UNITEN Smart Attendance System (UniSas) Using Beacons Sensor

Mohd Azmi M.S[1], Mohamed Zabil M.H[2], K.C. Lim[3] and Raja Azman R.F[4]

Department of Software Engineering, CSIT, Universiti Tenaga Nasional Kajang,43000, Malaysia

{sufyian[1], hazli[2], kokcheng[3] & fenin[4]}@uniten.edu.my

Noor Adnan N.A and Mohamed Azman M.A.S

Rocket Web Sdn. Bhd. Galleria Cyberjaya *Cyberjaya, 63000, Malaysia*

ariff@rocketweb.my

***Abstract* - Smart attendance system is the new way of taking student attendance using smart phone devices together with intelligent sensors. In many universities in Malaysia, students' attendance need to be tracked and become one of the requirements for a student to pass a subject. Common approach of attendance taking is using paper based attendance. Besides that, RFID technology becoming commonly used to replace the paper based attendance taking method. In this study, a smart attendance system using Bluetooth low-energy (BLE) beacon (UniSas) is proposed and implemented in Universiti Tenaga Nasional (UNITEN). Further, the performance (accuracy, time-consumption and energy-consumption) of the paper-based attendance, RFID attendance system and UniSas are compared. Results showed that the proposed UniSas outperforms traditional method and any current smart attendance systems.**

Index Terms – smart attendance, beacons, Bluetooth low-energy, android application, IOS application.

I. INTRODUCTION

Nowadays attendance taking is implemented in many organizations to track persons of interest. In organizations (i.e. government or private) staff attendance are recorded. In the context of academic institutions, besides staff, students' attendance need to be recorded and part of crucial academic data. According to Marcus, student's class attendance not only will influence their grades but also their characteristic and eventually affect their working performance in the future [1]. Apart of that, in the context of industry, some organizations will use the attendance to determine employee's regularity and may affect their salary and wages [2].

In this study, we propose the implementation of UniSas to be used for student attendance taking process in University Tenaga Nasional Putrajaya campus (UNITEN), Malaysia. The solution presented in the paper is a smart and fast attendance monitoring system with data analytics features through Bluetooth low energy (BLE) sensors known as beacon.

For presentation purpose, this paper is presented as follow: Section II discusses the related works, followed by section III which highlights the Bluetooth technology. Subsequently, Section IV discuss the implementation of UniSas. Section V presents the results and lastly Section VI state the study conclusion.

II. RELATED WORKS

A number of related works for different methods and principles to effectively monitor the attendance of students have been studied. In the context of Malaysia, majority of universities are still using traditional approach, that is, using paper based attendance method. Apart of high risk of losing the attendance data, it also produces high cost to university itself and obviously the maintenance and management of the traditional attendance sheets is tedious as it requires some time for students to sign their attendance. Besides of that, paper based attendance are prone to allow students signing the attendance on behalf of their friend who are not in the class.

Besides paper based attendance, there are also other implementations attendance systems such as RFID technologies, Iris recognition technique and portable fingerprint. RFID card attendance system is common and widely used in many organizations. However, by using RFID technology, it needs a special dedicated reader to read the RFID card for attendance taking. If it involved mass attendance taking, it is prone to bottleneck issue, where users need to stand in long queue for check-in and check-out. If attendance time is critical and user doesn't check-in within the given time frame or did not have the RFID card, then user will be assumed as absent or late on that day. There are also high possibility for the reader device or even RFID card itself cannot be use because of either device or card failure. According to Mandeep Kaur, it is difficult to read multiple RFID tags simultaneously. This can leads to different signals from the tags interfering with one another. The solution for that is by implementing computerized techniques for "detangle" such signals, but implementing and managing these techniques increases operation costs [3].

Another approach of attendance taking as discussed by Kadry, S. and M. Smaili is by using wireless attendance system that authenticates users based on their iris. The system uses an off-line iris recognition management system that can

978-1-5386-7263-1/18/$31.00 ©2018 IEEE

finish all the process including capturing the image of iris recognition, extracting minutiae, storing and matching [4]. However, this system is very complex and require more time for a user to scan the iris, especially during registration for the first time. Consequently user must stand in long queue for check-in and check-out.

Wireless fingerprint technology is another technology to take attendance as proposed by [5]. It uses wireless fingerprint attendance system based on GSM technology to take student attendance. In this system students report their attendance via biometric system and has option for parents to receive SMS notification. The fingerprint has a lot of advantages, such as unique, permanent, good anti-fake and easy to use. On the other hand, one significant disadvantage with such systems is the cost of biometric devices. As a result, the data processing requirements associated with biometric input and identification require substantial computer processing capabilities. Therefore, remote biometric input devices typically require fully functional, on-board computer hardware and software and thereby increasing costs. For example, a Biometric identification units, of the background are relying on conventional personal computer hardware and software (e.g. processor, hard drive, motherboard, video controllers, operating systems, etc.) installed on-board to enable the system to process and store data and to otherwise facilitate operation. Accordingly, biometric identification units of the background are burdened with an overabundance of computer hardware and software. The requirement for such abundance of computer hardware and software at each remote access location, however, is costly thereby limiting the proliferation of this technology [6].

The latest technique and among popular technique to capture student attendance in campus is by using QR (Quick Response) code. QR codes technology has been selected in determining the popular approach of taking students attendance compared to RFID technique because of the development cost is cheaper and easy to use [7]. However, a few weaknesses can be found in the technique that is, student who attend the lecture class can pass the QR code image to other student who are physically absent and the attendance will be count as attend. Not only that, as mentioned by Tim Dunn [8], the actual process of scanning a code can be a pain. Users have to get their phone out, fire up the code reader, before scanning and waiting for the landing page. With a fast internet connection this may work fine, but on a variable 3G signal, many users may lose patience.

III. BLUETOOTH LOW ENERGY TECHNOLOGY

Bluetooth is a wireless technology standard. Bluetooth was developed as a way to exchange data over a short range (like from pocket to shoulder) without the need for wires. Bluetooth Low Energy (BLE), sometimes referred to as "Bluetooth Smart", is a light-weight subset of the classic Bluetooth and was introduced as part of the Bluetooth 4.0 core specification. With BLE's power consumption, applications can run on a small battery for four to five years. Although this is not ideal for talking as on the phone, it is vital for applications that only need to exchange small amounts of data periodically like beacon sensors [9].

Beacon sensor is a small Bluetooth radio transmitter, it repeatedly transmits a single signal that other devices can see. Instead of emitting visible light, though, it broadcasts a radio signal that is made up of a combination of letters and numbers transmitted on a regular interval of approximately 1/10th of a second. A Bluetooth-equipped device like a smartphone can "see" a beacon once it's in range [10]. Beacons are ideal for sharing information with visitors and locating and tracking valuable items or equipment. They are helping venues like museums or university campus provide visitors with a more personalized and fulfilling experience.

Figure 1 Beacon by Kontakt.io.

In our implementation, beacon sensor from Kontakt [10] is used as shown in Figure 1. The beacon consisting of a CPU, accelerometer, temperature sensor and a 2.4GHz radio BLE. The Kontakt beacons is chosen in this study because of it is much smaller in size compared to the regular beacons. It has an average of one year battery life. Furthermore, the battery can easily be replaced. With low power consumption and cost, these beacon are ideal for this project.

IV. IMPLEMENTATION

In general, the implementation of UniSas is divided into two parts. The first part is a web-based management system, which is used by lecturers to monitor attendance data. The second part is the mobile application (currently supported for Android and iOS). The mobile application needs to be downloaded and installed by students and is used for recording attendance.

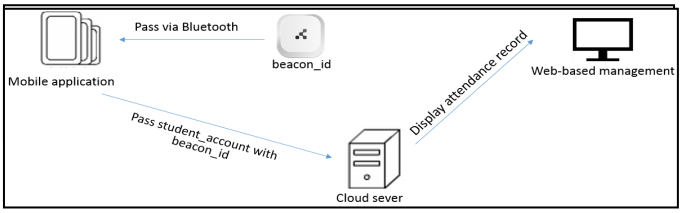

Figure 3 Step two on how UniSas is working

Before the semester begins, students' data, subjects and classes need to be mapped with a specific beacon as illustrated in Figure 2. Currently the mapping is done by importing a spreadsheet file into UniSas. Once the data has been prepared, UniSas is ready to record the attendance. Figure 3 illustrate the attendance taking process.

Figure 2 and Figure 3 represent the overview of UniSas for student data preparation and during attendance taking process. The steps to record attendance are as follows:

1) List of student data with registered class uploaded in the google cloud server.
2) Each beacon is assigned with an id and mapped with a specific classrooms and subjects.
3) When student enter their class (i.e. for a designated classroom and subject), they need to turn on their mobile phone Bluetooth connection and open UniSas mobile app. For the first time, student need to login via UniSas apps.
4) Once logged in, UniSas will listen to the beacon device and retrieve unique beacon ID via Bluetooth connection.
5) UniSas apps will combine both the Beacon dan student ID and send to UniSas backend server.
6) Subsequently, those IDs will be compared with student details, subjects and classes registered from the database. If matched, then the particular student will be marked as "attended". If at the end of the class session, the server did not receive any beacon ID and student ID, the particular student is assumed absent.
7) Lecturer can monitor their student attendance records through web-based management.

A. Mobile application platform

This system works on two major mobile platforms which are Android and iOS. Students need to download the UniSas apps and log in using their Student ID and password. The login page is shown in Figure 4. Once logged in, the main interface will be shown as in Figure 5 and the application starts listening to a BLE beacon device. Once a beacon device is detected, the application capture the Beacon ID and send it to UniSas backend server. At the server, corresponding information of class ID, subject ID and student details is looked up based on the Beacon ID and is sent back to the mobile phone by the server as shown in Figure 3. Besides that, there are also add on features included in the mobile app such as class reminder, student class timetable and also notification from lecturer to student.

Figure 4 Log in interface for UniSas application

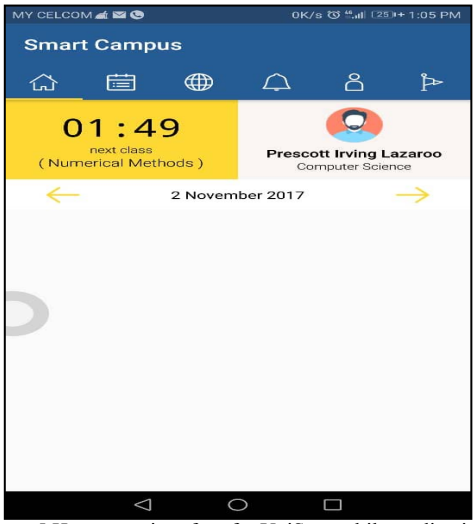

Figure 5 Homepage interface for UniSas mobile application

B. Server

In this project, the backend web service is implemented using Google Cloud platform [11]. Cloud server has been envisioned as the next generation architecture of the IT enterprise due to its long list of unprecedented advantages in IT: on demand self-service, ubiquitous network access, location-independent resource pooling, rapid resource elasticity, usage-based pricing, and transference of risk [12]. One fundamental aspect of this new computing model is that data is being centralized or outsourced into the cloud. From the data owners' perspective, including both individuals and IT enterprises, storing data remotely in a cloud in a flexible on-demand manner brings appealing benefits: relief of the

burden of storage management, universal data access with independent geographical locations, and avoidance of capital expenditure on hardware, software, personnel maintenance, and so on [13].

The server stores student's information, class registered, beacon ID, retrieve student's log in details and current beacon ID sent from the application as well as hosting the web-based management system. Following the HTTP request-response protocol, when there is a request (i.e. from browser or mobile apps), the backend web service sends back the corresponding data to requesters. As mentioned in Section IV, all student's information with class details and subjects registered details are uploaded in the server. The server then retrieves student credential information and beacon ID from mobile application. Beacon ID and student information then will be compared with values that is stored in the server. If the value in the server matched with beacon ID from mobile application within the correct class session and time then it will considered the student is attending the class on that period of time. All student records without the beacon ID are assumed absent for the particular class. Apart of that, the beacon ID from mobile application in every 5 minute will be sent to cloud server until the session for each class is finish. This is to ensure student attend on the class at least 80% from the class hour time.

C. Web-based application for management

The lecturers are authorized to use the web-based management system by log in using their own id and password. Each lecturer has been assigned with the list of their own students and classes. The web application offers some basic attendance management tools such as list student attendance, importing and exporting spreadsheets, as well as manually updating the attendance record. The dashboard of the web interface is as shown in Figure 6.

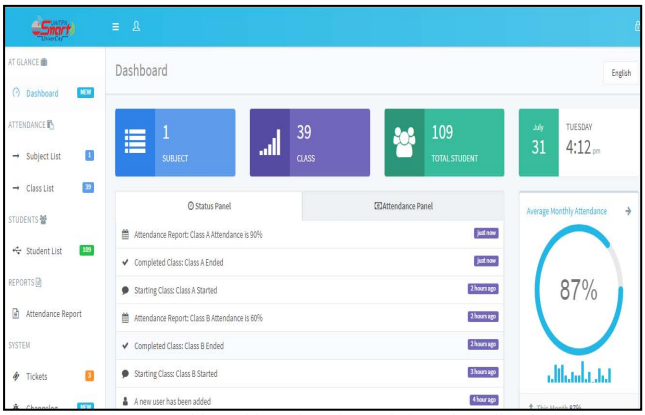

Figure 6 Dashboard interface for web-based application

V. RESULTS AND ANALYSIS

To benchmark the performance of UniSas, we conducted three experiments to test the accuracy, time-consumption and energy-consumption for UniSas application. The experiments were conducted involving 60 students with smart phone devices based on Android and iOS platform.

The first experiment was conducted using UniSas mobile apps together with beacon sensor to take attendance. The second experiment was conducted using RFID card together with RFID card reader to take an attendance. Lastly, the third experiment was conducted using paper based attendance, where attendance sheet was passed from one student to other and requires students to sign the attendance sheet. During the experiments, accuracy, time and energy consumption are measured. The results are as shown in Table 1.

Based on the results, it shows that UniSas performed best in all cases. Although, on accuracy it achieved the same result as paper-based technique, for other attributes it achieved best compared than other techniques. For RFID technique, the time taken and energy consumption is the highest. This is due to students need to stand in long queue for check-in and check-out. Apart of that the RFID reader need to be attached to power socket. For paper-based technique, although it achieves 100 percent on accuracy and no energy consumption at all, the time taken took approximately 6 minutes to complete the signature for all 60 students. Furthermore, Most importantly it disturb the student learning focus because the attendance sheet needs to be passed from one student to another until all students signed the sheet.

TABLE I. RESULTS OF PERFORMANCE FOR THREE TECHNIQUES

Techniques	Accuracy (%)	Time Taken	Energy Consumption
UniSas	100	5 seconds	5 years on battery
RFID	98	1200 seconds	Electric consumption
Paper-based	100	360 seconds	No energy consumption

VI. CONCLUSION

In this paper, we propose a new approach of attendance taking together with an attendance management system that gives the students the ability to submit their attendance through their own mobile devices. The use of multiple devices to submit the attendance in parallel reduces the time to finish registration of the attendance. Experiments have been conducted to benchmark the performance of UniSas against paper based and RFID attendance system. From the results, it shows that UniSas yields the best overall results in term of accuracy, time and energy consumption.

ACKNOWLEDGMENT

This work was supported by Tenaga Nasional Berhad (TNB) Sdn. Bhd, Universiti Tenaga Nasional (UNITEN) and RocketWeb Sdn. Bhd. in part of Smart Univercity project.

REFERENCES

[1] Credé, M., Roch, S. G., & Kieszczynka, U. M. (2010). Class Attendance in College. Review of Educational Research, 80(2), 272-295. doi:10.3102/0034654310362998.

[2] Kumar, B. D., & S. K. (2017). Smart Mobile Attendance System for Employees Using QR Scanner. Asian Journal of Applied Science and Technology, 1(5), 35-39.

[3] Kaur, M., Sandhu, M., Mohan, N., & Sandhu, P. S. (2011). RFID Technology Principles, Advantages, Limitations & Its Applications. International Journal of Computer and Electrical Engineering, 151-157. doi:10.7763/ijcee.2011.v3.306.

[4] Kadry, S., & Smaili, M. (2013). Wireless attendance management system based on iris recognition. Scientific Research and essays, 5(12), 1428-1435.

[5] Verma, P., & Gupta, N. (2013). Fingerprint based Student Attendance system using GSM.

[6] Roy, Ronald B., and John C. Sadlon (2008). "Biometric access control and time and attendance network including configurable system-on-chip (CSOC) processors with embedded programmable logic." U.S. Patent No. 7,424,618.

[7] Talip B, Zulkifli M. (2018). Mobile Attendance System Using Qr Codes Technology. Journal of Computing Technologies and Creative Content, 3(1), 1-3.

[8] Dunn, T. and Dunn, T. (2018). To QR or not to QR - Econsultancy. [online] Econsultancy. Available at: https://econsultancy.com/to-qr-or-not-to-qr/ [Accessed 11 Nov. 2018].

[9] Ray, B. (n.d.). Bluetooth Vs. Bluetooth Low Energy: What's The Difference? Retrieved from https://www.link-labs.com/blog/bluetooth-vs-bluetooth-low-energy.

[10] What are beacons? (n.d.). Retrieved from https://kontakt.io/beacon-basics/what-is-a-beacon/

[11] Google cloud (n.d.). Retrieved from https://cloud.google.com/

[12] Mell. P., & Grance. T. (2013). NIST Cloud Computing Standards Roadmap. doi:10.6028/nist.sp.500-291r2

[13] Fox, A., Griffith, R., Joseph, A., Katz, R., Konwinski, A., Lee, G.,& Stoica, I. (2009). Above the clouds: A berkeley view of cloud computing. Dept. Electrical Eng. and Comput. Sciences, University of California, Berkeley, Rep. UCB/EECS, 28(13), 2009.