Student Auto Attendance System Using Rapberry Pi with Face Recognition Module

G. Jahnavi[1], G. Nithin Reddy[2], CH. Uday Kumar[3], V.H.N.D. Madhuri[4], B. Nithin[5], A. Phani Madhuri[6]
[1,2,3,4,5] *UG Student, Department of ECE, NSRIT, Vizag, AP, India*
[6] *Assistant Professor, Department of ECE, NSRIT, Vizag, AP, India*

***Abstract*—Face recognition based smart attendance system using recognizing the students face while taking attendance by using face based on monitor camera image capturing. In our face recognition based smart attendance project, a raspberry pi system will be able to find and recognize human faces fast and precisely in images. The long-established method of calling name of each student is tedious and there is always a chance of proxy attendance. The proposed system is based on face recognition to maintain the attendance record of students. As the process of attendance taking starts the system takes pictures of the attendees and then applies face detection and recognition technique to the given image and the recognized students are marked as present and their attendance is updated with corresponding time, student name and register number. We have used deep learning techniques to develop this project. The project aims to eliminates manual roll-call, saving time and reducing proxy attendance, attendance data is recorded and stored in database which is excel sheet and through IoT, which makes it easy to manage and report.**

***Index Terms*—Attendance automation, Database, Data recording, Face recognition, Image processing, Internet of things, Python, Real time, Raspberry Pi**

I. INTRODUCTION

Attendance tracking has long been a fundamental aspect of educational administration. Its primary purpose is to monitor student presence, identify patterns of absenteeism, and ultimately, correlate attendance with academic performance. Traditionally, attendance records served as a basic metric for student engagement and institutional accountability. Over time, the methods used to track attendance have evolved from simple manual lists to more sophisticated electronic systems, reflecting the changing needs and technological capabilities of educational institutions. The evolution underscores a continued effort to improve efficiency, accuracy, and the overall management of student data. The move from physical attendance sheets to digital solutions represents an effort to improve the reliability of attendance data. Traditional attendance methods, such as manual roll calls, face several significant challenges. These methods are time-consuming, diverting valuable class time away from instruction. They are also prone to human error, leading to inaccurate records. Furthermore, traditional methods are susceptible to proxy attendance, where students mark attendance for their absent peers, compromising the integrity of the data. The manual nature of these methods also makes data analysis and reporting cumbersome, hindering timely interventions for students with attendance issues. These limitations highlight the need for automated solutions that can address these inefficiencies and improve the reliability of attendance tracking in educational settings. The Student Auto Attendance System is designed to address the shortcomings of traditional attendance methods by automating the process through face recognition technology. This system utilizes a Raspberry Pi as the central processing unit, a webcam for capturing student images, and Python for implementing the face recognition algorithms and data management. The system operates in real-time, identifying students as they enter the classroom and automatically recording their attendance. The captured attendance data is then stored in an Excel spreadsheet, providing a readily accessible and easily manageable attendance record. This automated approach eliminates the need for manual roll calls, reduces the risk of proxy attendance, and streamlines the attendance tracking process for both students and educators. The use of open-source tools like Python further reduces the cost and complexity of the system, making it a viable solution for educational institutions with limited resources. The primary objective of this

research is to develop and evaluate a functional and reliable Student Auto Attendance System using Python, Raspberry Pi, and image processing techniques.

Specific research objectives include: designing and implementing a face recognition algorithm suitable for real-time attendance tracking; developing a system architecture that integrates hardware and software components seamlessly; creating a data management system that stores attendance records accurately and efficiently in Excel; evaluating the system's performance in terms of accuracy, processing speed, and reliability; and assessing user feedback and acceptance of the system. The significance of this research lies in its potential to improve the efficiency and accuracy of attendance tracking in educational settings, freeing up valuable class time and providing educators with more reliable data for student monitoring and intervention. Furthermore, the system serves as a practical demonstration of the application of computer vision and machine learning techniques in education, potentially inspiring further innovation in this area. The research also contributes to the growing body of literature on automated attendance systems and their impact on educational institutions.

II. LITERATURE REVIEW

The authors propose various face recognition approaches using direct and complex analyses. S.T. Gandhi discusses a system identifying individuals through facial biometrics, applicable in identification, access control, and document management. Anil K. introduces a layout matching algorithm, addressing face recognition issues through edge representation and dimensional analysis. Sujatha G. reviews soft computing techniques like SVM and ANN, highlighting feature extraction methods such as ICA, PCA, and LDA, while noting factors that affect accuracy like image quality and lighting. Rhiddi Patel explores efficient face recognition methods that adapt to environmental changes. The current approach employs AI with a database created from videos of 11 individuals, using a 13MP camera to capture 234 images per class at a resolution of 244x244. Deep Neural Networks (DNNs) enhance face detection accuracy, utilizing the Single Shot Detector (SSD) framework. The images are pre-processed to 128x128 pixels and converted to a 1D array for feature extraction with PCA and LDA. The proposed attendance management system automates attendance tracking using facial recognition, addressing challenges like scaling and lighting variations. It incorporates multiple feature extraction techniques to improve accuracy, using Euclidean distance and k-nearest neighbours for face recognition. The system enhances attendance management in educational institutions and organizations.

III. EXISTING SYSTEM

In existing system uses RFID, KEYPAD based security system. Due to that system there is no accurate security for existing system. There are many limitations due to the existing system. To overcome the existing system limitations, we integrate to produce latest technology call face recognition. The present system of taking attendance is either by manual or by using finger impression as biometric parameter. Manual /Traditional attendance is usually taken by calling students by name which takes a lot of time and has a chance of errors and proxies which makes the analysis of student performance imprecise. The maintenance of record for this type of attendance is time consuming and resource consuming. Attendance by using finger impression as biometric parameter is done by taking finger print as biometric parameter which is in use in many places, which may not be a time-consuming process compared to manual attendance, however, keeping the recent pandemic in mind it is not safe to touch the finger print recognition sensor repeatedly without a huge time gap. Also, this type is high maintenance. So, there is a need for new attendance system which has no lecturer interference and has a contactless device.

IV. PROPOSED SYSTEM

The proposed system is designed to capture the face of each student and to store it in the database for their attendance. The face of the student needs to be captured in well-lit room so that student's face features can be detected, the seating and the posture of the student need to be recognized. With this system, there is no need for the teacher to manually take attendance in the class because the system records a video and through image processing/image training the face is

recognized and the attendance database is updated in a spreadsheet. The proposed system uses Raspberry Pi as computer and a webcam for capturing the images. Facial recognition Methodology is being widely used in many projects as it has many advantages. There is requirement of data for the system in order to trace and track the individual and mark his/her attendance. The data is loaded by assigning each individual's image with a corresponding id and name. Once the system starts, the option of taking image is available for which the pre-requirement is the input of id and name, thirteen to fifteen images will be taken in grey format using OpenCV. These images will be the input for Haar cascade. Haar Cascade codes the pictures into binary code after converting them into binary image. Once the system is given input, it is trained by clicking on train image option available on the screen using a file called Trainer.yml which is written in human readable data serialization language. The features of the face will be detected and stored for further actions. The dataset must be created to recognize faces when needed. The "Track images" option detects and recognizes individual faces, marking attendance in a spreadsheet with the date and time. The system activates by asking for a student's live image, name, and ID. Once inputted, it stores the information and trains for future use. The process includes capturing the student's image, applying Haar Cascade for face detection, extracting a bounding box, and processing images (grayscale conversion, histogram equalization, resizing). If updating the database, it stores the data; otherwise, it applies LBPH for feature extraction. The system also records a short video to update the attendance database accordingly.

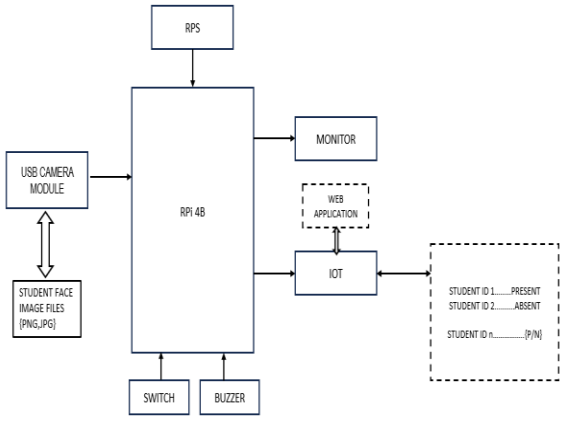

Fig 1: Block diagram

Fig 2: Implementation Algorithm

V. METHODOLOGY

The Student Auto Attendance System comprises several key hardware components working in concert. A Raspberry Pi 4 Model B serves as the central processing unit, chosen for its processing power, memory capacity, and connectivity options. A USB webcam with a resolution of at least 720p captures images and video of students entering the classroom. The webcam is positioned to provide a clear and unobstructed view of the entrance. A monitor connected to the Raspberry Pi displays the system's interface and provides real-time feedback. Optionally, a keyboard and mouse can be connected for system configuration and maintenance. The entire system is powered by a standard USB power supply. The selection of these components prioritizes cost-effectiveness, ease of use, and compatibility with the software components. The software architecture consists of several modules built using Python. The core module is the face recognition module, which implements the face detection and recognition algorithms using libraries such as OpenCV and face recognition. The data management module handles the storage and retrieval of attendance data, using the openpyxl library to interact with Excel spreadsheets.

Fig 3: Raspberry pi 4 Model B

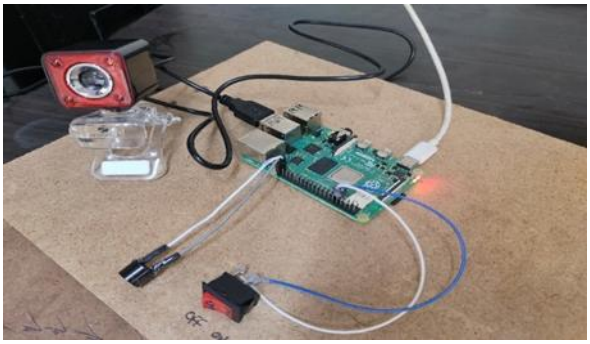

Fig 4: Hardware setup

The user interface module provides a graphical interface for system monitoring and configuration, built using a framework such as Tkinter or PyQt. The communication module manages communication between the Raspberry Pi and the webcam, ensuring seamless data transfer. An operating system, such as Raspberry Pi OS (formerly Raspbian), provides the underlying platform for running the software. The software components are designed to be modular and extensible, allowing for future enhancements and customization. The face recognition algorithm is based on a combination of face detection and feature extraction techniques. Face detection is performed using the Haar cascade classifier, a widely used algorithm for object detection. This classifier is trained on a large dataset of faces and non-faces, allowing it to accurately identify faces in real-time. Once a face is detected, feature extraction is performed using the dlib library, which implements a deep learning-based face recognition model. This model extracts 128 unique facial embeddings from each detected face. These embeddings are then compared to a database of known faces using a distance metric such as Euclidean distance. If the distance between the extracted embedding and a known embedding is below a certain threshold, the face is recognized.

The data collection process begins with capturing images of students entering the classroom using the webcam. These images are then processed by the face recognition algorithm to identify and recognize the students. The system maintains a database of known faces, along with their corresponding student IDs in 12-digit format and names. When a student is recognized, their attendance is automatically recorded in the system's memory. The system also stores the timestamp of the attendance record. The data processing module then aggregates the attendance data and formats it for storage in an Excel spreadsheet. The data processing module also includes error handling mechanisms to deal with situations such as unrecognized faces or system errors. The collected data is handled according to ethical guidelines and privacy policies.

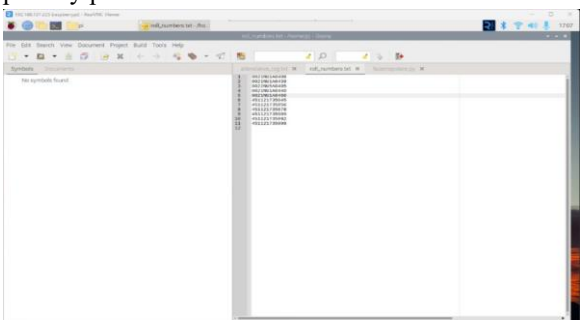

Fig 5: Student ID entry as 12-digit number

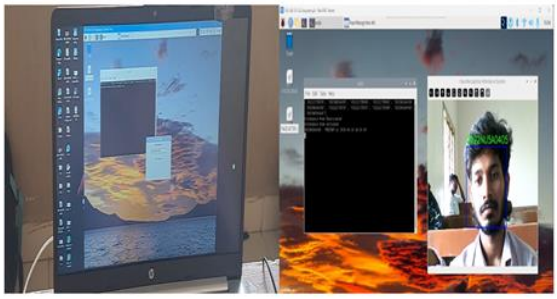

Fig 6: Student Face capture and recognition

The integration with Excel is achieved using the openpyxl library in Python. This library allows the system to create, modify, and read Excel spreadsheets. The attendance data is stored in a structured format, with each row representing a student's attendance record for a specific date. The columns include the student's ID, name, date, and attendance status (present or absent). The system automatically creates a new spreadsheet for each day, ensuring that attendance records are organized and easily accessible and can be easily imported into other data analysis tools for further processing and reporting. The system also includes functionality for generating summary reports, such as the total number of days a student was present or absent. The use of Excel provides a familiar and user-friendly interface for viewing and managing attendance data. The system also provides a web application integration (i.e., Telegram) where the attendance track data can be received with time and date stamp along with the count of the students.

VI. RESULTS

The dataset must be created to recognize faces when needed. The "Track images" option detects and recognizes individual faces, marking attendance in a spreadsheet with the date and time. The system activates by asking for a student's live image, name, and ID. Once inputted, it stores the information and trains for future use. The process includes capturing the student's image, applying Haar Cascade for face detection, extracting a bounding box, and processing images (grayscale conversion, histogram equalization, resizing). If updating the database, it stores the data; otherwise, it applies LBPH for feature extraction. The system also records a short video to update the attendance database accordingly. User feedback was collected from both students and educators to assess the system's usability and acceptance. The feedback was generally positive, with users praising the system's ease of use and efficiency. Students appreciated the fact that the system eliminated the need for manual roll calls, saving them time and effort. Educators appreciated the accuracy and reliability of the attendance data, as well as the system's ability to generate reports and identify attendance patterns. Some users expressed concerns about privacy and data security, which were addressed by implementing appropriate security measures and providing clear explanations of the system's data handling practices. Overall, the user feedback indicated a high level of acceptance of the Student Auto Attendance System. The system was perceived as a valuable tool for improving the efficiency and accuracy of attendance tracking in educational settings.

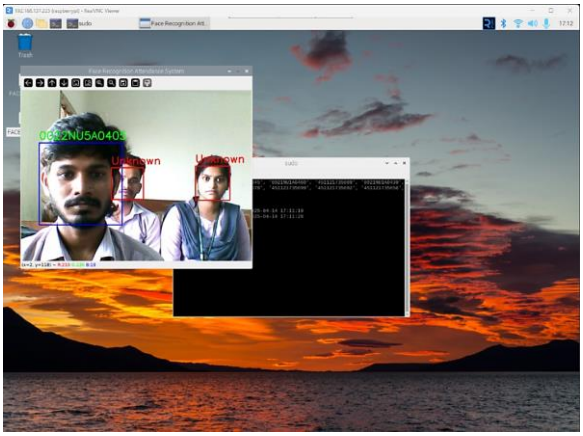

Fig 5: Recognizing multiple Student faces as known/unknown

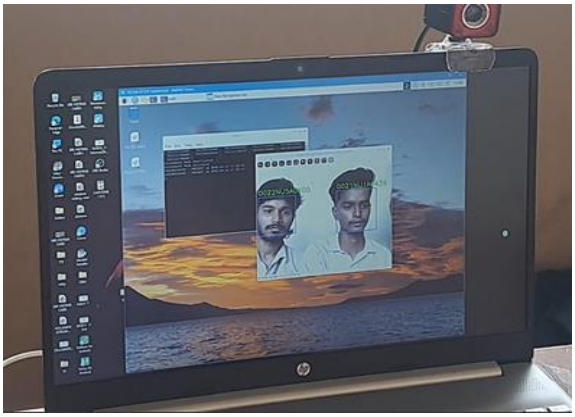

Fig 6: Recognizing multiple known faces

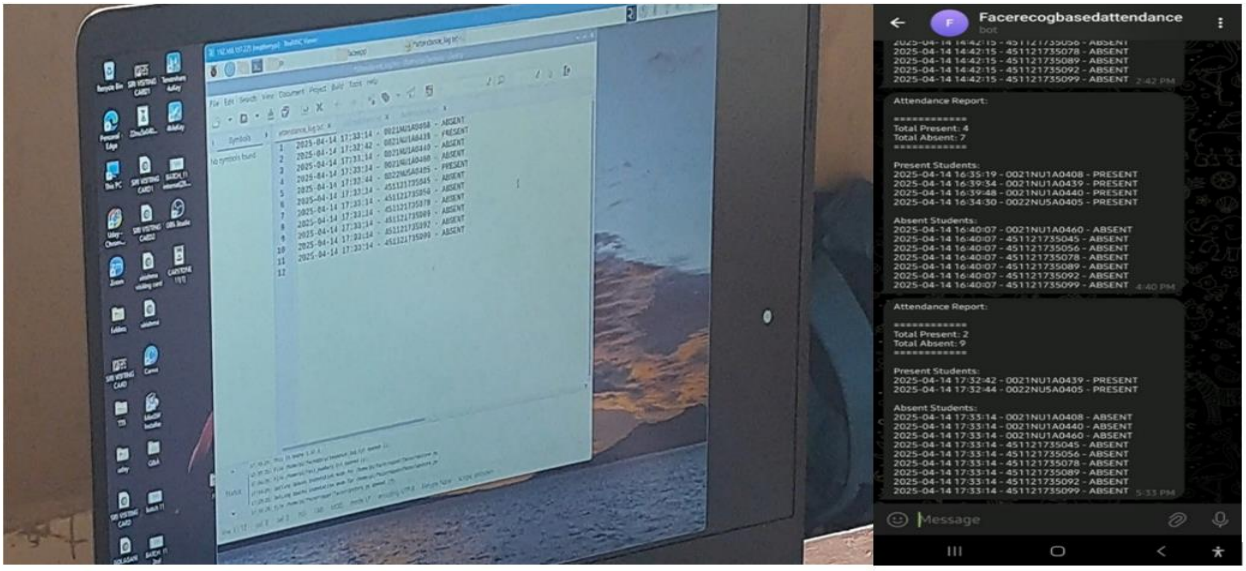

Fig 7: Attendance Track sheet in excel and telegram app.

VII. DISCUSSION

The Student Auto Attendance System offers several key advantages over traditional methods. Primarily, it automates attendance tracking, saving significant time during class sessions otherwise spent on manual roll calls. This efficiency allows educators to dedicate more time to instruction. Secondly, it reduces the potential for human error and proxy attendance, ensuring greater accuracy and reliability of attendance records. The system also provides real-time data, enabling instructors to promptly identify and address attendance issues. Furthermore, the digitized data facilitates easier analysis and reporting, offering valuable insights into student attendance patterns that can inform interventions and support strategies. The integration of face recognition technology offers a non-intrusive and convenient method for verifying student identity, further enhancing the system's efficiency and accuracy. Compared to traditional attendance methods, the Student Auto Attendance System offers several advantages. The system significantly reduces the time required for attendance tracking, freeing up valuable class time for instruction. The system also eliminates the risk of proxy attendance, ensuring that attendance records are accurate and reliable. The system provides real-time attendance data, allowing educators to quickly identify students with attendance issues and intervene accordingly. The system also automates the data management process, making it easier to analyse and report attendance data. In contrast, traditional attendance methods are time-consuming, prone to errors and fraud, and require significant manual effort. The Student Auto Attendance System offers a more efficient, accurate, and reliable solution for attendance tracking in educational settings. However, the initial setup cost and the need for technical expertise may be barriers to adoption for some institutions.

VIII. CONCLUSION

This project successfully demonstrated the feasibility and effectiveness of a Student Auto Attendance System utilizing Python, Raspberry Pi, and image processing techniques. The system automates attendance tracking, reduces time spent on manual roll calls, and improves the accuracy and reliability of attendance records. The system achieved a face recognition accuracy rate of approximately 90% in real-world classroom settings and processed faces in an average of 0.5 seconds. User feedback was generally positive, with students and educators praising the system's ease of use and efficiency. The system offers a cost-effective and scalable solution for automating attendance tracking in educational institutions.

IX. FUTURE SCOPE AND DEVELOPMENTS

The Student Auto Attendance System can be improved by integrating with learning management systems (LMS) for a holistic view of student engagement and by incorporating advanced face recognition algorithms that are resilient to lighting, pose, and occlusions. Features like emotion recognition could offer insights into student well-being, and supporting mobile devices would enable easy access to attendance records and notifications. Future developments should focus on scalability, reliability, and reducing cost. AI and machine learning could enhance the system's performance. The implementation of this system can automate attendance tracking, saving class time and reducing administrative burdens while improving data accuracy. It also fosters accountability and helps educators address attendance issues in real time. Recommendations include considering the ethical implications of facial recognition technology, ensuring privacy and data security, providing user training, and continuing research on algorithm robustness, cost reduction, and integration with other platforms. Further exploration is needed on the impact of these systems on student attendance patterns and academic outcomes.

REFERENCES

[1] Qian, J., Yang, J., Xu, Y., Xie, J., Lai, Z., & Zhang, B. (2020). Image decomposition-based matrix regression with applications to robust face recognition. Pattern Recognition, 102, 107204.

[2] Gandhe, S. T., Talele, K. T., & Keskar, A. G. (2007). Intelligent face recognition techniques: a comparative study. Int J Graph Vis Image Process (GVIP), 7(2), 53-60.

[3] Sao, A. K., & Yegnanaarayana, B. (2006, September). Template matching approach for pose problem in face verification. In International Workshop on Multimedia Content Representation, Classification and Security (pp. 191-198). Springer, Berlin, Heidelberg.

[4] 4.Bhele, S. G., & Mankar, V. H. (2012). A review paper on face recognition techniques. International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), 1(8), 339-346.

[5] Thiruvikraman, P., Kumar, T. A., Rajmohan, R., & Pavithra, M. (2021). A Survey on Haze Removal Techniques in Satellite Images. Irish Interdisciplinary Journal of Science & Research (IIJSR), 5(2), 01-06.

[6] Patel, R., & Yagnik, S. B. (2013). A literature survey on face recognition techniques. International Journal of Computer Trends and Technology (IJCTT), 5(4), 189-194.

[7] Suresh Kumar, K., Radha Mani, A. S., Sundaresan, S., & Ananth Kumar, T. (2021). Modeling of VANET for Future Generation Transportation System Through Edge/Fog/Cloud Computing Powered by 6G. Cloud and IoT-Based Vehicular Ad Hoc Networks, 105-124.

[8] Priyankha, J. J., & Kumar, K. S. Crop disease identification using a feature extraction HOG algorithm. Asian Journal of Applied Science and Technology, 1, 35-39.

[9] Pavithra, M., Rajmohan, R., Kumar, T. A., & Ramya, R. (2021). Prediction and Classification of Breast Cancer Using Discriminative Learning Models and Techniques. Machine Vision Inspection Systems, Volume 2: Machine Learning-Based Approaches, 241-262.

[10] Devadharshini, S., Kalaipriya, R., Rajmohan, R., Pavithra, M., & Ananthkumar, T. (2020, July). Performance Investigation of Hybrid YOLO-VGG16 Based Ship Detection Framework Using SAR Images. In 2020 International Conference on System, Computation, Automation and Networking (pp. 1-6). IEEE.

[11] Keerthana, R., Kumar, T. A., Manjubala, P., & Pavithra, M. (2020, July). An Interactive Voice Assistant System for Guiding the Tourists in Historical places. In 2020 International Conference on System, Computation, Automation and Networking (ICSCAN) (pp. 1-5). IEEE.

[12] Wang, P., & Bai, X. (2018). Regional parallel structure-based CNN for thermal infrared face identification. Integrated Computer-Aided Engineering, 25(3), 247-260.

[13] ArjunaraoVatti, R., Kumar, K., Haripriya, D., & Kumar, T. A. (2021). Design of low power RF CMOS power amplifier structure with an optimal linear gain controller for future wireless communication. Journal of Ambient Intelligence and Humanized Computing, 1-12.

[14] Kumar, T. A., Devi, A., Padmapriya, N., Jayalakshmi, S., & Divya, P. (2021). A Survey on Advance Black/Grey hole Detection and Prevention Techniques in DSR & AODV Protocols. International Journal on Wireless, Networking & Mobile Communication Innovations [ISSN: 2581-5113 (online)], 5(1).

[15] Kim, D., Hernandez, M., Choi, J., & Medioni, G. (2017, October). Deep 3D face identification. In 2017 IEEE international joint conference on biometrics (IJCB) (pp. 133-142). IEEE.

[16] Samuel, T. A., Pavithra, M., & Mohan, R. R. (2021). LIFI-Based Radiation-Free Monitoring and Transmission Device for Hospitals/Public Places. In Multimedia and Sensory Input for Augmented, Mixed, and Virtual Reality (pp. 195-205). IGI Global.

[17] Phillips, P. J., Yates, A. N., Hu, Y., Hahn, C. A., Noyes, E., Jackson, K., ... & O'Toole, A. J. (2018). Face recognition accuracy of forensic examiners, superrecognizers, and face recognition algorithms. Proceedings of the National Academy of Sciences, 115(24), 6171-6176.

[18] Kumar, K. S., Kumar, T. A., Radhamani, A. S., & Sundaresan, S. (2020). Blockchain Technology: An Insight into Architecture, Use Cases, and Its Application with Industrial IoT and Big Data. In Blockchain Technology (pp. 23-42). CRC Press.

[19] Wagner, A., Wright, J., Ganesh, A., Zhou, Z., Mobahi, H., & Ma, Y. (2011). Toward a practical face recognition system: Robust alignment and illumination by sparse representation. IEEE transactions on pattern analysis and machine intelligence, 34(2), 372-386.

[20] Revathy, P., Kumar, T. A., & Rajesh, R. S. (2019). Design of highly efficient dipole antenna using HFSS. Asian Journal of Applied Science and Technology (AJAST) Volume, 3,01-09.