AUGMENTED GRADING SYSTEM

By

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16042

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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Approved by,

_____

(Saipunidzam Mahamad)

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TRONOH, PERAK

MAY 2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am held responsible for the work submitted in this project, that the original work is my own except citations included in this project as stated in the references section and that the original work contained herein have not been undertaken or done by unspecified sources.

_____

Muhammad Nizarsyahmi bin Mohamad Ezzani

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ABSTRACT

Education plays an important roles in current generation as various type of education system have been adopted and revised to nurture an intelligent society. Most education system even though varied, still carry similarity in their way of assessing their scholars which is through a test or an examination. The multiple choice question is the most popular type of assessment and the tools to help an educator with them is through Optical Mark Recognition (OMR) papers and scanner. However, the scanner itself is very expensive and for the OMR papers, it is kind of waste when only a small number of questions are used with the OMR. Thus, an alternative has been proposed under Augmented Reality (AR) concept which is Optical Character Recognition (OCR) to be used instead of OMR when less formal kind of assessment are involved.

TABLE OF CONTENTS

TABLE OF FIGURE

CHAPTER 1

INTRODUCTION

1.1 Background of Study

In the 21st century there is widespread recognition that skills and human capital have become the backbone of economic prosperity and social well-being according to Tremblay, Lalancette and Roseveare (2012). Furthermore emphasized by Dill and Van Vught (2010) that the higher education represents a critical factor in innovation and human capital development and plays a central role in the success and sustainability of the knowledge economy. Hence, education system has leap and forth to become of what it is today.

Current education system relies mostly on technology to assess numerous amount of test paper by the students of their respective place of education. Majority of education organization used Optical Mark Recognition (OMR) to help their educators to mark the students' paper. The OMR marking accuracy is up to 98%, but only limited multiple-choice question and will not take any handwritten answer. Optical Character Recognition (OCR) in the other hand can detect either typed text or handwritten text from a document by using a camera.

Studies on Augmented Reality (AR) which is the combination of digital information with real time users' environment have been ongoing as early on year 1957, but its first mention was in 1901 by L. Frank Baum. Ever since the launch of smartphone, various developers have taken the opportunities to use the potential provided by the smartphone by developing their own application for the benefits of others. OCR is one of the technology produced from the studies on AR.

One of the smartphone core component is their camera. Some smartphone have a single camera attached while some have dual camera which are located at the front and at the back respectively. Even though this powerful component have been

provided by the manufacturer, their usage still have not been fully exploited yet as many more functionality can be created as long as correct programming is provided to the system such as OCR.

1.2 Problem Statement

Currently most of education organization used OMR to mark their examinee paper. The problem is that the limit imposed by OMR Marking scheme that it only applies when the examiner is answering multiple-choice question using the OMR sheets. Further problem is that when an educator wanted to mark the paper using the OMR sheets, they need to go through the examination or related department to actually mark the paper. Final problem provided by the OMR is that it is costly because OMR paper are special made unlike normal A4 paper and is especially costly when the OMR sheets are being used by thousands of student with multiple times according to their related course. Thus a study which investigates Augmented Reality using smartphones by implementing image processing to remedy the situation.

1.3 Objectives

In order to cater the problem stated from previous topic, the following objective has been considered:

i. To develop an Android Apps which able to detect, recognize and process handwritten text using Augmented Reality.
ii. To integrate the functionality of text detection, handwriting detection, optical character recognition and image processing into a single apps for grading purposes.

1.4 Relevancy and Feasibility of the Project

The application can help an educator to have an alternative for an OMR as there is no other application existing in the Google Play Market that have the same functionality of the application. Educators have been using OMR since for so long but there is no other alternative for OMR even though technology has advance so far.

CHAPTER 2

LITERATURE REVIEW

2.1 Augmented Reality

Augmented Reality (AR) as a real-time direct or indirect view of a physical real world environment which was augmented or enhanced by adding information which is generated by a virtual computer to it [1]. AR allows mixture of digital content and reality through the usage of tools such as camera overlaying digital content unto the perception of real world. The application of AR allows 2D or 3D objects such as media files, textual information and even tactile information to be incorporated into users' perception of real world [2].

2.2 Text Recognition

Text recognition is an operation done on a scanned image which also essentially enhance the image, rendering it suitable for segmentation. Text recognition involves binarization process which converts a gray scale image into a binary image using global thresholding technique. Detection of edges in the binarized image using sobel technique, dilation the image and filling the holes present in it are the operations performed to produce the pre-processed image suitable for segmentation [3].

2.3 Handwriting Recognition

Handwriting recognition is classified into two types as off-line and on-line handwriting recognition methods. In the off-line recognition, the writing is usually captured optically by a scanner and the completed writing is available as an image.

But, in the on-line system the two dimensional coordinates of successive points are represented as a function of time and the order of strokes made by the writer are also available. The on-line methods have been shown to be superior to their off-line counterparts in recognizing handwritten characters due to the temporal information available with the former [3].

For highly accurate character recognition, it is necessary to model the structure of characters as realistically as possible. Stroke relationships mean dependencies of positions between strokes; the location of a stroke gets influence from those of other strokes. [5]

2.4 Optical Character Recognition

Optical character recognition (OCR) is a powerful tool for bringing information from our analog lives into the increasingly digital world. This technology has long seen use in building digital libraries, recognizing text from natural scenes, understanding hand-written office forms, and etc [6]. Most of the character recognition program will be recognized through the input image with a scanner or a digital camera and computer software. OCR is a technology that enables conversion of different types of documents such as scanned paper documents, PDF files or images captured by a digital camera into editable and searchable data. Images captured by a digital camera differ from scanned documents or image [3].

2.5 Image Processing

Implementation OCR allows the inputs to be edited, several major steps are involved in image processing for data extraction. The first is preprocessing which is the major step in handwriting recognition system. Followed by, character segmentation and recognition which an image of each word received is decomposed into sub-images of individual characters [7].

CHAPTER 3

METHODOLOGY

3.1 Research Methodology

The following subtopic will describe the type of approach used to carry out the project. The method are chosen appropriately in order to collect and analyse the collected data in the most effective and efficient way which should resulted a solid scope which is the requirements of the apps to be developed. The requirements will determine the core functionality and other additional functions which are needed by the end-user.

3.1.1 Data Gathering

The project is to develop an apps which mainly focus on one type of user which namely an instructor. Qualitative research are chosen which is to conduct an interview that should be the best suited in this situation to gather the data needed to determine the application functional requirements. The OMR are mainly used by instructors from the high school level and also the university level. So, the interview should be carried out with an instructor from both education level as they are the potential end-user for the apps.

3.1.2 Data Analysis

Through the interview, the conclusion from the discussion will not only determine the core function of the apps, but also the user requirements for the apps which is what else aside from the core function that the stakeholder wants to be included with the

apps. The analysed data will be translated into functional requirement and non-functional requirements respectively in chapter 4.

From the functional and non-functional requirements, Unified Modelling Language (UML) Diagram will be designed. The UML Diagram should allow the stakeholder to get the general overview on how to application should work.

3.2 Development Methodology

The application itself is for an Android Smartphone, the best development method to be used in this case is Rapid Application Development (RAD).

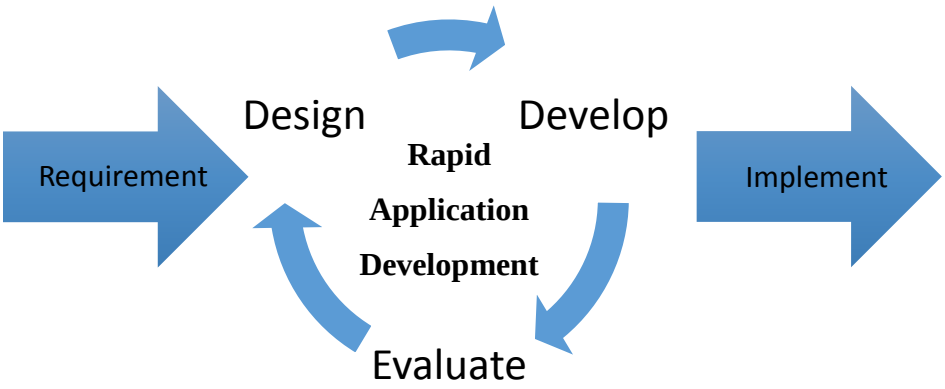

Figure 3.2.1 - Agile Development Process

3.2.1 Planning (Requirement)

Planning phase is very important as a project kick-off, as it usually played crucial roles on determining the scope for the project. The scope can be determined through a research of any past or similar project and also through the discussion by the stakeholders during the project proposal. After the scope has been established, follow-up activities such as design, development, evaluation and implementation are to be scheduled for the total duration of the project. For this project, a total of 7 months period are given and will be separated into their respective milestone such as planning, design, development, evaluation and implementation. The schedule will be represented by using a Gantt chart (*see Appendix 1*).

3.2.2 Design

The design phase is to design the working of the apps based on the findings on the data gathered and analysis. The working flow of the apps is to be represented with UML diagram, which for this project Use-Case diagram and Activity diagram. The Use-Case diagram shall explain the functionality available inside the apps which the Activity diagram shall explain on the flow on the interaction between the users and the functions.

The initial design of the apps or the prototype should indicate how the apps Graphical User Interface (GUI) should look. The design should be simple and user friendly to allow first time user to achieve high rate of learnability.

3.2.3 Development

The development phase will take the longest time from the total project period as this is the most crucial phase for any project. The development for each function will be done one by one along with its testing to reduce chance of major bug in the programming.

The development for this project shall be done on Android OS, using Java programming language. The tools to be used for the development of the apps is Android Studio. As for the apps engine, Tesseract-OCR will be used and Leptonica API for image processing. Other libraries such as JPEG and Eyes-two shall be added for better image processing based on different bitmap and also further improvement on the text recognition rate.

In simple term:-

- Platform: Android OS
- Development Tools: Android Studio
- Engine: Tesseract-OCR
- Main library: Leptonica API
- Other library: JPEG API, Eyes-two API

3.2.4 Evaluate (Testing)

The evaluation phase will start as soon as the first function have been developed, simultaneously with development phase. This are done because it is necessary for a testing to done quickly as not to interrupt any other functions' functionality when it is being run. The existence of bug in a function that affect another function will cause severe defect if not detected in the early stage. For unit testing, the developer will test for the functionality while for the system testing, an independence tester are preferred to do the testing. Besides testing, evaluation is also necessary to make sure the functions fulfilled the requirements. If the functionality does not fulfill the requirements, then it is necessary to check the design.

3.2.5 Implementation

The implementation is the release of the apps. Since RAD are being used, even with a release, the apps are still will not be considered completed because there will be a new release or updates every time a new functions are completed for the apps. The functionality will be added one by one with each subsequent release. So the users may should not expect a full version with all completed functions within the early period of the initial release.

CHAPTER 4

RESULT AND FINDINGS

4.1 Interview Result and Analysis

Just as aforementioned in chapter 3, an interview are conducted to gather data from instructor from a high school level and university level. Several question was asked from both instructors following the guidelines for interview question (Appendix 2). The following are the summary for the interview conducted with the instructors.

4.1.1 University Instructor

The number of test conducted by a university lecturer are usually two per courses which Multiple Choice Question (MCQ) are seldom being carried out because it is not suitable with the main reason that the test are carried out to measure the understanding of the students, not for them to randomly choose an answer that they think is the best one. Even if there will be a MCQ, it will be usually a combination of MCQ and subjective, so the number of MCQ question seldom be more than 40 and the average is around 15 to 30. Usual period to mark the paper is one to two weeks as the lecturers can just pass the OMR paper to the examination unit scan through the OMR papers. If there is an apps that can replace the OMR, the lecturers are willing to use it because it does the same thing as OMR scanner less trouble to go and wait for the examination unit.

4.1.2 High School Instructor

The number of test conducted by a high school teacher 3 times for normal test and once for final test. All of the tests conducted relies heavily on the usage of OMR paper because the test are carried out simultaneously on all grade and most of the subject have some MCQ. The average number for MCQ for high school is around 40 and the time taken to mark the OMR depends on the effort given itself, this is because the schools doesn't have an OMR scanner so it's all depend on manual way. Sometimes the teacher asked the help of their students to mark paper to make it faster. If an apps to mark the paper is available on smartphones, the teacher are willing to use it because it will make the marking easier and more efficient.

4.2 Testing

The testing are divided into two part which are unit testing, integration and system testing by the developer then another system testing together with acceptance testing with external tester.

4.2.1 Developer Testing

The unit testing and integration testing are done while the apps are still in development as to prevent accumulation of bugs or defects throughout the development. System testing are carried out after the whole functions of the apps are completed. The result of the system testing are all the functions are working as intended.

4.2.2 External Tester

The test are carried out after the prototype have all its functions and are considered to be fully functional. The external tester must try out all functions and give feedback on what she think about the functions. The quality being tested for each functions are effectiveness, efficiency, correctness and learnability. While these are the quality being tested, other opinion or comment regarding the apps will also be taken note.

4.3 Testing Result

The testing are done by the interviewed person which requirements are gathered from. The result of the testing are categorized accordingly to each software quality attributes being tested upon.

4.3.1 Effectiveness and efficiency

The view by external tester is that for a small number of paper to be graded, the apps are less effective but if the amount of paper to be graded are huge then the apps will be much more effective and efficient to be used for.

4.3.2 Correctness

The positive result from the test is that most of the detected text from the paper to be graded are correct, but not all of them. The problem on correctness is that some character are being read wrongly thus giving the wrong result when the paper are being graded. Out of 20 paper that was marked, the result for one of the paper are incorrect thus giving only 95% of correctness of the apps.

4.3.3 Learnability

Based on the tester experience, the learnability of the apps is great. This is due to the apps are very easy to use with only few buttons and simple interface are being used.

4.3.4 Other comment from tester

- The usage of the apps for many papers to be graded are battery draining.
- Too repetitive.
- Wanting functions that can grade subjective questions.
- Interface look too plain.

4.4 Graphical User Interface Design

The Graphical User Interface (GUI) should be designed to be simple and user friendly. Each activity will be having different GUI which their illustration will be provided as follows:-

4.4.1 Home

Figure 4.4.1 - Home Activity

Figure 4.2.1 shows the content of home activity which consist of buttons to launch next activity which is either Mark Paper, Set answer or History. The button will redirect users to their respective activities chosen for the functionality. This activity is the first activity upon the launching of the apps.

4.4.2 Mark Paper

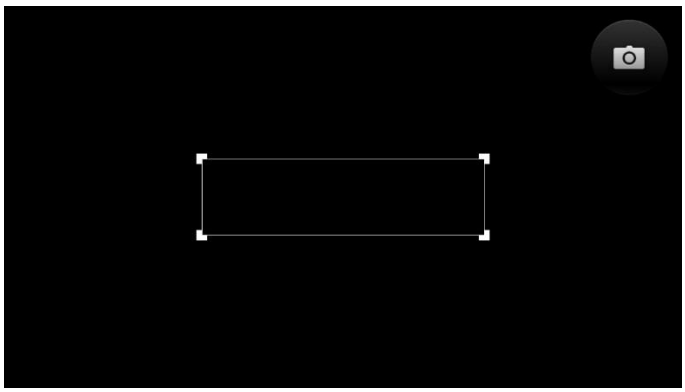

Figure 4.4.2 - Mark paper activity

Figure 4.2.2 shows the GUI of paper marking activity. The GUI used for mark paper activities are default GUI of the Tesseract-OCR. The default Tessaract-OCR GUI is already simple and user friendly which allows user to have minimal difficulty when using the apps for the first time.

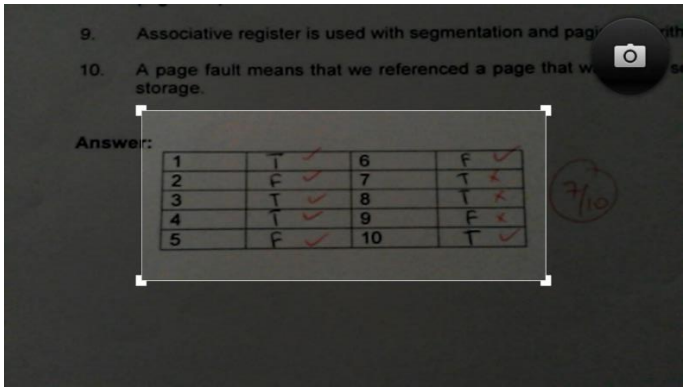

Figure 4.4.3 - Detecting Text

Figure 4.2.3 shows the action by a user to detect the text which consist of question numbers and its answer. User can set the focus point of the detection by resizing the highlight box according to their intention. Detected answer will be compared to answer which have been set and popup in will tell the user the results in percentage.

4.4.3 Set Answer

Figure 4.4.4 - Set Number of Question

Figure 4.2.4 consists of input text and a button. The input text will only accept integer numbers. Upon inserting the number and clicking “OK” button, the apps will generate the answer set as shown in Figure 4.2.5 according to the number entered in the input text.

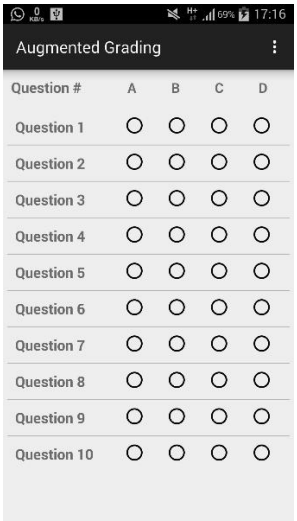

Figure 4.4.5 - Set answer

Figure 4.2.5 allow user to set the answer of the respective question numbers. The answer which was set will then be used to be compared with detected text similarly as shown in Figure 4.2.3.

4.4.4 History

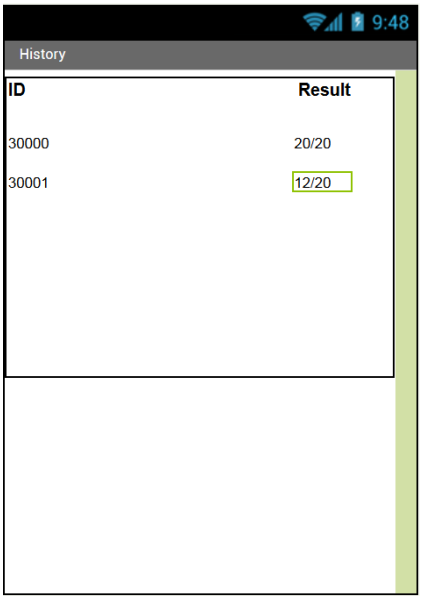

Figure 4.4.6 - History Activity

Figure 4.2.6 is the history activity which tabulated the previous recorded result. The result are stored in database format using Android smartphone embedded SQLite. The contents of history activity are primarily the ID detected from the paper and their respective result.

4.5 UML Diagram

The UML diagram is the representation of requirements through the analysis of data gathered. UML diagram shows the simplified version of what needed to be designed and developed in order to fulfil the expected requirements.

4.5.1 Use Case

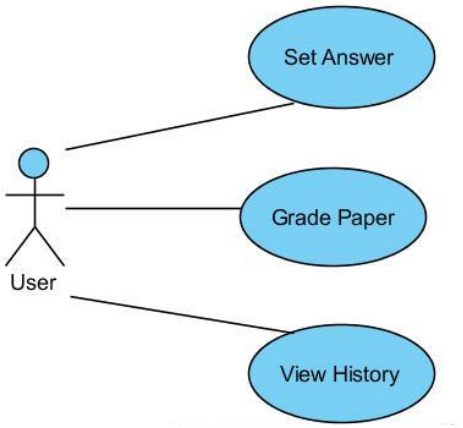

Figure 4.5.1 - Use Case diagram

The requirements for the apps for initial stage is just the three stated in Figure 4.3.1. Only a single user may interact with the apps since the platform for the apps itself is an Android smartphone that doesn't relate with any networking and is using embedded database to store the data. The three main functionality are "Set answer" which are used to set the number and answer combination for the marking purposes. Mark paper is the usage on OCR to detect, retrieve and extract text by using the camera to compare with the answer set. While view history functions to display past marking activities.

4.5.2 Activity Diagram (Set Answer)

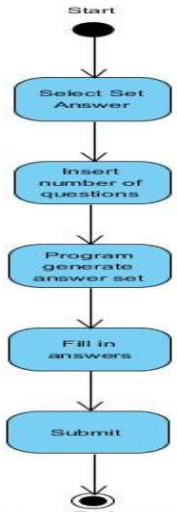

Figure 4.5.2 - Activity Diagram (Set Answer)

In home activity, user clicking the Set Answer button will be redirected to Set Answer activities. Figure 4.3.2 shows the activity need to be done to set the answer, which firstly user need to state how many question the test has. After the submission of the question number, the program will generate the answer form which user need to fill in the answer according to their respective number and click on Submit button to finalize the answer.

4.5.3 Activity Diagram (Mark Paper)

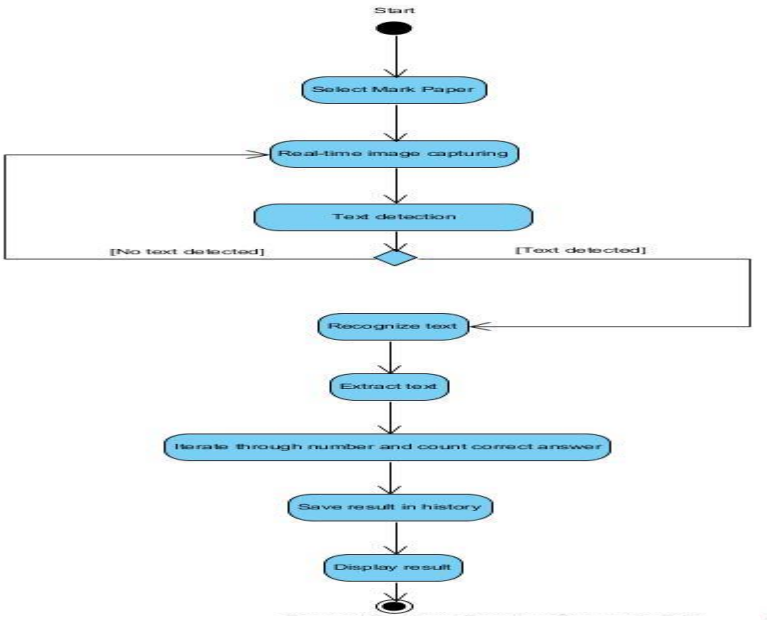

Figure 4.5.3 - Activity Diagram (Mark Paper)

From home activity, clicking Mark Paper will redirect user to Mark Paper activities that contain real-time image capturing and OCR functions that will try to detect text until successful. Upon text detection, recognition and text extraction will be executed to do comparison algorithm with the answer set. The result will then be saved in history and displayed to the users.

4.5.4 Activity Diagram (View History)

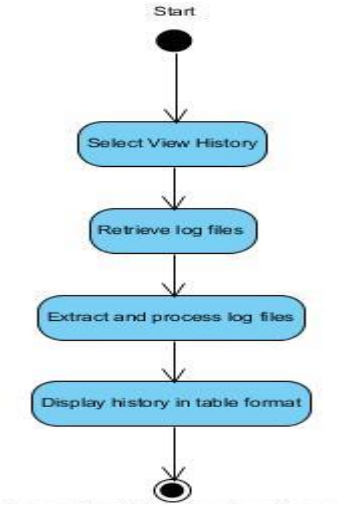

Figure 4.5.4 - Activity Diagram (View History)

View history functionality is to display past result to user in more organized way. After entering the View History activities, the program will retrieve the data from the log file and display the information to the users.

4.6 Discussion

The OCR technology for smartphones are still far behind other platforms due to its restriction on the hardware such as the processing power, battery and camera performance. Software instead, to use a single library to perform OCR on a smartphones are difficult due to the lacking of the programming for Android OS platform and to increase the recognition rate for the apps, several other library needed to be included. This shows that the AR technology on smartphones are still lacking due to various hardware and software problem.

The biggest issue about AR on smartphones is the power consumption. Just by opening any AR apps from a smartphones will cause the battery to be drained on higher rate than most of the existing apps because AR use various hardware simultaneously vigorously to carry out their functions. The best example is the Real-Time image processing where camera and processer performance are needed to be on the upper limit.

The camera are next on the list because with a low resolution camera, the time needed to actually recognize a text became longer because the blurry image make the camera get less accurate focus on the text. If a recognition rate became lower, it is more likely to have an error in the data gotten from the camera thus decrease the apps reliability. The only solution is to use smartphones that have at least 5MP camera resolution.

The least significant is the internet connection. The apps itself does not use Internet to functions, but for OCR it will be necessary to have Internet to update language data library. To have an updated language data library means that the apps though not much but still can have a small increase in the recognition rate.

CHAPTER 5

CONCLUSION

Augmented reality progression in smartphones industries are quite slow due to restriction on the hardware, but due to the rapid progression of smartphones technologies, AR now currently able to run smoothly on some of the phones with high specification. The usage of AR in education system are limitless but unfortunately not many interested to explore the possibility and focused more on the entertaining factor. As contribution to the education industry, the project is to create an apps that allows the usage of AR and OCR to detect, recognize and extract the text for comparison functioning as an alternative for the OMR.

With the launching of the apps, instructor can have more efficiency in term of grading especially in high school level where the school does not have an OMR scanner. It should reduce the traditional way that not only time consuming but also able to save money by reducing the usage of OMR paper.

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APPENDIX

Appendix 1: Gantt Chart

Activities	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
1.0 Planning														
1.1 Background of Study														
1.2 Problem Statement														
1.3 Objective/Scope														
1.4 Literature Review														
2.0 Design														
2.1 Data gathering														
2.2 Data analysis														
2.3 Results and Discussion														
2.4 Requirements gathering														
2.5 UML Diagram														

Gantt Chart FYP 1

Activities	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
3.0 Development														
3.1 Interface														
3.2 Mark Paper														
3.3 Set Answer														
3.4 View History														
4.0 Evaluation														
4.1 Testing/Debugging														
4.2 Requirement validation														
5.0 Implementation														
5.1 Maintenance														

Gantt Chart FYP 2

Appendix 2: Interview Question Guidelines

1) How often do you do a test?
2) Out of those test, how many are there mcq type of test?
3) What is the average number of question for mcq?
4) Is OMR scanner available in this place?
5) How do you grade the paper if the OMR scanner are not available?
6) How many papers are usually being graded at one time?
7) How long does it take to mark the OMR paper?
8) Do you often get help from others to grade the paper?
9) If you can use your phone to mark the paper, would you use it?
10) What other functionality would you think is good to have?