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Mobile Barcode Based Examination Attendance System

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Abstract

Smartphone usage has revolutionized the world to many settings including that of the education system with numerous potential and realized benefits. While the functions of smartphones, such as text messaging, multimedia, and Internet connectivity, may seem purely recreational, they can be used within the academic institution to manage students attendance to speed up the process of taking attendance by academic instructors, hence reduces time, human errors and redundant works as compared to the manual attendance system. In this paper, we introduced an automatic examination attendance system on smartphones based on the Barcode to automatically capture student examination attendance. Although many existing systems (Sudha et al. 2015) have been proposed using smartphones for automatic student attendance, there is little study known about a system that is specifically designed for capturing student examination attendance. The main difference among our system and existing systems is that existing systems are using extra hardware device Barcode reader while our system is using smartphone, which highly reduce the cost. Our experiment shows that our proposed student examination attendance system is better for capturing the student attendance information during the examination as compared to the general student attendance systems.

Keywords: *Attendance system, Attendance Database, Barcode Scanner, Blended Learning, Client Server, Examination Management*
Keywords: *Use about five key words or phrases in alphabetical order, Separated by Semicolon.*

1. Introduction

Student's attendance during an examination is an essential as well as a time consuming and tedious process especially when classes are big. Most of the universities in Malaysia are still using manual exam attendance system which requires the student to fill an attendance sheet in every exam. The invigilator needs to collect all the exam attendance sheets and records the attendance manually by checking each of the exam attendance sheets. Exam attendance record is important for lecturers to check who is absent to the exam and whose exam paper is missing. Exam attendance record of a university sometimes is too large and difficult to handled manually using papers. The manual verification, sorting out the invalid student and to compile exam attendance reports are inefficient tasks. This process may lose one and half hours of the instructor during an examination.

The exam attendance sheets may be lost due to human errors. The situation is worse when lecturers cannot locate their missing students' papers. Some students enter to a wrong Hall during the exam and mix their papers with the wrong group of students or with a different subject. This will cause the mix up of student's paper from different lecturer's group and bring hassle to the marking process.

Technology should be introduced to automate the exam attendance system. Smartphone has become an intelligent device and available with every university lecturer. This paper addresses the aforementioned problems and proposes a systematic barcode-based mobile exam attendance system. This system offers to reduce these problems by almost 90%. The proposed system is an ongoing research project and won two times bronze awards in Malaysia Technology Expo 2017 and in UNIMAS Innovation and Technology Expo, InTEX 2016.

In section II, we will discuss some related work. In section III, we will give a brief overview to QR codes. In section IV, we will explain structure and work flow, and finally in section V, we will show results of the proposed system and conclusion of the paper.

2. Related Systems

There are different approaches for managing the attendance system in literature. Most of them use an electronic card, radio frequency identification (RFID), biometric information, Bluetooth technology and barcode technology. In this section, we are briefly discussing these approaches.

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2.1. Electronic Card:

Shoewu et al. [1] have proposed an automatic attendance system using electronic card verification technique. The electronic card is a model of a smart card containing a chip that stores student identity such as student ID, student name, student matriculation number and five pins encrypted code. When the students swipe their respective card through the card reader upon attendance taking process, the card reader compares the entrance code with the encrypted code. The student is then granted the attendance approval/disapproval based on the result of the comparison by the backend software system running on the computer which is serially connected to the respective card reader. The card reader contains a microcontroller which receives the data and sends data to the computer for the attendance authentication process where the computer contains an interactive Object Oriented Programmed software system that can update, delete and modify the system database. The microcontroller used for the electronic card is the PIC16F84A. The main issue in this proposal is the use of extra hardware devices i.e card reader and a connected computer. Which makes the system costly and difficult to use.

2.2. Radio Frequency Identification (Rfid):

Radio frequency identification (RFID) is a wireless local area network that allows wireless data collection from the RFID tags to the reader device [2]. RFID technologies may different in terms of the read range between tag and reader, the data capacity of the tag and the processing speed of the reader in collecting information from the tag.

Hanafi et al. [3] have proposed RFID technology in providing a solution to student attendance system. The system also includes the use of the smart card, a reader device, database server and computer or PDA. The RFID tag is located on the smart card. This smart card system is different from electronic as it is contactless. The reader device captures the student's identity using radio waves. RFID tag is passive and requires no internal power source when it is idle; when the tag is near to the reader device, the tag then is activated. The tag communicates with the reader device by generating a signal to answer the queries. A reader device typically contains radio frequency module which acts as both transmitter and receiver. It receives the information from the nearby tag and forwards the information to another system such as a computer. This system also uses the extra hardware devices i.e reader device, tag, and a connected computer. Which makes the system costly and difficult to use especially when there are many tags around a single reader device.

There is another class attendance recording system proposed by Wyk in University of Stellenbosch, South Africa. The project aims to create effective attendance registration system that implemented the RFID technology and WIFI application. The RFID tag is embedded on the student card of the University of Stellenbosch. The RFID tag can be detected when students hold the card briefly against the configured proximity sensor. RFID application relies on two main components the scanner and the tag. During communicate with each other, both components must use the same carrier frequency ranging from 125 KHz in the LF range to 5.8 GHz in the UHF range [2]. Additionally, a secured system may make use of cryptographic functions for one-way or two-way identification.

According to Wyk and Carel [2], RDIF is easy to use and perfectly suited for use in an automate class attendance recording system. The advantages of using RFID are speed in the detection of student's identity, availability in term of that student always has their student card with them and the RFID tag can be scanned through wallets. Wyk and Carel [2] also stated the disadvantages using RFID such as the student may cheat on the attendance by giving their friends card to be scanned and it becomes an issue if the present student forgets or lost his/her student card. Also, RFID tags can only be detected in close proximity range to the reader device.

2.3. Biometrics: Fingerprint Recognition

Shoewu and Idowu [4], proposed an attendance management system using fingerprint biometric information. The system includes fingerprint device, database server, and an application program. The system aims to electronically record the student attendance stored in a database using fingerprint device. According to them, fingerprint identification is easy as it eliminates the need for any type of card. The students do not need to sign attendance sheet but only place their thumb over fingerprint scanner and the system will compare the fingerprint information against the list of pre-registered users. Once a match is made, the student will be registered as present status in the lecture. One of the major challenges in fingerprint system is the poor quality of images from the fingerprint scan which may result in the failure to match with the existing information in the database server. This may cause by several factors such as the sweaty or oily finger which blurred the scanning platen, the dry finger which causes light print, poor finger placement and the quality of fingerprint scanner itself [5].

Another student attendance system is proposed by NKIT Rourkela [6], which utilizes advanced effort in the improved and faster fingerprint recognition technology. They argue that fingerprint is the best and fastest method for biometric identification. Fingerprints are secure to use and unique for every person. The system consists of a fingerprint scanner, computer, and database server. The computer software will be interfacing the fingerprint scanner and at the same time connected to the database server. The computer software processes the fingerprint scanner input and executes the matching operation with the information in the database. This system also uses extra hardware and is not portable. It must be fixed at one place.

2.4. Biometric: Facial Recognition

Jha proposed a classroom attendance system using facial recognition to identify the students [7]. The processing flow of the system is like any biometric identification process, starting from face detection, to face alignment, to feature extraction and to feature matching with the available biometric information in the database. This system requires additional camera device to be installed in lecture halls, labs and exam halls for the students to check in using facial recognition.

Another facial recognition attendance system is developed by Balcoh et al. [8] which can perform batch processing on the captured students' face images. This means the system can detect, recognize and update more than one student's attendance in a single capture. According to their system, the camera in the classroom will continuously detect and recognize all student in the classroom. This over promises because face recognition can be affected by many factors, like lighting, view of angle, and overlapping of faces by other objects.

2.5. Bluetooth Technology

Bluetooth is a wireless local area network technology which is designed to connect with different devices. It allows the devices to communicate with each other.

Lodha et al. [9] designed a Bluetooth Smart System that is low power consumption and operate wirelessly to track attendance. The system makes use of the electronic tag contained inside the student ID card and a reader, which is the lecturer's mobile application. When lecturer moves around the lecture hall, his/her mobile application detects and collects the signals sent from students' ID Card. The signals are channeled using Bluetooth Low Energy Technology. Due to the range in detection using Bluetooth technology, only students in particular range of distance from the lecturer can be detected thus this has avoided the lecturer from taking the student's attendance who is far or outside the class. Lodha et al. [9] also have designed the system to be able to notify the student's

parents if the student's attendance does not pass the minimum threshold.

Patil et al. [10] have proposed that another attendance management system using Bluetooth technology. However, the implementation of the system is different from the Bluetooth system mentioned earlier. Patil et al. [10] have designed a system in which the staff members must connect to the main Bluetooth device which is only enabled for certain period in order to check in their attendance. Once the staff members connect to the Bluetooth device, the information of the staff member is transfer to the Bluetooth device and the system will check and update the staff member's attendance. The system is also complemented with the function where it will report the absentee with or without approved leave to the department. This ease the attendance management of the department as it saves the repetitive works, cumbersome attendance tracking process, and paper usage and manpower to manage the attendance of the entire department. This system also has the same limitation of using extra hardware and limitation of distance while using Bluetooth.

2.6. Barcode

There are also a number of related works exist on the application of barcode technology most of them are using an extra device for barcode reading. Which increases the cost and is not freely mobile like a smartphone.

Raymundo [11] has proposed a system for QR codes as mobile learning tools to assist nurses in the learning. He has explored the usefulness, acceptability and feasibility of QR codes in the learning process. A notable work has been done by Sudha et al. (2015) in Sies Graduate School Technology Navi Mumbai, India. They proposed a barcode-based attendance system which involves barcode scanner, database server, and a graphical user interface in a computer to take attendance of students entering the lab. Each student in the respective college has a barcode number on the backside of his/her ID Card. The barcode contains unique data of the student such as roll number, faculty and year of study. Each student will scan their barcode at the end of the lab session and the display screen on the computer will display feedback upon the attendance confirmation. Teachers and administrator will access the attendance record by logging in into the system with their respective login IDs. According to Sudha et al. [12] the attendance system is developed to improve the efficiency and effectiveness of the attendance information management system. They believe that computerized software system and hardware interaction can facilitate the attendance management system as well as the accuracy of the attendance information. The proposed system aims to reduce the amount of professor's works such as the needs to create a defaulters list manually whose attendance falls below 75%, the tedious attendance marking process in every lab session and the manual generation of attendance report. This system is also using extra barcode scanner which is not freely moveable like a smartphone and is an extra cost.

Liyana [13] has also proposed barcode technology to be incorporated into the attendance management system in University College of Engineering and Technology, Malaysia. She suggested a barcode reader is placed in front of every classroom where the students only need to scan their Matric Card which contains the respective student's barcode number at the barcode reader. The barcode reader will compare the student information in the database and update the student's attendance. The system also records the time when the card is scanned to detect late comers in the class. The lecturers then can access to the attendance record from the faculty server. Administrator of the system are the general office staffs who have the authorities to register, modify and control the lecturer's profile, student's profile and attendance information. Both lecturer and administrator have respective login information to access the database server of the system. Still, the constraint of this system is that is a risk where students cheat their attendance by scanning asking their friends to scan their matric card. It is also costly because the university needs to buy a barcode reader for each classroom.

In Universiti Teknologi Mara, Malaysia, a similar technology has also been proposed by Mohamad and Azlena [14] to apply barcode technology in class attendance signing system. The protocol of taking attendance in Azlena's system is also like the system proposed by Liyana [13]. The barcode reader scans the barcode number of student's smart card and communicates the information to the database server. However, the slight difference between the two systems is that Azlena does not involve administrator role in her system. Her system only involves the developer (herself), the lecturers and the students.

Sidi et al. [15] also used barcode technology complemented with interactive inputs and graphical user interface to improve the effectiveness of faculty-student attendance management in Faculty of Computer Science and Technology, Universiti Sarawak Malaysia. The proposed system allows students to take their attendance using the configured computer in every lecture hall or tutorial room. The attendance report will be generated automatically and sent to the respective lecturer. A student who always absence (attend less than 80% of the classes) will be put on a special list and may be disqualified for the final examination. These students will also receive a warning email from the system during the mid-semester break. The system also has limitations cost and mobility.

In medical field, QR codes can be used in health information; radiographic records [16]; medical records and information management [17-20]; patient recognition [21-23]; creation of patient resources [24]; medical presentations [25]; and the recognition of medications, pharmaceutical products, equipment and devices.

2.7. A brief review of QR Code

QR or Quick Response Codes are matrix barcodes that can be easily read by smartphones and dedicated QR reading devices. QR code was designed by Denso-Wave for the automotive industry in Japan, 1994. The inventor has made open source and free for human beings [26]. Bar codes are optical machine-readable labels and have a wide range of applications [27] such as attachment to text, emails, websites, phone numbers, magazines, brochures, leaflets and business cards as explained by [28]. Ramsden [29] has explained the following core types of content that a QR code can store: Uniform Resource Locators (URLs), which is a website on the internet; alphanumeric text information; automated Short Message Service (SMS) or text messages; and telephone numbers which may be immediately dialed. QR codes are excessively used on products, and billboard advertisements due to its quick readability and greater storage capacity compared to standard UPC barcodes. The code consists of black square dots arranged in a square grid on a white background. The encoded information contains different types of data like binary, numeric, alphanumeric etc. QR code file may be in HTML, PNG, Tiff, SVG, or EPS file format.

QR codes store data in both directions and can be scanned vertically or horizontally. QR Codes can be generated by 2D barcode generators, some 2D barcode generators are the following.

http://www.qrstuff.com/
http://qrcode.kaywa.com/
http://quikqr.com/

Following is a sample QR Code which contain my personal information.



Fig. 1: A sample Quick Response Code

3. The Proposed Attendance System

This system is a step from traditional education system towards online or blended learning systems to provide a systematic way attendance. This system will not only save lecturers time during class or examination but it will also help the student to keep focusing on lecture or exam.

The administrator of the system who maintains the online server can insert new subjects, halls, exam schedules and venues etc. The system has very friendly interface. The administrator can do all of the above mentioned tasks for the whole semester only in few clicks. The faculty releases a schedule of examination in the form of excel file. The system administrator will just browse the excel file and upload to the system. The database server will automatically insert all the relative information to respective tables in the database.

The system has accounts for each lecturer of the faculty. The lecturer will login before starting the attendance. The system will check lecturer authorization by comparing his/her user name and password with the respective database user name and password. The lecturer also needs to select his/her subject and exam hall as well as exam group. The students will scan their student card while entering the hall to confirm their attendance. If the student is valid for the exam, the system will check if the student has checked in for the exam prior this check-in or not. If the student has checked in before, he/she will receive an alert message mentioning repeated check-in action. If the student has not checked in before then he/she will be allowed to proceed into the exam hall and will receive a successful check-in alert. If the student is invalid for the exam hall he/she will receive an alert message mentioning failure in check-in with a reason of wrong hall entry.

The average time taken by students to complete their attendance is 5 seconds. If there are 3 lecturers then the whole process should take less than 8 minutes for a class of 250 students to complete their attendance confirmation. The Smartphones communicates with the server via either the local Wi-Fi or through the internet.

The system also has another module to handle the exceptional cases of students. If student has lost or forgot his/her matric card then he/she will enter his/her matric number manually. A unique matric number is issued to every student in the university. The system will check the validity of the student by comparing his/her matric number with the database. After validity check every student will get confirmation/rejection message based on the result.

This system consists of two modules, a mobile application and an online database server. These modules have the following tasks.

3.1. Mobile Module

The first module is a mobile application that has the following tasks.

i. Lecturers login management.
ii. Read the barcode information on student matric card.
iii. Send the barcode information to an online database server.

3.2. The Server Module:

The server module has the following tasks.

i. Providing login approval to lecturers.
ii. Receiving barcode information from mobile module.
iii. Confirmation of student attendance.
iv. Stopping unregistered students from entering the exam hall.
v. Keeping record of attendances.
vi. Providing dynamic reports about present and absent students, Exam halls, subjects and lecturers duties.
vii. Inserting, updating and deleting of exam schedules by administrators.
viii. Maintaining lecturers accounts etc.

Rapid application development (RAD) methodology was used for system design [30]. It aims to provide faster development and output high-quality product. RAD model is suitable for small team, between two to six people as mentioned by Totem [31] also. This recommendation is in line with our project structure. Also, RAD model attempts to break the development task into small chunks to make the progress manageable and modifiable if necessary.

In requirement planning stage, it is important for the team to acquire the understanding towards the objectives and business value of the project. Our team identified and understood the relevant technologies that will be incorporated in developing the system. Also, our team explored existing technologies to make a comparison and pick the best option. At the end of this stage, the system scope, such as cost and duration was documented.

Our team then designed storyboards, screen layouts and a subset of actual functional features of the system. We developed, test and refined a functional prototype iteratively until the prototype achieved the predefined objectives and acceptable level of performance. XCode Version 7.3 Beta is used to develop the iOS mobile application and Sublime Text 2 Version 2.0.2 is used to code for PHP codes. The development of AEAS is done using a personal computer (MacBook Air 13-Inch Mid-2013 Model). The deployment and testing of AEAS are done using iPhone 5, iPhone 5s and iPhone 6s. Figure 1 below is the system flow diagram.

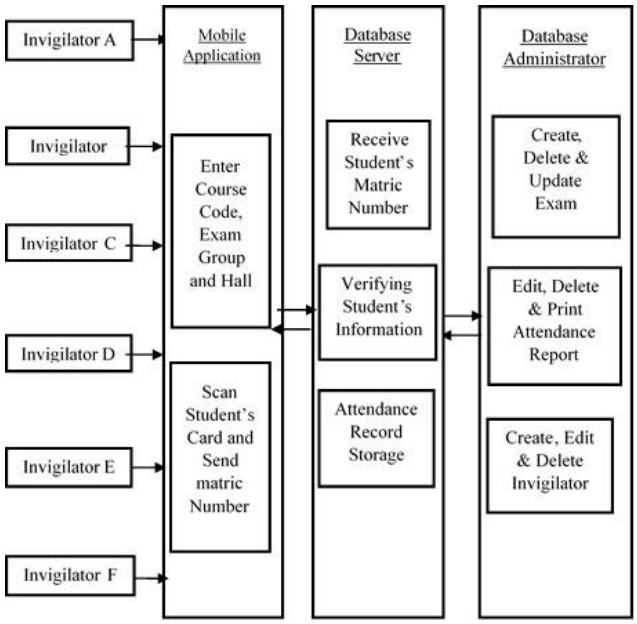

Fig. 2: System flow diagram of MBEAS mobile application

Fig. 2: System flow diagram of MBEAS mobile applicationAll paragraphs must be justified alignment. With justified alignment, both sides of the paragraph are straight.

4. Results and Discussion

The system was tested by 29 different test cases which were successfully passed.

Performance testing is carried out by walking through all the processes in the system. Experiments were conducted to verify the functionality and reliability of the system. Eleven (11) trials were conducted to simulate the attendance taking process during the examination. An average of 5 seconds per scanning is obtained.

To test the efficiency and time, an exam hall of 250 students was selected. The attendance was carried out in 7 minutes by three (3) invigilators,

$$\frac{250 \text{ students} \times 5 \text{ sec}}{3 \text{ invigilators}} = 7 \text{ mins} \quad (1)$$

Besides, there is no paper usage during the process (Attendance sheet, exam slip). Hence, the cost for printing and paper can be eradicated. Moreover, a large manual data input that is prone to errors can be avoided with the aid of automated examination the database which is more reliable as compare to manual attendance system. This shows that mobile barcode based examination system outweighs the conventional paper-based attendance system by reducing the consumption of time, energy and resources.

The limitation of this system is that it can be cheated easily if a student scans his/her friend card also. This limitation can be removed by adding a biometric and GPS modules, which is our next target.

Table 1 shows a comparison of RFID (Radio Frequency Identification), WBCS (Wireless Barcode Scanner), Biometrics and MBFEAS (Mobile Barcode Based Exam Attendance System). It is clear from the table that MBEAS best performs.

Table 1: A comparison of different scanners

Devices	RFID	WBCS	Biometrics	MBEAS
Accuracy	Good	Good	Good but can make mistakes with the dryness or dirt of the finger's skin, as well as with age.	Good
Cost	High	High	High	Very Low
Portability	Possible but along with a connected PC	Possible but along with a connected PC	Possible but along with a connected PC	Very easy. No need of any connected PC
Teamwork	Not Possible	Not Possible	Not Possible	Excellent in teamwork
Security	Good	Good	Very Good	Good
Reliability	Reliable	Reliable	Easily can be damaged	Reliable



Fig. 3: Lecturer's loginDetailed submission guidelines can be found on the journal web pages. All authors are responsible for understanding these guidelines before submitting their manuscript.

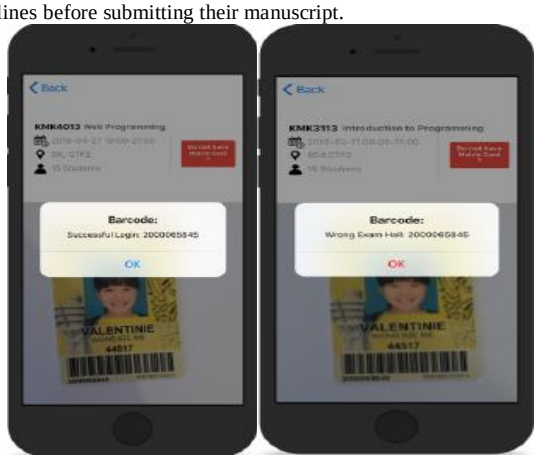

Fig. 4: Students matric card scanning

Table 1: A comparison of different scanners

Devices	RFID	WBCS	Biometrics	MBEAS
Accuracy	Good	Good	Good but can make mistakes with the dryness or dirt of the finger's skin, as well as with age.	Good
Cost	High	High	High	Very Low
Portability	Possible but along with a connected PC	Possible but along with a connected PC	Possible but along with a connected PC	Very easy. No need of any connected PC
Teamwork	Not Possible	Not Possible	Not Possible	Excellent in teamwork
Security	Good	Good	Very Good	Good
Reliability	Reliable	Reliable	Easily can be damaged	Reliable

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