# Smart-Hadir – Mobile Based Attendance Management System

Chung Seng Keau, Chin Kim On (✉), Mohd Hanafi Ahmad Hijazi
Universiti Malaysia Sabah, Kota Kinabalu, Malaysia
kimonchin@ums.edu.my

Manmeet Mahinderjit Singh
Universiti Sains Malaysia, George Town, Malaysia

**Abstract**—Manual time and attendance systems are still being practiced within a considerable number of universities, colleges, government departments and companies. This traditional system requires the user to fill in their timesheets or sign on the attendance sheet manually. The practice inefficient and ineffective for university's student attendance recording due to, i) lecturer may lose the attendance sheet, ii) student may sign for their friends, iii) student may forget to sign on the attendance sheet, and iv) challenging to monitor attendance rate and analysis. As a result, conventional attendance tracking methods must be replaced with more reliable ones. The attendance rate is important because students can focus and score better results if they attend classes consistently. As such, a mobile app, namely Smart-Hadir, is designed to overcome problems as mentioned above. Smart-Hadir is a smartphone application developed by UMS aimed to record student attendance digitally during a class session. The technology used is slightly different from the existing applications, where Smart-Hadir is not using RFID technology but rather covers NFC, QR code, and beacon technologies. Attendance could be taken either using NFC or QR code displayed on the wall using a projector or scan the available beacon. Lecturers can create class session using the Smart-Hadir anywhere and anytime. Students are then required to take their attendance either scan the QR code, search the beacon, or swiped their student card on the lecturer's phone. The students' attendance will be immediately captured and saved into the database. Lecturers will be able to view the statistic report, identify and e-mail absentees, as well as monitor students' attendance behaviour. A statistical report can be generated. It shows the percentages of students' attendance rate, absent rate, and status. The Smart-Hadir is advantageous as it can be used to capture meeting or event attendance record as well.

**Keywords**—Attendance Management System, Attendance Records, Registration, NFC, QR Code, beacon, Smart-Hadir App, Mobile App Development.

# 1 Introduction

Technology is rapidly developing, allowing thousands of embedded systems to be released into the market to meet the growing demands of everyday life [1, 2]. Therefore, wearable technologies such as smartphone, smartwatch, and smartglass have been improved rapidly with extra sensors capable of enhancing mobile features such as multiple cameras, bluetooth, GPS antennas, NFC antennas, fingerprint reader, etc [3, 4]. The availability of sensors has resulted in the production of thousands of applications. Most of the developed apps are mobile games. Some are related to artificial intelligence for gaming, social media, virtual reality, gamification, mobile e-learning, and measurement tools, as named a few [5, 6, 7]. A lot of work has been done to cater different situation. Furthermore, some mobile apps represented an essential tool that helps countries enhance their economy in both the educational, government and industrial sectors [8, 9].

Manual time and attendance systems are still being practiced in universities, colleges, government departments and industries [10]. The traditional system requires the users to fill in their timesheets or sign on the attendance sheet manually. The practice is inefficient and lack of effectiveness, particularly for university's student attendance record. Some of the issues pertaining to traditional attendances reporting are; i) recorded attendance sheet going missing, ii) integrity issue when students opt to sign on behalf of their absents friends and iii) student may forget to sign on the attendance sheet. Moreover, manual signing is time-consuming, and it comes without an automated comprehensive attendance analysis [11, 12, 13]. There are advancements in attendance system using either thumbprint recognition system, hand or face recognition systems. Biometrics attendances-based attendance system provides a strong authentication since biometrics identifiers are unique and non-transferable. However, these systems are not robust and inflexible. One major issue with biometrics based attendance systems are the biometrics collected could later be exploited and hackable [10]. Thus, the necessity to change these traditional attendance recording methods to a more efficient one is essential since recording of attendances has proven to lead towards a better Teaching and Learning (T&L) experiences and academic success. As such, a mobile app, namely Smart-Hadir, is designed to overcome problems as mentioned prior and will be suitable for the usage at Universiti Malaysia Sabah (UMS).

The Smart-Hadir is a Smartphone mobile apps developed by UMS to record student attendance digitally during a class session. The Smart-Hadir covers NFC, QR code, and beacon technologies. Attendance could be taken either using NFC or QR code that is displayed on the wall using a projector or scan the available beacon. Lecturers can create class session using the Smart-Hadir at anywhere and anytime. Students are then required to take their attendance either scan the QR code, search the beacon, or swiped their student card on the lecturer phone. The students' attendance will be immediately captured and saved into the database. Lecturers will be able to view the statistic report, identify and e-mail absentees, and monitor students' attendance behaviour. A statistical report can be generated, and it shows the percentages of students' attendance rate, absent rate, and status. The Smart-Hadir is advantageous as it can be used to capture meeting or event attendance record as well.

In the next sections, we will cover the following discussions. Related works are described in Section 2. Section 3 delves into the approaches used in the development phase, including requirements analysis, system design, and important implementation issues as seen by UML diagrams. Section 4 summarises the findings and explains the built app's user interfaces. Finally, future challenges are discussed, and closing remarks are made in Section 5.

## 2      Related Works

There have been plenty of technologies and methods used in capturing attendance record. It can be divided into five categories, and the summary is as follow.

### 2.1      Barcode based attendance systems

[14] proposed barcode-based attendance capturing system. The technology decodes text and information from a sequence of bars and spaces using a barcode scanner or reader. The barcode can be either printed or projected using any display devices. The barcode can be scanned, processed, and validated using a bar reader. The bar code could be in Code 49, PDF417, Data Matrix or QR Code formats. This technology has been widely used in other industrial sectors as well. Because of its effective and efficient to capture data. However, a specific barcode reader is required in the capturing process, and everyone must possess a particular identity card. Furthermore, staff or student may forget to bring their card or lost their card if the bar code is printed on the staff/student card.

### 2.2      RFID-enabled attendance systems

[15,16,17,25] proposed that a radio frequency identification (RFID)-based attendance system be created. Usually, RFID technology is used to monitor student attendance, which is then stored in a back-end database linked to the RFID readers. In [15], the RFID was combined with automatic door unit. The student attendance is captured using RFID technology when the students show up the Tagged ID to the RFID reader. The system opens the door and records the attendance when the RFID reader or the computer verifies the student's ID. [16] has proposed an additional function to record student's attendance to the database using the RFID system. The system has an added functionality to generate and send SMS to different stakeholders such as parents via SMS gateway or E-mail gateway. Similar to the barcode-based system, the systems possessed a specific identity card, and the student attendance will not be recorded if they forgot to bring their card or lost their card. In addition, RFID readers are costly and requires proper planning in its placement.

### 2.3 NFC-enabled attendance system

[18, 26] have developed NFC enabled automated attendance systems by adopting Near Field Communication (NFC) technology. NFC is type of low-cost sensors technology with short-range communication between compatible devices. The process requires at least one transmitting device, and another to receive the signal. The NFC standard can be used by a variety of devices, which can be passive or active. NFC, Bluetooth, Wi-Fi, and a variety of other wireless signals, operates on the principle of transmitting data over radio waves. Similar to the barcode-based system and RFID system, the systems possessed a specific identity card and reader.

### 2.4 GPS based attendance system

[19] has proposed a GPS based student attendance system. The lecturers can easily access the students record via a web server to check and monitor student attendance information. However, the study location is not necessary, except the lectures are conducted online, and the lecturers want to monitor whether the students join the classes in a library or at home.

### 2.5 Biometric based attendance system

Fingerprint recognition, face recognition, iris-based, [19，20，21，22] are those examples of biometric based systems for the attendance management system. The biometric recognition technologies had been used since many decades ago for capturing staff attendance. The fingerprint recognition system record attendance electronically with a fingerprint device. The records of the attendance are then stored in a database. Face recognition, iris-based, and voice recognition systems are seldom found in the market due to its high latency rate during the recognition process. The biometric-based systems have a long execution time of 4.29 seconds on average [23]. These systems are inefficient in areas with a large number of participants, such as colleges and universities. Each student would have to wait in line for a few minutes to register for classes.

### 2.6 Summary of review

The major shortcoming of the existing systems requires full electricity availability. In the event of a power outage, there is no substitute for attendance recording. Usually a reader is required for capturing the attendance, such as RFID card reader, camera, thumbprint reader, etc. The setup and maintenance costs are high with extra needed equipment. Students may lose their card. Attendance will not be captured if the capturing device has malfunctioned. Another issue is that the system allows cheating. Students may pass identification cards with one another, or one student may bring several cards from different friends. Furthermore, the teaching and learning process is interrupted if a student is late to join the class.

# 3    Methodology

This section discusses the development process involved in developing the Smart-hadir app, includes requirement analysis, proposed solutions, use case diagram, and development technologies.

## 3.1    Problems identification

The problems were identified and summarized below:

1. Setting up and implementation costs – Most of the proposed systems require high implementation costs. RFID cards, RFID reader, thumbprint reader, etc. Thus, it is challenging especially for the university with a huge number of classrooms and halls.
2. Maintenance costs – The maintenance cost to keep the system fully operational at least five years before the system is replaced with new technology.
3. Accuracy, speed, and simplicity – Providing fast, easy, and accurate operations while consuming the least amount of valuable lecture time.
4. Flexibility and customizability – The system's ability to be customised to meet the needs of individual teachers, and student attendance should be able to be stored/captured from a long distance without interfering with the teaching and learning process. This feature is essential as some faculties/universities often use large classrooms to fit more than hundreds of students.
5. Power shortage – All of the existing systems are highly depended on electricity, and there is no alternative solution in the case of an electricity outage during the attendance recording process.
6. Monitoring progress and attendance analysis – Attendance analysis is required for the top management to monitor the student attendance rate.
7. System security and data safety – Mitigation towards unethical registration of students being absent aka an integrity issue relating towards cheating and unhealthy behaviour among students and Personal Identifiable Information (PII) collected from biometrics systems which could be compromised and hacked for other usages without owner consents.

## 3.2    Proposed solutions

The web and mobile apps named Smart-Hadir has been proposed to overcome the challenges mentioned above. The Smart-Hadir is available in web, iOS, and Android versions. The development of Smart-Hadir does not require high setup cost and long-term high maintenance costs. There is no extra card reader, capturing device, additional infrastructure, and renovation is needed.

The Smart-Hadir app provides the features of QR-code, NFC, or beacon technologies after the lecturer has created a class with the app. The combination of technologies has provided flexible attendance capturing, with no disturbance in lecturing exe-

cution, scalable for huge participants, automated with easy one-click to capture attendance, and overcoming the power shortage problem.

The Smart-Hadir web app provides attendance analysis feature. The analysis includes the percentage of individual attendance rate, date of absence, the status of absent (e-mailed a letter of reminder to students and accepted reason, if any), and the lecturer can generate a pdf report when needed.

### 3.3    Use case diagram

This section explains how to view data and how to decompose it into its constituent parts in use case diagram, as shown in Figure 1. The lecturer must first log in to the Smart-Hadir and create a class/lecture. Students may take the attendance by either scan the QR-code displays by the lecturer using a projector or scan the lecturer phone via NFC technology or search the available beacon. The lecturer may view the attendance rate anytime, monitor students' absent rate, view absentee status, and e-mail students via the Smart-Hadir web app. All data is saved in the university's Data Centre.
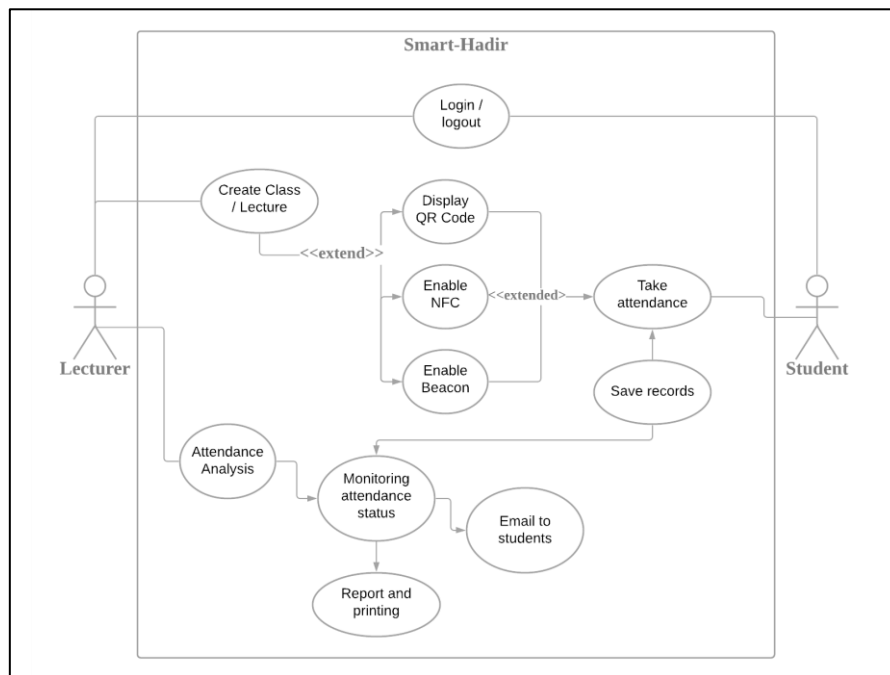


**Fig. 1.**  The Smart-Hadir use case diagram

### 3.4 Development technologies

The Android Studio Software Development Kit (SDK) is used to develop the Android-based mobile app, and the Swift is used to create the iOS version of Smart-Hadir app. The smartphone user should have at least 1 GB of RAM, a 5MP camera (back), NFC technology, with at least 3G connection. A website was created using the .net framework with asp programming was used, and the data was saved in the MySQL database. The beacon used is available in [24]. It provides the most reliable experience for iOS and Android. The battery life is sustainable for 4-5 years on typical proximity use-cases. Hence, it could be located on the ceiling in any lecturer hall that can fit 200-1000 students/participants, and it requires meagre maintenance costs.

## 4 Results and Discussions

The Smart-Hadir is available in the Google App Store since 2017 and the iOS App Store at the end of 2019. Everyone can install the Smart-Hadir apps, but only those with specific login info will be allowed to use the apps. Figure 2 show the availability of Smart-Hadir apps in both Google App Store and iOS App Store.
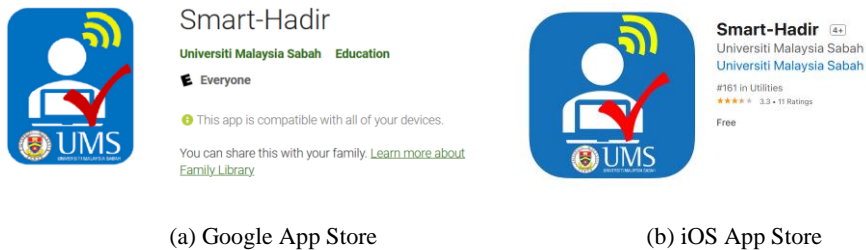


(a) Google App Store                    (b) iOS App Store

**Fig. 2.** The Smart-Hadir app's availability

https://play.google.com/store/apps/details?id=com.umsattendance&hl=en&gl=US
https://apps.apple.com/my/app/smart-hadir/id1480796416

This section demonstrates and addresses the main interfaces and functions of the proposed Smart-Hadir apps. The interfaces are shown in Figures 3, 4, and 5, respectively.
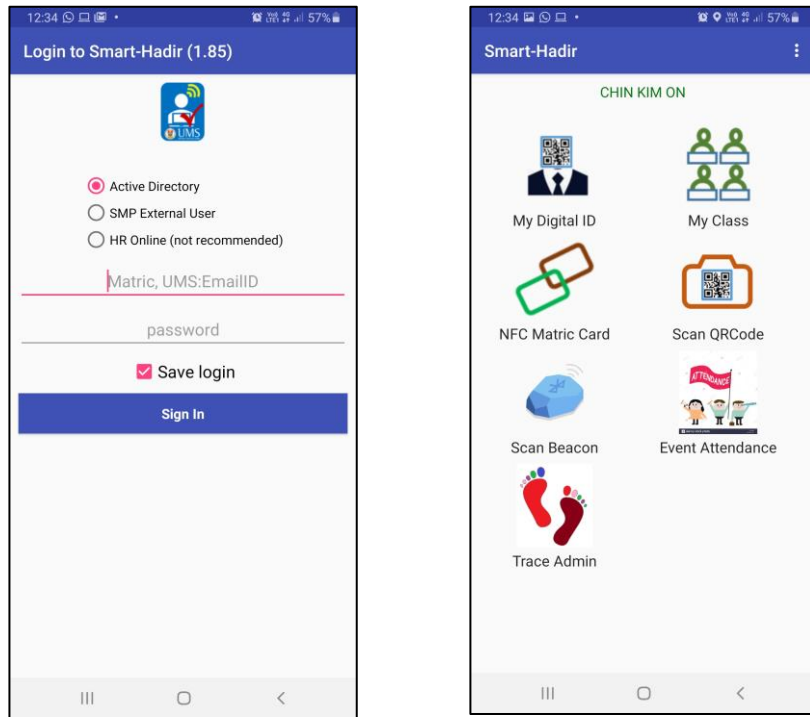
(a) Main page of Smart-Hadir          (b) Page after user login

**Fig. 3.** The Smart-Hadir Login Authentication

User must log in to the Smart-Hadir system using their UMS ID and password. Figure 3(b) will be shown if the user has successfully logged in to the system. The staff may display personal QR code ID for scanning purpose using the "My Digital ID" feature. The lecturer may create a class session using the "My Class" feature. The lecture may scan the student's matrix card if their phone is out of battery using the "NFC Matrix Card" feature. User may click on the "Scan QRcode" icon for placing his/her attendance record. The QR code will be refreshed every 60 seconds for security purposes and avoid student cheating. Users may click on the "Scan Beacon" icon to place their attendance record without using the phone's camera in case their smartphone camera is not functioning. Admin staff may create an event using the "Event Admin" feature. Other users may then place the attendance record either using beacon or NFC or scan the QR code. Lastly, the user may view their history of attended events using the "Event Attendance" feature.
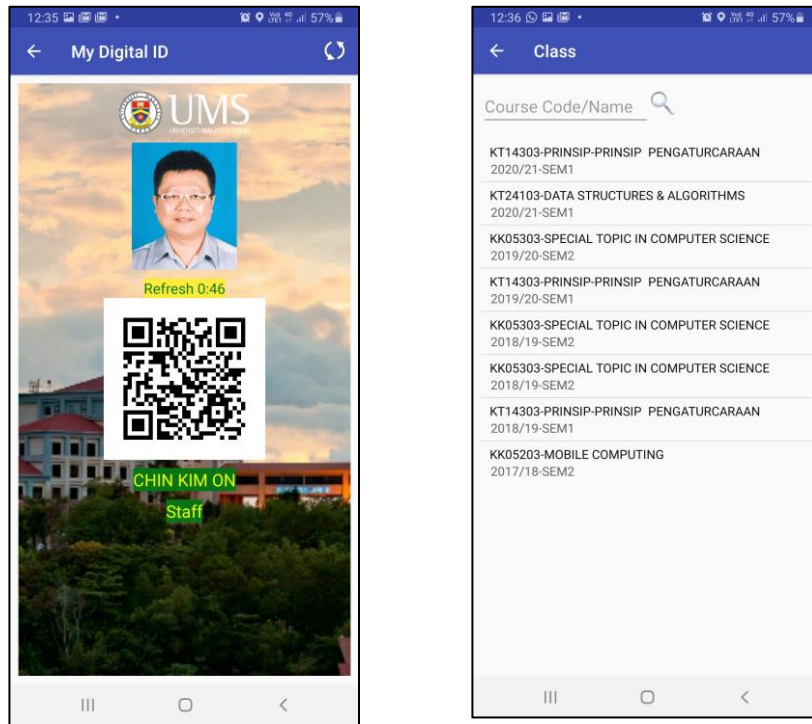
(a) Temporary ID code

(b) List of subjects taught
by the lecturer

**Fig. 4.** The Smart-Hadir Temporary ID code and List of Subjects Taught

Figure 4(a) shows that staff may create a temporary ID code for attendance capturing purpose in case needed. The QR code can be used for event attendance recording, or students may scan it for joining the classes. Figure 4(b) shows the list of subjects taught by the lecturer. A simple report could be generated after the staff/lecturer clicked on the subject taught. The QR code will be refreshed every 60 seconds for security purpose.
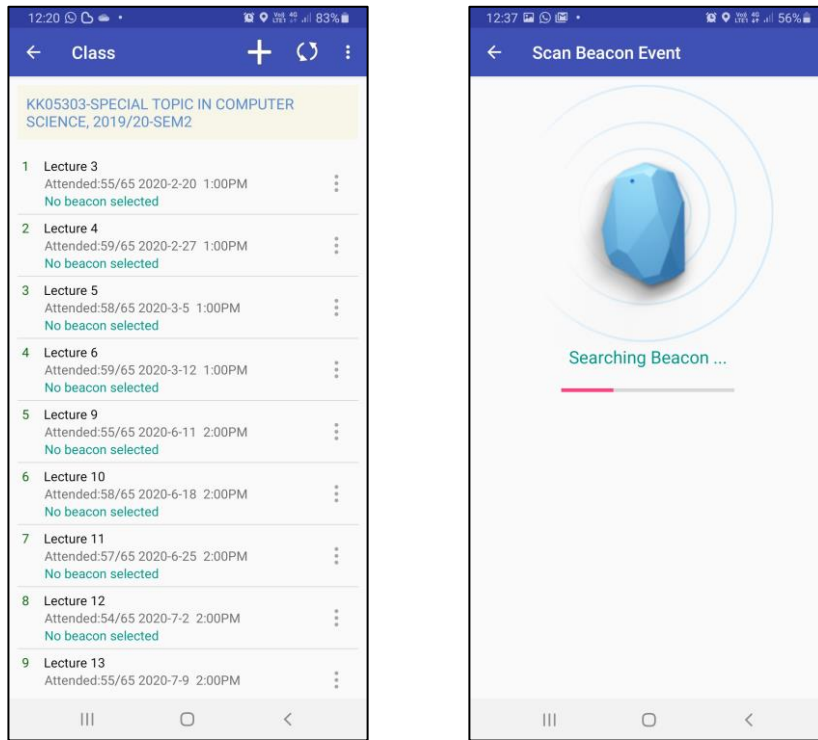
(a) Attendance Records          (b) Searching class using beacon

**Fig. 5.** The Smart-Hadir Attendance Records and Searching Beacon Feature

Figure 5(a) shows the list of attendance records. The lecturer may click on any of the records to generate a simple attendance report. Figure 5(b) shows the interface of beacon searching. The class detail will be displayed if the beacon is found. The student must select the class to place attendance.

## 5 Conclusion

The UMS is using the Smart-Hadir for capturing the students' attendance records since 2017. There have been numerous modifications due to end-user requests. The most challenging part lies in lecturers and students that have no smartphone at all. Few lecturers are reluctant to have a smartphone as they believe the smartphone will change their lives and increase their workloads. Hence, they still record student's attendance using manual sheets. A small number of students are not affordable to have a smartphone, although the cheapest one is just about USD 80. The lecturer has to manually key in the student's ID in the Smart-Hadir system either before or after

the lecture session to place the student's attendance. The second issue is related to a new user. A new student may face difficulty to log in as they may be confused with the ID and password used. A user manual for login should probably be included and displayed to the user when the Smart-Hadir is first downloaded and used. Overall, the management team received good feedback from the staff and lecturers as the Smart-Hadir has ease and faster the tasks for capturing attendance and preparing reports.

Teaching and learning in the Covid-19 pandemic is challenging. Lecturers conducted the teaching and learning sessions using various technologies. Most of the technologies do not come with an attendance recording module that can automatically capture students' full name and matrix number. In advance, the Smart-Hadir has provided the feature that solves the problem as mentioned above. The lecturers display the Smart-Hadir's auto-generated QR-code in Google Meet 5 minutes before the class. The attendances are captured to the web server, and lecturers can monitor and generate the attendance report with one-click.

The Smart-Hadir app is filing for copyright/patent for its features and designs due to its usage and capability. Thus, not much technical content can be shared in this writing.

# 6    References

[1] Marwedel, P. (2006). Embedded system design. New York: Springer.

[2] Gajski, D. D., Abdi, S., Gerstlauer, A., & Schirner, G. (2009). Embedded system de-sign: modeling, synthesis and verification. Springer Science & Business Media. https://doi.org/10.1007/978-1-4419-0504-8

[3] Martin, F., & Ertzberger, J. (2013). Here and now mobile learning: An experi-mental study on the use of mobile technology. Computers & Education, 68, 76-85. https://doi.org/10.1016/j.compedu.2013.04.021

[4] Kim, D. Y., Park, J., & Morrison, A. M. (2008). A model of traveller acceptance of mobile technology. International Journal of Tourism Research, 10(5), 393-407. https://doi.org/10.1002/jtr.669

[5] Chin, K.O., Syukri, M.H., & Tan, T.G. (2017). Design and Development of Novel Android 3D 3rd Person Shooting Game. International Conference on Computa-tional Science and Technology, Singapore (pp. 302-313). Springer. https://doi.org/10.1007/978-981-10-8276-4_29

[6] Ching, E. T. Y., On, C. K., Alfred, R., Hijazi, M. H. A., & Guan, T. T. (2020). An Android Mobile-based Measurement Application-Object and Interior Room Measurement App. International Journal of Interactive Mobile Technologies, 14(20). https://doi.org/10.3991/ijim.v14i20.15415

[7] Kalogiannakis, M., & Papadakis, S. (2017). Combining mobile technologies in environ-mental education: A Greek case study. International Journal of Mobile Learning and Or-ganisation, 11(2), 108-130.

[8] C Fook Ming, C Kim On, A Rayner, T Tse Guan, A Patricia. (2018). The determi-nant factors affecting cloud computing adoption by small and medium enter-prises (SMEs) in Sabah, Malaysia. Journal of Telecommunication, Electronic and Computer Engineering (JTEC). 10(32): 83-88.

[9] Heron, K. E., & Smyth, J. M. (2010). Ecological momentary interventions: incor-porating mobile technology into psychosocial and health behaviour treatments. British journal of health psychology, 15(1), 1-39. https://doi.org/10.1348/135910709X466063

[10] Arif, Z. H., Ali, N. S., Zakaria, N. A., & Al-Mhiqani, M. N. (2018). Attendance Manage-ment System for Educational Sector: Critical Review. International Journal of Computer Science and Mobile Computing, 7(8), 60-66.

[11] Shukla, A. K. (2017). Microcontroller Based Attendance System Using RFID and GSM. International Journal of Emerging Technologies in Engineering Research (IJETER), 5(8).

[12] Kavitha, E., Tarangini, K., & Roopak, H. (2017). Smart Card System using NFC. Science and Technology, 3(08), 212-215.

[13] Siddiqui, F., Naik, M., Yadav, S., & Sunesara, M. (2017). Wireless Attendance System Using Fingerprint. Imperial Journal of Interdisciplinary Research, 3(5).

[14] Gao J.Z., Prakash L. & Jagatesan R. (2007). Understanding 2d-barcode technolo-gy and applications in m-commerce-design and implementation of a 2d barcode processing solu-tion. 31st Annual International Computer Software and Applica-tions Conference (COMPSAC 2007), Vol. 2. https://doi.org/10.1109/COMPSAC.2007.229

[15] Patel, U. A. (2013). Student Management System based on RFID Technology. Internation-al Journal of Emerging Trends & Technology in Computer Science (IJETTCS), vol. 2, p. 6, 2013.

[16] Nainan, S. (2013). RFID Technology Based Attendance Management System. IJCSI Inter-national Journal of Computer Science Issues., vol. 10, p. 6, 2013.

[17] Arulogun O. T., O. A. (2013). RFID-Based Students Attendance Management System. In-ternational Journal of Scientific & Engineering Research vol. 4, p. 9.

[18] Benyo, B., Sodor, B., Doktor, T., & Fördős, G. (2012, April). Student attendance monitor-ing at the university using NFC. In Wireless Telecommunications Sympo-sium (WTS), 2012 (pp. 1-5). IEEE. https://doi.org/10.1109/WTS.2012.6266137

[19] Buddhiwant, A., Bharkshe, M., Bansod, R., & Chandekar, M. (2017). Smart At-tendance Application. International Journal of Engineering and Management Research (IJEMR), 7(2), 221-224.

[20] Dhope, M. G., & Bhombe, D. L. (2017). Face Recognition Based Attendance Sys-tem us-ing SIFT Algorithm.

[21] Siddiqui, F., Naik, M., Yadav, S., & Sunesara, M. (2017). Wireless Attendance System Using Fingerprint. Imperial Journal of Interdisciplinary Research, 3(5).

[22] Khatun, A., Haque, A. F., Ahmed, S., & Rahman, M. M. (2015, May). Design and imple-mentation of iris recognition based attendance management system. In Electrical Engineer-ing and Information Communication Technology (ICEEICT), 2015 International Confer-ence on (pp. 1-6). IEEE. https://doi.org/10.1109/ICEEICT.2015.7307458

[23] Kotevski, Z., Blazheska-Tabakovska, N., Bocevska, A., and Dimovski, T. (2018). On the Technologies and Systems for Student Attendance Tracking. Internation-al Journal of In-formation Technology and Computer Science. 10, 44-52. https://doi.org/10.5815/ijitcs.2018.10.06

[24] Estimote. (2020). Beacon. Retrieved from https://estimote.com/

[25] Zhi M., Mahinderjit Singh M. (2015) RFID-Enabled Smart Attendance Manage-ment Sys-tem. In: Park J., Pan Y., Kim C., Yang Y. (eds) Future Information Technology - II. Lec-ture Notes in Electrical Engineering, vol 329. Springer, Dor-drecht. https://doi.org/10.1007/978-94-017-9558-6_26

[26] Ong, David Da Wei and Singh, Manmeet Mahinderjit (2016) A secure near field commu-nication (NFC)-enabled attendance on android mobile for higher educa-tion. In:

Knowledge Management International Conference (KMICe) 2016, 29 - 30 August 2016, Chiang Mai, Thailand.

# 7      Authors

**Chung Seng Keau** is a senior lecturer at the Faculty of Engineering, Universiti Malaysia Sabah. He is the project leader for Smart-Hadir applications. He has vast experiences in website, Arduino-based system and Android apps design.

**Chin Kim On** is a Malaysia computer scientist, Senior Member of IEEE, and Computational Thinking educator at Faculty of Computing and Informatics, Universiti Malaysia Sabah, Kota Kinabalu, Sabah. His research interests include artificial neural networks, image processing and its applications, and sentiment analysis.

**Mohd Hanafi Ahmad Hijazi** is an Associate Professor at the Faculty of Computing and Informatics, Universiti Malaysia Sabah, has research interest in data mining, knowledge discovery in healthcare and computer vision.

**Manmeet Mahinderjit Singh** is Senior Lecturer at the Faculty of Computing and Informatics, Universiti Malaysia Sabah, has research interest in data mining, knowledge discovery in healthcare and computer vision.