Automated Engineering Quiz Contest System Using Wi-Fi and Android App

Ann E. Dulay*, Katrina M. Pangan [†], Mary L. Requilman[‡], Mark U. Te[§] and Bryan L. Young[¶]

*Electronics and Communications Engineering Department

De La Salle University

Email: ann.dulay@dlsu.edu.ph

[†] Email: katrina _pangan@dlsu.edu.ph

[‡] Email: mary_rose_requilman@dlsu.edu.ph

[§] Email: mark_kevin_te@dlsu.edu.ph

[¶] Email: bryan_young@dlsu.edu.ph

Abstract—This research aims to develop a Wi-Fi based data transmission system for automated engineering quiz contest applications. The system consists of an Android app that serves as the 'answer sheet' for each school participant. The recognition system used is the Optical Character Recognition (OCR). The system mimics the typical engineering quiz contest where questions are flashed on the screen and the contestants are given a certain amount of time to give their answer. The system was tested with fifteen devices operated by fifteen participants in order to determine the capacity of the network to simultaneously process the transmitted signal. The timer flashed on the screen is synced to the timer of the image-to-text converter and a grace period is allotted to allow all the images to get through. The grace period can be set by the administrator depending on the number of participants. For the fifteen devices tested, a 1-sec grace period is added to the timer of the converter since the time it takes to transmit the data from the Android device to the server is 0.1 sec. When this time lapses, the converter program closes thereby blocking all the other transmissions. The test shows that this time is sufficient to accommodate all fifteen devices.

The OCR has a character recognition accuracy of 83.95 %. The accuracy of detection for answers comprising several letters and symbols depends entirely on the way the letters were written. If a letter overlaps another letter, the OCR misinterprets it to another character, hence the image is converted incorrectly. It is therefore recommended that scoring be done manually but it's GUI is still embedded with the GUI of the 'answer sheets' so that as each answer is shown, the scorer simply presses a GUI button to update the score on the corresponding cell.

The communications between the Android device and the server is simplex, hence, the system has no control over the Android device. It is recommended that the App of the Android device be integrated with a timer that will be synced with the server. This would require two way-communications and allows the system to have control of the Android device such that when the time lapses, the App is disabled, hence disallowing the device from sending the answer to the server. This would ultimately eliminate disputes regarding the ability of the system to receive the answers at the allotted time.

I. INTRODUCTION

Quiz contests come in different forms. Some contests are based on the speed of the contestants to give the correct answer, that is, whoever presses the buzzer first shall be the one who will give the answer. This type is practical for contests with less than five contestants. Other contests use devices that the contestants press to give their answers ([1], [2], [3], [4]), but this type is practicable only for contests where answers are supplied through multiple choices and the mode of answering is by pressing the 'button' that corresponds to one of the choices, either electronic or through a device. Some contests require all of the participants to give their answers within the allotted time, each answer is scored manually and tallied, and whoever has the highest score at the end of the last round wins. Engineering quiz contests conducted by the Institute of Electronics Engineers of the Philippines (IECEP) use the last type contest for its National Quiz Bee. It is participated by various schools all over the country with more than thirty contestants still remaining after doing the regional elimination. The answers to the questions being asked are not supplied through multiple choices or other similar forms, instead the contestants write their answers in an acetate because handwritten answers are faster than typewritten answers ([5]) especially when it involves answers from solutions.

During the contest proper, the questions are flashed on the screen; a Quiz master reads the question twice, then a timer is activated. Once the time is up, the contestants should stop writing, gives the acetate to the

collector, the collector brings the acetate to the OHP operator, and the answer of each contestant is flashed on the screen, and another person writes and tallies the scores. This process requires several people doing the collecting, the OHP operation and the scoring, and consequently requires lots of time to do all of these processes. This research aims to remove the need for such manual process by using an Android device and a Wi-Fi connection. The Android device serves as the contestants answer sheets through the use of a Scratch Pad Application. The answers are sent to the Master Unit (MU) through Wi-Fi. The MU contains the main program that has several GUIs for showing the images of the answers and the running total of scores. The conversion of the handwritten image into text is implemented using an optical character recognition (OCR) algorithm. A dedicated router is set-up to create the local area network for the Android tablets. Each tablet is registered before the start of the contest where each contestant is provided the password of the router so that other Android devices in the venue would not meddle with the entire quiz contest process.

The rest of the paper is constructed as follows. Section II explains the quiz contest setup. In Section III, the process flow of the system along with the developed graphical user interface (GUI), the implemented optical character recognition (OCR) system, and the developed Scratch Pad Writing Application are described. Section IV presents the evaluations and discussions based on the results. Finally, Section V provides some concluding remarks and offers some recommendations for future work.

II. Quiz Contest Set-up

The quiz contest set-up is shown in Fig.1. It comprises of the Android devices, the router, and the main server. For purposes of demonstration, only fifteen (15) Android tablets are utilized in the simulation of the contest. The limitation is due to the available devices rather than the capacity of the router. Each Android device is first registered by connecting to the dedicated local router Wi-Fi. Before the registration process, the devices are installed with the Scratch Pad app developed by the proponents. Fig. 2 shows the user interface of the android app that serves as the answer sheet. It contains the pen, the text tool, eraser tool, and the worksheet shown on top and at the bottom is the mail icon which serves as the SEND button. The first three tools can be adjusted depending on the android device's settings. The router is communication media between devices and the main server.
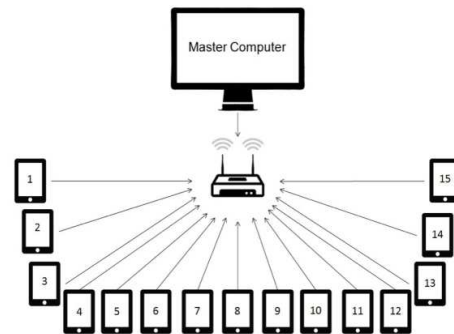

Fig. 1. Quiz Contest Set-up

The summary of the contest process with the automated system in place is shown in Fig. 3. It starts with the installation of Android application to the tablets of each contestant. Each participant is then asked to establish the connection with the dedicated router by providing them a password. This is done to prevent other devices of the audience from connecting with the dedicated Wi-Fi. As each participant connects their devices, the Administrator/Quiz Master writes the name of the school in the GUI. Once all devices have been registered, the contest proper starts. Each question is flashed on the screen; timer starts after the quiz master reads the question twice. The contestants should write their final answer on the tablet and press the submit button before the designated time ran out. Once the data have been sent, the master unit will then automatically verify the answers through the automated system developed which converts the image (handwritten text) to text, and automatically update the score sheet. The original handwritten answer of each contestant is flashed on the screen while the scores are automatically updated and shown at a portion on the side of the screen.

III. System Process Flow

A wireless network using the D-Link DIR-655 Wireless N Gigabit Router is established in order to connect at least fifteen (15) simultaneous connections of Android devices. An Android application that serves as the verification and the connection entry point to the network is developed. This application is also developed to function as the answer sheet or writing canvas of the participants. The data from the Android application in the form of *.jpg files are then transmitted to the master unit through a server application. A database is also developed so as to allow the master
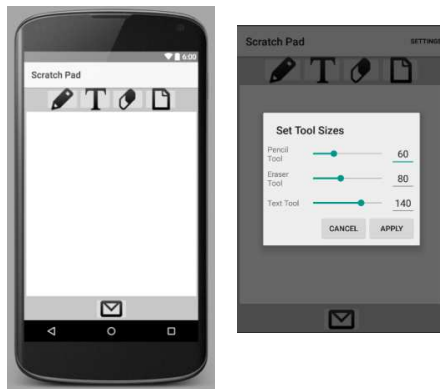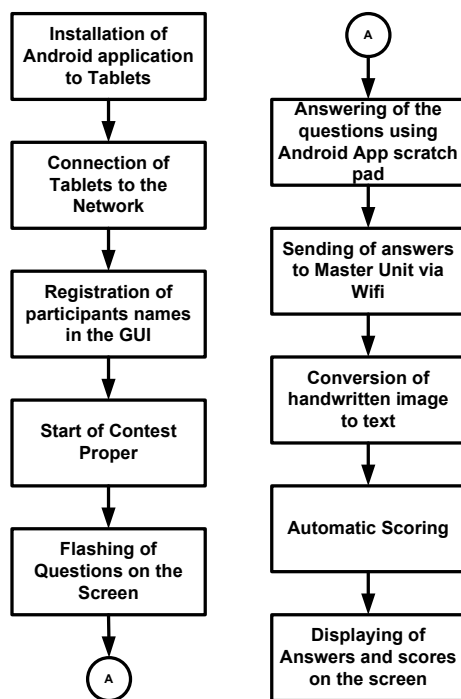
Fig. 2. Scratch Pad User Interface

Fig. 3. The Contest Process

unit to compile all of the transmitted data and view all of the devices connected to the network.

Different MATLAB *.fig files consist the GUI for the quiz contest. The quiz questionnaire, poster, mechanics, and list of the contestants are created and edited by the quiz master provided that the three files are saved as *.jpg files per slide following the file allocation for the GUI (i.e. Slide1.jpg will contain question number one). The latter is then connected to the Score Database which is the same file where

the scores gathered from each question windows and scores displayed to each answer windows are stored and retrieved, respectively. The scaling of the GUI limits the number of participants to only 15-30. The GUI has an assigned duration of the timer depending on the category which ranges from 30 seconds, 60 seconds, and 90 seconds. The GUI then calls the function which is responsible to running the *.m files for automatic checking and scoring of images at the end of each question. At the end of each question, the answers of the contestants along with their registered names, current scores, and total scores are displayed (Fig. ??)). The developed GUI also allows the option to manually override the scores at the end of every question. The ranking of the contestants are then displayed at the end of the quiz contest. Fig. 4 summarizes the system process flow.

An OCR program is also implemented in order to convert the handwriting of the participants to text for the automatic scoring. In order to do so, the program loads the images sent by the contestants to MATLAB. Once loaded, the image is converted to gray scale, then to black and white. An example is shown in Fig. 6. Several template files containing all of the characters (in matrix form) were used to train the system. After identification of the number of lines and the number of characters in each line, the characters are then cropped individually and resized to a 42 x 24 matrix.

The correlation between the templates and the input image is done by a loaded program. The output of this program is the string containing the letter that the input image correlated with. After conversion, the automatic scoring program is then implemented which compares the file containing the converted handwriting to the text file containing the correct answer. The scores are then stored in an excel file and called by the GUI for display.

IV. Results and Discussion

A. Device Connectivity

Fig. 7 shows the signal strength of the dLink router as a function of distance. The tool used to measure this is the Wifi Analyzer application which is loaded in the device under test (DUT). The DUT is an Android device and represents all the possible Android devices that could be used in the contest. Expectedly, the signal strength monitored by the DUT gets weaker as it goes farther from the dLink router, or simply put, the signal strength is inversely proportional to distance.

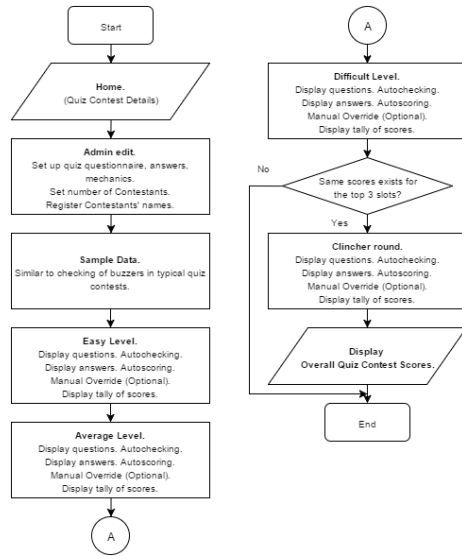This test also shows the reliability of the router connection amidst several wifi sources present in the
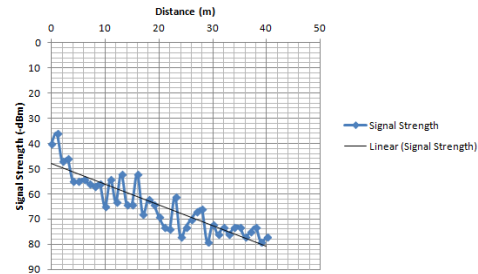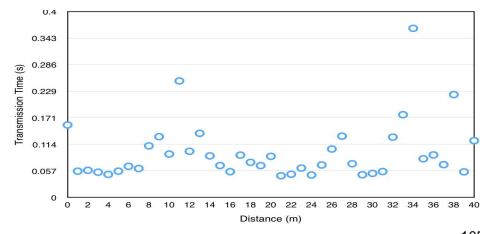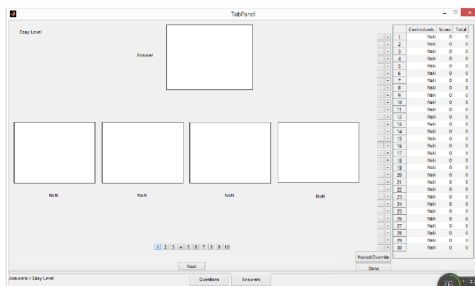
Fig. 4. System Process Flow

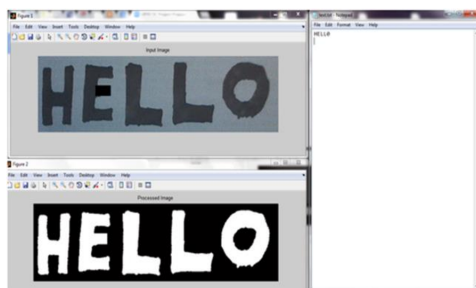Fig. 5. GUI for Displaying the Answers and Scores

Fig. 6. Character recognition process

area that are also received by the DUT. This is crucial during the actual contest such that Android devices registered by the participants should never be disconnected at any time during the entire contest.

Fig. 7. Wi-fi Signal Strength

Fig. 8. Transmission Time vs Distance

B. Data Transmission

In this test, the DUT sends data to the router at various distances to determine the maximum distance at which the router could still establish a connection. In the test conducted, the maximum distance at which the router can receive data from the Android device is 40 m. For the same set-up, the transmission time is measured. This is done to determine the grace period that will be included in the GUI's timer before it closes and prohibits any data from any device to be sent to the main program. Engineering Quiz contest are buzzer beater types of contests where contestants are required to submit their answers within the designated time. It was observed in the test that the average time it takes to transmit the data is 0.1 sec and this is notwithstanding the distance of the DUT from the router as long as it is within its range. The transmission time is relative to the image size (answers from the Android device). The typical size of the image is only about 30 kb in size.

C. Character Accuracy of OCR

The group aimed to determine the accuracy of the OCR system by getting thirty samples per letter. Figs. 9 and 10 show the accuracy obtained per letter, and the letters that the developed system gets confused with. Fig. 9 shows the accuracy obtained by each of the capital letters. The letters which got a perfect accuracy were letters L, and V. Letters which got 90%-99%
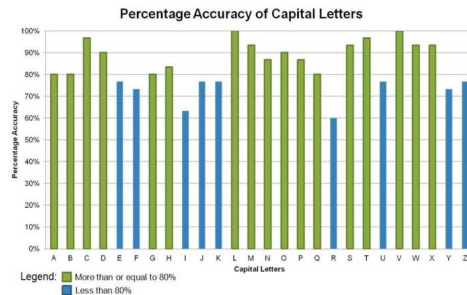
Fig. 9. OCR Accuracy for Capital Letters

Fig. 10. OCR Accuracy for Lowercase Letters

accuracy were C, D, M, O, S, T, W, and X. Letters which got 80%-89% accuracy were A, B, G, H, N, P, and Q. Letters which got 70%-79% accuracy were E, F, J, K, U, Y, and Z. Letter R had the lowest accuracy with only 60% which was followed by letter I with 63.33%. The average accuracy of the capital letters is 83.72%.

Fig. 10 shows the accuracy of the small letters. The letter which obtained a perfect accuracy was letter v. Letters which obtained 90%-99% accuracy were c, d, j, o, r, s, w, and x. Letters which obtained 80%-89% accuracy were a, b, f, h, m, p, and q . Letters which obtained 70%-79% accuracy g, t, u, y, and z. Letters which obtained the smallest accuracy at 50% were letters i, and l followed by letters e and k with 66.67%.

Fig. 11 shows the accuracy obtained for numbers 0-9. The number which got 100% accuracy was number 0. Numbers which obtained 90%-99% accuracy were 1 and 3. Numbers which got 80-89% accuracy were 2, 4, 7, and 9. The numbers which got 70% -79% accuracy were 5, and 6. Lastly, the number which was the least accurate with only 67% was number 8.

Fig. 12 shows the accuracy obtained by the most commonly used math symbols. The division symbol, / and the greater than sign, $>$ had 100% accuracy. The symbols with 90% accuracy were the plus symbol $(+)$, lambda (λ), and ohm (Ω). The multiplication symbol $(*)$ had 70% accuracy. Lastly, the symbols with the lowest accuracy 60% were the caret $(\char94)$ and the square root $(\sqrt{})$ symbols. The average accuracy obtained was 82.50%.

V. CONCLUSION

A new approach in conducting quiz contests was introduced in this study. A Wi-Fi based data transmission system was developed which is specifically for quiz contest applications. The whole system consists of 5 parts namely: the Android application Scratchpad along with its dedicated Android server, the optical
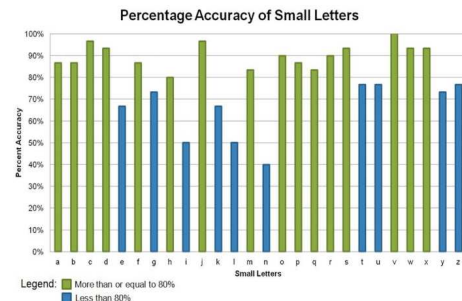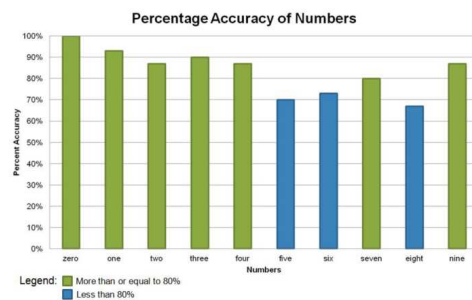

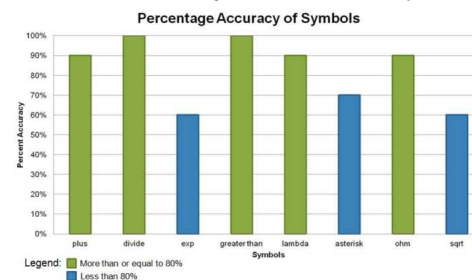Fig. 11. OCR Accuracy for Numbers

Fig. 12. OCR Accuracy for Symbols

character recognition (OCR) system coded in MAT-LAB, the checking and scoring part of the system, the graphical user interface (GUI) for the whole system, and the Wi-Fi connection serving as the backbone network connecting all of the parts and combining them into one whole system with the use of a router. Based on the test results gathered, the system proved itself to be efficient in three aspects; data transmission, character recognition, and automatic scoring.

On average, it takes less than a second for a person to raise his/her answer in the typical quiz contest set-up. From the various tests conducted, the system proved that the transmission time between the tablet

and the server is less than a second, as well, regardless of the distance from the router. The character recognition program (OCR) was trained with various strokes and different handwriting to reach a best case accuracy of 82.40%. The characters tested include both the uppercase and lowercase letters, numbers, and special mathematical symbols. Best case scenario here means that the system is able to convert the handwritten image to the correct text when the characters do not overlap, and are in block letters and not scripts. It is therefore recommended that an intensive OCR algorithm be used or developed to consider scripts and overlaps in the handwritten to text conversion. As for the scoring, the system automatically scored and updated the running total after each conversion. However, the conversion of answers that contain several characters was not very efficient since the OCR has very limited training samples. An additional feature, the manual override, is added to the system to allow the Quiz master to change the score in cases where the system has incorrectly converted the answer or a dispute regarding the answer arises and the judges consider the disputed answer as correct.

The scope of this research is delimited to the implementation of the system from the Android App to the OCR conversion up to the scoring only. The possibility of cheating through sending of text messages to the Android device or other manner of cheating involving the Android device is not included in this research. It is therefore recommended that the Android app be made more impervious by either blocking it or include a feature that will close the App once another device attempts to send a message to it. It is also recommended to improve the OCR algorithm in order to fully realize the essence of the system for engineering quiz contest. The very reason why handwriting is preferred over typing character streams is to allow writing of answers that will involve equations. While these Apps may already be available, the speed of the contestant in writing the answers would beat the speed of typing or using a text and equation tool.

REFERENCES

[1] STI, "Think quest," *http://www.sti.edu/25th_anniversary/pdf/tagisan/thinkquest_mechanics.pdf*.

[2] N. Nanjiani, M. Kuhlke, M. Mishra, and B. Ramakrishnananda, "Automated quiz generation system," May 12 2015, uS Patent 9,028,260. [Online]. Available: http://www.google.com/patents/US9028260

[3] Z. Sarker and M. Rahman, "Online intelligent quiz system," Master's thesis, BRAC University, 2007.

[4] B. S. Batok, "Multi-platform tv quiz show," US Patent US20 150 145 214 A1, 2015.

[5] D, Li, D. Zhang, and Y. Zhang, "Handwritten input for asian languages," US Patent US20 050 276 480 A1, 2005.