International Journal For Recent Developments in Science & Technology
2581-4575
Crossref
A Peer Reviewed Research Journal

Availability and Attendance Monitoring System for Faculty using IoT

Inti Hemanth
Dept. of ECE
Aditya Engineering College (affiliated to JNTUK)
Surampalem, A.P., India
intihemanth01@gmail.com

Jaddu Swathi Kiran
Dept. of ECE
Aditya Engineering College (affiliated to JNTUK)
Surampalem, A.P., India
jadduswathikiran@gmail.com

Darisipudi Saahil
Dept. of ECE
Aditya Engineering College (affiliated to JNTUK)
Surampalem, A.P., India
darisipudisahil8@gmail.com

Abstract: Recently, student attendance has been considered as one of the crucial elements or issues that reflect the academic achievements and the performance contributed to any university compared to the traditional methods that impose time-consuming and inefficiency. In a similar manner, monitoring the availability of a professor for the students to approach them is also an aspect that must be taken care off. We came across many researches that have designed attendance monitoring and identification systems for students and professors using technologies like RFID (Radio Frequency Identification) or barcodes, etc. along IoT devices to store and view the information. The current study focuses on designing an attendance and availability monitoring system for professors

Keywords: Node MCU, RFID Readers, RFID Tags, Attendance, Monitoring, Location Tracking, Arduino IDE.

International Journal For Recent Developments in Science & Technology
2581-4575
Crossref
A Peer Reviewed Research Journal

I. NTRODUCTION

Traditional tracking and attendance monitoring systems are manual, time-consuming and prone to errors. They usually involve using paper-based attendance sheets, signing attendance registers, or manually marking attendance in a physical record book. This method can be inefficient, and there is a high likelihood of errors, especially when handling large groups of people. On the other hand, smart tracking and attendance monitoring systems use technology such as biometrics (facial recognition, fingerprints, iris scans), RFID (Radio Frequency Identification) tags, or GPS (Global Positioning System) to track attendance and monitor movement automatically. These systems can help eliminate errors and ensure accurate tracking and monitoring.

Monitoring the availability of professors has become an important evaluation in some colleges and universities. In the traditional approach, students have to reach out to their lecturers or professors in order to clarify their doubts or communicate with them to get some suggestions. For example, if a student wants to meet a professor in between the class he can take the permission of the professor present in the class and meet the required professor. But what if the professor is not available at the time, then the student can take this as a chance and escape the class.

In order to overcome such situations and make it easy for both teachers and students to have effective communication within the campus premises, we need to develop better methodologies that are useful and cost-efficient. In recent years, several technologies have been developed that can be used in tracking and attendance monitoring system such as biometric systems, RFID systems, GPS tracking, barcode scanning, NFC systems, Bluetooth Low Energy (BLE) beacons and Wi-Fi tracking.

Each of the technology has their own advantages and disadvantages based on their applications. Moreover, with the integration of machine learning and artificial intelligence, smart

II. LITERATURE REVIEW

[15] Chao Yang, Xuyu Wang and Shiwen Mao, developed "RFID based 3D human pose tracking: A Subject generalization based on RFID technology and some IoT based devices used to transfer and store data via internet and web-based application to view the required information. The proposed system aims to monitor the availability of professor for the student to meet him/her and also to record the attendance. If the proposed system works as per the requirements, it would be time-efficient for the students to not wait for their professors.Tracking and attendance monitoring systems can offer more personalized features and predictive analytics. For instance, the system can predict people who may be at risk of absences, monitor attendance trends, and help in decision-making.

The era we live is called the Digital age, this is because every day we can come across different technologies that come into existence and the existing one's being updated and upgraded. These technologies have revolutionized the way we access information, connect with others, and perform tasks, making many aspects of our lives more efficient, convenient, and interconnected. They have also brought about new opportunities and challenges, including the need to adapt to changing job requirements, address privacy and security concerns, and navigate the complexities

of an increasingly digital world.

IoT can be used for tracking and attendance monitoring in several ways. One approach is to use sensors or beacons that are placed in different locations to detect when someone enters or exits a particular area. This data can be transmitted wirelessly to a central system, which can then use this information to track attendance and generate reports. Overall, IoT technology provides a range of options for tracking and attendance monitoring, and the specific approach will depend on the needs of the organization and the available resources.
In the present project, we are proposing an Availability and Attendance Monitoring system. Although we have different methods to track as mentioned above, we are using RFID technology in our proposed methodology which in turn is integrated with IoT system which consists of a Node MCU which helps the data to be stored in a central system. RFID readers are installed at various locations throughout the campus, and when an RFID tag passes by a reader, its location is recorded. This location is then stored in a database with the help of Node MCU approach". They proposed a subject-adaptive, real-time 3D pose estimation and tracking system called Cycle-Pose. A pre- processing module was proposed to effectively mitigate the effect of phase distortion and missing RFID data samples. The proposed system then leveraged a novel cycle kinematic network to estimate human postures in real time using RFID phase data, which was trained with unpaired RFID and vision data sampled from different subjects. The Cycle-Pose system was implemented with commodity RFID tags/reader and compared using a traditional RFID based technique.

[4] Zhigang Gao, Yucai Huang, Leilei Zheng and their team, developed "A Student Attendance Management Method Based on Crowdsensing in Classroom Environment". They proposed an intelligent attendance management method named AMMoC. AMMoC consists of the initialization phase and the authentication phase. In the initialization phase, each student will submit his location information from the student side. In the authentication phase, AMMoC first optimizes the assignment of crowdsensing0' tasks, and then the MCTS algorithm selects several students to perform student verification. AMMoC will analyze the truth of the submitted locations based on the student number of sub regions submitted by the verifiers. The experiment results show that the AMMoC has the advantages of short attendance codhecking time and high accuracy.

[14] Salah Elaskari, Muhammad Imran, Abdurrazag Elaskri and Abdullah Almasoudi, developed "Using Barcode to Track Student Attendance and Assets in Higher Education Institutions". The designed barcode system provides a simple methodology to track student attendance and assets. It has several benefits over the manual methods including the process takes less time and stores the data in electronic mode instead of paperwork. It is considered one of the AIDC technologies which provide a high degree of automation, eliminates data entry error, and improve the efficiency of erring data.

[8] Riya Lodha, Suruchi Gupta, Harshil Jain and Harish Narula, developed "Bluetooth Smart based Attendance Management System". In this paper, they have discussed about an automated attendance recoding system that utilizes the capabilities of Bluetooth Smart technology. They have also discussed about major

advantages of using Bluetooth Smart that include low power consumption, high data transfer rate, small size of chips and low cost and simple implementation of Bluetooth Smart based wireless sensors.

[13] Rashmi A, S Brindha, Srinthin S B and Gnanasudharsan A, developed "Smart Attendance System using RFID and Face ID". The methodology used in the system avoids proxy attendance with help of Tensor Flow, Image Processing, OpenCV, etc. This process will assist the staff or management to note the attendance properly and save the class time. Also, the attendance will automatically be uploaded to a webpage.

[1] Vivek Seelam, M. Bindu Priya, M. Durga Prakash and their team, developed "Smart attendance using Deep Learning and Computer Vision".K The proposed automatic attendance using face recognition has been implemented on a raspberry pi and is therefore very portable and requires very little maintenance. The system even sends a confirmation SMS to the students present, so the proposed system is fairly accurate given that the faces in the images captured contain properly posed and are not occluded. The solution saves an enormous amount of time in the long run of any academic institution.

[16] Kiran Ghadge, Thippeswamy Achar and their team, developed "Indoor positioning of metal parts by fingerprinting using passive RFID". The study appears to be the first study involving positioning of metal parts in a manufacturing assembly facility. They also claim that this method is affordable compared to other technologies.

[17] Leila Gholamhosseini, Farahnaz Sadoughi and Aliasghar Safaei, developed "Hospital Real-Time Location System". The implementation of a real-time location system enables hospitals to achieve their goals such as improving efficiency, increasing patient satisfaction and reducing time and cost considerably. Accordingly, regarding the organization's requirements, novel technologies such as IoT and cloud computing or a combination of these two technologies can be used to design the real-time location system in order to overcome the existing constraints and shortcomings.

[19] Sakthi Jaya Sundar Rajasekar, developed "An Enhanced IoT based Tracing and Tracking Model for COVID-19 Cases". The main contributions of the proposed work is to effectively trace and track the persons who have been in the proximity to the suspected cases to further take necessary measures such as undergoing quarantine and treatments. The proposed model effectively transmits the details to the administrative authorities to take further actions in preventing the social transmission of the disease even in case of ignorance of the suspected ones.

[6] Sarmad Hameed, Faraz Junejo and their team, developed "Radio Frequency Identification (RFID) Based Attendance & Assesment System with Wireless Database Records". The system is a low-cost system which is designed to withstand any terrain and surrounding, providing tactical and surveillance and better comfort. Moreover, implementation of wireless & GSM connection in control board allows the system install in more simple way. RFID technology positively promises an increased effectiveness and improved efficiency for business and administrative processes.

[9] Saurabh S. Chakole, Neema A. Ukani and Sohail Sheikh, developed "GPS and GSM Enable Tracking, Monitoring and Control system for Multiple Application". The algorithm is designed and developed for locking mode, Tracking monitoring mode and control mode. It works comfortably and provides good accurate output. Location is easily traced out on GMAP. Locking mode provides major safety which sends alert message if the vehicle or system changes its position. It works as an antitheft for Vehicle. It can work in the absence of internet.

[19] Lu Bai, Fabio Ciravegna, Raymond Bond and Maurice Mulvenna, developed "A Low-Cost Indoor Positioning System Using Bluetooth Low Energy". The BLE sensing based system localizes the position of the BLE beacon through two proposed algorithms. One method used the trilateration algorithm to track the position of the BLE beacon in a known coordinate reference frame. Another method used the fingerprinting-based method to locate the BLE beacon in one of the grids or one of Location-of Interest. The smoothing method has been proposed in order to remove the noise of from the raw RSSI values. The experimental results have shown good accuracy in indoor positioning.

[20] Anna Fay E Naive, Paul Joseph M Estrera and Archie O Pachica, developed "Design and Implementation of class attendance monitoring system using BLE Beacons". The use Bluetooth Low- Level Energy (BLE) Beacons for faculty attendance monitoring, of web and mobile-based application provides an easier and more organized way of monitoring the attendance of the faculty to his/her classes. The result of the study in terms of functionality and proximity testing is acceptable.

[21] Didi Surian, Vitaliy Kim, Ranjeeta Menon and their team, developed "Tracking a moving user in indoor environments using Bluetooth low energy beacons". They demonstrated a novel method to detect the location of a moving user in indoor and dynamic environments. They introduced RNSI as a new measurement, and proposed a practical method for removing signals that could lead to incorrect location prediction. Their results suggest that the RNSI-based method produced more consistent patterns than the RSSI- based method for determining locations.

[22] A. R. Al-Ali ,Fadi A. Aloul, Nada R. Aji, Amin A. Al- Zarouni, Nassar H. Fakhro, developed Mobile RFID Tracking System. An RFID based kids tracking system was developed and tested. Results show that the overlapping method accurate. It is recommended that the system be tested in the real park.

[23] Muawia Ramadan, Hassan Al-Maimani & Bernd Noche, developed RFID-enabled smart real-time manufacturing cost tracking system. This research highlighted the financial setbacks in a traditional VSM and addressed the real-time manufacturing cost tracking system. The costing process is executed during the progress of the production operations where the products' real-time data is mapped onto the corresponding VVSM/AVSM to estimate the actual cost of tracked time-totask activities and the consumed materials.

[24] Yeong-Lin Lai, Jay Cheng, developed A Cloud-Storage RFID Location Tracking System. The cloud-storage location tracking system was developed by the RFID, WSN, CLA, cloud computing, and LTA technologies. The LTA

using the LQI, SAM, and reference tag approaches was proposed. The system with the advantage of easy maintenance demonstrated an accuracy improvement of over 31% and a hardware cost reduction of 18.2%.

[25] N. Renuka; Ng Chin Nan; Widad Ismail, developed Embedded RFID tracking system for hospital application using WSN platform. The ultimate objective of the proposed system is successfully achieved. The detection words from the GSM reply message is successful and stable. It shows that the message which sent or receives from GSM module is readable by Mev. This means that if any additional functions are implemented, the MeV can be control via SMS services.

[26] Oladiran Tayo Arulongun, Adeboye Olatunbosun, Fakoulujo
O. A., Olayemi Mikali Olaniyi, developed RFID-Based Students Attendance Management System. The application of RFID to student attendance monitoring as developed and deployed in this study is capable of eliminating time wasted during manual collection of attendance and an opportunity for the educational administrators to capture face-to-face classroom statistics for allocation of appropriate attendance scores and for further managerial decisions.

[27] Bardaki,C., Kourouthanassis, P. and Pramatari, K., Developed RFID-Enabled Services in the Retail Supply Chain: Lessons Learned toward the Internet of Things, Information Systems Management. Through this article we present our efforts to describe and share the design and deployment challenges of two RFID enabled retail services: promotion management and dynamic pricing in the supermarket floor, while offering some primary guidelines on prospective solutions. Mohamed A.B, Abdel-Hamid A and Mohammed K.Y, developed Implementation of an Improved secure system detection for E passport by using EPC RFID tags. This paper presents the design and prototype implementation of an e-passport reader on an 8-bit AVR microcontroller. Performance evaluation results indicate the enhancement of AES encryption execution cycles on an 8-bit microcontroller to 19% Hinkka V, developed Implementation of RFID tracking across the entire supply chain. The results of this thesis indicate that improved tracking would help companies develop their SCMs to better respond to the requirements of their operational environments. SCM concepts of postponement and speculation could be used to evaluate the trade-offs between the resources needed to implement wide-spanning tracking with benefits that the wider coverage would offer.Zhoubing Xiong, Zhenyu Song, Andrea Scalera, Enrico Ferrera, Francesco Sottile, Paolo Brizzi, Riccardo Tomasi & Maurizio A Spirito, developed Hybrid WSN and RFID indoor positioning and tracking system. WSN system provides adequate RSSI observations but with large errors, and RFID system provides accurate detections but with sparse observations. Thanks to the hybridization of RFID measurements and cooperation among mobile nodes, the proposed positioning solution based on EKF is able to increase the robustness and accuracy of indoor positioning systems in harsh propagation conditions. Simulation and experimental results showed that the hybrid WSN-RFID configuration outperformed the set-ups employing single technology.

[28] Xiong Z, Sottile F, Spirito MA, Garello R, developed Hybrid indoor positioning approaches based on WSN and RFID. This paper proposed two hybrid WSN/RFID positioning approaches which adopt the RFID

technology to help WSN positioning in harsh indoor environments, where the traditional WSN-based only positioning solutions suffer. In particular, the two algorithms, one based on EKF and the other one on PF, have been designed to be suitable for the WSN/RFID hybridization. Although the proposed solutions require new hardware (i.e. one RFID reader and a certain number of fixed tags deployed in the environment), the computation complexity is not so much increased compared to the WSN only positioning systems.

[29] M Kiers, E Krajnc, M Dornhofer, W Bischof, develped Evaluation and improvements of an RFID based indoor navigation system for visually impaired and blindpeople. The first result of this project is to pinpoint the fact that it is not easy to choose the right types of tags for indoor navigation, because not every RFID-reader can be used. Furthermore, the reading range of the different tags is lower than expected. The reading range of the passive RFID-tags varies from two to thirty centimeters; in the final functionality a reading range of at least sixty centimeter is needed

[30] JM Lopez Garde, J Larranaga, L Muguira, JI Vazquez, developed Indoor Positioning and Indoor Navigation (IPIN). An environment adaptive ZigBee-based indoor positioning algorithm. We have obtained quite promising results, since other indoor positioning systems are far from offering better results; they require more pre-processing work and do not automatically take into account changes in the environment.

[31] M Bouet, AL dos Santos, RFID tags, developed positioning principles and localization techniques. Globally, in terms of scalability and availability, these RFID positioning techniques have their own important characteristics when applied in real environments. The choice of technique and technology (passive or active tags) significantly affects the granularity and accuracy of the location information but also the whole cost and the efficiency of the RFID system.

[32] KC Cheung, SS Intille, K Larson, developed An inexpensive Bluetooth-based indoor positioning hack. We have described a strategy that employs Bluetooth for positioning with mobile devices, that is effective indoors, at a spatial resolution of two to three meters, and requires only low cost off-the-shelf hardware. Our methods of using presence of beacon signals as positioning information have shown to be reliable in a real world setting with greater than normal expected noise, in terms of electronic equipment, etc.

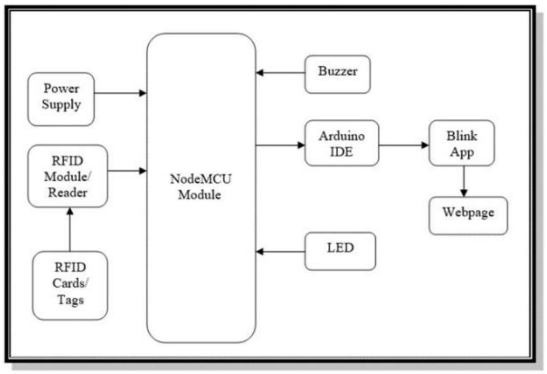
III. METHODOLOGY:

Methodology includes block diagram, circuit diagram and flow chart along with the explanations. The Attendance and Availability Monitoring system is a real-time tracking system designed to keep track of the location of professors within a college or university campus. The system is built using RFID (Radio Frequency Identification) technology and NodeMCU boards. The system consists of RFID reader modules that are placed at the entrances of each classroom, and each professor wears an RFID tag. The system collects data from the reader modules and uses it to update the location of each professor in real-time. The data is then sent to webpage that displays the location of each professor, which can be viewed by the students and the college management.

International Journal For Recent Developments in Science & Technology
2581-4575
Crossref
A Peer Reviewed Research Journal

i. Block Diagram

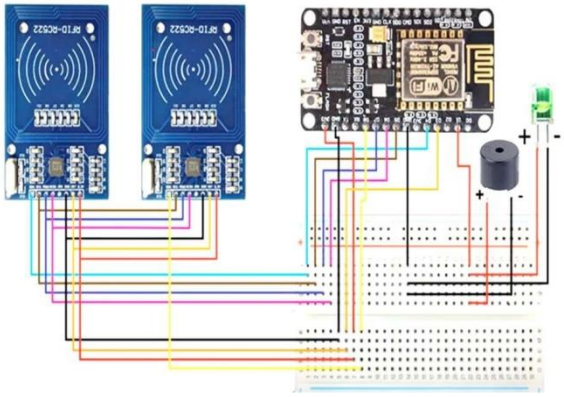
Initially the RFID tags/cards are tapped with the RFID Module, the data is then transferred to the Blynk App with help of NodeMCU and the code written for RFID on Arduino IDE. When the RFID card is tapped with the RFID Module for the first time, the buzzer beeps once considering it as the user logged in and is in a particular room. When the same card is again tapped, the buzzer beeps twice considering that the user logged out and is out of the room. If some error operation occurs, the buzzer beeps thrice. The operation the LED is to indicate that a tag has been tapped. From the Blynk App the data is integrated to a webpage where we can see the location of the faculty.



Block Diagram

ii. Circuit Diagram

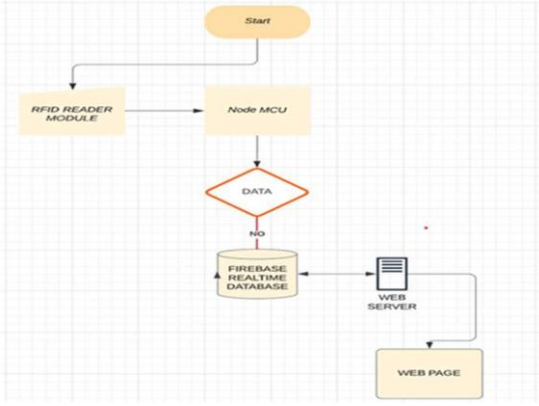
The diagram shows the connections in the following circuit. The NodeMCU module is connected with the following components – RFID reader modules, Buzzer and LED using a Breadboard. The NodeMCU module is connected to a PC for power supply and also a code is written for the NodeMCU and RFID reader using Arduino IDE. An input is taken from the user whenever a RFID tag is tapped with the RFID reader. As the reader is connected to the NodeMCU which in return is connected to the PC and the code in Arduino IDE is executed, based on the operation, the buzzer beeps and the LED lights up.



Circuit Diagram of Working Model

iii. Flow Chart

The flow chart represents the execution of code and the system. Initially the input is taken from the RFID tags. These tags are tapped with the RFID reader. The RFID reader collects the data from these tags and the data is then sent to the database using NodeMCU module. This data is then verified and the output in the webpage is updated based on the algorithm. The code is written in Arduino IDE which is executed whenever the tag is tapped and the output is updated on the webpage based on the operation where the webpage is hosted using a web server.



Flow chart

International Journal For Recent Developments in Science & Technology
2581-4575
Crossref
A Peer Reviewed Research Journal

IV. RESULTS

In this project we designed Availability and Attendance Monitoring System using RFID and NodeMCU which helps students locate faculty location like if they are in a certain classroom, staffroom or neither of these places, so that students can have an idea whether they have to wait for the faculty or not. This data is then verified and the output in the webpage is updated based on the algorithm. The code is written in Arduino IDE which is executed whenever the tag is tapped and the output is updated on the webpage based on the operation where the webpage is hosted using a web server The proposed methodology along with hardware consists of a predefined webpage which gets updated using the data from Blynk app every second. Hence, we can conclude that the system is not only cost efficient but also efficient and accurate.

V.DISCUSSION / LIMITATIONS

The results demonstrate the potential of RFID technology to complete this project. All the components used in this project are of low cost and are efficient. Although, we have many other technologies that are used for tracking like BLE Beacons, Wi-Fi tracking, Biometric, etc, because it is very cost efficient and accurate.

However, it is essential to understand that the system is designed for only some customized users. Also, it can only find out the location of faculty if he/she is in a classroom or staffroom. Future studies should consider using this system for a organization or institution level along with a web application for campuses where mobiles are allowed or an LED display displaying the location of faculty.

VI CONCLUSION

In conclusion, we know that students often have doubts or issues that they cannot discuss within the class timings. If the students want to meet the faculty, they need to approach them at staff room. But the problem is that the faculty may not be available at the staffroom all the time, as the faculty has to attend different classes or there may be some meetings or some other reasons.

In this project we designed Availability and Attendance Monitoring System using RFID and NodeMCU which helps students locate faculty location like if they are in a certain classroom, staffroom or neither of these places, so that students can have an idea whether they have to wait for the faculty or not. The proposed methodology along with hardware consists of a predefined webpage which gets updated using the data from Blynk app every second. Hence, we can conclude that the system is not only cost efficient but also efficient and accurate.

As explained above the developed system consists of a webpage that is predefined. If an institution would like to implement this type of a system, then in terms of future scope we do some modifications to this system. Such as: giving custom data to each tag, containing the data of each faculty respectively, create a customized that is compatible with institution, also deploy the application on a cloud platform so that users can obtain data from anywhere.

REFERENCES

[1] V. Seelam, Akhil kumar Penugonda, B. Pavan Kalyan et al., "Smart attendance using deep learning and computer vision". Materials Today: Proceedings, pg.1-4, 2021.

[2] Eid Al Hajri, Farrukh Hafeez and Ameer Azhar N V. "Fully Automated Classroom Attendance System". International Journal of Interactive Mobile Technologies, Vol.13, No. 8, pg. 95-106, 2019.

[3] Gatete Marcel and Harubwira Flaubert. "A Development of an Online Student Attendance Management Information System". International Journal of Scientific Research in Computer Science and Engineering, Vol.10, Issue.1, pp.32-48, 2022.

[4] Zhigang Gao, Yucai Huang, Leilei Zheng et al., "A Student Attendance Management Method Based on Crowdsensing in Classroom Environment", IEEE Access, Vol.9, pg. 31481-31492, 2021.

[5] Khaled Mohammed, A.S Tolba and Mohammed Elmogy. "Multimodal student attendance management system (MSAMS)". Ain Shams Engineering Journal 9, pg. 2917-2929, 2018.

[6] Sarmad Hameed, Syed Muhammad Taha Saquib, Moez ul Hassan, and Faraz Junejo. "Radio Frequency Identification (RFID) Based Attendance & Assessment System with Wireless Database Records". World Conference on Technology, Innovation and Entrepreneurship, Procedia - Social and Behavioral Sciences 195, pg. 2889 – 2895, 2015.

[7] Bawar Ali Abdalkarim and Devrim Akgun. "A Literature Review on Smart Attendance Systems". 3rd International Conference on Applied Engineering and Natural Sciences, pg. 1568-1574, 2022.

[8] Riya Lodha, Suruchi Gupta, Harshil Jain and Harish Narula. "Bluetooth Smart based Attendance Management System". International Conference on Advanced Computing Technologies and Applications, Procedia Computer Science 45, pg. 524-527, 2015.

[9] Saurabh S. Chakole, Neema A. Ukani and Sohail Sheikh. "GPS and GSM Enable Tracking, Monitorig and Control system for Multiple Application". Second International Conference on Smart Systems and Inventive Technology, pg. 1027-1030, 2019.

[10] K. Aravindhan, S.K.B. Sangeetha, K. Periyakaruppan et al., "Design of Attendance Monitoring System Using RFID". 7th International Conference on Advanced Computing & Communication Systems, pg. 1628-1631.

[11] Yangzi Chen and Xiaofeng Li. "Research and Development of Attendance Management System Based on Face Recognition and RFID Technology". IEEE International Conference on Information Communication and Software Engineering, pg. 112-116, 2021.

[12] Sonali Gaionde, Mayuresh Shelar, Riddhi Pandey and Gaurav Tuntune. "Radio Frequency Identification Based Attendance System". IEEE International Conference for Innovation in Technology, pg. 1-5, 2021.

[13] Rashmi A, S Brindha, Srinithin S B and Gnanasudharsan A. "Smart Attendance System using RFID and Face ID". IEEE International Conference on Communication, Computing and Internet of Things, 2022.

[14] Salah Elaskari, Muhammad Imran, Abdurrazag Elaskri and Abdullah Almasoudi. "Using Barcode to Track Student Attendance and Assets in Higher Education Institutions". The 12th International Conference on Ambient Systems, Networks and Technologies (ANT), Procedia Computer Science 184, pg. 226-233, 2021.

[15] Chao Yang, Xuyu Wang and Shiwen Mao, "RFID-based 3D human pose tracking: A subject generalization approach", Digital Communications and Networks, Volume 8, Issue 3, June 2022, Pages 278-288.

[16] Kiran Ghadge, Thippeswamy Achar, Aakash Bhatt, Balan Gurumoorthy and Amerash Chakrabarti, "Indoor positioning of metal parts by

fingerprinting using passive RFID", Procedia CIRP, Volume 88, 2020, Pages 60-63.
[17] Leila Gholamhosseini, Farahnaz Sadoughi and Aliasghar Safaei, "Hospital Real-Time Location System", Iran J Public Health. 2019 Apr; 48(4): 593–602.
[18] Sakthi Jaya Sundar Rajasekar, "An Enhanced IoT based Tracing and Tracking Model for COVID-19 Cases", SN Computer Science volume 2, Article number: 42 (2021) .
[19] Lu Bai, Fabio Ciravegna, Raymond Bond and Maurice Mulvenna, "A Low-Cost Indoor Positioning System Using Bluetooth Low Energy", IEEE Access , Volume: 8, 136858 – 136871, 27 July 2020.
[20] Anna Fay E Naive, Paul Joseph M Estrera and Archie O Pachica, "Design and Implementation of class attendance monitoring system using BLE Beacons", Indian Journal of Science and Technology 13(40): 4234-4243.