AI-BASED IMAGE PROCESSING SYSTEM FOR COLLEGE BUSES

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Abstract - The "Al-Based Image Processing System For College Buses" project addresses the critical need for enhanced safety and security in college bus transportation through the implementation of an innovative AI-based image processing system. This system is designed to efficiently check student entry and verify active passes, ultimately creating a secure environment for all passengers on college buses. Leveraging advanced machine learning models, the primary goal is to improve the capacity and accuracy of the system, enabling it to capture multiple faces simultaneously with faster execution and more precise output. The hardware components of the AI-Secure Bus system include a Raspberry Pi, GSM module, GPS module, LCD display, and a reliable power supply. These components work in tandem to create a robust and versatile platform capable of real-time tracking, image processing, and communication. The workflow of adding datasets involves capturing student facial data, adding information about pass validity, and incorporating home location coordinates into the dataset. This meticulous process ensures that the system has comprehensive data to accurately authenticate and monitor student entries. The workflow toward the college involves making the bus location live, checking the proximity of students' home locations, and notifying students about the bus's arrival with approximate timings. This real-time tracking and communication significantly contribute to the efficiency and transparency of the transportation system.

Keywords: *Open CV, V2 camera, Raspberry Pi, image processing, Artificial Intelligence*

1. INTRODUCTION

The development and implementation of an AI-based image processing system for college buses represent a significant milestone in enhancing the safety, efficiency, and management of transportation services within educational institutions. Throughout the course of this project, various components including artificial intelligence, computer vision, and machine learning algorithms have been integrated to create a robust and multifunctional system tailored to the specific needs of college bus operations.[1]

This project has demonstrated the effectiveness of utilizing AI technologies in addressing key challenges faced by college bus services. By harnessing the power of computer vision, the system is capable of real-time detection, recognition, and analysis of various objects and events occurring within the bus environment. This includes but is not limited to, identifying unauthorized access, monitoring passenger behavior, and detecting potential safety hazards. Such capabilities enable prompt intervention in case of emergencies and facilitate proactive measures to ensure the safety and well-being of students during their commute.

Furthermore, the AI-based analytics embedded within the system provide valuable insights into bus utilization patterns, route optimization, and scheduling adjustments. By leveraging data-driven decision-making, college administrations can optimize resource allocation, streamline fleet management, and ultimately, reduce operational costs associated with transportation services.[2]

2. METHODOLOGY

In the dynamic landscape of technological innovation, the development of complex software solutions demands meticulous planning, precise documentation, and a clear roadmap to guide the entire project life cycle. The Software Requirements and Specifications (SRS) document plays a pivotal role in this process, providing a detailed and comprehensive outline for the creation of our transformative project: the AI-Based Image Processing System for College Buses. The primary purpose of the Software requirements and specification is to serve as a comprehensive guide that delineates the project's scope, functionalities, constraints, and desired outcomes.

It acts as a reference point throughout the software development life cycle, ensuring a shared understanding among all stakeholders regarding the project's goals and parameters. The scope of the Software requirements and specification encompasses both the macro and micro aspects of the software project. At a macro level, it

defines the overall objectives, features, and functionalities that the software solution aims to deliver. Simultaneously, at a micro level, it details the specific components, modules, and interactions between different elements of the software. [3]

1. Purpose Of The System: The AI-Based Image Processing System for College Buses is conceived with a multifaceted purpose aimed at revolutionizing safety, efficiency, and communication within the context of student transportation. The primary objectives and purposes of the system are outlined below: [4]

2. Enhancing Safety and Security: The fundamental purpose of the system is to elevate safety measures within college bus transportation. By implementing advanced facial recognition technology and pass validation mechanisms, the system ensures that only authorized students gain access to the bus, mitigating the risks associated with unauthorized entry and bolstering overall security protocols. 3.1.2 Streamlining Student Transportation: The system aims to streamline the process of student transportation by providing a secure and efficient means of verifying student entries. Through facial 13 recognition and pass validation features, the system reduces the time and effort required for manual checks, ensuring a swift and organized boarding process.

3. Real-Time Communication: Facilitating effective communication is a key purpose of the system. The integration of a robust notification system allows real-time communication between the system and students. This feature alerts students about the proximity of the bus, reducing wait times and enhancing overall communication efficiency. [5]

4. Improving Data Accuracy: The system addresses the need for accurate and reliable data collection and validation. By employing sophisticated image processing algorithms and machine learning models, the system minimizes errors in student entry verification and pass validation, contributing to the overall accuracy of the data recorded. [6]

5. User-Friendly Operations: A pivotal purpose of the system is to create a user-friendly experience for bus drivers, administrators, and students alike. By employing a seamless interface and intuitive design, the system streamlines daily operations associated with student transportation, enhancing user satisfaction and system usability.

3. PROCESS OF PROJECT

1. Initiation Phase:

- Define Objectives: Clearly outline the project's goals, such as improving student safety, optimizing bus operations, and enhancing security.
- Form Project Team: Assemble a multidisciplinary team including AI experts, software developers, hardware engineers, transportation specialists, and project managers.
- Identify Stakeholders: Identify all parties involved, including college administrators, bus drivers, students, and maintenance staff.[9]

2. Planning Phase:

- Scope Definition: Define the scope of the project, including the number of buses to be equipped, functionalities to be implemented, and project timeline.
- Risk Assessment: Identify potential risks and challenges, such as technical limitations, budget constraints, and regulatory compliance issues.
- Resource Allocation: Allocate resources, including budget, manpower, and equipment, based on project requirements and priorities.

3. Analysis Phase:

- Gather Requirements: Conduct interviews and surveys with stakeholders to gather requirements and understand their needs and expectations.
- Assess Existing Infrastructure: Evaluate the current state of college buses, including onboard systems, cameras, GPS, and communication networks.
- Define System Specifications: Define detailed specifications for the AI-based image processing system, including hardware and software requirements.

4. Design Phase:

- System Architecture: Design the overall architecture of the image processing system, including hardware layout, software components, and data flow.
- Algorithm Selection: Choose appropriate AI and computer vision algorithms for tasks such as object detection, facial recognition, and anomaly detection.
- Hardware Selection: Select suitable hardware components, such as cameras, processors, and memory, based on system requirements and budget constraints.

5. Development Phase:

- Software Development: Develop software modules for implementing selected algorithms, ensuring compatibility and optimization for the chosen hardware.

- Hardware Integration: Install and integrate hardware components onto college buses, including cameras, sensors, and processing units.
- System Integration: Integrate software and hardware components to create a cohesive image processing system, ensuring seamless communication and functionality.[10]

6. Testing Phase:

- Unit Testing: Test individual software components and algorithms to ensure they function correctly and produce accurate results.
- Integration Testing: Test the integrated system as a whole to verify compatibility, performance, and reliability.
- Field Testing: Deploy the system on a subset of college buses for real-world testing, collecting feedback and identifying any issues or improvements needed.

7. Deployment Phase:

- Full-Scale Deployment: Roll out the image processing system to all college buses, ensuring proper installation, configuration, and testing.
- User Training: Provide training to bus drivers, maintenance staff, and administrators on how to use the system effectively and troubleshoot common issues.

8. Monitoring and Maintenance Phase:

- Monitoring: Implement monitoring tools to track system performance, uptime, and any anomalies or failures.
- Maintenance: Establish a maintenance schedule for regular updates, inspections, and repairs to ensure the system's ongoing functionality and reliability.[12]

4. SOFTWARE/TECHNOLOGY USED

1. Raspberry pi 4

Install a suitable operating system on the Raspberry Pi. Raspbian, the official Raspberry Pi OS, is a good choice. Ensure it's up-to-date and configured properly.

Install libraries and frameworks for image processing. Popular choices include OpenCV, TensorFlow, or PyTorch. These libraries offer various functions for tasks like object detection, image recognition, and more.

Fig 1:- Raspberry pi 4

2. Webcam

It could serve various purposes such as enhancing security, monitoring driver behavior, and ensuring adherence to safety regulations. Develop or utilize existing image processing software tailored to the specific needs of monitoring college buses. This software would be responsible for analyzing the captured video feed in real-time.

Fig 2:- Web cam

3. Firebase

It can offer several benefits in terms of data management, real-time updates, and scalability. Firebase Authentication can be used to secure access to the system, ensuring that only authorized users can view or modify data. This is crucial for maintaining the integrity of the system, especially in a sensitive environment like college transportation.

4. Android studio

Create a design for the Android application. This includes deciding on the user interface layout, functionalities, and how the image processing will be integrated. This involves implementing the user interface, integrating camera functionality for capturing images, and integrating image processing algorithms for analyzing the images.

5. IDE

This could be achieved using cameras installed on the buses. These cameras could capture images at regular intervals or continuously, depending on the requirements.

This is the core of your image processing system. Using algorithms such as Convolutional Neural Networks (CNNs), you can detect and recognize various objects in the images, such as the bus itself, pedestrians, other vehicles, etc.

6. Python

Using Python in an AI-based image processing system for college buses sounds like a great idea! Python offers a rich ecosystem of libraries and tools that can be leveraged for image processing tasks, especially in combination with AI techniques. Python can interface with cameras or other image-capturing devices to capture images of college buses. Libraries like OpenCV or PIL (Python Imaging Library) can be used for this purpose.

5. IMPLEMENTATION

1. **Hardware Installation:**
   - Install a high-resolution camera inside the college bus, positioned to capture the entire interior space effectively.
   - Mount additional sensors, such as motion sensors or infrared sensors, to enhance the system's capabilities for detecting passenger movement and occupancy.
   - Connect the camera and sensors to a central processing unit (CPU) or microcontroller installed on the bus.

2. **Software Development:**
   - Develop software modules for image processing and analysis using AI and computer vision algorithms.
   - Implement object detection algorithms to identify and track passengers, objects, and potential safety hazards within the bus.
   - Integrate a facial recognition algorithm to identify authorized personnel and detect any unauthorized individuals boarding the bus.
   - Design an anomaly detection algorithm to identify unusual behavior or events, such as overcrowding or suspicious objects.[15]

3. **System Integration:**
   - Integrate the developed software modules with the hardware components installed on the bus.
   - Ensure seamless communication and functionality between the camera, sensors, and processing unit.
   - Test the integrated system to verify its performance, accuracy, and reliability in a controlled environment.

5. **Testing and Calibration:**
   - Conduct thorough testing of the AI-based image processing system under various operating conditions.
   - Test the system's responsiveness to different scenarios, such as crowded buses, varying lighting conditions, and passenger movements.
   - Calibrate the camera and sensors to optimize performance and accuracy, adjusting settings such as exposure, focus, and sensitivity as needed.

6. **Pilot Deployment:**
   - Deploy the AI-based image processing system on the selected college bus for a pilot test.
   - Monitor the system's performance in real-time during regular bus operations, collecting data and feedback from drivers and passengers.
   - Evaluate the system's effectiveness in detecting and responding to safety and security incidents, such as unauthorized access or unusual behavior.

7. **User Training:**
   - Provide training to the bus driver on how to operate and interact with the AI-based image processing system effectively.
   - Educate the driver on how to interpret alerts and notifications generated by the system and respond appropriately to any detected incidents.

8. **Feedback Collection and Refinement:**
   - Gather feedback from the bus driver and passengers regarding their experience with the AI-based image processing system.
   - Identify any usability issues, operational challenges, or areas for improvement based on user feedback.
   - Refine the system's algorithms and parameters as needed to enhance performance, accuracy, and user experience.

9. **Full-Scale Deployment:**
   - Roll out the AI-based image processing system to additional college buses once the pilot test confirms its effectiveness and reliability.
   - Ensure proper installation, configuration, and calibration of hardware and software components on each bus.
   - Provide ongoing support and maintenance to ensure the system's continued functionality and effectiveness in enhancing safety and security.

CONCLUSION

The AI-Based Image Processing System for College Buses represents a significant leap forward in the realm of student transportation safety and efficiency. By leveraging advanced technologies such as facial recognition and pass validation, the system ensures secure and seamless student entry verification. Real-time notifications, accurate data logging, and a modular design contribute to an enhanced overall experience for both students and administrators. The successful implementation of this system in college bus transportation addresses immediate safety concerns and establishes a foundation for future advancements. The systematic workflows, integration of machine learning models, and effective hardware components collectively create a robust solution that significantly improves the security and efficiency of the transportation process.

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REFERNCE

[1] P. Chaiprapa, S. Kiattisin, and A. Leelasantitham, "A Real- Time GPS Vehicle Tracking System Displayed on a Google-Map- Based Website," University of the Thai Chamber of Commerce Journal, 2011.

[2] . P. Zhou, Y. Zheng, and M. Li, "How Long to Wait? Predicting Bus Arrival Time with Mobile Phone Based Participatory Sensing, "Transactions S. A. E. Yosif, M. M. Abdelwahab, M. A. E. ALagab, and F. Muhammad, "Design of Bus Tracking and Fuel Monitoring System,"In Proc. of International Conference on Communication, Control,Computing and Electronics Engineering (ICCCCEE), IEEE,Khartoum, Sudan, 16-18 January 2017.

[3] Kumbhar, Meghana Survase, Pratibha Mastud, Avdhut Salunke, "Real Time Web Based Bus Tracking System," International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 02, Feb2016.

[4] Sharmin Akter, Thouhedul Islam, Rashidah F. Olanrewaju, Ajayi Adeniyi, "A Cloud- Based Bus Tracking System based on Internet of Things Technology," 7th International Conference on Mechatronics, 2019.

[5] Priyanka V. Narkhede, Radhika V. Mahalle, Priya A. Lokhande, Reetu M. Mundane, Dhiraj M. Londe, "Bus Tracking System based on Location-Aware Services," International Journal of Emerging Technologies in Engineering Research, Volume 6, Issue 3, March 2018.

[6] Shettar IM. Quick response (QR) codes in libraries: case study on the use of QR codes in the central library, NITK. Proc. TIFR-BOSLA National Conference on Future Librarianship. Mumbai: Imperial Publications; 2016. p. 129–34.Search in Google Scholar

[7] Karrach L, Pivarčiová E, Božek P. Identification of QR code perspective distortion based on edge directions and edge projections analysis. J Imaging. 2020;6(7):67.10.3390

[8] Sharma A, Ansari MD, Kumar R. A comparative study of edge detectors in digital image processing. 2017 4th International Conference on Signal Processing, Computing and Control (ISPCC). Solan, India: IEEE; 2017 Sept. p. 246–50.10.1109/ISPCC.2017.

[9] Rathee G, Sharma A, Kumar R, Ahmad F, Iqbal R. A trust management scheme to secure mobile information centric networks. Comput Commun. 2020;151:66–75.10.1016/j.comcom.2019.12.

[10] Sharma A, Kumar R. Computation of the reliable and quickest data path for healthcare services by using service-level agreements and energy constraints. Arab J Sci Eng. 2019;44(11):9087–104.10.1007/s13369-019-03836-

[11] Bithas PS, Michailidis ET, Nomikos N, Vouyioukas D, Kanatas AG. A survey on machine-learning techniques for UAV-based communications. Sensors. 2019;19(23):5170.10.3390/

[12] Xu T, Zhang H, Liu G, Zhao H, Zhang E, Zhang C. Two-dimensional code recognition algorithm based on neural network. Comput Sci Appl. 2018;8(10):1552–7.

[13] Gan Z, Fang J, Guan H, Tang J, Chen Z. Research and application of binarization algorithm of qr code image under complex illumination. J Appl Opt. 2018;39(5):667–73

[14] Jiang S, Wu W. inventors; Fujian Landi Commercial Equipment Co Ltd, assignee. Method and system for decoding two-dimensional code using weighted average gray-sclae algorithm.United States patent US 10,108,835; 2018.

[15] Vera E, Lucio D, Fernandes LAF, Velho L. Hough transform for real-time plane detection in depth images. Pattern Recognit Lett. 2018;103(FEB.1):8–15.10.1016/j.patrec.2017.12.

[16] Karrach L, Pivarčiová E, Božek P. Identification of QR code perspective distortion based on edge directions and edge projections analysis. J Imag. 2020;6(7):67.10.3390/jimaging607006

[17] Li S, Shang J, Duan Z, Huang J. Fast detection method of quick response code based on run-length coding. IET Image Process. 2017;12(4):546–51.10.1049/iet-ipr.2017.