Journal on Electronic and Automation Engineering

Vol: 2(1), March 2023

REST Publisher; ISSN: 2583-6951 (Online)

Website: https://restpublisher.com/journals/jeae/

DOI: https://doi.org/10.46632/jeae/2/2/8

Visitor Monitoring System Using Raspberry PI and PI Camera

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Abstract. *The visitor monitoring system (VMS) offers a convenient solution for front desk officers to easily search and monitor the visitors on a given day, ensuring a secure environment for organizations. By employing our application, organizations can effectively protect themselves from unauthorized individuals. Our system operates efficiently with minimal resources, allowing organizations to track visitors and maintain records for future reference. To implement this, we integrate a camera with a raspberry pi to capture images of visitors entering through gates or doors. We employ the haar cascade algorithm for face detection and utilize numpy and pillow python algorithms for face recognition. Consequently, our system establishes a database that keeps track of visitors who visit the organization. To ensure the security of the premises, visitors are granted entry only after their identity is verified using either the face recognition technique or by sending a one-time password (OTP) to their registered mobile number. This feature proves highly effective in preventing unauthorized individuals from gaining access to the campus, thus enhancing overall security measures.*

1. INTRODUCTION

In today's fast-paced world, emerging technologies are revolutionizing security and automation practices. With people leading busy lives, ensuring the safety of their belongings has become a top priority. Unfortunately, cases of robbery are on the rise, not only in residential areas but also in industrial and organizational settings. Consequently, it has become crucial to restrict the entry of strangers into organizations. This is where the Visitor Monitoring System proves invaluable. By implementing such a system, organizations can enhance their security measures and effectively monitor and track visitors, thus minimizing the risk of unauthorized individuals gaining access to their premises. The Visitor Monitoring System (VMS) offers a user-friendly solution for front desk officers to efficiently search and manage the ongoing visitors of the day. By utilizing VMS, organizations can easily maintain records of all incoming and outgoing visitors and employees. Currently, many organizations rely on manual methods to track visitor records in each department. However, this approach becomes problematic when the number of visitors increases over time, leading to difficulties in managing and organizing the records effectively. Moreover, relying solely on a log register to track visitor records proves to be insufficient. Log registers are not an efficient method for long-term record-keeping, especially when it comes to storing records spanning several years. Retrieving or querying previous records, particularly those from 2-3 years ago, becomes challenging and time-consuming. Generating reports based on the log register data also becomes a tedious task. Therefore, a more advanced and streamlined system is needed to overcome these limitations and ensure efficient retrieval and management of visitor records and reports. VMS greatly improves the efficiency of information retrieval and inquiries. With the implementation of VMS, the cumbersome manual searching procedure becomes significantly easier. Consider a scenario where hundreds of visitors come in and out regularly. Instead of manually searching through piles of records, users can simply input the visitor's card number into the system, and it will display the relevant information that was previously entered by the user. This streamlined process eliminates the need for long queues and waiting times, creating the impression of a well-organized system. Ensuring a secure environment is of utmost importance for all organizations as it directly relates to security. By utilizing VMS, organizations can effectively track and monitor visitors while maintaining detailed records for future reference and verification. Furthermore, VMS achieves this goal while utilizing minimal resources, making it a cost-effective solution for organizations.

2. LITERATURE SURVEY

Harish Rapartiwar, Pushpanjali Shivratri, Omkar Sonakul, and Prof. Ashwini Bhugul [1] have developed a system that addresses the issue of appointments by efficiently capturing all relevant visitor information. This information is then

recorded in a centralized database server, providing effective data management. On the other hand, Mr. Mogare Sumit R, Sanagare Prathamesh S, Ms. Anjarlekar Shraddha S, Mr. Kharat Ratnadipak N, and Mr. Shikalgar Isaq A. [2] have designed a system focused on biometric identification using Raspberry Pi. This project enhances security measures by preventing unauthorized individuals from entering a home without the owner's permission. The system alerts the homeowner about any person attempting to enter their home. The owner can then visually identify the person through the use of Raspberry Pi and image processing technology. Based on this information, the owner can decide whether to meet the person or not, ensuring an additional layer of security. The main focus of this project is biometric identification, where a person's face is recognized using a web camera. The captured details are then sent to the owner's mobile Android app through Raspberry Pi using a Wi-Fi module. Through the Android app, the owner can press a button to open the gate automatically if they want to allow that person inside. Additionally, the gate will automatically close after a certain period of time. This system proves beneficial not only for individual homes but also for societies or residential complexes. By implementing this solution, residents can enhance the security of their premises and effectively control access to their homes. The combination of biometric identification, wireless communication, and automation features makes this system a valuable tool for ensuring home security and convenience. K.S. Shilpashree, Lokesha.H, and Hadimani Shivkumar [3] have designed an implementation of image processing operations on Raspberry Pi. Raspberry Pi is a cost-effective single-board computer that simplifies real-time applications. This platform primarily relies on Python programming. The Raspberry Pi camera is interfaced using the Camera Slot Interface (CSI) to capture dark and low-contrast images. This concept finds application in real-time scenarios such as Micro Air Vehicles (MAVs). Behzad ShoarianSatari, Nor Azlina Abd Rahman, and Zety Marla Zainal Abidin [4] have developed a system that effectively manages and monitors visitors in an organization using face recognition as the authentication method. By employing face recognition technology, this system enhances security and ensures accurate identification of visitors. Once the authentication and verification process is completed, a valid visitor ID is generated, which includes the face image of the visitor, the date and time of the visit, and the name of the person to be visited. This ID serves as a record and confirmation of the visitor's identity. The Face Recognition Visitors Management System (FRVMS) is introduced with the aim of bolstering the security of an organization against unauthorized individuals attempting to enter the premises for malicious purposes such as espionage or theft of assets. By implementing this system, organizations can effectively verify the identity of visitors and ensure that only authorized individuals gain access to the building. This advanced security measure provides an added layer of protection and helps safeguard the organization's assets and sensitive information.Amritha Nag, Nikhilendra J N, and Mrutyunjay Kalmath [5] have implemented a system aimed at enhancing door security in sensitive locations using face detection and recognition. The proposed system comprises several subsystems, including image capture, face detection and recognition, email notification, and automatic door access management. The system utilizes the OpenCV library, which supports face recognition, and specifically employs Eigenfaces to reduce the scale of face images while retaining essential features. The database can store facial images for multiple individuals. Additionally, the door lock can be accessed remotely from any part of the world using the Telegram Android application, providing convenient and secure access management. For safety purposes, the captured image from the Raspberry Pi camera is sent to the authorized person via email. This additional step ensures that a record of the visitor is retained and enhances the overall security of the location. Regenerate response Nashwan Adnan Othman and Ilhan Aydin [6] have developed a real-time recognition system designed to handle images efficiently. The system focuses on identifying faces in different locations, including homes and offices. The system incorporates a Passive Infrared (PIR) sensor to detect movements in specific areas. Once movement is detected, the Raspberry Pi captures images and proceeds with face recognition. The recognized faces are then processed and notifications, along with the captured images, are sent to a smartphone-based Internet of Things (IoT) device using the Telegram application. The proposed system is characterized by its real-time functionality, fast processing capabilities, and low computational cost. By leveraging these features, the system ensures efficient and timely face recognition, enhancing security and enabling quick response to potential security breaches. Mangayarkarasi Nehru and Dr. Padmavati [7] conducted a study on illumination face detection using the Viola-Jones algorithm. The Viola-Jones Cascade Object Detector employs various filters and features to detect different parts of the face. The objective of the study was to enable computers to accurately detect faces amidst non-facial structures present in an image, with the identified parts of the face selected. On the other hand, Norizan Anwar, Mohamad Noorman Masrek, and Yanty Rahayu Rambli [8] implemented a Visitor Management System to monitor visitor movement within an organization. This system allows personnel in different sections of the organization to monitor visitor-related activities through a Local Area Network (LAN) or Intranet using a standard web browser. The Use of Technology model (UTAUT) was employed to assess user acceptance and evaluate the effectiveness of the visitor application system. Overall, these studies contribute to the development and improvement of face detection algorithms and visitor management systems, respectively, offering advancements in the fields of computer vision and organizational security. M. Vadivel, M. Poongodhai, R. Madhumitha, V. Nivetha, and J. KamilaBanu [9] have implemented a face recognition system capable of replacing traditional methods such as passwords and RF I-Cards for accessing high-security systems and buildings. By utilizing Raspberry Pi, the system becomes cost-effective, user-friendly, and exhibits high performance. The paper outlines the design and development of an IoT-based security surveillance system in buildings, incorporating Raspberry Pi single-board computers with WiFi network connectivity. Once a face is detected, the controller activates the camera to capture the event and notifies the user by displaying live video footage of the event

on a webpage accessible via an Android mobile device. Similarly, Md. Nasimuzzaman Chowdhury, Md. Shiblee Nooman, and Srijon Sarker [10] have developed a system that connects any door to the internet, allowing for remote control of door access from anywhere in the world. This system facilitates convenient management of door access and enhances security measures by enabling users to control door access remotely. These implementations showcase the integration of Raspberry Pi and IoT technologies to create efficient and advanced security systems, offering improved access control and surveillance capabilities for buildings and high-security environments. In scenarios where an individual is not present at home, and a visitor arrives at the doorstep, the proposed system ensures that the authorized person is notified about the visitor via Twitter. The authorized person can then view the visitor through a web interface using a camera. The system also captures a picture of the visitor and stores it as a record, which can be sent as an attachment through email or tweeted. Additionally, if the authorized person wishes to communicate a message, it can be easily sent through the internet, and the message will appear on a screen located on the door. The door lock can be controlled remotely using internet connectivity. By employing this system, evidence of the visitor can be recorded, which can be valuable in emergency situations or for future reference. This comprehensive solution allows for efficient visitor management, remote communication, and enhanced security measures for residential settings. Omar Abdul Rhman Salim, Rashidah Funke Olanrewaju, and Wasiu Adebayo Balogun [11] have developed a comprehensive embedded class attendance system that incorporates facial recognition and door access control. The system is built around the Raspberry Pi, running the Raspbian (Linux) operating system installed on a micro SD card. The Raspberry Pi Camera and a 5-inch screen are connected to the Raspberry Pi for image capture and display purposes. When a student faces the camera, an image is captured and passed to the Raspberry Pi, which employs the Local Binary Patterns (LBPs) algorithm for facial recognition. If the input image matches with the trained dataset image of the student, the prototype door is opened using a Servo Motor. Simultaneously, the attendance results are stored in a MySQL database. The database is connected to an Attendance Management System (AMS) web server, making the attendance results accessible through any web browser connected to the internet. This allows convenient access to attendance information for instructors or administrators. By combining facial recognition, door access control, and online attendance management, this system offers an integrated solution for efficient and automated class attendance tracking, ensuring accurate records and simplifying attendance management processes.

BLOCK DIAGRAM

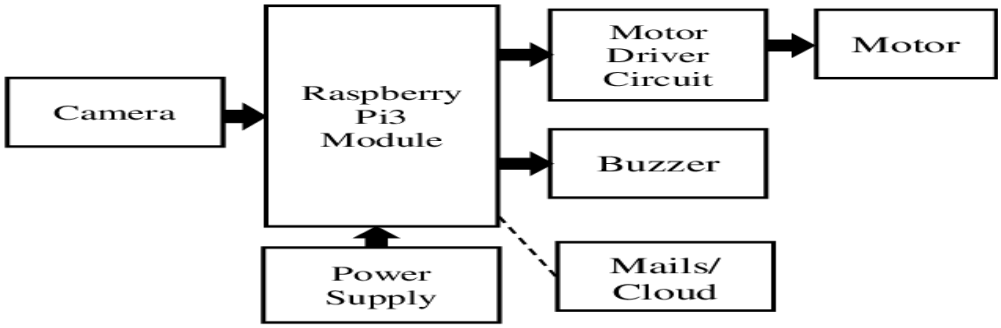


FIGURE 1. Block Diagram

In the described system, a camera is connected to the Raspberry Pi module, which is powered by a 5V adapter. The camera is used to capture images of visitors. Additionally, a buzzer and a stepper motor are interfaced with the Pi module. When a visitor arrives, they press a button at the door. Upon pressing the button, the Raspberry Pi instructs the camera to capture the visitor's image. This image is then compared with the images stored in the database. If a match is found, the stepper motor is activated, and the gate opens. If there is no match, the gate remains closed. Once the gate is opened and the visitor enters, an email notification is sent to the respective employee whom the visitor has come to meet. Similarly, when the meeting concludes, the employee sends a mail to the security guard. The recorded data, including visitor information, entry records, and meeting details, is accessible anytime and anywhere, as the database is shared on the cloud. This enables convenient and remote access to the system's data, ensuring easy retrieval and management of visitor records.

Circuit: Pi camera module is connected at camera slot of the Raspberry Pi. A buzzer is connected to GPIO pin 26 of Raspberry Pi for indication purpose. LED is connected to GPIO pin 5 through a 1k resistor and a push button is connected to GPIO pin 19 with respect to ground, to trigger the camera and open the Gate. DC motor (as Gate) is connected with Raspberry Pi GPIO pin 17 and 27 through Motor Driver IC (L293D). Rest of connections are shown in circuit diagram.

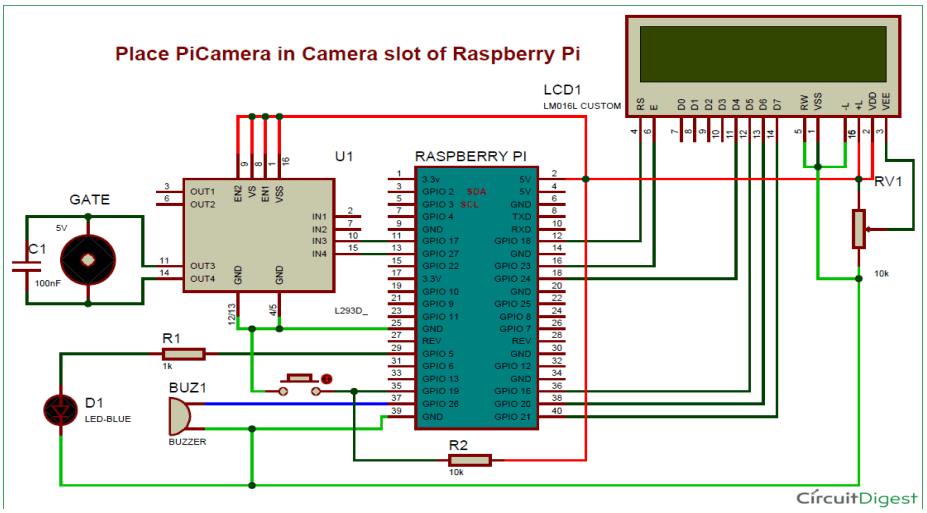


FIGURE 2. circuit diagram

Working Principle: In this project, the proposed Visitor Monitoring system utilizes Raspberry Pi along with image processing techniques. The choice of Raspberry Pi as the platform simplifies the implementation process. While the Pi camera can be used for image capture, it is also possible to opt for another web camera with higher pixel resolution for better image quality. By leveraging the capabilities of Raspberry Pi and employing image processing techniques, the Visitor Monitoring system aims to enhance the monitoring and management of visitors. The system can capture and process visitor images, perform face recognition, and store relevant data for further analysis or record-keeping.The flexibility of Raspberry Pi allows for customization and expansion of the system, enabling the integration of additional features and functionalities as required. Overall, the project aims to provide an efficient and effective solution for visitor monitoring using Raspberry Pi and image processing techniques. In this project, the Pi camera is connected to the Raspberry Pi to facilitate the capture of images of every visitor entering through the gate or door. The system is designed so that when a person arrives at the gate, they need to press a button to open the gate. Upon pressing the button, the Raspberry Pi triggers the Pi camera to capture the visitor's picture, which is then saved in the system. By implementing this mechanism, the system ensures that an image of each visitor is recorded and stored for further processing or identification purposes. This approach enables the system to maintain a visual record of individuals who have entered the premises, enhancing security and visitor management.

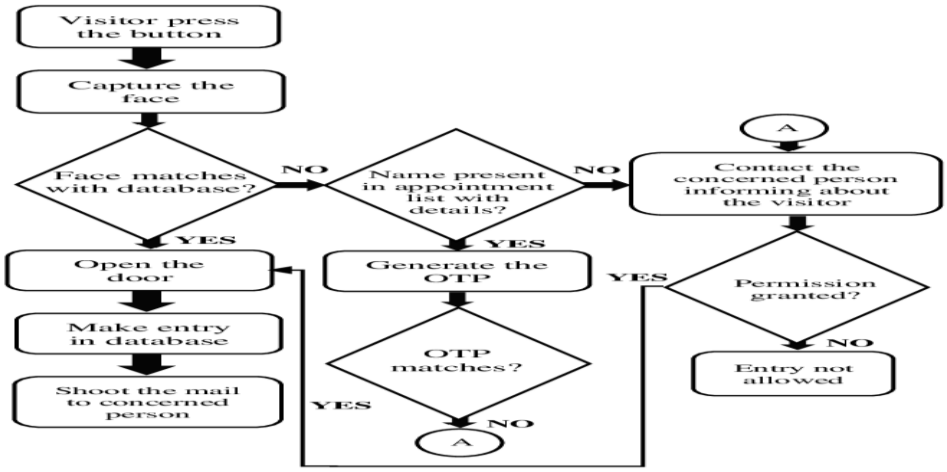
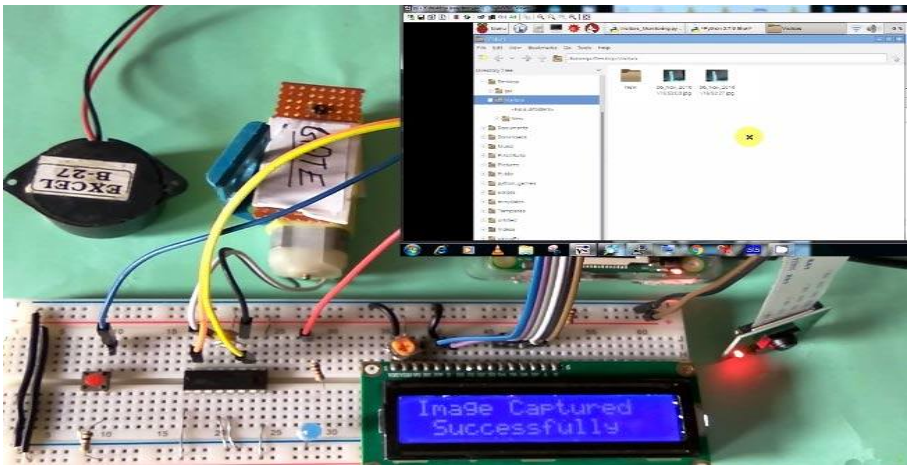


FIGURE 3. Case A: When Visitor record already present in database

In this scenario, the visitor arrival and monitoring process is described in detail. When a visitor arrives at the gate, they press a button on the door to initiate the process. The Raspberry Pi receives this signal and instructs the camera to capture the visitor's face image. The captured image is then compared with the pre-saved database of authorized individuals. If a match is found, the gate opens, granting the visitor access to the premises. Once the visitor is inside, the concerned person or manager acknowledges their arrival, indicating that the meeting can proceed. When the meeting is concluded, the manager sends a notification via email, informing that the meeting is over and the visitor has left the meeting zone. To ensure the visitor's safety and timely departure, a time window of approximately 10 to 15 minutes is given. If the visitor does not reach the gate within this time frame, a notification is sent to both the gate security guard

and the manager, alerting them that something might be wrong. During the visitor's exit, their face image is again captured and compared with the database. If a match is found, the gate opens to allow the visitor to leave. Throughout the process, various data such as the visitor's name, photo, entry and exit timings, and the name of the concerned meeting person are recorded and stored in the database. This comprehensive record-keeping helps in maintaining accurate visitor logs and monitoring their movements within the premises. Case B: When Visitor record does not exist in database. When a visitor arrives at the gate, they press the button on the door. In response to the button press, the Raspberry Pi instructs the camera to capture the visitor's face. The captured face image is then compared with the stored database of authorized individuals. If the captured face does not match any entry in the database, indicating that the visitor is not recognized as an authorized person, the system triggers a buzzer to alert the security personnel or relevant authorities. The ringing of the buzzer serves as an indication that an unrecognized individual is attempting to gain access to the premises, alerting the security team to take appropriate action. This functionality enhances the security of the system by promptly notifying the authorities when an unauthorized person is detected, allowing for immediate response and intervention to prevent potential security breaches. Case B1: In the proposed system, the visitor's name and phone number details are stored in the appointment list. An OTP (One-Time Password) is generated and sent to the visitor's registered phone number. The visitor is required to enter the OTP to gain access to the premises. Upon successful OTP verification, the door will open, allowing the visitor to enter. At the same time, an email notification is sent to the respective person with whom the visitor has a scheduled meeting. Once the acknowledgment from the concerned person is received, indicating that the meeting is approved, the visitor is allowed to proceed to the meeting location within the industry. After the meeting is concluded, the manager sends an email notification stating that the meeting is over and the visitor has left the meeting zone. A grace period of approximately 10 to 15 minutes is provided for the visitor to reach the gate. If the visitor fails to reach the gate within the designated time, a notification is sent to the gate security guard and the manager, indicating a potential issue. During the exit process, another OTP is generated for the visitor. Upon successful verification of the exit OTP, the gate opens, allowing the visitor to leave the premises. The system records and stores information such as the visitor's name, photo, entry timing, exit timing, and the name of the person they had a meeting with, in the database for future reference and tracking. Case B2: If a visitor's name is not present in the appointment list, the security guard will need to take appropriate action. In such a scenario, the security guard should contact the authorized person or the concerned department to verify whether the visitor has permission to enter. If the authorized person grants permission, the security guard can proceed with the database creation process for the visitor. This may involve collecting the necessary information such as the visitor's name, contact details, purpose of visit, and any other relevant information. Once the database entry is completed, the visitor can be granted entry into the industry.It is important to follow proper protocols and procedures to ensure the security and safety of the premises. By contacting the authorized person and obtaining their approval, any unauthorized access can be prevented, and the visitor can be properly recorded and monitored during their visit

RESULT



CONCLUSION

The Visitor Monitoring System described in the paper aims to enhance the security of an organization by effectively monitoring and managing visitor activity. The system workflow module provides an overview of how the system operates, while the hardware requirements outline the necessary components for its implementation. By implementing the Visitor Monitoring System, organizations can mitigate the risk of unauthorized individuals entering their premises. This includes potential threats from strangers and criminals such as robbers. The system helps in verifying the identity of visitors, tracking their movements, and maintaining a record of their activities. The system workflow module details the steps involved in the visitor monitoring process, from the visitor's arrival at the gate or entrance, to their identification

and validation, and finally to their access to the desired areas within the organization. It may include processes such as capturing visitor details, conducting face recognition or authentication, and granting access permissions. The hardware requirements section outlines the necessary components for the system, which may include a camera or biometric device for capturing visitor information, a server or database for storing visitor records, and other supporting infrastructure such as network connectivity and access control devices. By implementing the Visitor Monitoring System, organizations can enhance their security measures and reduce the potential threats posed by unauthorized individuals. The system provides a comprehensive approach to managing visitor access and ensuring the safety of the organization and its assets.

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