INTEGRATED AUGMENTED REALITY SIGN BOARD MOBILE TRANSLATION SYSTEM

By

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14161

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Technology (Hons)
(Information and Communication Technology)

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
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Approved by,

_____

(Saipunidzam Mahamad)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2014

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgments, and that the original work contained herein has not been undertaken or done by unspecified sources or persons.

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(Stelio Sergio Nhane)

ABSTRACT

Malaysia continuously receives students, businessmen and tourists coming from all parts of the world. More often than not, these have little or no knowledge of the Malay language. Moreover, these will often miss important messages that will be conveyed through sign boards, information boards and any other written method because they are not versed in Malay language. Hence, an app has been proposed and developed to combine a highly accurate Optical Character Recognition engine, Tesseract and little of Augmented Reality concepts to provide Malay translation to foreigners. This app will prove to be useful because it will provide Malay translation with almost no user input, requiring only that these focus their devices' cameras to the sign board's text they intent to translate.

ACKNOWLEDGMENTS

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Doing this dissertation as well as the project herein required more than academic support, therefore I would like to take the next couple of lines to thank my colleagues. Their feedbacks were much appreciated at times I needed for both answering my questionnaire as well as agreeing to participate in the testing for my application.

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Lastly, I thank the Almighty for His blessings onto me. Most importantly, a very special thanks to my family. I am grateful to my father and mothers for the encouragement and support given to me throughout my course. To all of my siblings whom despite the distance between us, were there to support as well as humor my days, every day. I also thank all of my friends whom each had an unequal way of cheering me on throughout my Final Year Project; you are the family that I got to choose. And to all that I have not personally mentioned herein, my personal Thank You.

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ABBREVIATIONS AND NOMENCLATURES

API	Application Programming Interface
App	Application
AR	Augmented Rality
MT	Machine Translation
OCR	Optical Character Recognition
SDLC	Software Developmente Life Cycle
SOA	Service-Oriented Architecture

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Sign boards, letterheads, billboards and other sources of textual information are part of everyone's daily lives. That is attributed to the fact that these written sources of information convey specific messages which can be directions to a specific location, warnings, publicity, and others, which are intended to be understood by all those who read them. Hence, it is safe to state that a fraction of the information an ordinary person uses daily is inferred from sign boards or information boards.

Globalization is a contributing factor when it comes to bringing people from different places together and also making it possible for these to share similarities as well as differences. One major difference that remains noticeable although world communities are becoming global, is the language. The language remains consistent throughout all particular locations even though there is always the threat of slowly modifying it through incorporating words derived from other languages such as from English.

Notwithstanding, people who travel to different destinations afar from their countries, either for business or even for sheer pleasure, need to understand their surroundings. Often, when one is in another location different from one's own country or even within the country, is first greeted by an information board or a sign board which might deliver a welcoming message, general information, directions or even warnings. Therefore, it is important to understand the message being conveyed by those sign boards to understand one's surroundings.

Augmented Reality (or simply AR) is the combination of digital information with live video of the user's environment being broadcast in real time [1]. For short, AR deals with the enhancement of the live image viewed through a video camera. Despite the fact that AR still requires slightly more processing power to enrich the images in the view [2], recent studies have been focusing in enabling similar processing in mobile phones.

Moreover, modern mobile phones, also dubbed smartphones have at least one camera which can be used for both video and photos. Therefore, studies have been carried in order to add even more functionality to smartphones, such as the ability to translate languages. What's more, considering the fact that an ordinary traveler possesses a smartphone, it is fruitful to provide means to use the smartphone to infer knowledge from the text boards in the traveler's surroundings.

1.2 Problem Statement

When people travel to countries wherein English is not the main language, they tend to face communication problems because they are prepared to communicate in a language that is universally used, such as English. For instance, in Malaysia, even though English is extensively used, is not the main language. Hence it can be seen that sign boards, letterheads, information boards and others contain text written in Malay, and in some cases they contain other languages such as Chinese, Tamil, and English.

Moreover, since verbal communication of the travelers with the country's people is limited to the knowledge of English, travelers will often seek additional information such as directions, in sign boards. Nevertheless, that may prove to be a difficult task because very often, sign boards not only contain text written in Malay but also are short, concise, and at times do not include any type of pictures. As a result, travelers that do not speak nor understand Malay cannot infer any knowledge from the sign boards, letterheads, billboards and other sources of textual information that might surround them, thus leaving them unaware of the information to them being presented

1.3 Objectives and Scope of Study

In order to appreciate as well as to take a delight in the experience of traveling to Malaysia, businessmen, tourists, and even students need to understand their surroundings. One source that enables such is the written text which can be found in sign boards, letterheads, information boards, billboards and others that often contain useful information and are placed all around.

Therefore, in order to overcome the limitation that travelers cannot understand the information being conveyed by sign boards, letterheads, information boards and others written in Malay when these are in Malaysia, the present project has been undertaken to:

i. Develop an app to do detection, recognition, and translation of text written in Malay language;
ii. Leverage on existing technologies such as OCR to provide simpler means to understanding Malay text in sign boards
iii. Provide mechanism to get the meaning text, word, and sentences from Malay to English and vice-versa.

There are already many applications in the market that provide translation services. Hence, the present project's scope was limited in order to make the app relevant as well as useful. In terms of scope, the project focused on the aspects related to the detection, recognition, and translation between Malay and English. Although there are even more broad areas that could have been explored such as full AR, the project only focused on the real time feature, which is the automation of the instantaneous text detection until the translation.

Additionally, since there are apps that users can use to translate pages of text, for example Google Translate, the result of the present project was not intended to translate many words, although it can. Instead, it was designed to translate a few words such as the number found in a normal sign board.

1.4 Relevance and Feasibility of the Project

Malaysia has been a destination for businessmen, tourists, and students alike. With activities, events, and festivals lasting all-year round, Malaysia will attract even more foreigners who most likely do not understand nor speak Malay. Hence, with the app resulting from this project, all incoming foreigners can be provided with means to use their smartphones to decipher text from sign boards, letterheads, information boards, and other sources of textual information that might be in the surroundings.

Although there are apps in the market that provide a similar functionality (the translation between languages), the result of the present project stands out by means of fusing and enhancing the best practices of the apps that are already in the market. Moreover, differently from the existing apps, the result of this project focuses on a narrow segment of languages, which are Malay and English, thus expecting the app to have a high performance rate when it comes to effectuating the translation.

CHAPTER 2

LITERATURE REVIEW

2.1 Augmented Reality and Interaction

Augmented Reality (or simply AR) is the fusion of digital info with live video of the user's environment, broadcast in real time [1]. In smartphones, AR focuses on producing an enhanced scene form the live video captured by the device's video camera [2]. Since AR is said to be shaping its path towards implementation in smartphones, there are relatively few limited collective efforts to implement Machine Translation (MT) using AR in mobile devices. Nonetheless, the use of smartphones will be the seamless delivery method in the near future [3].

Some implementations of AR are said to allow the users to interact with the augmented reality. However, that concept was not pursued in the present project. That was because Hurst and van Wezel [2] believe that interacting with the augmented reality in smartphones can be difficult due to both holding and trying to manipulate it. Therefore the desired interaction the user could have with the result of the augmented reality was neither implemented nor conceptualized.

2.2 Text Detection

A solid foundation must be integral part in any activity or project. Similarly, text detection is of the most importance because it is through it that the later steps or processes namely text recognition and translation will get their inputs. Hence, the main

purpose of text the detection is to locate regions that contain text on the image or video [4], which in turn is passed to the OCR.

The quality of the result of the text detection will influence all forthcoming steps, and text detection's is influenced by several other factors. For instance, it was said that the natural scene wherein the text is localized, illumination, and distortion make text detection a difficult task [5], [6], [7], or in worst cases, can mislead the OCR [8]. In addition, the proprieties of the text such as the color, sizes, alignment of the characters, and background are also challenges to the OCR [4], [9], [10], [11], [12], [13].

As means to overcome inaccurate text detection problems, a variety of studies, with each implementing algorithms which optimized the intended results of the study. A couple of studies [7], [14] have depended on the user to point out the location of the text in the image. Further in another, a character classifier mechanism that relied on appearance referencing pattern which identified character candidates from anyplace in the given picture was used [5]. The aforementioned method was exposed to have achieved a low precision rate but with high position recall rates. Neumann and Matas [10] suggested a detection method based on a hypothesis-verification framework for simultaneous processing of multiple text lines.

In a more recent study, [15] used an algorithm which horizontally scanned the provided image to find the first and last black pixels in a line with the aim of supplying the area in between. Shivakumara et al. [9] advocated a method which handled both video and graphic texts, and focused on the text orientation to identify and segment text strings. Charjan et al. [8] on the other hand, saw that passing the image to recognition without a proper preprocessing could be computationally expensive, which could lead to inaccurate results. Hence, methods to identify text-containing regions were studied by locating points in areas with similar luminance, and the conclusion was that the detection influences accuracy as well as performance.

Rajendran et al. [11] proposed a method centered on the features of Fourier-moments to extract characters and words from text line images and word images. The segmentation

based on gradient features was put forth [12]. Both studies aforementioned concentrated on texts with multiple directions and the gap between the characters and words. Kumar [13] studied an algorithm which was founded on the uniqueness of the edges in image texts to create projection profiles and with that, analyzed until text regions were found. On another study, a multi-scale character detection that used sliding window classification with Random Ferns was performed [16].

Li et al. [17] proposed an approach that combined stroke-related features and machine learning modeling for detection in both images and video. It was said to have achieved faster and better representation of the text's fundamental characteristics. Ye et al. [4] proposed a coarse-to-fine detection which obtained candidate text regions from the image to detect text lines, regions were separated into text lines, and then fine detection was done.

Although the existence of a variety of studies with diverse methods to achieve proper text detection is eminent, one method was pursued. The method is the one which consisted in identifying text-containing regions through detecting points in areas with consistent luminance [8]. The choice of the method is owed to the method's accuracy and performance, as well as the fact that it reduced the computational need by preprocessing the image before sending these so the OCR.

2.3 Text Recognition

Recognition is another important of OCR based systems because without recognition there is no input for further processing. In short, if errors were to occur during the recognition of the text, then the quality of the translation would be affected. Therefore, in some of the consulted literature materials, text recogniton was merged with text detection in a single step, however that is not the case herein.

Several studies [7], [14], [15] took advantage of the binarization process, which consists of gradually converting the given image into gray until only a binary image remains. Once the binary image is obtained, pattern strings are extracted and supplied to the MT

subsystem. In addition to that, synthetic fonts were used to train the algorithm because it would be time-consuming to acquire and label real-world training data [10].

In an earlier study, the likelyness of recognizing multiple characters in the same location was analyzed. Words in the string were identified using a probability of character combinations which subsequently were matched by applying an algorthm that matched similar characters, world retrieval, and word sequence search [6]. Pictorial Structures formulation which took locations and scores of detected characters as inputs in order to find the optimal configuration of a precise word, was used in the second step of a pipeline proposed [16].

Therefore, it to be said that the choice of the text recognition methos was mostly centered on the degree of precision that could be achieved by it. Hence, more information on how the above was achieved is given below in the Optical Character Recognition.

2.3.1 Optical Character Recognition

OCR is a subdivision of Pattern Recognition, referred as Text Recogntion within this report, where the recognition, separation of characters in images, and posterior conversion into text occurs [8], [18]. Although OCR has been in existence since the 1980's, only recently that the technology has been found reliable and sophesticated that it made it's way towards extensive implementation [19]. Similar to algorithms mentioned earlier, OCR gets the image after this has gone through the binarization process.

Concerns regarding the computational friendliness of OCR in smart phones along with its efficiency and low memory consumption were raised [18]. These concerns have been addressed in the currently available OCR systems. Some of the highly accurate OCR systems in existence include Tesseract (93.51%), Adaptive Algorithm for Text Detection (AATD) (93.3%), Low Complexity Sign Detection and Text Localization IS

(LCSD&TD) (92.74%) [18]. Therefore, because of its high accuracy rates, Tesseract [20] was used in this project.

2.4 Text Translation

The text translation is initiated after the text is has been segmented, extracted, and then recognized by the OCR. The translation of text from Malay to English and vice versa was achieved within this step. Ishahara [21] recently afirmed that the quality of the translated text as well as the degree of its usefullness, that is, its meaning to the readers is affected by the quality of the translation. Therefore it is of high importance to have the precise translation of the messages in order to properly gasp the meaning of the information being read.

A couple of studies [5], [14] used a MT subsystem that performed the requested translation in a Remote Host. Therein, a lexical transfer provided a term-to-term translation from a dictionary that contained pairs of words and phrases [22]. In a more recent study, the approach used consisted of a database dictionary wherein every word received was searched and the translation returned, however if no translation was achieved, then the recognized word was appended to the output as it is and was considered a name [15].

Although now there can be found many web sites offering translation services, not all ae considered developer-friendly. Such was found in [23] wherein one translation services provider consulted did not provide a structured API in order for apps to interface with the servers, and the response times were considerbly long. As a result, Google Translator was used in some studies due to its simplicity in terms of implementation as well as the availability of a well documented API [19], [23].

Nevertheless, Google Translate is not the only reliable translation services provider which is currently available. There is also Microsoft Translator [24], with besides being less costly, offers more characters to translates at a lesser fee. Therefore, it was the

chosen option for providing translaion services to the app resulting from the present project.

2.5 Comparative Study

As a closing note of the present chapter, a little comparative study was done. There are numerous studies towards the implementation of MT using the mobile camera, and a few focusing on AR, however no significant numbers of these studies have produced an app to demonstrate the concept they proposed. As a result, only the some apps which can be found on Google Play Store will be compared. The apps listed on the Table 2.1 below are not all that exist, they are merely some which either the functionalities resemble each other or that are abundantly used.

Table 2.1 Comparison of some apps on Google Play Store

	Applications		
	Google Translate	World Lens Translator	Photo Transfer
Mobile Platform	Android	IOS/Android	Android
Character support	Extended	Normal Alphabet	Normal Alphabet
Detection, recognition and translation mechanism	From picture with the help of the user to point at the text area	Automated, from the video feed. No picture needed	Automated from the picture supplied.
Mobile Data	Required	Not required	Required

As it can be seen from the table above, the compared apps have a lot in comon, with a few slight differences. Similar to the apps on the table below, the proposed app will require mobile data to do the translation and will be built for the Android OS, however the difference will be that no user input such as a photography will be required, only the view finder image will be needed for translation. One may claim that World Lens Translator already does what the proposed app intends to do, however if one takes a look at the apps install page in Google Play Store, it can be seen that the app has very

few install rates and high dissatisfaction from the users because they claim the app does not function as advertised.

CHAPTER 3

METHODOLOGY

3.1 Research Methodology

The present subsection describes the approaches which were undertaken in order to carry a research relevant to the project. Since quantitative research method is deemed reliable and objective, as well as are said to allow critical interpretation of the results, it was used. The research was designed to gather the user expectations as well as to understand the need of an app with such functionality – the ability to translate text written in Malay language to English and vice versa, using the smartphone's camera

3.1.1 Data Gathering

To gather the user expectations as well as views on the idea of the app, a quantitative research was conducted. Questionnaires are a widely used method of data gathering for quantitative research, and hence one was used here. The research consisted of a 6-questions online questionnaire which was aimed at both Malaysians and foreigners as well.

Besides the origin, questions regarding the number of languages the respondents understand were asked, including whether Malay was one of those languages. Further into the questionnaire, respondents were asked the rank their usage of translator apps, the ease of use, as well as whether they would consider using one. Based on that question, a prediction of user acceptance of the app was to be later inferred.

3.1.2 Data Analysis and Results

Through analysis and inference, meaningful information is deducted from questionnaires. Similar approach was used to analyze the responses given in the questionnaire distributed to respondents. The responses' data was graphically represented in Microsoft Excel and from there inferences pertaining the questions asked were made. The results are provided in Questionnaire's Results and Analysis.

3.2 Development Methodology

The development of software followed standard framework of methodologies such as those outlined in the SDLC. In turn, these methodologies contain a set of activities that are carried in a certain order. For the present project, a Rapid Application Development based methodology; more precisely the Throwaway Prototyping Methodology was used (see Figure 3.1 below).

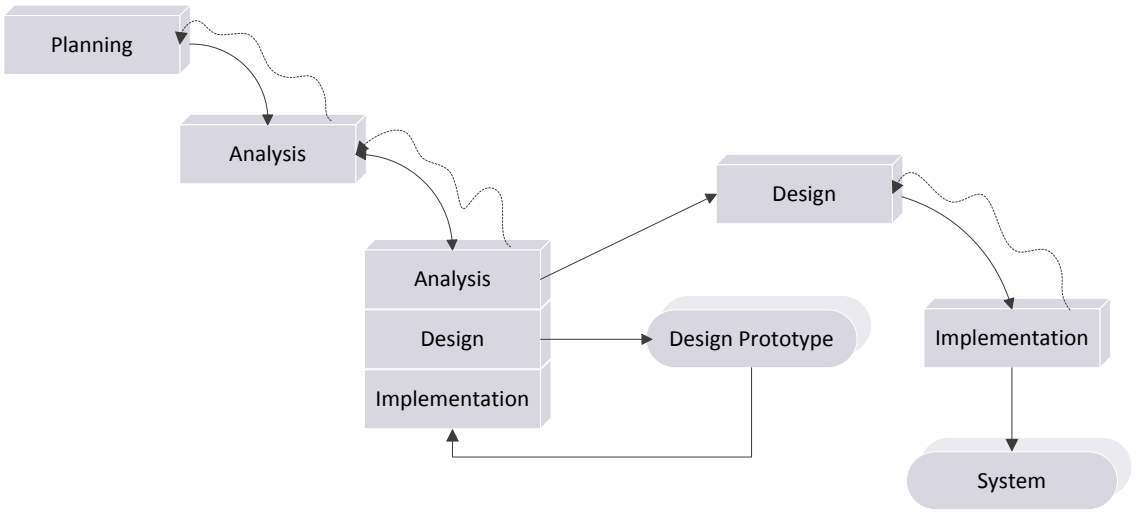

Figure 3.1. Throwaway prototyping-based methodology

The above represented methodology was chosen because the requirements, familiarity with the technology, complexity, and reliability of the built system were not well defined at the moment when the project was initiated. Hence, because throwaway prototyping has been said to perform excellently under the aforementioned conditions, it was a preferential choice, although there was no user involvement in the drafting of the requirements of the app, nor during the development. Finally, in the development methodology, the phases that were followed consisted of planning, analysis, design, and implementation phases, which are individually detailed next.

3.2.1 Planning

As the leading phase, planning is very important to the development of a software system. It was during this stage that the title was proposed, followed by a brief research on the apps that exist in the marked with similar functionality. Moreover, the frameworks of the activities that are part of the development lifecycle were plotted into a Gantt chart (see APPENDIX I: WORKS PLAN). As planned, the overall project was scheduled to last for 2 academic semesters, that is September 2013 and January 2014 semesters – a total of about 7 months.

3.2.2 Analysis

More often than not, analysis runs concurrently with the planning so that the plans are cohesive in fulfilling the objectives set. Henceforth, the analysis activities for the present project were carried in parallel with the planning activities. Herein this phase, the concept of the proposed app was further developed, the target users were identified, and the main functionality of the app was set forth.

The concept has been to have a Malay language translator app, but not similar to those which are already on the market because it would be redundant and unlikely to be used. The main target users were identified to be all those that visit Malaysia, wherein Malay language also is used to convey messages in sign boards, letterheads, information

boards, billboards and others. Moreover, Malaysia is not the only country with uses Malay language; since there are few similarities between the languages, with little effort the app was theorized to be able to work with languages in Brunei and Indonesia.

The main and unique functionality of the app was set to be a provider of real time language translation between Malay and English. After the questions which are often asked during analysis were answered, a literature review was conducted to find approaches used by other studies in proposing similar functionality. The analysis culminated with the drafting of the initial system requirements that would be used to build the app.

3.2.3 Design

The Design phase of SDLC involves a meticulous and systematic approach to defining the system. Decisions regarding how the app was to operate, the components, interfaces, dictionaries and databases, and translator service provider for the app were made. The design strategy revolved solely on having the student building the app. While the interface was designed to require minimal user input, the architecture design of the app was derived and enhanced from several consulted literature materials.

In the core components of the app, the text detection, recognition and translation modules' interactions were designed. Herein, the fetching and display of the translation from the online translation services provider was designed in order to offer optimal arrangement in terms of localization in the user interface. As a closing note, this phase was made up of the activities leading to the design of the architecture, user interfaces, text detection, recognition, and translation modules. Once these activities were completed, the results were bundled together into one document, the requirements specification document.

3.2.4 Implementation

The implementation phase is where all the plans which started at the planning phase until the design were put into motion. This phase saw mainly the development of the app. The development of the app was gradually done, one module at a time, where at the completion the integration was tested. Once all the modules were in place, the text detection, recognition, and translation, the app was finally put together and prepared for a final verification.

3.2.5 Verification

The verification phase encompasses benchmarking the build systems against its requirements specifications. On that note, the app was checked for compliance with the specifications finalized in the design phase. In addition, the accuracy as well as correctness of the translation were evaluated in order to ensure the perfection and completeness of the app. Afterwards, the app was released to a selected few users who provided their contact information in the survey to test the app. This testing was to demonstrate the concept mentioned within the questionnaire to the prospect users.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Questionnaire's Results and Analysis

As it was mentioned earlier in the present report, a questionnaire to gather the user's perception towards an application that does translation using the mobile camera. The questionnaire consisted of mainly six questions where for five of them, respondents were required to rank their level of understanding using a Likert scales ranging from strongly disagree to strongly agree.

The survey was distributed online, and a total of 20 valid responses were considered. When asked about their origins, 60% answered to be Malaysians and the remaining 40% were foreigners from diverse countries. Other demographics related questions such as age and gender were not included in the questionnaire because they were deemed irrelevant to the user's perceptions towards an app that uses the smartphone's camera to translate between languages.

When inquired about their understanding of the Malay language, 12 respondents strongly agreed to have a solid understanding of the language while other 4 strongly disagreed. The distribution of responses is believed to be in that way because the 12 respondents represent the respondents which are Malaysians. As for the remaining it can be said that they have little understanding because of the lack of similarities with their countries of origin's languages. The inverse can also be said to be true for the one respondent that agreed to understand Malay language. The distribution of the responses can be seen on Figure 4.1 below.

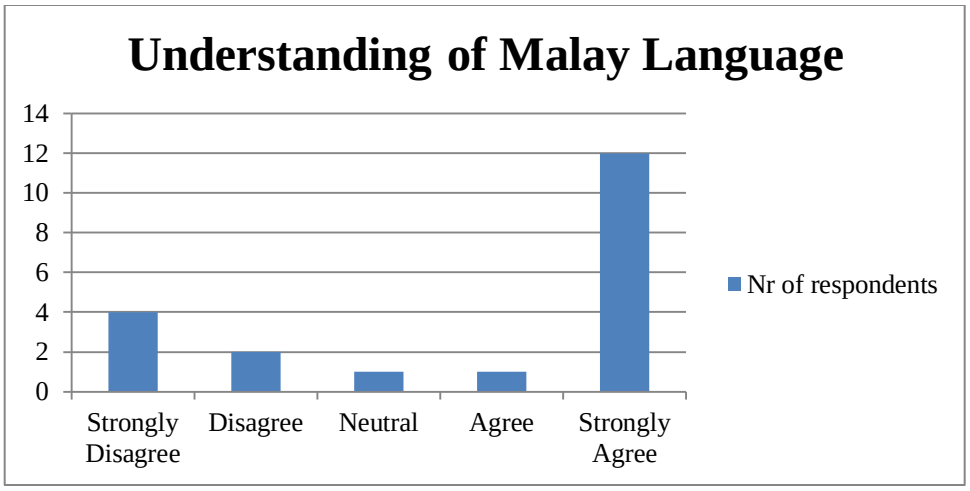

Figure 4.1 Respondents' understanting of Malay language

The next question aimed at gathering whether respondents use an app to translate between the languages they speak or understand. As it can be seen in

Figure 4.2 below, only 3 respondents asserted not using any app to translate between languages, 4 were neutral and the remaining 13 affirmed to use one. This distribution cannot be tied to any particular reason other than the fact that those who affirmed to use preferred to get translations while using their smartphones.

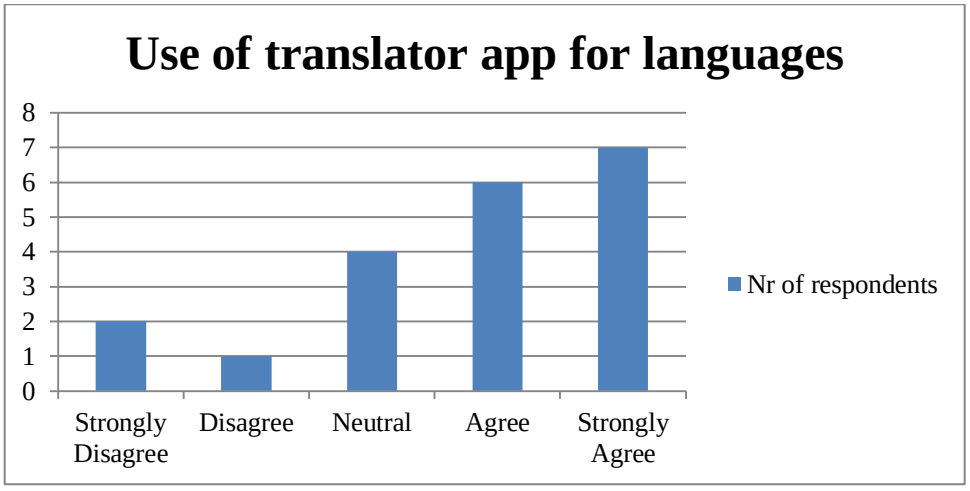

Figure 4.2 Respondents use of a translator app between languages they undrestand

Additionally, respondents were asked about the number of languages they undrestand or speak. The question specifically asked whether they understood any other 2 languages appart from English, and 65% said yes. Further question aimed at knowing whether respondents would use an app to translate between Malay and English. This yeileded to 17 agreeble results, meanig the number f respondents that either agreed or strongly agreed that would use such app. The number of respondents can be attributed to the fact that the question asked between Malay and English, that is, from Malay to English and vice-versa. See Figure 4.3 below.

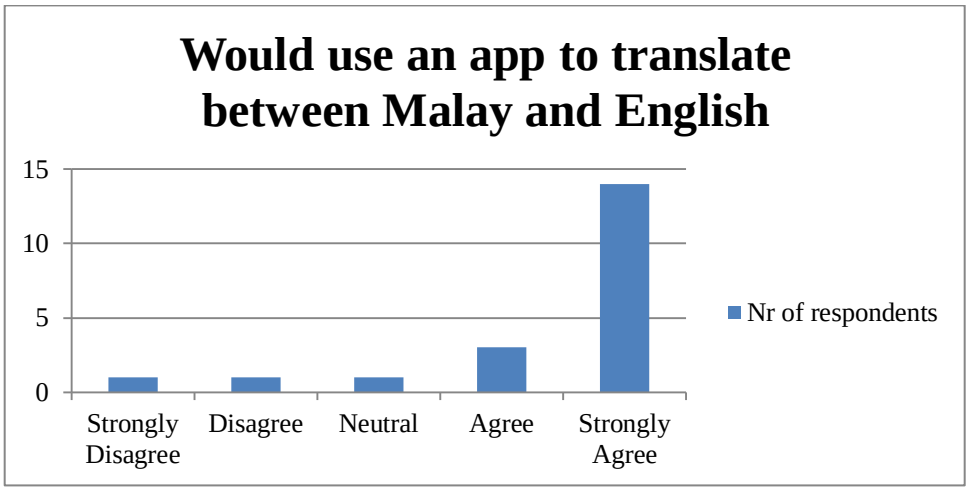

Figure 4.3 Respondents' possible use of an app to translate between Maly and English

The last question intended to evaluate the ease of use of the apps respondents frequently use. The distribution of the results was equal in the disagreeing and neutral sides both with 5 responses each, while the other 10 respondents pointed that the apps they use required considerable effort from them (See Figure 4.4 below). This particular question was of much consideration when the user interactions with the interface of the app were designed.

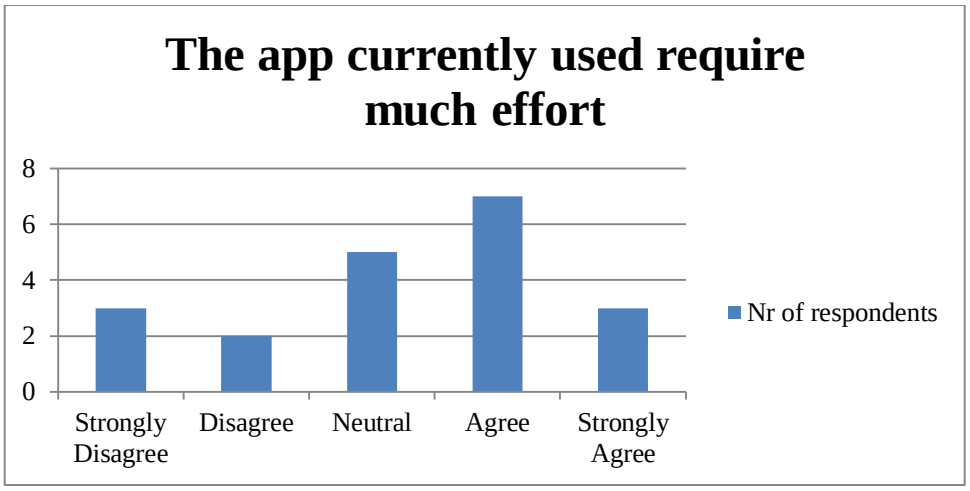

Figure 4.4 Respondents' ease of use for their current translator apps

4.2 User Interfaces Design

The app's user interfaces were designed to be straightforward in order to be as easy to use as possible. Moreover, the interfaces feature as minimalistic design approach in order to smoothen the operation of the app with little or no user input. When the user opens the app, it will properly initialize the components and once ready, the main will stay in display, as shown in Figure 4.5.

The Malay represents the current language being recognized; the arrows pointing in opposite directions make up the button which is used to toggle between the languages; and English represents the language in which the translation results will be displayed. When clicked, menu options button (at the top right corner) shows additional options which are Settings, About, Help, and Exit, which the user can select according to what action is intended.

Figure 4.5 The app's main user interface

Once the main user interface is ready, the apps starts scanning the viewfinder to attempt recognition. When the user points the smartphone towards a surface containing text, the app will immediately attempt recognition and if successful, then a translation will also be attempted (see Figure 4.6). The top of the screen contains the recognized text while the bottom contains the translation.

Figure 4.6 The app recognizing a text

4.3 App's Architecture

The architecture is said to be a basis of development of any system. That is because not only covers for the present problem at hand, but also any foreseeable; in addition, it implements practices that were already proven effective in existing systems. With that in consideration, the architecture followed in the present app was a service-oriented architecture (SOA). The SOA architectural pattern was applied because the app will initially require an internet connection with the external service provider responsible of providing the translation. Moreover, the app also requires a layered architecture, which will reside within the mobile device, which contains 3 layers (see Figure 4.7).

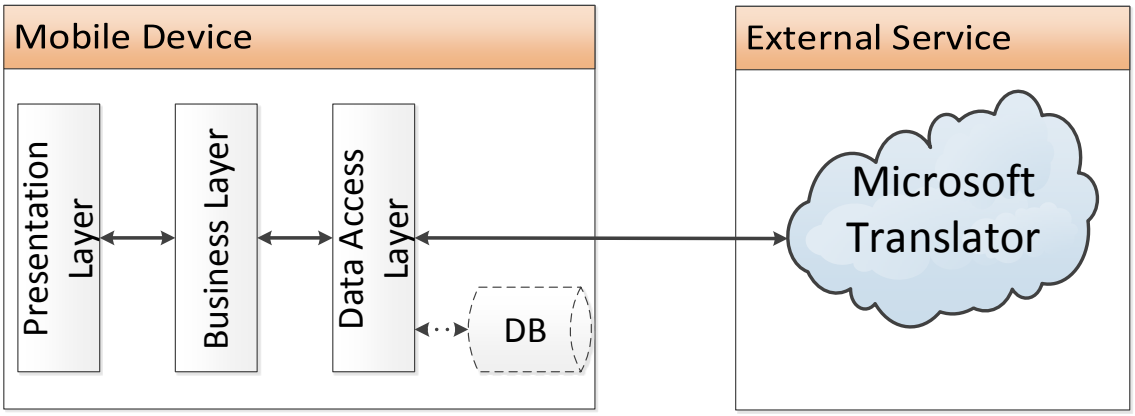

Figure 4.7 App's architectural diagram

In the layers within the mobile device, the presentation will be filled by the user interfaces which will permit user interaction with the app. The business layer will include 2 components, the camera and OCR. The camera will capture the image of the text, while the OCR will attempt to extract text from the image in view.

Once the detection and recognition are completed, the text will be passed to the data access layer, which will use its Service Agents to request translation services from the external service provider. A small database is planned to be stored locally, to contain only some of the most common words in sign boards so that the app can still provide a basic functionality even if the smartphone does not have data connection.

4.4 Activity Diagram

Diverse diagrams are used to visually model the software system. One visual model that is widely used is the activity. At times it is called flow chart because it shows the behavior of the system. Figure 4.8 below depicts the essential activities performed by the app after it properly initializes. The app continuously looks for text in the viewfinder. Once text is detected, it is passed to the OCR for detection, and then the result of the detection is sent to Microsoft Translator for translation. While the translation takes place, the recognized text is displayed in the user interface, and when the result of the translation is returned, it too is displayed in the main user interface.

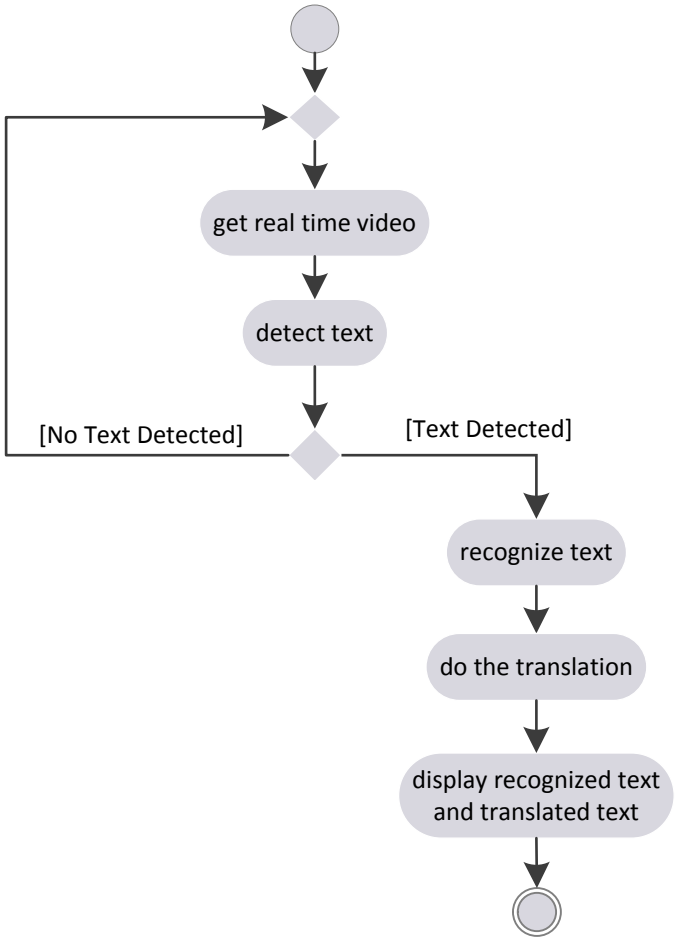

Figure 4.8 App's activity diagram

4.5 Discussion

AR in the form of real time applications is still making its way towards full implementation in smartphones. In order to develop the app, several APIs were integrated to provide the required interfaces for the app. Tesseract OCR was used to provide the text detection and recognition, while Microsoft Translator was later used to provide the translation services. When using diverse components and APIs, some issues such as performance and the need for data connection for the translation need to be addressed.

The first performance related issue is the overall response time of the app. This will vary from one device to another, being that older smartphones will be relatively slower than the new ones due to the capability of the hardware. Another factor that is tied to hardware that affects performance is the quality of the camera. The app performs well in a 5 Mega Pixels camera which is standard in many older smartphones, and is expected to perform even better in any smartphone with a larger camera resolution. In turn, the aforementioned performance factors combined will influence the duration the app will take to recognize text in each particular smartphone.

The app does operate without any data connection, however not fully. In order to fully operate and provide the required translation, the app needs constant connection to the internet. The connection to the internet has to be good in order to allow a fast retrieval of the results, else the app will not process in real time, and the results (if any) will be displayed with a significant delay.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Augmented Reality is gradually finding its path in the direction of implementation and use in smartphones. Smartphone's usefulness increases as this is loaded with the right apps. To overcome the difficulties travelers who do not understand Malay might face when trying to decipher sign boards written in Malay language, the present project was undertook to develop an app that can detect, recognize, and translate Malay to English and vice-versa.

Before the development of the app, a study was conducted to find the current existing apps and based on those, seek for areas of improvement. Once the study was well on the way, a SDLC methodology, more precisely the Throwaway prototyping was used as the framework to develop the app. Once the app was complete, it was given to some users who do not understand Malay in order to observe how they interact with it and whether this helps them to better understand their surroundings.

As it was said earlier, Malaysia is receiving more and more guests coming from different parts of the world, whom most of the times have little or no knowledge about the Malay language. With the present app, those travelers will be able to appreciate the nature of the information being conveyed to them through sign boards, letterhead, information boards, billboards, and others. Moreover, the comprehension of the information will enhance the pleasantness of the experiences travelers will undergo in when visiting Malaysia.

5.2 Recommendations

Malaysia is a country with diverse cultures living together in harmony. Since language is part of culture, it can be noticed that there are various languages that are spoken in Malaysia, and often are also put into sign boards. Hence one recommendation for future works is to add translation for and between the other languages spoken in Malaysia, namely Chinese and Tamil.

An additional recommendation for future improvements is to fully incorporate the AR into the app. At this moment the app only benefits from the real time aspect of the AR, hence, further implementing the AR to allow the change of the text on the scenery itself and not in two different positions can be a factor when it comes to attracting user to use the app, because it will always be a different experience.

Lastly, in the future improvements of the app, a small database dictionary containing pairs of basic words between Malay and English. That implementation is to allow the app to still provide basic translation functionality even at the absence of data connection to the internet.

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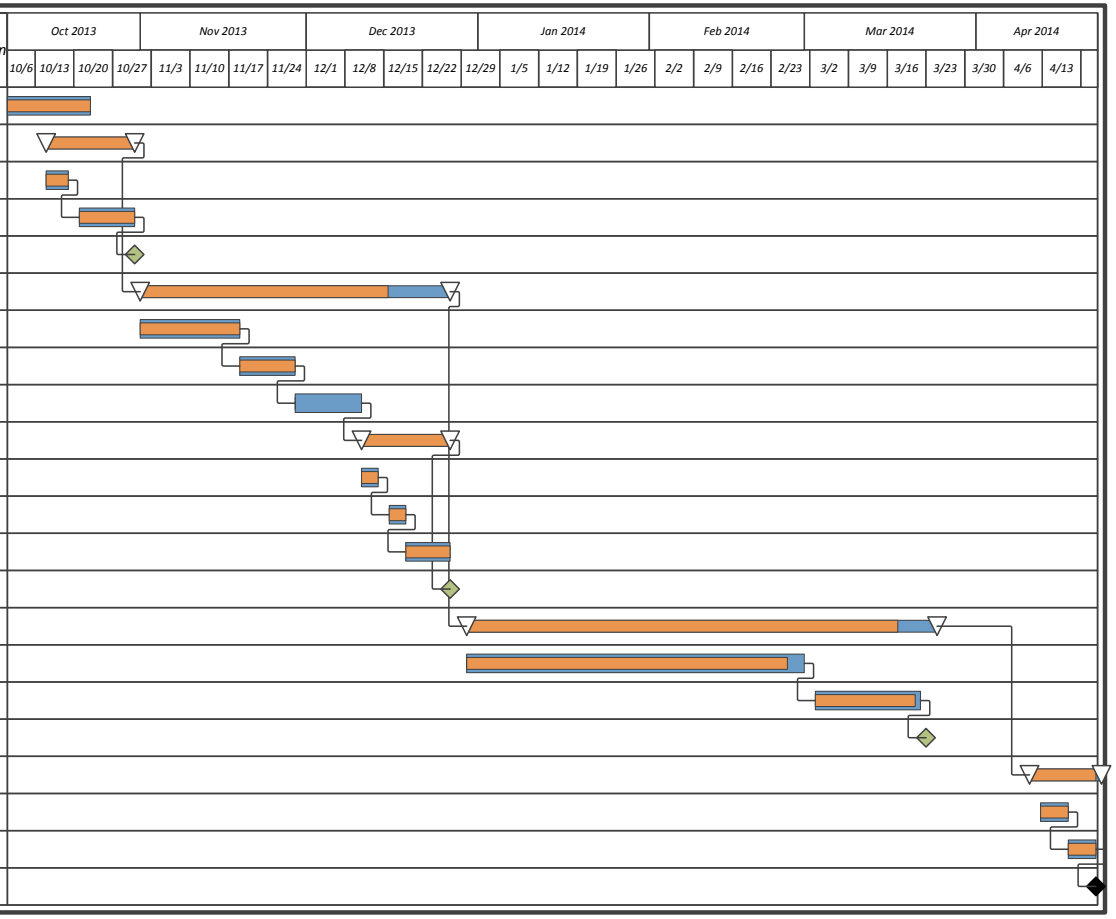
APPENDICES

7.1 APPENDIX I: WORKS PLAN

ID	Task Name	Start	Finish	Duration
1	Planning	10/8/2013	10/22/2013	2.2w
2	**Analysis**	**10/15/2013**	**10/31/2013**	**2.4w**
3	Analyze the App's concept	10/15/2013	10/18/2013	.8w
4	Carry out Literature Review	10/21/2013	10/30/2013	1.6w
5	High level project plan and proposal	10/31/2013	10/31/2013	0w
6	**Design**	**11/1/2013**	**12/27/2013**	**8w**
7	App Architecture	11/1/2013	11/18/2013	2.4w
8	Interfaces	11/19/2013	11/28/2013	1.6w
9	Translation Dictionary Database	11/29/2013	12/10/2013	1.6w
10	**Programs**	**12/11/2013**	**12/26/2013**	**2.4w**
11	Text Detection	12/11/2013	12/13/2013	.6w
12	Text Recognition	12/16/2013	12/18/2013	.6w
13	Text Translation	12/19/2013	12/26/2013	1.2w
14	App's Specification	12/27/2013	12/27/2013	0w
15	**Implementation**	**12/30/2013**	**3/24/2014**	**12w**
16	Build the app	12/30/2013	2/28/2014	9w
17	Do Testing	3/3/2014	3/21/2014	3w
18	Working app	3/24/2014	3/24/2014	0w
19	**Verification**	**3/24/2014**	**4/7/2014**	**2w**
20	Conformity to specifications	3/24/2014	3/28/2014	1w
21	Correct functionality	3/31/2014	4/4/2014	1w
22	Final App	4/7/2014	4/7/2014	0w



7.2 APPENDIX II: QUESTIONNAIRE

Potential Users' perception on an app to translate Malay text using the mobile phone's camera

This Form gathers users' idea on an app that will do translation between Malay and English languages using the mobile phone's camera and data connection. Please note that no personal information is requested in this survey form.

* Required

I am: *

- Malaysian
- Foreigner

Other than English, i am fluent or understand 2 other laguages *

- Yes
- No

I understand Malay language *

Please select a scale that best represents your level of understanding of the Malay language

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I use a translator or app to translate between languages i speak or understand *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

The app or translator that i use requires considerable effort from me *

For example, i need to type all the text i wish to translate

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I would use an app that instantly translates text between Malay and English languages using my mobile phone's camera *

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

I am willing to be contacted to try the app once it is completed.

if yes, please leave your email.

Submit

7.3 APPENDIX III: TECHNICAL PAPER

An Integrated Augmented Reality Sign Board Mobile Translation System

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ABSTRACT. *Malaysia continuously receives students, businessmen and tourists coming from all parts of the world. More often than not, these have little or no knowledge of the Malay language. Moreover, these will often miss important messages that will be conveyed through sign boards, information boards and any other written method because they are not versed in Malay language. Hence, an app has been proposed and developed to combine a highly accurate Optical Character Recognition engine, Tesseract and little of Augmented Reality concepts to provide Malay translation to foreigners. This app will prove to be useful because it will provide Malay translation with almost no user input, requiring only that these focus their devices' cameras to the sign board's text they intent to translate.*

KEY WORDS: *Augmented Reality, Optical Character Recognition, Sign board text, Malay translation, Tesseract.*

INTRODUCTION

Sign boards play a predetermined role of informing or conveying intended messages to viewers or readers. Hence, it is important for the targeted audience to properly understand them. With globalization, people travel all around the world and at times their destination is Malaysia. In Malaysia, information is often delivered in Malay, sometimes with the addition of Chinese and Tamil, and occasionally English. Commonly, people need to comprehend the information provided by sign boards, letterheads, and other sources of written information to better appreciate their surroundings.

There are diverse studies which look at enabling and enhancing processing of video and images in mobile phones. One of those is Augmented Reality, or simply AR which is a field that handles the real time enhancement of live image or video viewed through a video camera. AR is of special interest because through it, the view of the user's environment (in terms of understanding) is going to be enhanced with a real time instantaneous translation.

Foreigners in Malaysia (especially those who do not understand Malay), together with a smartphone that has the build app installed shall be able to decipher text from any sign board, letterhead, information board, and any other form containing text written in Malay. With the built app, it is safe to mention that all ordinary travelers that visit Malaysia and do not have any knowledge of the Malay language will have a significant ease to understand the sign boards containing text written in Malay.

RELATED WORK

Augmented Reality (AR), when it comes to mobile devices, it is still finding its path towards implementation. Moreover, there are still limited collective efforts to implement Machine Translation (MT) using AR in mobile devices. Nonetheless, the use of mobile phones will be the seamless delivery method in the near future [1].

In order to guarantee an accurate output translation, the initial steps of the process are crucial. Such is the case of the text detection which the main purpose is to find on the image, regions that contain only text [2]. In turn, text detection depends on the overall natural scene wherein the text is located [3], [4], [5] that at times can mislead the Optical Character Recognition (OCR). In order to avoid improper text detection, a sizeable number of studies have been conducted, where each implemented a variety of algorithms that optimized the outputs to what it aimed at achieving. The highlight was a process which identifies text-containing regions by detecting points in areas with consistent luminance [6].

The choice of this technique is owed to the method's accuracy and performance, as well as because transferring an image to recognition without a proper preprocessing is likely to be computationally expensive, also is likely to yield inaccurate results [6]. Other considerations were Fourier-moments based method [7] and segmentation based on gradient features [8]. However these where not further considered because they focus on texts with multiple directions and the gaps between the words.

Subsequently, during text recognition studies made the most of binarization. Binarization involves converting the given image into gray until only a binary image remains, whereupon pattern strings are extracted and supplied to the MT system [9],

[10]. After the binarization process, considerable studies perform the text recognition using OCR. This technology has been in existence since the 80's and with time it had gradually developed until becoming reliable [11].

Nevertheless, concerns regarding the computational friendliness of OCR in smart phones together with its efficiency and low memory consumption were raised [12]. Furthermore, these concerns have been addressed in currently available OCR systems. Some of the highly accurate OCR systems in existence include Tesseract (93.51%), Adaptive Algorithm for Text Detection (AATD) (93.3%), Low Complexity Sign Detection and Text Localization IS (LCSD&TD) (92.74%) [12]. Therefore, the OCR used further in the study was Tesseract [13].

After duly recognizing the text, this is passed along for translation. It is to mention that the text will only be meaningful to the readers if the translation is accurate and thus the message conveyed. Therefore, a MT system which performs the translation in a Remote Host was used [3], [10] whereupon a lexical transfer delivered term-to-term translation from a dictionary containing pairs of words and phrases [14]. Other than that, another approach used relied on a database dictionary wherein each word was searched and the translation was returned, however if no translation was achieved, then the recognized word was returned and considered a name [9].

Other studies used a range of translator websites in order to get text translation. However, it was found that some web translators do not provide well-documented API to permit applications to access the service provided, or the response time is significantly long [15]. Therefore, in order to allow simplicity in implementation alongside the availability of a well-documented API Google Ajax Language API was used [11], [15]. Nevertheless, in the app built from this project, Microsoft Translator [16] was used. The underlying reasons were that Microsoft Translator offers more characters to translate at a lesser fee. That is it offers more value.

Although there is wide range of research toward machine translation using the mobile camera and few of AR, no significant number of those studies has produced an app to demonstrate the concept they propose. As a result only some apps are compared on the table below in order to validate the need for the app proposed. Similar to the apps on the table below, the proposed app will require mobile data to do the translation and will be built for the Android OS, however the difference will be that no user input such as a photography will be required, only the view finder image will be needed for translation.

Table 2. Comparison of some market apps

	Applications		
	Google Translate	World Lens Translator	Photo Transfer
Mobile Platform	Android	IOS/ Andoroid	Android
Character support	Extended	Normal Alphabet	Normal Alphabet
Detection, recognition and translation mechanism	From picture with the help of the user to point at the text area	Automated, from the video feed. No picture needed	Automated from the picture supplied.
Mobile Data	Required	Not required	Required

METHODOLOGY

In order to properly complete the study of the app, the methodology was divided into the research and development methodology. In terms of research methodology, a quantitative research method was designed to gather the user expectations as well as to understand the need of an app with such functionality – to translate text written in Malay language to English and vice versa, using the camera.

On the other side, the development will follow a Rapid Application Development based methodology, more concisely Throwaway prototyping. The choice of the methodology is due to the fact that throwaway prototyping allows a relatively faster application development. Lastly, the summary of activities for each phase (see Figure 9) are, the creation of the activities framework in planning; conducting requirements need and analyze the app's concept during analysis; design the app's interfaces during design phase; and develop the app during the implementation phase, and hence culminating with the system or android application in this case.

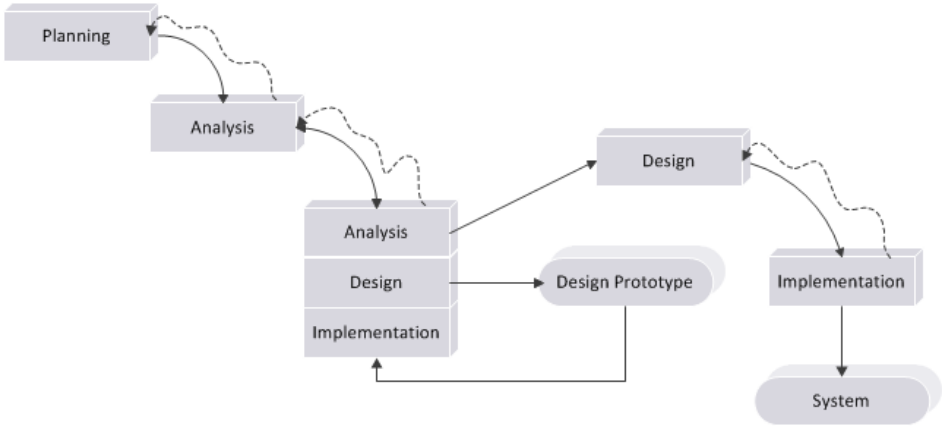

Figure 9. Throwaway prototyping based software development methodology

SYSTEM ARCHITECTURE

The architectural pattern used was Service-oriented Architecture. The underlying reasons of the choice of the architecture were that the system requires internet connection in order to communicate with the external translation service provider. Moreover, within the mobile device, the system is portrayed in terms of a layered architecture, containing Presentation, Business, and Data Access Layers. The Database is to be placed in future improvements of the app (see).

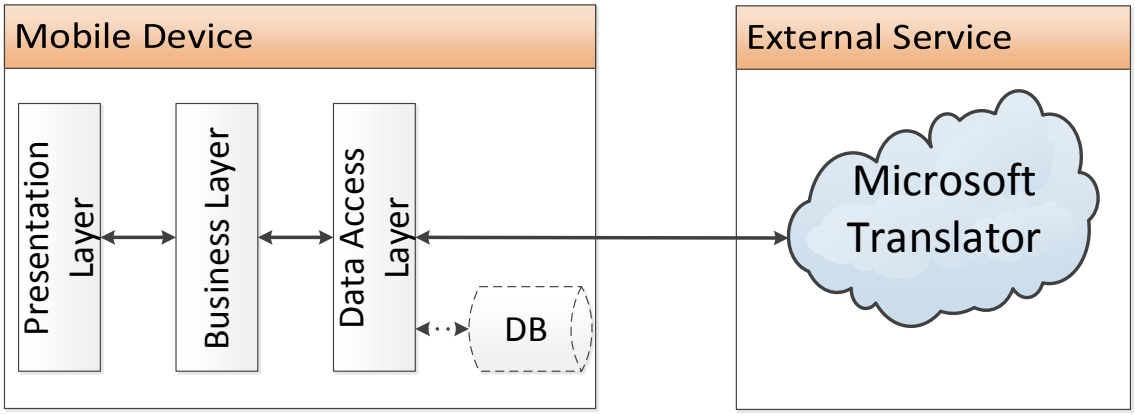

Figure 10: App's architectural diagram

SYSTEM DESIGN

The app is designed to be straightforward and simple to use. Moreover, it features a minimalist user interface design in order to smoothen the operation with little user input. The app will be launched by pressing the launcher icon (see Figure 3.a.i) which will properly initialize all components and wait (Figure 3.b). At this point, if the user wishes to exit, he will just be returned to the home screen. In case of proceeding and pointing the smartphone to any text surface, the app will immediately attempt recognition and posterior translation (Figure 3.c). From any of the screens below, the user can exit the app or return to the main activity.

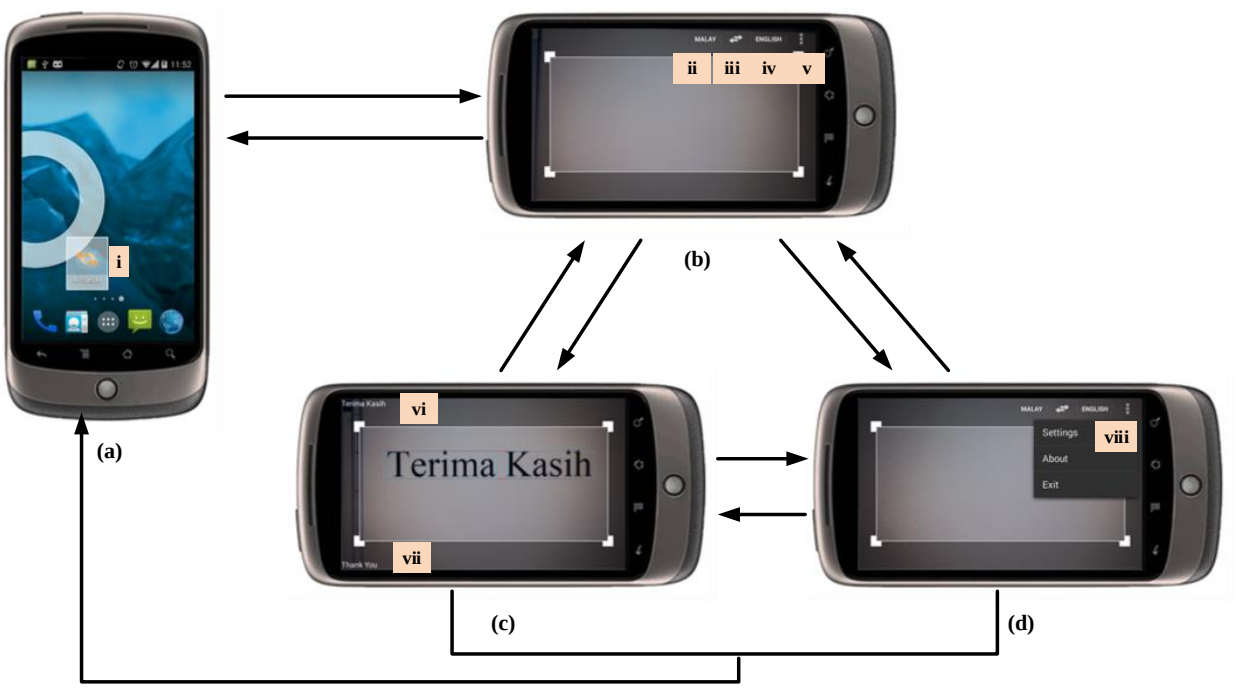

Figure 11. The app's working design. **(a)i** is the home screen launcher icon of the app; **(b)ii** is the source language; **(b)iii** is the toggling button to switch between languages; **(b)iv** is the destination language to which the translation has to be achieved; **(b)v** is the overflow menu button that when pressed displays the menu options, as in **(d)viii**; the recognized text will be displayed in **(c)vi** and the translation will be placed in **(c)vii**.

In terms of modeling, the behavior of the app can be best envisioned using an activity diagram. After the app properly initializes, it starts detecting whether there is any text in the view finder. On successful detection, the OCR module will then send the recognized text to Microsoft Translator so that a translation is attempted. While the translation takes place, the recognized text is displayed in the user interface, and when the result of the translation is returned, it too is displayed in the main user interface (see Figure 4 below).

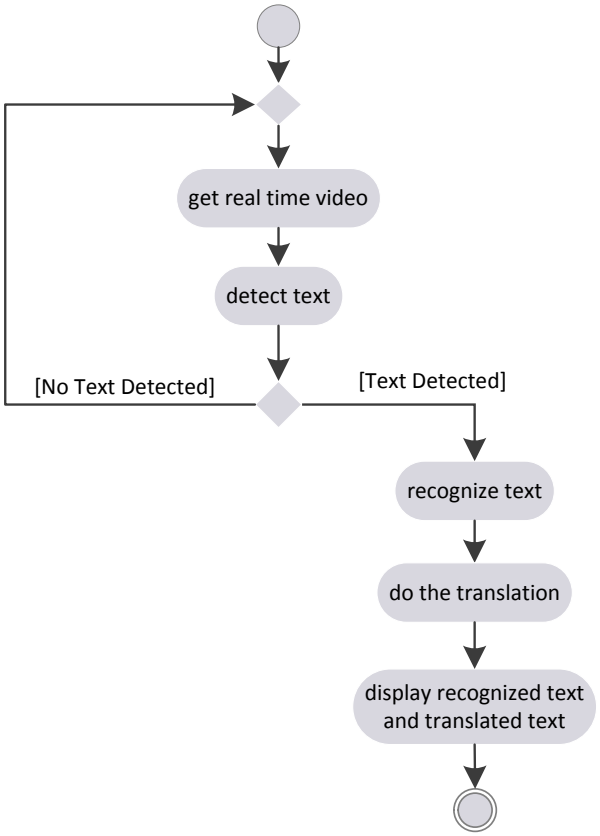

Figure 12. The app's activity diagram

CONCLUSION AND RECOMMENTIONS

Sign boards were given the task of informing or conveying intended messages to viewers. Not often the viewers can understand the messages being transmitted due to the fact that these are foreigners and are not versed in Malay language. With smart phones exponentially increasing their processing power, fields such as AR and OCR are taking advantage of this processing power to provide additional use to the smart phones. Moreover, by relating AR, OCR, and some past studies it was possible to produce the app herein revealed. This app is intended to aid foreigners to better understand sign boards written in Malay language in Malaysia.

As recommendations, since the app is intended to be used in a Malaysian context, it would be beneficial to include the other 2 languages that are spoken in Malaysian, namely Chinese and Tamil. Another recommendation is to include a small database with the most basic words in order to allow the app to provide a basic translation even when there is no data connection.

ACKNOWLEDGMENTS

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