION OF THE PROGRESS Since the main function voice recognition working, hopefully can done the application within 2 weeks

_____ _____

Supervisor's signature Student's signature

FINAL YEAR PROJECT II BIWEEKLY REPORT

Trimester 3, Year 3	Study week no.: week 8
Student Name & ID: Fan Chee Khuen 100ACB6681	
Supervisor: Mr. Goh Hock Guan	
Project Title: Voice-based data entry through Android phone	

1. WORK DONE Most of the function for the application have done
2. WORK TO BE DONE -application interface
3. PROBLEMS ENCOUNTERED Need to learn how to create interface with Java code, but online providing less tutorial, mostly is using .XML
4. SELF EVALUATION OF THE PROGRESS Able to start do the documentation

_____ _____

Supervisor's signature Student's signature

FINAL YEAR PROJECT II BIWEEKLY REPORT

Trimester 3, Year 3	Study week no.: week 10
Student Name & ID: Fan Chee Khuen 100ACB6681	
Supervisor: Mr. Goh Hock Guan	
Project Title: Voice-based data entry through Android phone	

1. WORK DONE Application done
2. WORK TO BE DONE Documentation for the FYP2 -chapter 4, chapter 5, chapter 6, chapter 7
3. PROBLEMS ENCOUNTERED Not sure for the content for the documentation
4. SELF EVALUATION OF THE PROGRESS So far so good

_____ _____

Supervisor's signature Student's signature

FINAL YEAR PROJECT II BIWEEKLY REPORT

Trimester 3, Year 3	Study week no.: week 12
Student Name & ID: Fan Chee Khuen 100ACB6681	
Supervisor: Mr. Goh Hock Guan	
Project Title: Voice-based data entry through Android phone	

1. WORK DONE Documentation -chapter 4 , chapter 5
2. WORK TO BE DONE Documentation for the FYP2 chapter 6, chapter 7
3. PROBLEMS ENCOUNTERED Not sure for the content for the documentation
4. SELF EVALUATION OF THE PROGRESS Able to submit documentation on time

_____ _____

Supervisor's signature Student's signature

Appendix B

WORD ERROR RATE RESULT TABLE – 5 WORDS

italian spaghetti sauce with meatballs, Round=20, N = 5					
Count	**S**	**D**	**I**	**WER**	**Wacc**
1	0	0	0	0	1
2	2	0	0	0.4	0.6
3	2	0	0	0.4	0.6
4	0	1	0	0.2	0.8
5	2	0	0	0.4	0.6
6	1	0	1	0.4	0.6
7	0	0	0	0	1
8	1	1	0	0.4	0.6
9	0	0	0	0	1
10	0	0	2	0.4	0.6
11	0	0	0	0	1
12	0	0	1	0.2	0.8
13	1	0	1	0.4	0.6
14	0	0	0	0	1
15	0	0	0	0	1
16	1	0	1	0.4	0.6
17	0	0	0	0	1
18	0	0	0	0	1
19	3	0	1	0.8	0.2
20	0	0	0	0	1
Average Wacc					0.78

WORD ERROR RATE RESULT TABLE – 4 WORDS

soft chocolate chip cookies				Round=20, N = 4	
Count	**S**	**D**	**I**	**WER**	**Wacc**
1	0	0	0	0	1
2	1	0	0	0.25	0.75
3	1	0	0	0.25	0.75
4	0	1	0	0.25	0.75
5	0	0	0	0	1
6	1	0	1	0.5	0.5
7	0	0	0	0	1
8	1	0	0	0.25	0.75
9	0	0	0	0	1
10	0	1	0	0.25	0.75
11	0	0	0	0	1
12	1	0	0	0.25	0.75
13	1	0	1	0.5	0.5
14	1	0	0	0.25	0.75
15	0	0	0	0	1
16	0	1	0	0.25	0.75
17	1	0	0	0.25	0.75
18	0	0	0	0	1
19	0	0	0	0	1
20	0	0	0	0	1
Average Wacc					0.8375

WORD ERROR RATE RESULT TABLE – 3 WORDS

creamy rice pudding, Round=20, N = 3					
Count	**S**	**D**	**I**	**WER**	**Wacc**
1	0	0	0	0	1
2	0	0	0	0	1
3	0	0	0	0	1
4	0	0	0	0	1
5	0	0	0	0	1
6	1	0	0	0.333333	0.666667
7	0	0	0	0	1
8	0	0	0	0	1
9	0	0	0	0	1
10	0	1	0	0.333333	0.666667
11	0	0	0	0	1
12	0	0	0	0	1
13	1	0	0	0.333333	0.666667
14	0	0	0	0	1
15	0	0	0	0	1
16	1	0	0	0.333333	0.666667
17	0	0	0	0	1
18	0	0	0	0	1
19	0	1	0	0.333333	0.666667
20	0	0	0	0	1
Average Wacc					0.916667

WORD ERROR RATE RESULT TABLE – 2 WORDS

pasta salad			Round=20, N = 2		
Count	**S**	**D**	**I**	**WER**	**Wacc**
1	0	0	0	0	1
2	0	0	0	0	1
3	0	0	0	0	1
4	0	0	0	0	1
5	0	0	0	0	1
6	0	0	0	0	1
7	0	0	0	0	1
8	0	0	0	0	1
9	1	0	0	0.5	0.5
10	0	0	0	0	1
11	0	0	0	0	1
12	0	0	0	0	1
13	0	0	0	0	1
14	0	0	0	0	1
15	0	0	0	0	1
16	0	0	0	0	1
17	1	0	0	0.5	0.5
18	0	0	0	0	1
19	0	0	0	0	1
20	0	0	0	0	1
Average Wacc					0.95

Appendix C

SYSTEM TESTING RESULT TABLE - Recipe

Recipe Round = 5			
Count	**TRUE**	**FALSE**	**Accuracy %**
1	5	0	1
2	4	1	0.8
3	5	0	1
4	4	1	0.8
5	3	2	0.6
6	4	1	0.8
7	5	0	1
8	4	1	0.8
9	4	1	0.8
10	4	1	0.8
11	3	2	0.6
12	5	0	1
13	4	1	0.8
14	5	0	1
15	4	1	0.8
16	4	1	0.8
17	4	1	0.8
18	5	0	1
19	4	1	0.8
20	3	2	0.6
Average			0.83

SYSTEM TESTING RESULT TABLE – Ingredient

Ingredient Round = 5			
Count	**TRUE**	**FALSE**	**Accuracy %**
1	4	1	0.8
2	5	0	1
3	4	1	0.8
4	5	0	1
5	5	0	1
6	4	1	0.8
7	5	0	1
8	4	1	0.8
9	5	0	1
10	4	1	0.8
11	5	0	1
12	5	0	1
13	4	1	0.8
14	5	0	1
15	4	1	0.8
16	4	1	0.8
17	5	0	1
18	5	0	1
19	4	1	0.8
20	5	0	1
Average			0.91

SYSTEM TESTING RESULT TABLE – Command

Command Round = 5			
Count	**TRUE**	**FALSE**	**Accuracy %**
1	5	0	1
2	5	0	1
3	5	0	1
4	4	1	0.8
5	5	0	1
6	5	0	1
7	5	0	1
8	4	1	0.8
9	5	0	1
10	3	2	0.6
11	5	0	1
12	5	0	1
13	5	0	1
14	4	1	0.8
15	5	0	1
16	4	1	0.8
17	5	0	1
18	5	0	1
19	4	1	0.8
20	5	0	1
Average			0.93

Appendix D

TESTING DATA

Recipe	Ingredient	Command
Sesame chicken	Chicken breast	Exit
Mushroom soup	Honey	Next
Fruit salad	Water	Buy
Bacon roll	Ginger	Inventory
Cocktail meatballs	Sesame seed	Previous
Marinated grilled shrimp	Salt	Home
Bacon tomato cup	Chicken soup	Inventory
Garlic bread	Beef	Tobuy
Potato chips	Bacon	Transfer
Pizza pinwheel	Onion	Clear
Corn fritters	Garlic	delete
Egg roll	Lemon juice	
Garlic chicken wings	Apple	
Sweet sour meatballs	Sugar	
Bacon deviled egg	Tomato	
	Potato	
	Black pepper	
	Cabbage	
	Baking powder	
	Cheese	
	Basil	
	Butter	
	Mayonnaise	

	Bread	
	Flour	
	Salt	
	Curry power	
	Chicken wings	
	Egg	
	Soy sauce	
	Cider vinegar	
	Tomato sauce	
	Chili sauce	