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SMART CAMPUS: A REVIEW ON SMART ATTENDANCE SYSTEMS AS AN EFFICIENT APPROACH

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Abstract: Smart attendance systems that utilize advanced technologies such as RFID, BLE, and NFC have been developed to provide more efficient and accurate way of tracking attendance with real-time monitoring and tracking capabilities. The implementation of smart attendance systems can help universities stay relevant and competitive in the future as the world becomes more interconnected and technology-driven. This paper provides an overview and study on the benefits of smart attendance systems and a comprehensive analysis of the different types of systems currently being used by universities worldwide. Overall, this paper contributes to the body of knowledge on smart attendance systems and their potential impact on the educational sector.

Keywords: Attendance Taking System; RFID; NFC; IoT; Real time monitoring

1. Introduction

Educational institutions are beginning to adopt IoT systems on their main campus; such as Smart Parking and Smart Security. However, majority of universities have little to none smart systems implemented into the campus lifestyle. This can be problematic as educational institutions will fall behind the rest of the world in terms of technological advancements. While the world is moving at a faster pace towards embracing IoT, educational institutions are progressing slowly, which may lead to a potential loss of competitive advantage in the long run. As the world becomes more interconnected and technology-driven, it is essential for educational institutions to embrace IoT and other emerging technologies to stay relevant and competitive in the future.

The aim of this paper is to study the feasibility and effectiveness of implementing a Smart Attendance System using different technologies, such as Radio-Frequency Identification (RFID), Bluetooth Low Energy (BLE), and Near-Field Communication (NFC).

2. Literature Review

Traditionally, attendance has been taken through manual methods such as roll call or sign-in sheets. However, these methods are prone to errors and can be time-consuming, particularly for large classes (Nordin, & Fauzi, 2020). With advancements in technology, there has been an emergence of smart attendance systems that utilize RFID (Radio Frequency Identification), BLE (Bluetooth Low Energy), and NFC (Near Field Communication) technologies. These systems offer a more efficient and accurate way of tracking attendance, which can save time and resources for educators, students, and administrative staff.

2.1 Traditional Attendance Taking System

There are several traditional attendance taking system which is as follows:

2.1.1 Roll Call Method

According to the Cambridge Dictionary, roll call is defined as “the act of reading aloud the names of people on a list to check whether they are present” (Cambridge University Press, n.d.). Roll call is a common method used in various settings; mainly in classrooms, and workplaces as a way to take attendance and ensure accountability. It is often conducted at the beginning of a class or meeting to establish who is present and who is absent and may also include additional information such as the purpose of the gathering or any announcements to be made. In some cases, roll call may be used as a formal process to document attendance or participation for legal or administrative purposes.

2.1.2 Sign-in Sheet Method

The sign-in sheet method involves students’ signing a piece of paper; often called the attendance sheet, to indicate their presence for that class (Patil, et al., 2014). This attendance sheet usually consists of all the names of the registered students in that specific class. Students signature will be placed beside their name as proof of their presence in the class.

2.2 Smart Attendance System

In a rapidly evolving technological change, traditional attendance taking system have often proven inefficient, time-consuming and prone to errors. With the power of cutting-edge technology, more innovative system is poised to revolutionize the way of attendance system is managed across many different platforms which are as follows:

2.2.1 Bluetooth Low Energy Beacon as a Smart Attendance System

According to Garcia et al. (2016), the emergence of Bluetooth Low Energy (BLE) technology was announced by the Bluetooth Special Interest Group (SIG) when it introduced the Bluetooth Core Specification 4.0. This technology provided a wireless connection that was continuously available (Bluetooth BR/EDR), enabling features such as audio streaming and short bursts of long-distance radio connections (BLE). This made BLE an ideal solution for the Internet of Things (IoT) because it helped reduce battery consumption of mobile devices since it did not require constant connectivity (Garcia et al. ,2016). The Bluetooth Low Energy (BLE) beacon can be described as a wireless personal area network device which regularly broadcasts the signals of a Bluetooth Low Energy advertising. Nowadays, most smart devices are equipped with Bluetooth capabilities, thus any of these devices will be able to receive signals, and they are used to detect the location of the users (Abdulkareem, 2018). Beacons enable mobile apps to determine location accurately at very close ranges and deliver context-specific information to nearby receivers. BLE is predominantly utilized for indoor user/device localization to create positioning and distribution maps based on fingerprint models. Research has demonstrated that the use of BLE is more effective than solutions based on Wi-Fi technology because BLE is more sensitive to rapid fading and large fluctuations of Received Signal Strength (RSS). As a result, precise measurements can be obtained in indoor settings using positioning algorithms (García, et al., 2016). The objective of BLE is to offer a comparable communication range, but with significantly lower power consumption and expenses (Jantan et al., 2022). According to Lodha, et al. (2015), a Bluetooth based Smart systems provides improved efficiency as well as delivering accurate and precise data about tagged entities. This can also benefit the community, business, and consumers in the near future. There are a number of studies of smart attendance systems being done in Malaysian universities. The first study is from UNITEN which proposed a Bluetooth low-energy (BLE) beacon to record students' attendance when they are in proximity to the Bluetooth scanner (Lodha, et al., 2015). The outcome of the research and implementation of the BLE beacon showed that it outperforms traditional attendance-taking methods and any current smart attendance systems (Azmi et al., 2018). In a research study

conducted by Raoof, (2019) at the Altinbas University in Turkey, it was concluded that in order to achieve 100% accuracy in classifying students in and out of the classroom using random forest classifiers, a minimum of four Bluetooth Low Energy (BLE) devices were necessary for each class. This shows that depending on the specifications of the BLE devices and the size of the room, the strength of the BLE signals can vary (Raoof, 2019).

2.2.2 Radio Frequency Identification (RFID) as a Smart Attendance System

Radio Frequency Identification (RFID) technology involves the use of radio waves to capture digital data that is encoded in RFID tags or smart labels with the help of a reader. This method is similar to barcoding, where the data from a label or tag is captured by a device and stored in a database (American Barcode and RFID, 2022). In addition to physical tags that are affixed to objects or people, there are several components involved in RFID technology, including the antenna which detects the tag, the reader which receives information from the tag, the communication infrastructure which enables RFID to interact with the network, and the application software. RFID devices can be classified as either active or passive. A passive tag does not have its own power source and relies on the RFID reader to power it through interrogation. While these tags have a long lifespan, their range is limited. On the other hand, an active tag has an internal power source that allows for greater operating range, but a shorter lifespan between charges. Semi active tags also have an embedded power source but are triggered to power on, allowing them to conserve battery life and last longer than active tags. Typically, passive tags are used for identification purposes while active tags are used for tracking (Mehta, et al, 2020). Smart labels are adhesive labels that incorporate both RFID and barcode technologies. They contain an RFID tag inlay and may also feature a barcode and/or other printed information. Smart labels can be encoded and printed on-demand using desktop label printers, whereas programming RFID tags are more time consuming and requires more advanced equipment (American Barcode and RFID, 2022).

A study conducted by Miao, et al. (2020) proposed a smart attendance system that identifies unique phase characteristics of individuals, which helps to distinguish and recognize different targets. It was found that the system's performance was evaluated through extensive experimentation, it had an average accuracy of 92%, demonstrating its efficiency and accuracy. Furthermore, the evaluation indicated that the system design is resilient to variations in clothing and time of day, confirming the system's successful performance (Miao et al., 2020).

Renaldo et al. (2021) carried out a research study on a lecturer and student attendance system and concluded that data entry into the database, RFID reading, and lateness checking functions properly. However, it was found that reading from the same RFID card sometimes results in a different unique ID being read, which could be due to a malfunction in either the RFID reader or tag. Additionally, the test on time accuracy for lateness recording revealed only 80% accuracy, which is thought to be caused by the unstable Internet connection between the PC and database (Renaldo et al., 2021).

2.2.3 Near-Field Communication (NFC) tags as a Smart Attendance System

Near Field Communication (NFC) technology is a type of device that is capable of detecting information or commands from a tag through close proximity or touch (Nasir et al., 2015). NFC devices operate in two modes, namely active and passive mode. An active device generates its own RF field, while a passive device retrieves power from another device. The device that initiates communication is referred to as the initiator and is always in active mode. The initiator can have multiple targets, which can be in either active or passive mode. However, the initiator can only communicate with one target at a time, while other relevant targets will be ignored initially. As a result, NFC technology does not support broadcasting messages (Chew, et al., 2015). According to a study proposed by (Shoewu et al., 2022), a solution for taking attendance efficiently and easily is where students can use their ID cards to tap on a NFC reader. This method employs NFC technology and is cost-effective, efficient, and easy to maintain. Automating the attendance process saves time and reduces stress. The NFC system can take a student's attendance in an average of 3.5 seconds, compared to the conventional method which takes 16 seconds. In addition, the accuracy of attendance recording is improved by 31% through the use of NFC technology. In a study conducted by Zay, et al. (2016), it was noted that the main focus was on implementing NFC technology in a smart environment that is designed to assist various university stakeholders, including administrative and academic staff as well as students, with a primary goal of enhancing class activities. The motivation behind this study is to replace some of the physical objects used in class and subsequently reduce the tasks required for university operations. The implementation of NFC technology aims to reduce the time spent executing tasks, decrease expenses associated with resources, lower the cost of skilled labor, and create an environmentally friendly system (Zay, et al., 2016). The study conducted surveys to gauge the acceptance of NFC technology among students and lecturers. It was found that a majority of 60% of the participants expressed strong agreement with their satisfaction and contentment with the system, indicating their delight with

it. Additionally, 66% of the participants strongly agreed that the system should be implemented in a university environment and recommended its use. Meanwhile, a significant percentage of 60% of lecturers highly recommend the implementation of this system in the university setting, and they express their willingness to continue utilizing the system once it has been implemented. Hence, it can be concluded that a majority of both students and lecturers are keen and accept any NFC based changes towards the attendance system. It was argued that NFC-based attendance systems are a viable alternative to traditional attendance management methods. The authors suggest that NFC technology can be used not only in educational settings but also in other industries that require attendance management. They recommend further research to explore the potential of NFC technology in attendance management and other applications. Overall, the study showed that NFC-based attendance systems have the potential to improve efficiency and security while reducing costs.

3. Methodology

The methodology adopted for the study is based on the Systems Development Life Cycle (SDLC) approach, which is a widely recognized and accepted framework for software development. The SDLC approach consists of six phases, namely planning, analysis, design, implementation, testing, and maintenance. Each phase involves specific tasks and activities that contribute to the overall development and implementation of the smart attendance system. Based on the requirements and characteristics of the proposed smart attendance system, an Agile SDLC model is more suitable than a traditional, linear approach.

According to McCormick (2012), this software development methodology is a lightweight software development model, which was developed back in the 1990s' is based on iterative and incremental model of software development (McCormick, 2012),. The demands and solutions arise from a collaboration among teams that are both self-organized and cross-functional. The Agile SDLC model breaks down the project into smaller, manageable iterations or sprints, with each iteration producing a working prototype or increment of the system. The system is continuously reviewed and refined based on feedback from stakeholders, including users and developers, throughout the development process (Gillis, et al., 2023). Therefore, the research project adopted the Agile SDLC model, with a focus on regular communication, collaboration, and user-centred design practices to ensure the successful development and implementation of the smart attendance system based on the suggested technologies.

Figure 1 below is the utilization of the use case diagram, meticulously designed to show the intricate operational facets of the smart attendance taking system. This diagram provides a comprehensive functionality of the system that will provide the profound understanding of its operational skill.

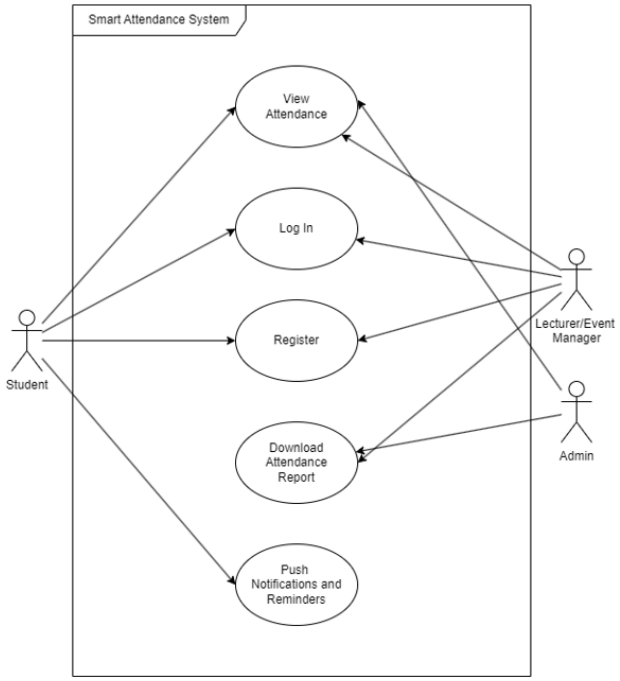

Figure 1 Use case diagram

4. Conclusion

After conducting an in-depth study and analysis of various attendance management systems, including traditional methods, it is evident that the proposed smart attendance system using Bluetooth Low Energy (BLE), Radio-Frequency Identification (RFID), and Near Field Communication (NFC) technologies is a viable and practical approach to overcome the limitations and disadvantages of the traditional attendance system. The smart attendance system's main advantage is its efficiency, reliability, and user-friendliness, which allows for real-time attendance data recording, automated data analysis, and eliminates the need for manual record-keeping, thus reducing the likelihood of errors. These technologies work seamlessly together to provide a comprehensive and efficient solution for attendance management.

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Conflicts of Interest

"The authors declare no conflict of interest".

References

Abdulkareem, A. (2018). The Design, Development and Evaluation of a Smart Attendance Tracking System Using Bluetooth Low Energy Beacons [Thesis]. Cankaya University.

Azmi, M. S. M., Zabil, M. H. M., Lim, K. C., Azman, R. F. R., Adnan, N. N., & Azman, M. M. (2018). UNITEN Smart Attendance System (UniSas) Using Beacons Sensor. 2018 IEEE Conference on e-Learning, e-Management and e-Services (IC3e). https://doi.org/10.1109/ic3e.2018.8632631

Cambridge University Press. (n.d.). roll call. In *Cambridge Dictionary*. https://dictionary.cambridge.org/dictionary/english/roll-call

Chew, C. B., Singh, M. M., Wei, K. C., Sheng, T. W., Husin, M. H., & Malim, N. H. a. H. (2015). Sensors-enabled smart attendance systems using NFC and RFID technologies. *International Journal of New Computer Architectures and Their Applications*, *5*(1), pp.19–28. https://doi.org/10.17781/p001645

García, G., Ruiz, I. L., & Gómez-Nieto, M. Á. (2016). State of the Art, Trends and Future of Bluetooth Low Energy, Near Field Communication and Visible Light Communication in the Development of Smart Cities. *Sensors*, 16(11), pp.1968. https://doi.org/10.3390/s16111968

Gillis, A. S., Torode, C., & Pratt, M. K. (2023). Agile project management (APM). CIO. https://www.techtarget.com/searchcio/definition/Agile-project-management

Jantan, S. R., Rasli, A., Zainudin, A. J. M., Mustafa@Dain, N. W., & Khairuzzaman, M. G. (2022). Smart Attendance for Faculty Monitoring System Using the Bluetooth Low Energy: Design and Implementation. Faculty of Computing & Multimedia. https://doi.org/10.20944/preprints202211.0001.v1

Lodha, R., Gupta, S., Jain, H., & Narula, H. (2015). Bluetooth Smart Based Attendance Management System. *Procedia Computer Science*, 45, pp.524–527. https://doi.org/10.1016/j.procs.2015.03.094

McCormick, M. (2012, September 12). Waterfall vs. Agile Methodology. www.mccormickpcs.com. Retrieved April 8, 2023, from http://www.mccormickpcs.com/images/Waterfall_vs_Agile_Methodology.pdf

Mehta, S., Grant, K., Atlin, C. R., & Ackery, A. (2020). Mitigating staff risk in the workplace: the use of RFID technology during a COVID-19 pandemic and beyond. *BMJ Health & Care Informatics*, 27(3), e100230. https://doi.org/10.1136/bmjhci-2020-100230

Miao, Q., Xiao, F., Huang, H., Sun, L., & Wang, R. (2020). Smart attendance system based on frequency distribution algorithm with passive RFID tags. *Tsinghua Science & Technology*, 25(2), pp.217–226. https://doi.org/10.26599/tst.2018.9010141

Nasir, M. S., Asmuni, M. H., Salleh, N., & Misra, S. (2015). A Review of Student Attendance System Using Near-Field Communication (NFC) Technology. *Lecture Notes in Computer Science*, pp.738–749. https://doi.org/10.1007/978-3-319-21410-8_56

Nordin, N., and Fauzi, N. H. (2020). A Web-Based Mobile Attendance System with Facial Recognition Feature. *International Journal of Interactive Mobile Technologies*,14(05), pp.193–202. https://doi.org/10.3991/ijim.v14i05.13311.

Patil, C. S., Karhe, R. R., & Jain, M. D. (2014). Student Attendance System and Authentication using Face Recognition. *International Journal of Engineering Research and*

Raoof, M. (2019). *A Smart Attendance Tracking System Using Bluetooth Low Energy Beacons* [Master Thesis]. Altinbas University.

Renaldo, Aribowo, A., and Putra, A. S. (2021). Lecturer and Student Attendance System with RFID. *Journal of Physics*, 1858(1), pp.012063. https://doi.org/10.1088/17426596/1858/1/012063

Shoewu, O. O., Akinyemi, L. A., Mumuni, Q. A., Ajasa, A. A., Folorunso, C. O., & Edozie, R. (2022). Development of a smart attendance system using near field communication (SMAT-NFC). *Global Journal of Engineering and Technology Advances*, 12(2), pp.121–139. https://doi.org/10.30574/gjeta.2022.12.2.0150

Zay, A. Z. Z., Nor, R. M., Razi, M. J. M., Mantoro, T., & Ayu, M. A. (2016). NFC BASED ATTENDANCE: MORE THAN JUST A TOUCH. *Jurnal Teknologi (Sciences & Engineering)*, 9–3(78), pp.69–78. https://doi.org/10.11113/jt.v78.9720