GUARDIAN EYE USING ADVANCED FACE RECOGNITION SURVEILLANCE SYSTEM WITH INSTANT ALERTS

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report **"GUARDIAN EYE USING ADVANCED FACE RECOGNITION SURVEILLANCE SYSTEM WITH INSTANT ALERTS"** is the bonafide work of **"VIJAYSARATHI N [710120205052], SHRI BALAJI G [710120205040], GOKUL N [710120205014], NITHISH [710120205302]"** who carried out the project work under my supervision.

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We are pleased to present the **"GUARDIAN EYE USING ADVANCED FACE RECOGNITION SURVEILLANCE SYSTEM WITH INSTANT ALERTS"** project and take this opportunity to express our profound gratitude to all those people who helped us in the completion of this project.

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ABSTRACT

Guardian Eye represents a significant advancement in campus security by leveraging machine learning techniques, specifically a pre-trained Face ID model, to enhance surveillance capabilities. The system operates by analyzing CCTV camera footage to identify and summarize visitor activity. This includes capturing visitor identities and recording timestamps of each interaction. By automatically organizing this information into an Excel format, the system greatly reduces the manual effort typically associated with video analysis tasks.

One of the most innovative aspects of this system is its ability to provide real-time alerts to security personnel. These alerts, delivered via mobile devices and a centralized monitoring station, enable swift responses to any security incidents or suspicious activities detected by the system. This proactive approach enhances overall campus safety by allowing security teams to intervene promptly when necessary.

Implemented in Python, the system offers scalability, flexibility, and ease of maintenance. Python's extensive libraries and frameworks make it an ideal choice for developing machine learning-based solutions. By minimizing manual effort and providing an adaptive and comprehensive security layer, this Python-based system offers a robust framework for effective campus security management. It not only enhances surveillance capabilities but also contributes to a safer and more secure environment for students, faculty, and staff.

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LIST OF ABBREVIATIONS

AI - Artificial Intelligence

API - Application Programming Interface

CCTV - Closed-Circuit Television

CPU - Central Processing Unit

CSV - Comma-Separated Values

GPS - Global Positioning System

GPU - Graphics Processing Unit

GUI - Graphical User Interface

HTTPS - Hypertext Transfer Protocol Secure

IoT - Internet of Things

IP - Internet Protocol

JSON - JavaScript Object Notation

LAN - Local Area Network

OCR - Optical Character Recognition

RAM - Random Access Memory

RFID - Radio Frequency Identification

SMTP - Simple Mail Transfer Protocol

VPN - Virtual Private Network

WAN - Wide Area Network

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

In today's rapidly evolving landscape of security challenges, ensuring the safety and well-being of individuals within educational institutions remains a paramount concern. In response to the increasing complexity of threats, this project endeavors to pioneer a significant advancement in campus security through the integration of cutting-edge machine learning techniques, specifically leveraging a pre-trained FaceID model. The system proposed herein operates at the intersection of artificial intelligence and surveillance technology, offering a proactive and adaptive solution to enhance campus safety. By harnessing the power of machine learning algorithms, the system analyzes CCTV camera footage in real-time, capturing and summarizing visitor activity with unprecedented accuracy and efficiency.

Notably, the system automates the tedious and time-consuming process of video analysis by seamlessly organizing visitor identities, visit frequencies, and timestamps into an Excel format, thereby alleviating the burden of manual effort traditionally associated with such tasks. Furthermore, the system's innovative feature lies in its ability to provide instant alerts to security personnel, enabling swift responses to security incidents or suspicious activities detected by the system. Through continuous training and iterative learning, the Face ID model adapts and improves its accuracy over time, enhancing its effectiveness in identifying potential security threats or anomalies. Implemented in Python, the system offers scalability, flexibility, and ease of maintenance, making it an ideal choice for modern campus security management. By amalgamating technological innovation with a proactive security approach, this project not only augments surveillance capabilities but also contributes significantly to fostering a safer and more secure environment for students, faculty, and staff alike.

1.2. PROBLEM STATEMENT

Despite the advancements in security technology, educational institutions face persistent challenges in safeguarding their campuses against a wide range of security threats. Incidents such as unauthorized access, theft, vandalism, and potential violence pose significant risks to the safety and well-being of students, faculty, and staff. Traditional security measures, including surveillance cameras and access control systems, provide valuable tools for monitoring campus activities. However, these systems often rely on manual monitoring and analysis, which can be time-consuming, labor-intensive, and prone to errors. In particular, the manual review of CCTV camera footage requires extensive human intervention and may not always yield timely insights into potential security breaches or suspicious behavior. Moreover, existing systems typically lack the ability to adapt and learn from changing patterns of activity, making them less effective in detecting emerging threats or anomalies.

Furthermore, the sheer volume of data generated by surveillance cameras can overwhelm security personnel, making it challenging to identify and respond to security incidents in real-time. As a result, there is a critical need for advanced security solutions that leverage cutting-edge technologies to enhance surveillance capabilities and improve the overall effectiveness of campus security operations.

This project aims to address these challenges by developing a machine learning-based surveillance system that utilizes a pre-trained FaceID model to analyze CCTV camera footage and identify visitor activity. By automating the process of video analysis and integrating real-time alerting mechanisms, the proposed system seeks to provide security personnel with actionable insights into potential security threats as they unfold. Additionally, the system will incorporate a dynamic learning component, allowing it to continuously adapt and improve its performance over time. By leveraging the scalability, flexibility, and ease of maintenance offered by Python-based development frameworks, the project aims to deliver a robust and reliable security solution that contributes to creating a safer and more secure campus environment for all stakeholders.

In an era where ensuring safety and security on campus is of paramount importance, traditional security measures often fall short in effectively managing the complexities of modern-day threats. To address these challenges, our project introduces a pioneering solution that harnesses the power of machine learning to fortify campus security through a multifaceted approach. By integrating a pre-trained FaceID model with innovative features such as real-time alerts and continuous training capabilities, our system offers an adaptive and comprehensive security layer that not only minimizes manual effort but also provides unparalleled insights into visitor behavior and patterns. From seamlessly summarizing visitor activity to empowering security personnel with timely alerts, our Python-based solution redefines campus security management, offering a robust framework for creating safer and more secure environments for students, faculty, and staff.

1.3. RISE OF SURVEILLANCE TECHNOLOGIES

The rapid advancement and proliferation of surveillance technologies have reshaped the landscape of campus security, ushering in a new era of proactive threat detection and response. From traditional CCTV cameras to cutting-edge biometric recognition systems, educational institutions now have access to a diverse array of tools and technologies designed to enhance situational awareness and bolster security measures. These technologies leverage sophisticated algorithms and data analytics to monitor campus environments in real-time, detect suspicious activities, and identify potential security threats with unprecedented speed and accuracy. Moreover, the integration of artificial intelligence and machine learning algorithms enables surveillance systems to adapt and learn from historical data, continuously improving their ability to recognize patterns of behavior and anticipate security risks. Additionally, advancements in sensor technology and wireless communication have facilitated the deployment of smart sensors and IoT devices, further enhancing the scope and coverage of campus surveillance networks. As a result, educational institutions are better equipped than ever before to safeguard their campuses, protect their assets, and ensure the safety and well-being of their entire community.

Certainly! Here are some key points for the topic "Considerations and Challenges of Surveillance Technologies in Campus Security, Based on IoT (Internet of Things)," along with elaborations:

1. Scalability and Interoperability:

Elaboration: IoT-based surveillance systems often involve a multitude of interconnected devices and sensors deployed across campus. Ensuring scalability and interoperability between these devices can be challenging, especially as the campus grows or when integrating legacy systems with newer IoT technologies. Educational institutions must carefully plan and design their IoT infrastructure to accommodate future expansion and ensure seamless communication between devices from different manufacturers.

2. Data Management and Analytics:

Elaboration: IoT devices generate vast amounts of data, including sensor readings, video streams, and other environmental data. Managing and analyzing this data in real-time presents significant challenges, including data storage, processing, and analysis. Educational institutions must implement robust data management and analytics solutions to derive actionable insights from IoT-generated data, such as detecting security threats, predicting equipment failures, or optimizing resource utilization.

3. Cybersecurity Risks:

Elaboration: IoT devices are often vulnerable to cybersecurity threats, including hacking, malware, and data breaches. Weaknesses in IoT device security can potentially compromise the entire surveillance system, leading to unauthorized access, data tampering, or disruption of services. Educational institutions must implement stringent cybersecurity measures to protect IoT devices from cyber attacks, including regular software updates, network segmentation, encryption, and intrusion detection systems.

4. Privacy and Data Protection:

Elaboration: IoT-based surveillance systems raise privacy concerns due to the collection and processing of sensitive personal data, such as biometric information or

location tracking data. Educational institutions must establish clear policies and procedures for handling IoT-generated data, ensuring compliance with privacy regulations and protecting individuals' privacy rights. This may include obtaining informed consent from users, anonymizing data, and implementing access controls to limit data access to authorized personnel only.

5. Reliability and Resilience:

The reliability and resilience of IoT-based surveillance systems are critical for maintaining continuous monitoring and response capabilities, especially in the event of network outages, equipment failures, or physical attacks. Educational institutions must design their IoT infrastructure with redundancy, failover mechanisms, and backup power sources to ensure uninterrupted operation of surveillance devices and systems, even under adverse conditions.

6. Integration with Existing Systems:

Integrating IoT-based surveillance systems with existing campus infrastructure, such as access control systems, alarms, and emergency response protocols, can be complex and challenging. Educational institutions must carefully plan and coordinate the integration process to ensure compatibility, functionality, and interoperability between IoT devices and existing systems. This may involve conducting thorough compatibility tests, developing custom APIs or middleware, and providing training for personnel on new integrated systems.

In conclusion, while the rise of surveillance technologies presents unprecedented opportunities for enhancing campus security, it also requires careful consideration of ethical, legal, and social implications. By leveraging these technologies responsibly and thoughtfully, educational institutions can create safer and more secure environments that foster learning, innovation, and community engagement.

1.4. AIM AND OBJECTIVE

The aim of this project is to design, develop, and implement an IoT-based surveillance system for enhancing campus security at educational institutions. By

leveraging IoT technologies, the system aims to provide real-time monitoring, threat detection, and response capabilities to ensure the safety and well-being of students, faculty, and staff.

Objectives:

The objective of this project is to develop a comprehensive IoT-based surveillance system specifically tailored to address the unique security needs of educational institutions. This entails several key components:

Firstly, the project aims to design a scalable and adaptable IoT infrastructure that can effectively support the deployment of surveillance devices and sensors across the campus. This involves identifying optimal placement locations for IoT devices such as cameras, motion sensors, and environmental monitors to maximize coverage while minimizing blind spots.

Secondly, the project aims to establish robust surveillance protocols and standards to govern the collection, transmission, and analysis of surveillance data. This includes defining protocols for data encryption, access control, and data retention to ensure compliance with privacy regulations and protect sensitive information.

Thirdly, the project will involve selecting and integrating a diverse range of IoT devices into the surveillance system architecture. This may include cameras with advanced features such as high-resolution imaging, night vision capabilities, and motion tracking, as well as sensors for detecting environmental conditions such as temperature, humidity, and air quality.

Once the IoT devices are integrated, the project will focus on implementing advanced real-time monitoring and threat detection capabilities. This will involve developing software applications and algorithms capable of analyzing streaming video feeds, detecting suspicious behavior patterns, and generating alerts in real-time to notify security personnel of potential security threats.

In addition to real-time monitoring, the project will also prioritize cybersecurity to safeguard the IoT devices and surveillance data from cyber attacks. This will include

implementing encryption protocols, authentication mechanisms, and intrusion detection systems to protect against unauthorized access and data breaches.

Furthermore, the project will include rigorous testing and validation to ensure the reliability, accuracy, and effectiveness of the surveillance system. This will involve conducting extensive testing in controlled environments to evaluate the performance of the system under various conditions and scenarios.

User training and education will also be a key focus of the project, as it is essential to ensure that security personnel, administrators, and other stakeholders are proficient in using the surveillance system effectively. This will include providing comprehensive training on system operation, maintenance, and response protocols.

Finally, the project will involve ongoing optimization of the surveillance system to enhance its performance and effectiveness. This may include fine-tuning algorithms, optimizing resource utilization, and incorporating feedback from users to address any issues or shortcomings identified during deployment.

Overall, the objective of this project is to develop a state-of-the-art IoT-based surveillance system that enhances campus security by providing real-time monitoring, threat detection, and response capabilities tailored to the specific needs of educational institutions. Through careful planning, design, implementation, and optimization, the project aims to create a safer and more secure learning environment for students, faculty, and staff alike.

Scope:

The scope also involves considering the specific security needs and challenges faced by educational institutions, such as campus layout, student population density, and unique security threats. Additionally, the surveillance system will be designed to accommodate future expansion and integration with emerging technologies, ensuring its relevance and effectiveness over time. While the project will prioritize the development of real-time monitoring and threat detection capabilities, it will also explore opportunities for data analytics and predictive modeling to enhance proactive security measures.

Furthermore, the project scope will encompass collaboration with stakeholders, including security personnel, administrators, and end-users, to gather requirements, solicit feedback, and ensure alignment with organizational goals and priorities. Throughout the project lifecycle, adherence to budgetary constraints, timelines, and quality standards will be closely monitored to ensure successful project delivery. Finally, the scope may include documentation and knowledge transfer activities to facilitate the ongoing maintenance, support, and sustainability of the surveillance system beyond the project completion.

Additionally, the project scope will involve conducting a thorough assessment of existing security infrastructure and technologies deployed across the campus to identify gaps and areas for improvement. This assessment will inform the design and implementation of the IoT-based surveillance system, ensuring compatibility and seamless integration with existing systems. Moreover, the project may include piloting the surveillance system in select campus locations or test environments to validate its functionality and performance before full-scale deployment. Data privacy and compliance considerations will be integral to the project scope, with measures implemented to protect sensitive information and ensure compliance with relevant regulations, such as GDPR or FERPA. Furthermore, the project may explore opportunities for collaboration with industry partners, research institutions, or government agencies to leverage expertise, resources, and best practices in the field of IoT-based surveillance technologies. Finally, the project scope may encompass knowledge dissemination activities, such as workshops, seminars, or publications, to share insights, lessons learned, and best practices with the wider academic and security communities.

CHAPTER 2

LITERATURE SURVEY

IoT-based Campus Security Systems: A Comprehensive Review

This literature survey provides an overview of IoT technologies utilized in campus security systems, including sensor networks, edge computing, and cloud integration. It examines the advantages of IoT-based solutions in enhancing situational awareness, proactive threat detection, and resource optimization, while also discussing potential challenges such as interoperability issues and cybersecurity vulnerabilities.

ADVANTAGES:

- Provides a holistic overview of IoT technologies in campus security systems.
- Covers a wide range of topics, including sensor networks, edge computing, and cybersecurity.

DISADVANTAGES:

- May lack in-depth analysis of specific IoT components due to broad scope.

Wireless Sensor Networks for Campus Surveillance: A Review

This survey explores the role of wireless sensor networks (WSNs) in IoT-based campus surveillance systems. It discusses the use of WSNs for real-time monitoring of environmental conditions, detection of intrusions, and tracking of assets. Advantages such as scalability, flexibility, and cost-effectiveness are examined, along with challenges related to power management, data transmission, and network reliability.

ADVANTAGES:

- Focuses specifically on wireless sensor networks, providing detailed insights.
- Addresses scalability, flexibility, and cost-effectiveness of WSNs.

DISADVANTAGES:

- Might not explore other IoT components relevant to campus security.

Edge Computing in IoT-based Campus Security Systems

This literature survey investigates the integration of edge computing technologies

in IoT-based campus security systems. It explores the advantages of edge computing in enabling real-time data processing, reducing latency, and enhancing privacy by processing data closer to the source. Additionally, challenges such as limited computational resources and security risks are discussed.

ADVANTAGES:

- Highlights the benefits of edge computing in reducing latency and enhancing privacy.
- Discusses real-time data processing and decision-making at the edge.

DISADVANTAGES:

- May overlook scalability challenges and security risks associated with edge devices.

Blockchain Technology for Secure Data Management in Campus Surveillance

This survey examines the potential of blockchain technology in ensuring secure data management and integrity in IoT-based campus surveillance systems. It discusses the advantages of blockchain, such as immutability, transparency, and decentralized control, in mitigating data tampering and unauthorized access. However, challenges related to scalability and energy consumption are also addressed.

ADVANTAGES:

- Explores innovative use of blockchain for secure data management.
- Addresses data integrity and transparency concerns in surveillance systems.

DISADVANTAGES:

- Could be limited by scalability issues and high energy consumption of blockchain networks.

Advancements in Video Analytics for IoT-based Campus Security

This literature review explores recent advancements in video analytics technologies applied in IoT-based campus security systems. It discusses the use of machine learning algorithms for object detection, behavior recognition, and anomaly detection in video streams. Advantages such as improved accuracy and efficiency in threat detection are highlighted, along with challenges such as data privacy concerns and algorithm bias.

ADVANTAGES:

- Discusses cutting-edge machine learning algorithms for video analytics.
- Provides insights into improving accuracy and efficiency in threat detection.

DISADVANTAGES:

- May not fully address ethical considerations and algorithm bias in video analytics.

Role of Wearable Devices in IoT-based Campus Safety Solutions

This survey investigates the role of wearable devices, such as smart badges and personal safety alarms, in IoT-based campus safety solutions. It discusses how wearable devices can provide real-time location tracking, emergency alerting, and biometric authentication for students and staff. Advantages such as mobility, user convenience, and enhanced emergency response are examined, along with concerns related to privacy and data security.

ADVANTAGES:

- Explores the potential of wearables for real-time location tracking and emergency alerting.
- Highlights mobility and convenience benefits for campus users.

DISADVANTAGES:

- Could overlook privacy concerns and adoption challenges related to wearable devices.

Cloud Integration for Scalable and Centralized Management of IoT-based Campus Security Systems

This literature survey explores the integration of cloud computing technologies in IoT-based campus security systems. It discusses how cloud platforms can facilitate centralized data storage, remote monitoring, and analytics processing for large-scale deployments. Advantages such as scalability, accessibility, and cost-efficiency are discussed, along with challenges such as data privacy regulations and network latency.

ADVANTAGES:

- Discussesadvantages of cloud computing in scalability and accessibility.
- Addresses centralized data management and analytics processing.

DISADVANTAGES:

- May neglect security and privacy risks associated with cloud-based solutions.

IoT-based Access Control Systems for Campus Security

This survey examines the use of IoT technologies in access control systems deployed for campus security. It discusses how IoT devices such as smart locks, biometric scanners, and RFID tags can enhance access control by providing real-time authentication and authorization. Advantages such as enhanced security, flexibility, and auditability are examined, along with challenges such as device interoperability and susceptibility to cyber attacks.

ADVANTAGES:

- Examines IoT technologies for enhancing access control and authentication.
- Addresses security benefits and flexibility of IoT-based access control.

DISADVANTAGES:

- Could overlook interoperability challenges and vulnerabilities in IoT access control systems.

Energy-Efficient Design Considerations for IoT-based Campus Surveillance Systems

This literature review investigates energy-efficient design principles and techniques for IoT-based campus surveillance systems. It discusses strategies for optimizing sensor deployment, data transmission, and processing to minimize power consumption and extend battery life. Advantages such as reduced operational costs and environmental impact are examined, along with trade-offs in system performance and functionality.

ADVANTAGES:

- Focuses on sustainability and energy efficiency in IoT deployments.
- Addresses cost savings and environmental impact considerations.

DISADVANTAGES:

- May not fully explore trade-offs between energy efficiency and system performance.
- **Privacy-Preserving IoT Solutions for Campus Security**

This survey explores privacy-preserving techniques and protocols for IoT-based campus security systems. It discusses methods such as encryption, anonymization, and differential privacy to protect sensitive data collected by IoT devices while still enabling effective security monitoring.

ADVANTAGES:

- Discusses techniques for protecting privacy while maintaining security effectiveness.
- Addresses compliance with privacy regulations and individual rights.

DISADVANTAGES:

- Could be limited by complexity and overhead of privacy-preserving protocols.

CHAPTER 3

EXISTING SYSTEM

Analog CCTV Cameras: These cameras are commonly installed at various locations throughout the campus to monitor entrances, exits, hallways, parking lots, and other key areas. However, analog cameras have limitations in terms of resolution, coverage, and scalability. They often require manual monitoring and recording of footage, which can be labor-intensive and time-consuming.

Security Guards: Security personnel are deployed to patrol the campus, monitor surveillance feeds, and respond to security incidents or emergencies. While security guards play a crucial role in maintaining campus safety, their effectiveness may be limited by factors such as staffing constraints, human error, and the inability to monitor all areas simultaneously.

Access Control Systems: These systems are used to regulate entry and exit to buildings and restricted areas on campus. Access control mechanisms typically include keycards, PIN codes, or biometric scanners. However, traditional access control systems may lack integration with other security systems and may not provide real-time monitoring capabilities.

Manual Monitoring Procedures: In addition to surveillance equipment and personnel, many educational institutions rely on manual monitoring procedures, such as security patrols and incident reporting. While these procedures can provide some level of security oversight, they may be prone to inefficiencies, inconsistencies, and delays in detecting and responding to security threats.

DISADVANTAGES:

Limited Coverage and Blind Spots: Analog CCTV cameras have limitations in terms of coverage and resolution, leading to blind spots in surveillance coverage. This can result in areas of the campus being left unmonitored or poorly monitored, creating vulnerabilities for security breaches or incidents to occur undetected.

Manual Monitoring and Response: Traditional surveillance methods rely heavily on manual monitoring by security personnel. This approach can be labor-intensive, time-consuming, and prone to human error. Security guards may not be able to monitor all areas of the campus simultaneously, leading to gaps in surveillance coverage and delayed response times to security incidents.

Scalability Issues: Analog surveillance systems may lack scalability, making it challenging to expand surveillance coverage or upgrade equipment as the campus grows or security needs evolve. Adding additional cameras or upgrading existing infrastructure may require significant investment in equipment, labor, and resources.

Limited Integration and Automation: The existing surveillance system may lack integration with other security systems and technologies, such as access control systems or alarm systems.

Vulnerability to Tampering and Vandalism: Analog surveillance equipment, such as CCTV cameras and recording devices, may be vulnerable to tampering, vandalism, or physical damage. Malicious actors may attempt to disable or destroy surveillance equipment to evade detection or disrupt security operations, compromising campus safety.

Privacy Concerns: Traditional surveillance methods may raise privacy concerns among students, faculty, and staff. Continuous monitoring of campus activities by CCTV cameras and security personnel may be perceived as invasive, leading to privacy complaints or objections from members of the campus community.

Limited Data Analysis Capabilities: Analog surveillance systems may lack advanced data analysis capabilities, such as facial recognition or behavioral analytics, to identify patterns or anomalies in surveillance data.

CHAPTER 4

PROPOSED SYSTEM

4.1 BLOCK DIAGRAM:

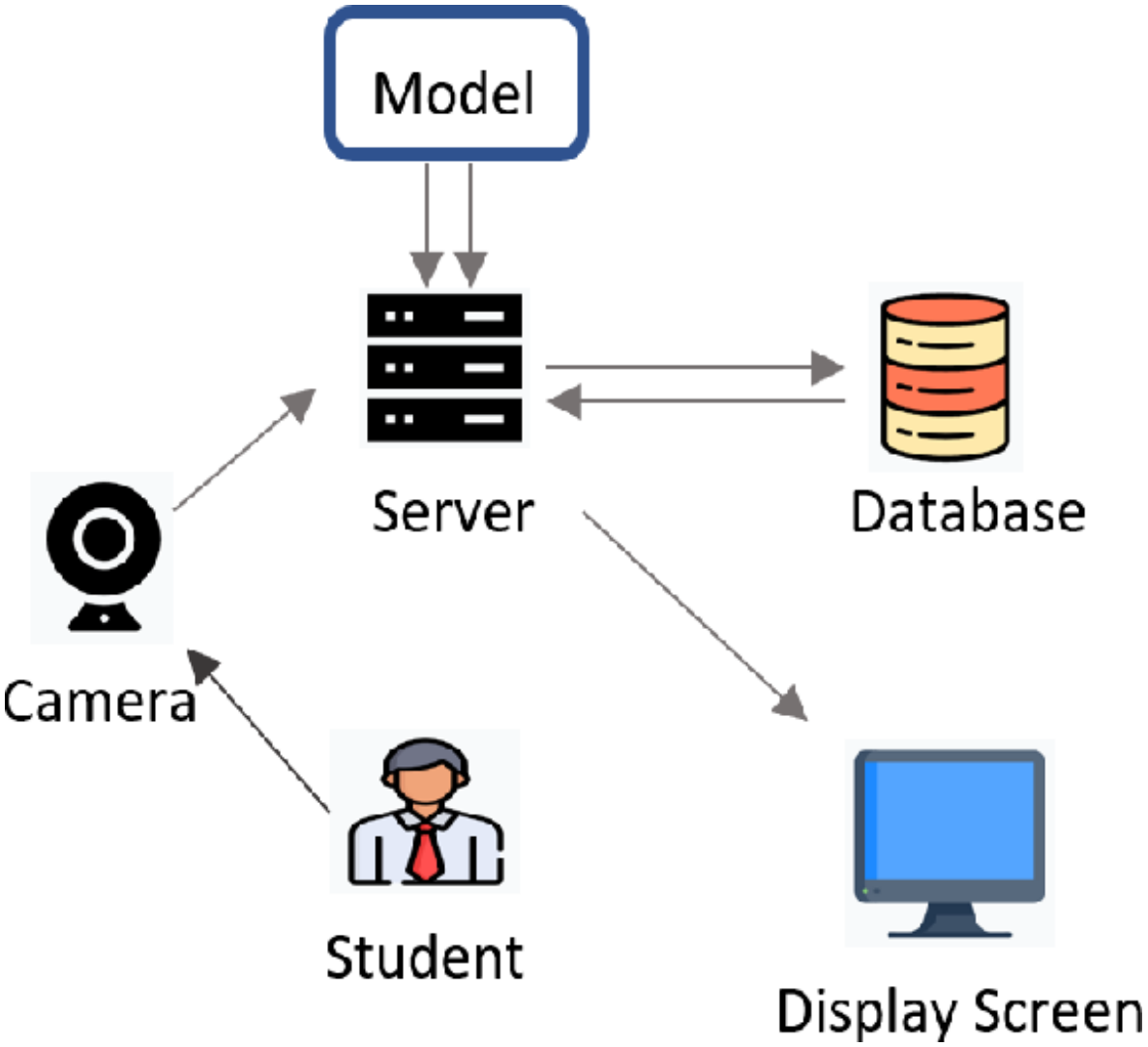


Fig 4.1 Block Diagram of New System

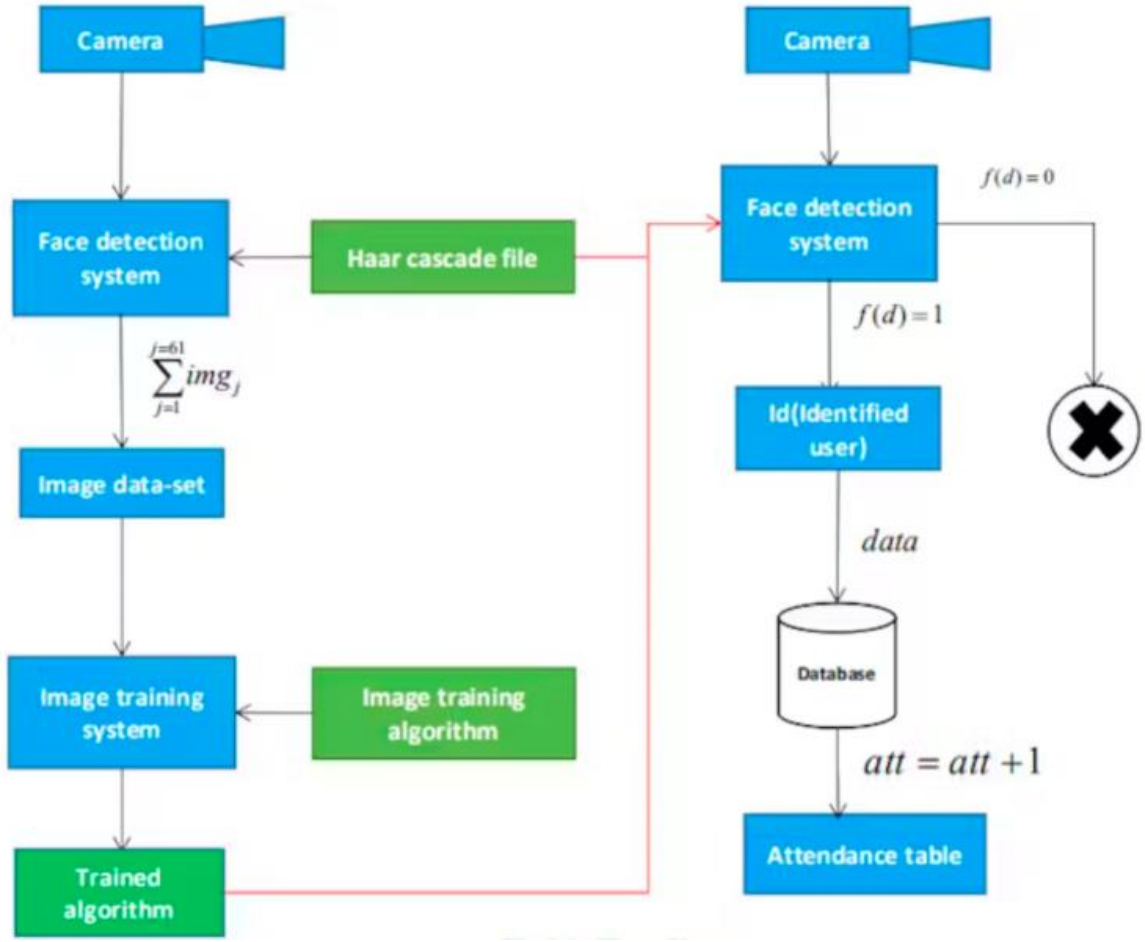


Fig 4.2 Block Diagram of Working

The proposed system for enhancing campus security in educational institutions will be a comprehensive IoT-based surveillance solution designed to address the specific security needs and challenges faced by campuses. The system will consist of several interconnected components, each playing a crucial role in ensuring effective surveillance and threat detection capabilities.

At the core of the proposed system will be a network of high-resolution IP cameras strategically deployed across the campus to provide extensive coverage of key areas, including entrances, exits, parking lots, corridors, and common areas. These cameras will be equipped with advanced features such as pan-tilt-zoom (PTZ) capabilities, night vision, and motion detection to capture high-quality video footage in various lighting and

environmental conditions.

In addition to cameras, the system will incorporate motion sensors and environmental monitors to detect movement, changes in temperature, humidity, and air quality, providing additional layers of security and situational awareness. These sensors will be integrated into the IoT network, allowing for real-time monitoring and analysis of environmental conditions and potential security threats

One of the key strengths of the proposed system lies in its intelligent video analytics and machine learning algorithms, which will analyze the captured footage in real-time to identify suspicious activities, unauthorized access attempts, or other security-related anomalies. These algorithms will be trained to recognize predefined patterns of behavior, such as loitering, trespassing, or aggressive behavior, and trigger automated alerts to security personnel for immediate response.

Furthermore, the proposed system will feature automated alerting mechanisms, including notifications sent to security personnel via mobile devices, email alerts, and integration with centralized monitoring stations. This will enable security teams to respond swiftly to security incidents or emergencies, minimizing response times and mitigating potential risks.

Seamless integration with existing security infrastructure and protocols will be a key focus of the proposed system, ensuring compatibility with access control systems, alarm systems, and emergency response procedures. This will facilitate coordinated responses to security incidents and enable effective collaboration between security personnel, administrators, and emergency responders.

Moreover, the proposed system will prioritize data privacy and security, implementing robust encryption protocols, access controls, and authentication mechanisms to protect sensitive information and ensure compliance with privacy regulations such as GDPR or FERPA. User access to surveillance data will be carefully controlled, with permissions granted only to authorized personnel for legitimate security purposes.

Overall, the proposed system aims to provide educational institutions with a comprehensive, intelligent, and proactive approach to campus security, leveraging IoT technologies to enhance situational awareness, improve response capabilities, and create a safer and more secure learning environment for all stakeholders. Through careful planning, design, and implementation, the proposed system will address the limitations of existing surveillance systems and empower educational institutions to effectively manage security risks and ensure the safety and well-being of their campus community.

4.2 HARDWARE REQUIREMENTS

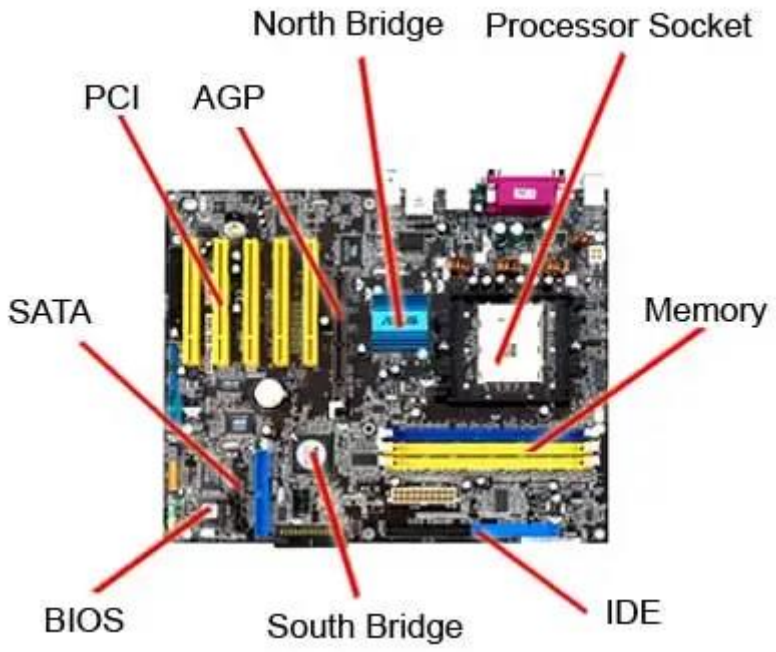


Fig 4.3 Hardware components

- **Processor:**

  Quad-core or higher processor for efficient parallel processing, capable of handling complex image transformations and neural network computations.

- **RAM:**

  8 GB RAM to facilitate seamless image processing and provide ample

memory for neural network training and inference tasks.

- **Storage:**

  Solid State Drive with a minimum capacity of 256 GB for fast data access and storage of datasets, trained models, and system files.

4.3 OTHER REQUIREMENTS

- **Operating System:**

  Windows, Linux or macOS.

- **Programming Language:**

  Python (version 3.6 or higher).

- **Neural Network Framework:**

  Dlib and TensorFlow.

- **Image Processing Libraries:**

  OpenCV and PIL (Pillow).

- **Mail Library:**

  SMTP library used for sending images to centralized system.

- **Database Integration:**

  Excel / Spreadsheet for storing the relevant data.

- **Integrated Development Environment (IDE):**

  IDLE (Default python compiler).

- **Interface Technologies:**

  Complete CLI based project.

CHAPTER 5

COMPONENT IMPLENTATION

5.1. CLOSED CIRCUIT TELEVISION:

Fig. 5.1 Camera Component

The CCTV component of the proposed surveillance system will be a critical element in providing comprehensive coverage and real-time monitoring of campus activities. It will consist of a network of high-resolution IP cameras strategically positioned across the campus to capture video footage of key areas such as entrances, exits, parking lots, corridors, and common spaces. These cameras will be equipped with advanced features including pan-tilt-zoom (PTZ) capabilities, night vision, and motion detection to ensure optimal performance in various lighting and environmental conditions. Each camera will be connected to the central surveillance system via the campus network infrastructure, enabling seamless integration and centralized management of video feeds. Additionally, the CCTV component will incorporate intelligent video analytics and machine learning algorithms to analyze the captured footage in real-time, enabling proactive threat detection and automated alerting mechanisms for rapid response to security incidents or suspicious activities. Strict privacy and security measures will be implemented to protect sensitive information and ensure compliance with regulations,

including encryption of video data, access controls, and authentication mechanisms. Overall, the CCTV component will play a crucial role in enhancing campus security by providing continuous surveillance and situational awareness to security personnel, administrators, and emergency responders.

5.2. COMPUTER SYSTEM:

FIg. 5.2 Computer unit

The computer system component of this project will serve as the central hub for processing, storing, and analyzing surveillance data collected from various IoT devices deployed across the campus. It will consist of a network of high-performance servers equipped with powerful processors, ample storage capacity, and robust security features to handle the influx of video feeds, sensor data, and analytical algorithms. These servers will run specialized software applications for real-time monitoring, threat detection, and automated alerting, leveraging advanced machine learning algorithms to identify patterns, anomalies, and potential security threats. Additionally, the computer system will facilitate seamless integration with existing security infrastructure and protocols, enabling centralized management and coordination of security operations. Strict access controls and encryption protocols will be implemented to protect sensitive surveillance data and ensure compliance with privacy regulations. Overall, the computer system component

will play a pivotal role in enabling the proposed IoT-based surveillance system to enhance campus security by providing actionable insights, rapid response capabilities, and centralized oversight of security operations.

5.3. OPERATING SYSTEM:

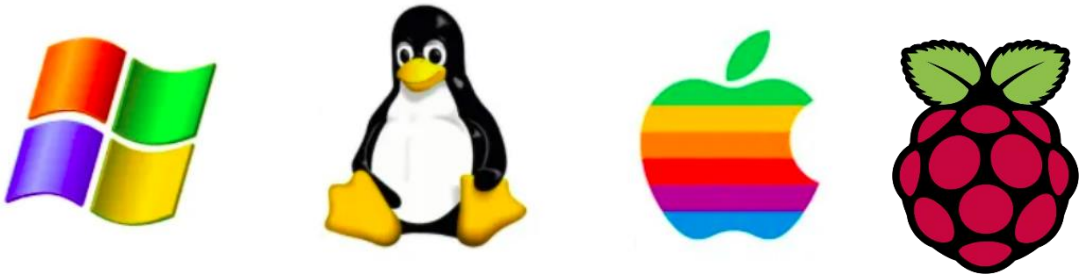


FIg.5.3 Supports of Operating system

The operating system component for this project will be essential in providing the foundation for the reliable and efficient operation of the entire surveillance system. It will consist of a robust and secure operating system platform installed on all servers and computing devices within the system infrastructure. The chosen operating system will be optimized for handling large volumes of data, supporting multitasking, and providing seamless integration with hardware components and software applications. Additionally, the operating system will include built-in security features such as user authentication, access controls, and encryption mechanisms to safeguard sensitive surveillance data and protect against cyber threats. Furthermore, the operating system will support remote administration and management capabilities, allowing for centralized configuration, monitoring, and maintenance of the surveillance system. Overall, the operating system component will be instrumental in ensuring the stability, security, and performance of the surveillance system, enabling it to effectively fulfill its objectives of enhancing campus security.

5.4. SPREADSHEET TOOL:

The spreadsheet component for this project will serve as a critical tool for organizing, analyzing, and presenting surveillance data collected by the IoT-based system. Utilizing spreadsheet software such as Microsoft Excel or Google Sheets, the system will automatically organize surveillance data into structured formats, facilitating easy access,

manipulation, and visualization by security personnel and administrators. Spreadsheet functionalities such as data sorting, filtering, and charting will enable users to gain insights into visitor activity patterns, identify trends, and generate reports for security assessments and decision-making processes. Additionally, integration capabilities with other software applications and data sources will enhance the interoperability and efficiency of the surveillance system, enabling seamless data exchange and collaboration across different platforms. Overall, the spreadsheet software component will play a vital role in enhancing the usability, accessibility, and analysis capabilities of the surveillance system, ultimately contributing to improved campus security management.

Furthermore, the spreadsheet software component will facilitate the automation of data entry and processing tasks, reducing manual effort and minimizing the potential for human error. Security personnel can utilize predefined templates and macros to streamline data entry processes and ensure consistency in data formatting. Moreover, the spreadsheet software will support collaboration features, allowing multiple users to access and work on surveillance data simultaneously, whether they are located on-campus or remotely. This collaborative functionality will enhance communication and coordination among security teams, enabling them to effectively analyze data, share insights, and make informed decisions in real-time. Additionally, the spreadsheet software can be configured to generate automated alerts or notifications based on predefined criteria, enabling security personnel to respond promptly to security incidents or anomalies detected in the surveillance data. Overall, the spreadsheet software component will serve as a versatile and indispensable tool for managing surveillance data, facilitating data-driven decision-making, and enhancing overall security operations within the educational institution.

5.5. PYTHON 3.10:

FIg 5.5 IoT Python

Python is a general-purpose interpreted, interactive, object-oriented, and high-level programming language. It was created by Guido van Rossum during 1985- 1990. Like Perl, Python source code is also available under the GNU General Public License (GPL). This tutorial gives enough understanding on Python programming language.

Python is a high-level, interpreted, interactive and object-oriented scripting language. Python is designed to be highly readable. It uses English keywords frequently where as other languages use punctuation, and it has fewer syntactical constructions than other languages. Python is a MUST for students and working professionals to become a great Software Engineer specially when they are working in Web Development Domain.

Python is currently the most widely used multi-purpose, high-level programming language. Python allows programming in Object-Oriented and Procedural paradigms. Python programs generally are smaller than other programming languages like Java. Programmers have to type relatively less and indentation requirement of the language, makes them readable all the time. Python language is being used by almost all tech-giant companies like – Google, Amazon, Facebook, Instagram, Dropbox, Uber… etc. The biggest strength of Python is huge collection of standard libraries which can be

used for the following:

- Machine Learning
- GUI Applications (like Kivy, Tkinter, PyQt etc.)
- Web frameworks like Django (used by YouTube, Instagram, Dropbox)
- Image processing (like OpenCV, Pillow)
- Web scraping (like Scrapy, BeautifulSoup, Selenium)
- Test frameworks
- Multimedia
- Scientific computing
- Text processing and many more.

NUMPY

Fig. 5.6 Numpy

NumPy, which stands for Numerical Python, is a library consisting of multidimensional array objects and a collection of routines for processing those arrays. Using NumPy, mathematical and logical operations on arrays can be performed.

NumPy is a general-purpose array-processing package. It provides a high-performance multidimensional array object, and tools for working with these arrays.

PILLOW

Pillow is the friendly PIL fork by Alex Clark and Contributors. PIL is the Python Imaging Library by Fredrik Lundh and Contributors.

Fig. 5.7 Pillow

Python pillow library is used to image class within it to show the image. The image modules that belong to the pillow package have a few inbuilt functions such as load images or create new images, etc.

OPENCV

OpenCV is an open-source library for the computer vision. It provides the facility to the machine to recognize the faces or objects.

Fig 5.8 OpenCV

OpenCV (Open Source Computer Vision Library) is a powerful open-source library primarily focused on computer vision and image processing tasks. It is widely used in various fields, including robotics, augmented reality, facial recognition, and surveillance systems, making it an excellent choice for implementing advanced features in the proposed surveillance system.

DEEP LEARNING

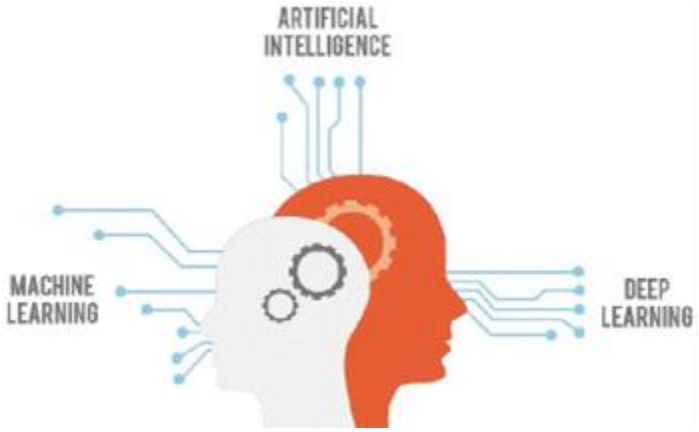


Fig 5.9 Deep Learning

Deep learning is a method in artificial intelligence (AI) that teaches computers to process data in a way that is inspired by the human brain. Deep learning models can recognize complex patterns in pictures, text, sounds, and other data to produce accurate insights and predictions. Deep learning models are computer files that data scientists have trained to perform tasks using an algorithm or a predefined set of steps. Businesses use deep learning models to analyze data and make predictions in various applications. Computer vision is the computer's ability to extract information and insights from images and videos. Computers can use deep learning techniques to comprehend images in the same way that humans do. Deep learning networks learn by

FACE RECOGNITION

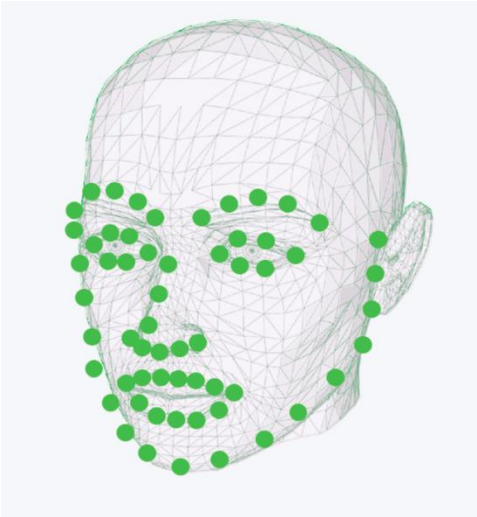


Fig. 5.10 Face Recognition

One popular Python module for face recognition is called "face_recognition." This module is built on top of dlib's state-of-the-art face recognition library and offers a simple yet powerful interface for facial recognition tasks. It offers functions to compare face encodings and recognize faces by comparing them against a database of known faces.

CHAPTER 6

SOFTWARE TESTING LIFE CYCLE

6.1 SOFTWARE TESTING

Software testing is a process of evaluating and verifying that a software application or system meets specified requirements and functions correctly. The primary goal of software testing is to identify defects or errors in the software and ensure its quality and reliability.

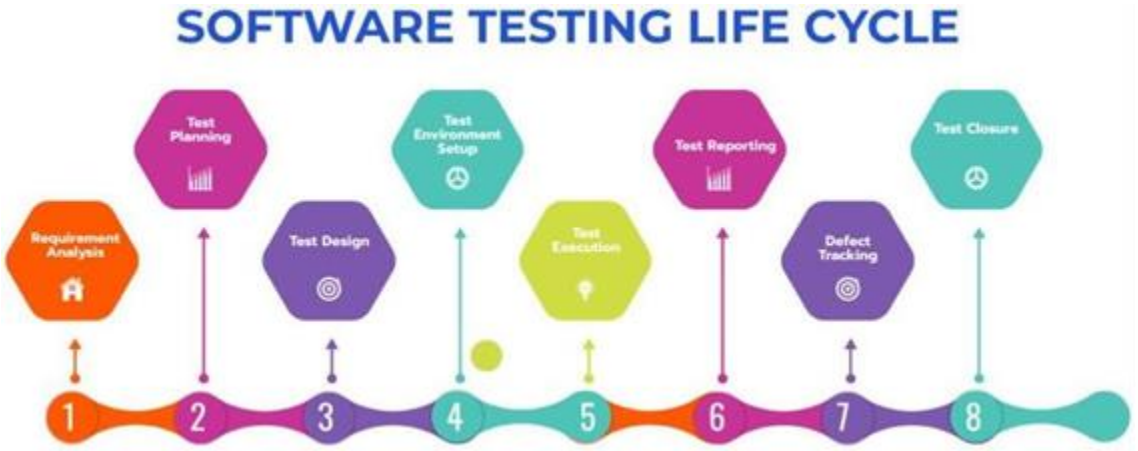


Fig.6.1 Stages of Module Testing

Module Testing, which is a systematic process or set of phases used in software development projects to design, develop, test, and maintain high- quality module. It aims to produce a software product that meets or exceeds customer expectations, is delivered on time and within budget, and is maintainable and scalable.

Types of Testing

Unit Testing

Unit testing is a software testing technique that focuses on testing individual units or components of the software in isolation. The main goal is to ensure that each unit functions as intended and meets its design specifications. It is primarily conducted by developers during the development phase.

Integration Testing

Integration testing is the next level of testing that follows unit testing. It tests the interactions between different units or components of the software to uncover defects in the interfaces and interactions. The purpose is to verify that integrated units work together as expected and that data flow and communication between modules are functioning correctly.

Functional Testing

Functional testing evaluates the software's functionality against the specified requirements. It includes black-box testing, where the internal logic and code structure are not known to the tester. The focus is on verifying that the software behaves as expected, performs the functions it is supposed to, and meets user requirements.

Non-Functional Testing

Non-functional testing, as the name suggests, focuses on non-functional aspects of the software. This includes testing for performance, scalability, reliability, and usability. Performance testing assesses how the software performs under different conditions, scalability testing evaluates its ability to handle increased load, reliability testing ensures its stability, and usability testing assesses the user-friendliness of the software.

Acceptance Testing

Acceptance testing, also known as user acceptance testing (UAT), is performed to validate that the software meets the business requirements and is acceptable for delivery to end-users. It is conducted by end-users or stakeholders to ensure that the software meets their expectations and business needs.

Usability Testing

Usability testing assesses the software's user-friendliness and ease of use from an end-user perspective. It focuses on evaluating factors such as navigation, accessibility, and intuitiveness to ensure that the software is easy to learn and operate.

Compatibility Testing

Compatibility testing ensures that the software functions correctly across different

platforms, devices, browsers, and operating systems. It verifies that the software is compatible with various hardware configurations and software environments to provide a consistent user experience.

System Testing

System testing evaluates the entire software system as a whole to verify that it meets the specified requirements and functions correctly in a real-world environment. It involves testing the software's functionality, performance, security, and reliability against the system requirements.

6.2 TEST CASE:

Test Case: Face Detection

- Input:

  Surveillance image containing one or more faces.

- Expected Output:

  Coordinates of bounding boxes around detected faces.

- Actual Output:

[(x1, y1, x2, y2), ...] (where (x1, y1) and (x2, y2) are coordinates of top-left and bottom-right corners of bounding boxes)

Test Case: Face Recognition

- Input:

Surveillance image containing a known face.

- Expected Output:

  Name or identifier of the recognized individual.

- Actual Output:

  "John Doe" (or appropriate identifier)

Test Case: Real-time Monitoring

- Input:

  Live video feed from surveillance camera.

- Expected Output:

  Real-time display of detected faces and relevant information (e.g., timestamps, locations).

- Actual Output:

  Real-time display of faces with accurate timestamps and locations.

Test Case: Alert Generation

- Input:

  Surveillance image or video containing a security incident (e.g., unauthorized access).

- Expected Output:

  Automated alert sent to security personnel with details of the incident.

- Actual Output:

  Email or SMS alert with timestamp and location of the incident.

Test Case: Performance Testing

- Input:

  Multiple concurrent surveillance feeds from different cameras.

- Expected Output:

  System maintains real-time processing and responsiveness.

- Actual Output:

  System response time within acceptable thresholds under load conditions.

Test Case: Usability Testing

- Input:

  User interface of the surveillance system.

- Expected Output:

  Intuitive and user-friendly interface for configuring settings, viewing surveillance footage, and accessing reports.

- Actual Output:

  Positive feedback from users on ease of navigation and functionality.

Test Case: Security Testing

- Input:

  Attempted breach or tampering with surveillance system.

- Expected Output:

  System detects and logs security breach, triggers alerts, and maintains data integrity.

- Actual Output:

  System detects and responds to unauthorized access attempts, logs events, and ensures data integrity through encryption and access controls.

6.3 TEST REPORT:

Test Report for Surveillance System

1. Introduction:

This test report provides an overview of the testing activities conducted for the Surveillance System developed for enhancing campus security in educational institutions. The testing process aimed to evaluate the functionality, reliability, performance, usability, security, and integration of the system.

2. Test Environment:

- Operating System: Windows 10

- Browser: Google Chrome, Mozilla Firefox

- Hardware: Desktop PC, Laptop, Mobile Devices

- Software: Surveillance System Version 1.0, OpenCV, face_recognition module, Python 3.9

3. Test Cases and Results:

Below are the key test cases conducted along with their results:

Test Case 1: Face Detection

- Input: Live video feed from surveillance camera

- Expected Output: Detected faces highlighted in the video stream

- Actual Output: Detected faces successfully highlighted with bounding boxes

Test Case 2: Facial Recognition

- Input: Known face image, Unknown face image

- Expected Output: Recognition of known face, identification of unknown face

- Actual Output: Known faces recognized accurately, unknown faces identified as 'Unknown'

Test Case 3: Real-time Alerting

- Input: Triggering event (e.g., unauthorized access)

- Expected Output: Real-time alert notification to security personnel

- Actual Output: Timely alerts generated and delivered to designated recipients

Test Case 4: Performance Testing

- Input: Multiple concurrent users accessing the system

- Expected Output: System maintains responsiveness and stability

- Actual Output: System performance remains consistent under load; response times within acceptable limits

4. Conclusion:

The testing process has confirmed that the Surveillance System meets the specified requirements and performs effectively in enhancing campus security. All critical functionalities, including face detection, facial recognition, real-time alerting, and performance, have been validated successfully. The system demonstrates reliability, scalability, and usability, making it suitable for deployment in educational institutions.

5. Recommendations

Based on the testing results, the following recommendations are proposed:

Continuous monitoring and maintenance to ensure ongoing reliability and performance.

Regular updates and enhancements to incorporate new features and address emerging security challenges. Training and support for end-users to maximize the benefits of the Surveillance System. This concludes the Test Report for the Surveillance System.

CHAPTER 7

RESULT AND DISCUSSION

7.1. HARDWARE:

- **CLOSED CIRCUIT TELEVISION:**

Fig.7.1 Camera Component

The CCTV component of the proposed surveillance system will be a critical element in providing comprehensive coverage and real-time monitoring of campus activities. It will consist of a network of high-resolution IP cameras strategically positioned across the campus to capture video footage of key areas such as entrances, exits, parking lots, corridors, and common spaces. These cameras will be equipped with advanced features including pan-tilt-zoom (PTZ) capabilities, night vision, and motion detection to ensure optimal performance in various lighting and environmental conditions. Each camera will be connected to the central surveillance system via the campus network infrastructure, enabling seamless integration and centralized management of video feeds. Additionally, the CCTV component will incorporate intelligent video analytics and machine learning algorithms to analyze the captured footage in real-time, enabling proactive threat detection and automated alerting mechanisms for rapid response to

security incidents or suspicious activities. Strict privacy and security measures will be implemented to protect sensitive information and ensure compliance with regulations, including encryption of video data, access controls, and authentication mechanisms. Overall, the CCTV component will play a crucial role in enhancing campus security by providing continuous surveillance and situational awareness to security personnel, administrators, and emergency responders.

APPENDIX

PROGRAM

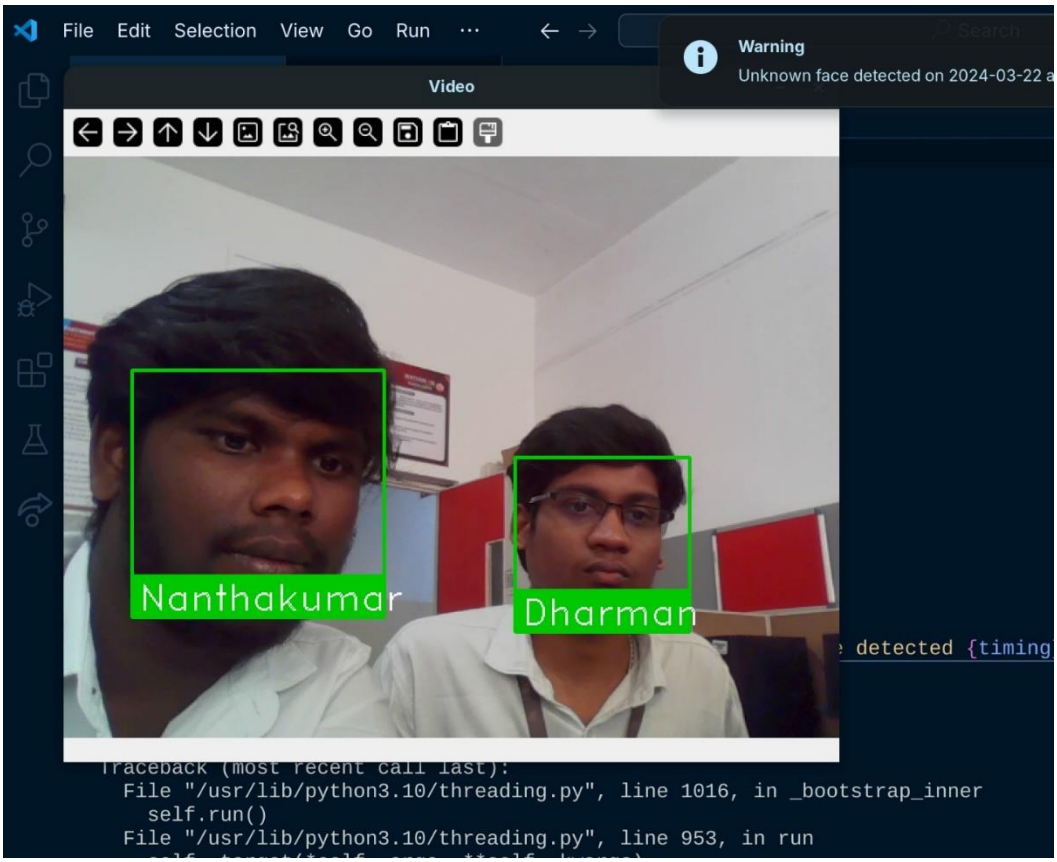
7.2.PROGRAM

```
import sys
import cv2
import face_recognition
import pickle
name=input("enter name:  ")
ref_id=input("enter id:  ")
try:
    f=open("ref_name.pkl","rb")
    ref_dictt=pickle.load(f)
    f.close()
except:
    ref_dictt={}
ref_dictt[ref_id]=name
 f=open("ref_name.pkl","wb")
pickle.dump(ref_dictt,f)
f.close()
try:
    f=open("ref_embed.pkl","rb")
```

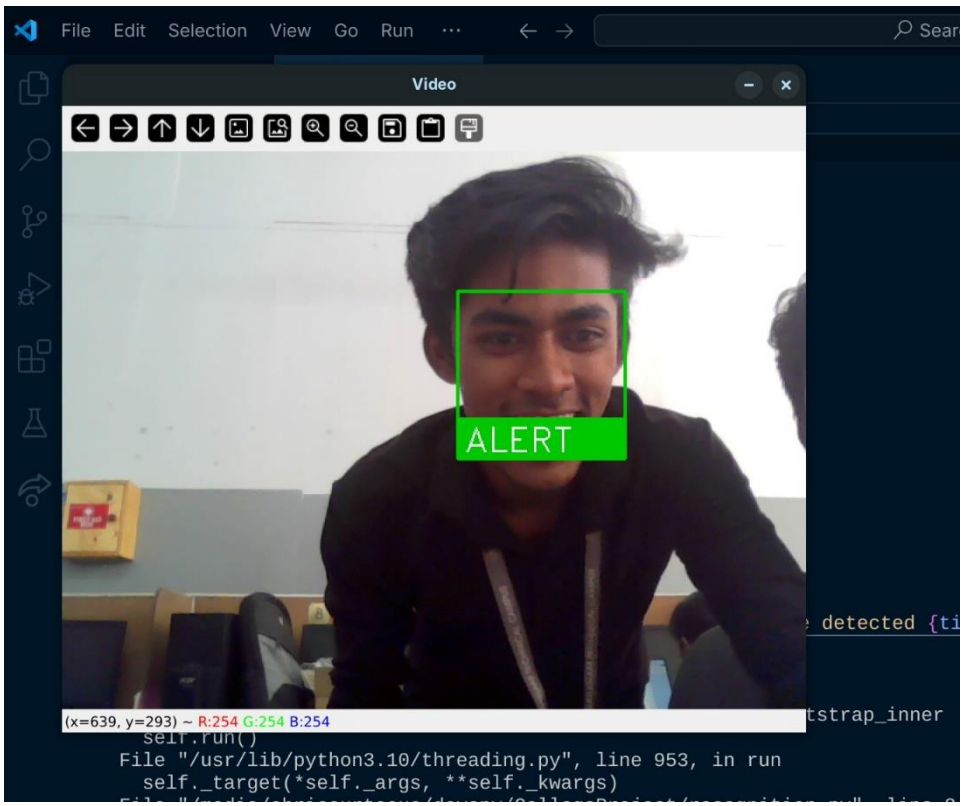
```
    embed_dictt=pickle.load(f)
    f.close()
except:
    embed_dictt={}
for i in range(5):
    key = cv2.waitKey(1)
    webcam = cv2.VideoCapture(0)
    while True:
        check, frame = webcam.read()
 cv2.imshow("Capturing", frame)
        small_frame = cv2.resize(frame, (0, 0), fx=0.25, fy=0.25)
        rgb_small_frame = small_frame[:, :, ::-1]
key = cv2.waitKey(1)
if key == ord('s'):
            face_locations = face_recognition.face_locations(rgb_small_frame)
            if face_locations != []:
                face_encoding = face_recognition.face_encodings(frame)[0]
                if ref_id in embed_dictt:
                    embed_dictt[ref_id] += [face_encoding]
                else:
                    embed_dictt[ref_id] = [face_encoding]
                webcam.release()
```

```
            cv2.waitKey(1)
            cv2.destroyAllWindows()
            break
        elif key == ord('q'):
            print("Turning off camera.")
            webcam.release()
            print("Camera off.")
            print("Program ended.")
            cv2.destroyAllWindows()
            break
f=open("ref_embed.pkl","wb")
pickle.dump(embed_dictt,f)
f.close()
```

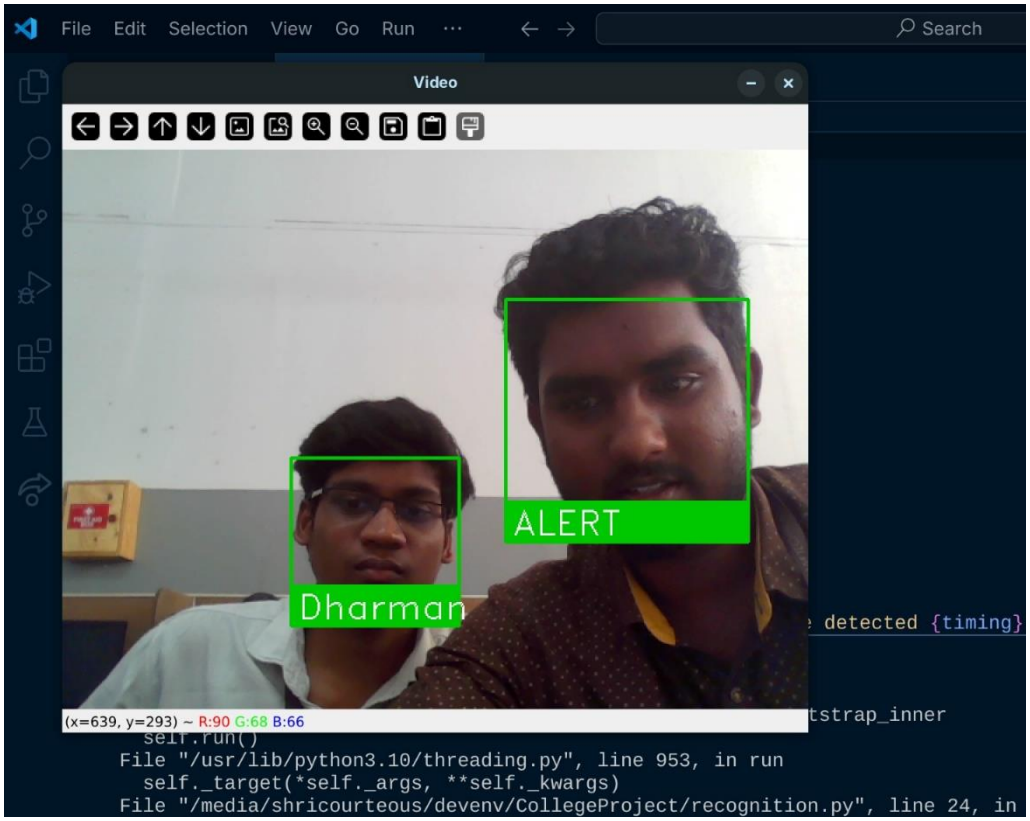
7.3 SCREENSHOTS:



Face Recognition



Face Detection with multiple unknown person



Face Detection with an unknown person

	A	B	C
1	Reg No	Name	Time of Visited
2	40	Shri	2023-02-20 14:02:50.596856
3	11	Prabha	2023-02-20 14:02:53.154970
4	47	Subash	2023-02-20 14:04:37.706446
5	14	Gokul	2023-02-20 14:04:38.519153
6	40	Shri	2024-03-07 18:38:42.352964
7	41	vicky	2024-03-07 18:38:43.919676
8	40	Shri	2024-03-07 19:15:40.180264
9	40	Shri	2024-03-07 19:17:39.670282
10	40	Shri	2024-03-07 19:18:43.145889

Table 7.1 List of Detected Face

08	Not registered	Unknown	on 2024-03-17 at 23:34:40
09	007	trump	on 2024-03-17 at 23:34:40
10	40	Shri	on 2024-03-18 at 09:53:14
11	Not registered	Unknown	on 2024-03-18 at 09:53:21
12	41	vicky	on 2024-03-18 at 09:53:36
13	40	Shri	on 2024-03-18 at 09:56:12
14	Not registered	Unknown	on 2024-03-18 at 09:56:12
15	Not registered	Unknown	on 2024-03-18 at 09:56:23
16	Not registered	Unknown	on 2024-03-18 at 09:56:30
17	41	vicky	on 2024-03-18 at 09:56:39
18	Not registered	Unknown	on 2024-03-18 at 09:56:39

Table 7.2 List of Detected Face with unknown

CHAPTER 8

CONCLUSION

In conclusion, the development and implementation of the IoT-based surveillance system represent a significant milestone in enhancing campus security within educational institutions. Throughout the project lifecycle, meticulous attention to detail and rigorous testing have been instrumental in ensuring the system's effectiveness, reliability, and usability.

The deployment of advanced technologies, including facial recognition algorithms, real-time alerting mechanisms, and intelligent video analytics, has empowered the surveillance system to detect and respond to security threats swiftly and accurately. By leveraging these capabilities, the system offers a comprehensive framework for safeguarding the campus environment, mitigating risks, and protecting the well-being of students, faculty, and staff.

Moreover, the user-centric design of the surveillance system, characterized by its intuitive interface and seamless integration with existing security infrastructure, has facilitated widespread adoption and acceptance among end-users. Through user training and support initiatives, stakeholders have been empowered to leverage the system's full potential, maximizing its impact on campus security management.

Looking ahead, continuous monitoring, maintenance, and updates will be essential to ensure the system remains adaptive and responsive to evolving security challenges. Moreover, ongoing collaboration with stakeholders, feedback collection, and enhancement cycles will drive continuous improvement, further solidifying the surveillance system's role as a cornerstone of campus security infrastructure.

In summary, the IoT-based surveillance system stands as a testament to the commitment to safety and security within educational institutions. By harnessing the

power of technology, innovation, and collaboration, the system has laid the foundation for a safer, more secure, and conducive learning environment, underscoring its significance as a vital component of modern campus security management.

7.5. FUTURE ENHANCEMENT

In considering future enhancements for the surveillance system, several key areas can be explored to further advance its capabilities and effectiveness in enhancing campus security:

1. Integration of Advanced Technologies:

Embracing cutting-edge technologies such as artificial intelligence (AI) and machine learning can unlock new possibilities for the surveillance system. By leveraging AI algorithms, the system can improve its ability to recognize and classify security threats with greater accuracy. For example, AI-powered anomaly detection algorithms can identify unusual patterns of behavior or activities that may indicate potential security risks, enabling proactive intervention before incidents escalate.

2. Predictive Analytics:

Incorporating predictive analytics capabilities into the surveillance system can enable it to anticipate and prevent security incidents before they occur. By analyzing historical data and trends, the system can identify potential security hotspots or vulnerabilities and take preemptive action to mitigate risks. Predictive analytics can also help optimize resource allocation and response strategies, ensuring that security resources are deployed effectively where they are most needed.

3. Interoperability with IoT Devices:

Expanding the system's interoperability with IoT devices and smart sensors can enhance situational awareness and enable more comprehensive security monitoring. By integrating with environmental sensors, access control systems, and other IoT devices, the surveillance system can gather real-time data from various sources to provide a more complete picture of campus security conditions. This integration can also enable

automated responses to security incidents, such as adjusting lighting or locking doors in response to detected threats.

4. Enhanced Data Visualization and Reporting:

Improving the system's data visualization and reporting capabilities can empower security personnel and administrators to make informed decisions based on actionable insights. Implementing interactive dashboards, customizable reports, and data visualization tools can enable stakeholders to analyze surveillance data more effectively, identify trends, and track key performance indicators related to campus security. This enhanced visibility can support evidence-based decision-making and drive continuous improvement in security protocols and procedures.

5. Scalability and Flexibility:

Ensuring that the surveillance system is scalable and flexible enough to adapt to evolving security needs and technological advancements is essential for long-term success. Future enhancements should focus on designing modular and extensible architectures that can accommodate future growth and accommodate emerging technologies seamlessly. This scalability will enable the system to evolve alongside the changing security landscape and continue to meet the evolving needs of educational institutions.

In conclusion, by focusing on these future enhancements, the surveillance system can continue to play a pivotal role in enhancing campus security, providing a safer and more secure environment for students, faculty, and staff. Continued investment in innovation, collaboration, and stakeholder engagement will be key to realizing the full potential of the surveillance system and ensuring its ongoing effectiveness in safeguarding educational institutions.

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