AUTOMATED AUTOMOBILE SURVEILLANCE SYSTEM (AASS)

Capstone Project Proposal

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TABLE OF CONTENTS

Mentor Consent Form

I hereby agree to be the mentor of the following Capstone Project Team

Project Title: Automated Automobile Surveillance System		
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Project Overview

The Automated Automobile Surveillance System (AASS) represents a pioneering approach to campus security and administration, revolutionizing how universities manage vehicle access and safety measures. By incorporating cutting-edge technologies such as speed monitoring, vehicle tracking, real-time tracking, boom barriers, and mobile-friendly apps for guards, the system ensures the seamless flow of authorized vehicles and personnel within campus premises while enforcing safety protocols.

AASS is distinguished by its ability to integrate with existing camera networks, eliminating the need for specific ANPR cameras and significantly reducing initial investment costs. The system features a centralized database that meticulously records vehicle entries and exits, complemented by a user-friendly website for managing vehicle registrations and monitoring activities. The user-friendly web interface of AASS includes an ANPR system that automatically scans and recognizes vehicle number plates. This allows guards to promptly identify unauthorized vehicles and enforce safety measures by accurately capturing vehicle speeds, issuing fines, and responding to suspicious behavior.

The implementation of AASS offers a comprehensive solution to elevate campus security, leveraging advanced technology for enhanced monitoring and enforcement. It optimizes traffic flow through intelligent vehicle identification and improves parking efficiency with real-time data and designated parking zones. By enhancing safety and efficiency for students, professors, and visitors alike, AASS aims to create a more favorable and secure campus environment.

Problem Statement

The purpose of college campuses is to provide a secure environment for all individuals, faculty, students, and visitors. Nevertheless, ensuring security on academic campuses is a multifaceted undertaking, particularly in light of the wide array of daily activities and interactions. These limitations give rise to inefficiencies, security vulnerabilities, and delays in the response to security incidents. The absence of integration with contemporary technologies and real-time monitoring functionalities further impedes the efficacy of safety measure enforcement.

In order to optimize security measures and operational processes, academic institutions necessitate a comprehensive solution that incorporates state-of-the-art technologies, including Automated Number Plate Recognition (ANPR), real-time monitoring, and mobile-friendly applications. To reduce expenses, this solution should incorporate a centralized database for vehicle management and integrate the cutting-edge technology with existing camera networks. Implementing this system would facilitate the expeditious detection of unauthorized vehicles, the enforcement of safety protocols, and the timely resolution of security breaches; in essence, it would guarantee a more secure setting for visitors, students, and faculty.

Need Analysis

College campuses are vibrant hubs of activity, hosting thousands of students, faculty, and visitors daily. Ensuring the safety and security of everyone on campus is paramount, requiring robust surveillance systems. However, current systems often fall short, lacking integration with modern technologies and real-time tracking capabilities.

1. **Security Concerns:** Campuses are susceptible to various security threats, including unauthorized access, theft, vandalism, and even violent incidents. Ensuring the safety and security of everyone on campus is paramount, requiring robust surveillance and monitoring systems.
2. **Population and Traffic:** College campuses often host a large number of students, faculty, and visitors daily. For instance, a medium-sized college may have thousands of students and faculty members, along with numerous daily visitors for events, meetings, and other activities. This high volume of people coming and going creates a need for efficient management of vehicle access and movement within the campus.
3. **Incident Response Time:** In the event of a security incident or emergency, such as a medical emergency, fire, or criminal activity, quick response time is critical. A surveillance system that enables real-time monitoring and alerts can significantly improve response times and help mitigate potential risks.
4. **Resource Optimization:** Manual monitoring and management of campus security can be labor-intensive and inefficient. An automated surveillance system can help optimize resources by reducing the need for constant human monitoring and enabling proactive security measures.
5. **Cost-Effectiveness:** ANPR cameras, which are essential for vehicle tracking and identification, can be costly to install and maintain. Integrating ANPR technology with existing cameras can be a cost-effective solution compared to installing standalone ANPR cameras, making it a more feasible option for campuses with budget constraints

Literature Survey

- The system introduced in [1] utilizes YOLO v4, a CNN architecture, for object detection, and SORT with deep correlation metric for vehicle tracking. This integration enables real-time vehicle tracking and speed estimation with high accuracy and computational efficiency.
- The paper [3] proposes a system that automatically estimates vehicle speed from video sequences taken from a single calibrated camera using optical flow technique-Lucas Kanade using Pyramidal implementation.
- The CNN method proposed in [4] efficiently counts vehicles passing through specific locations in surveillance videos by identifying and categorizing them, including motorcycles, cars, buses, and trucks
- In a survey in [5], traditional methods like Gaussian mixed models(GMM) struggle with factors such as lighting changes and cluttered backgrounds, while deep learning techniques, particularly CNNs, offer superior performance in vehicle detection tasks. Deep neural networks like Faster R-CNN and YOLO are emphasized for their effectiveness in this regard.
- Automobile surveillance systems or vehicle identification systems usually follow three basic steps: localization of the license plate region, segmentation of license plate characters, and recognition of each individual character. This summarises various papers using these three steps:
- **License Plate Localization:** Various techniques have been explored for the localization of license plate regions in automobile surveillance systems. A novel adaptive image segmentation technique, combined with connected component analysis, was proposed [6], aiming to accurately isolate license plate areas. Another approach involved comparing RGB color processing with a predefined range after applying Homography to mitigate distortion effects [7]. Additionally, studies focused on refining smearing and edge detection algorithms to enhance license plate localization [8], alongside the application of morphological operations such as dilation and erosion [9,19]. Furthermore, techniques involving x-axis and y-axis projection were employed for effective localization [11]. Histogram analysis for differentiating varying license plate colors and subsequent segmentation based on the character's color contrast were explored as well [12].

Furthermore, methods like the Canny edge detection technique, coupled with Extended Hough transform, were utilized to refine the localization process [13].

- **Character Segmentation:** Following license plate localization, character segmentation is crucial for extracting individual characters accurately. Techniques such as SCWs segmentation combined with bounding box methods were utilized for this purpose [6]. Moreover, projection algorithms were implemented to further refine character segmentation [7,12]. Researchers also delved into refining smearing algorithms and employing morphological operations to improve character segmentation [8-9]. Innovative approaches like the Gibou-Fedkiw algorithm proposed by Sunhee Kim were explored as well [10], alongside techniques involving projection algorithms using the Hough Transform [11]. Additionally, novel methods like discrete wave transform using multi-resolution analysis concepts were proposed to enhance character segmentation accuracy [13].

- **Character Recognition:** The recognition of segmented characters is vital for the complete identification of license plate information. Probabilistic Neural Networks, consisting of Input, Hidden, and Output layers, were employed for character recognition, achieving recognition rates exceeding 90% [6]. Optical Character Recognition (OCR) techniques using correlation methods demonstrated impressive performance ratios, reaching 92.57% accuracy [7,10]. Furthermore, statistical-based template matching methods were explored for recognizing known images, while cross-correlation techniques were utilized for matching correlation coefficients with unknown images [8]. Notably, the implementation of two Back Propagation Neural Networks resulted in a remarkable recognition rate of 96.84% for license plate data [12]. These approaches collectively contribute to the robustness and efficiency of character recognition systems in vehicle identification frameworks.

Speed Estimation:

- In [14], a speed estimation method using the YOLO algorithm for vehicle detection and tracking, and a recurrent neural network (RNN) for speed estimation was proposed, which

achieved an average error of 4.08 km/h using only the area of bounding box as input feature.

- In [15] the authors present a novel computer vision algorithm for vehicle speed estimation, which is based on the sampling method and skipping method, which are compared with the reference speed data from the IR sensor group, the mean square error was calculated, and the analysis of the accuracy of these methods was carried out for various moving speeds.

Conclusion

Conducting a comprehensive literature survey on various methodologies for vehicle tracking, speed estimation, and license plate recognition reveals significant advancements and a plethora of techniques employed by researchers to address these challenges. However, despite the notable progress in the field, several gaps and opportunities for further research emerge from the reviewed literature:

1. Integration of Techniques: Various methods for vehicle tracking, speed estimation, and license plate recognition have been identified. However, there is a need to integrate these techniques into a unified system for a comprehensive solution. Further exploration is required to develop an integrated framework that seamlessly combines these functionalities to provide a holistic approach to vehicle monitoring and identification within our project.

2. Real-world Deployment: While many existing systems show promising results in controlled environments, their real-world applicability needs further exploration. Validation of these techniques in diverse settings with varying environmental conditions is necessary to assess their robustness and reliability in practical scenarios within our project.

3. Robustness to Environmental Factors: Environmental conditions such as adverse weather or varying illumination can impact system performance. Enhancement of the robustness of algorithms to such factors through data augmentation or incorporation of multimodal sensor inputs is essential within our project.

Novelty

- **Integration of ANPR and Existing Infrastructure:** This project proposes the integration of Automated Number Plate Recognition (ANPR) with potentially existing access control systems, such as gates or barriers. This avoids the need for complete infrastructure overhauls and leverages existing systems for smoother implementation.
- **Real-time Mobile App for Security Personnel:** The project incorporates a mobile-friendly web application for security personnel, which is often absent in existing solutions. This app provides real-time access to vehicle information and violation notifications, enhancing their response capabilities and situational awareness.
- **Focus on Over-speeding Detection and Reporting:** This project prioritizes the detection and reporting of over-speeding within the campus, promoting safer driving practices and contributing to a more secure environment compared to solutions focused solely on access control.
- **Cost-Effectiveness through Potential Hybrid Approach:** By potentially utilizing existing infrastructure where feasible, the project aims to offer a cost-effective solution compared to completely new system implementations.
- **Adaptability to Diverse Use Cases:** The proposed system is designed to be adaptable to various campus layouts and traffic patterns, allowing for customization and broader application compared to solutions tailored to specific scenarios.

Objectives

- Design and deploy an automated logging mechanism for tracking vehicle entry and exit activities within the campus premises, facilitating seamless monitoring and record-keeping.
- Establish a centralized database of authorized vehicles, enabling easy access and efficient management of campus traffic while facilitating timely identification of unauthorized vehicles.
- Implement real-time monitoring capabilities to track vehicle movement within the campus, empowering security personnel to promptly respond to any suspicious activities or security threats.
- Create a user-friendly mobile web application for security guards, providing them with convenient access to vehicle information retrieved through Automatic Number Plate Recognition (ANPR) technology, enhancing their efficiency in monitoring and managing campus traffic.

Methodology

Backend:

Vehicle Identification:

- Implement Adaptive Image Segmentation: Employ adaptive image segmentation techniques to accurately extract license plate regions from captured images, enhancing robustness against varying lighting and background conditions.
- Utilize Homography Comparison: Compare RGB color processing techniques with predefined ranges after applying Homography for distortion removal, ensuring accurate license plate localization and extraction.
- Apply Smearing and Edge Detection Algorithms: Implement smearing and edge detection algorithms to precisely locate license plates amidst complex backgrounds and partial occlusions, enhancing recognition accuracy.
- Incorporate Morphological Operations: Utilize morphological operations like dilation and erosion to refine license plate region extraction, ensuring completeness and accuracy.
- Enhance with Histogram Analysis: Employ histogram analysis techniques to identify varying license plate colors adaptively, optimizing image processing parameters for improved recognition under different environmental conditions.
- Combine with Canny Edge Detection and Extended Hough Transform: Apply Canny edge detection along with Extended Hough transform for robust and accurate license plate localization, especially in scenarios with low contrast or noisy backgrounds.

Database Management:

Utilize NoSQL Database: Implement a NoSQL database to efficiently store data related to authorized vehicles, including license plate numbers, vehicle owner information, and authorization status. Utilize security measures such as hashing and salting to protect sensitive information.

Real-time Monitoring:

- **Integrate ANPR Technology with Existing Campus Cameras:** Integrate ANPR technology with existing campus surveillance cameras to continuously monitor vehicle movement within the campus.
- **Log Entry and Exit Events:** Automatically log entry and exit events in real-time, enabling security personnel to track vehicle movements and respond promptly to any suspicious activities.

Violation Detection:

Develop Speed Detection Algorithms: Implement algorithms to detect violations such as over-speeding within the campus by analyzing vehicle speed data collected by surveillance cameras. Compare vehicle speeds against predefined speed limits and notify security personnel of any violations for immediate intervention.

Frontend:

User Interface:

Develop with React.js: Utilize React.js to develop a user-friendly frontend interface for security personnel, providing easy access to real-time data on vehicle movements, authorization status, and detected violations.

Communication:

Integrate with Existing Camera Systems: Modify the communication module to integrate with the existing camera systems on campus. utilize protocols or APIs provided by the existing camera systems to access and retrieve video feeds for monitoring and analysis.

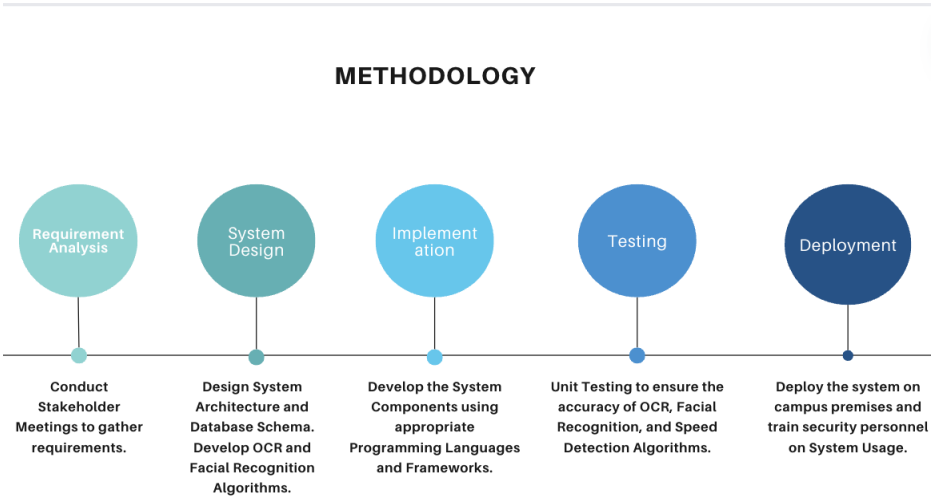

Fig 1.1 Methodology

Work Plan

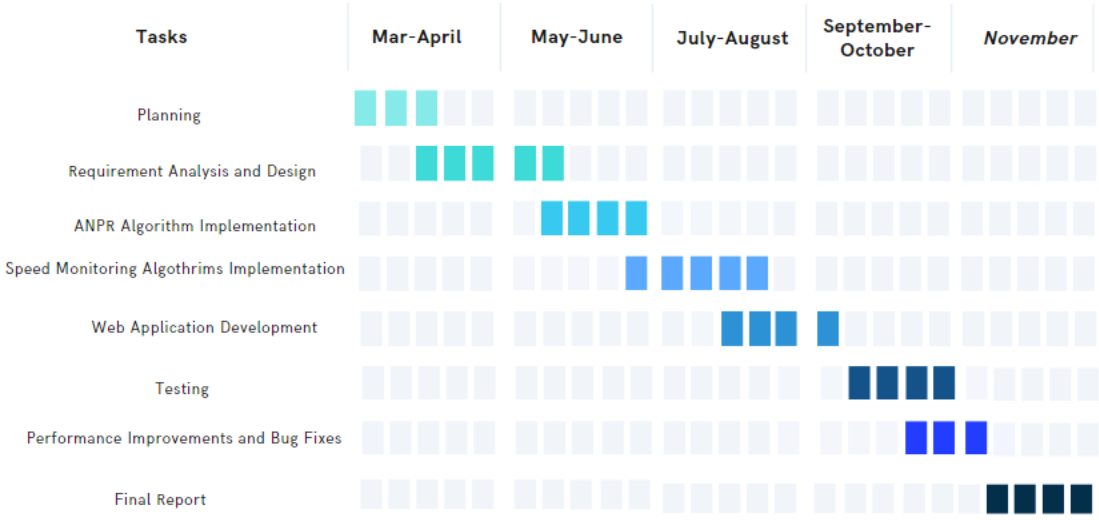

Fig 1.2 Work Plan

Project Outcomes

- Eliminates physical stickers for vehicle identification.
- Automatically logs vehicle entries and exits.
- Creates a database of authorized vehicles for efficient traffic monitoring and unauthorized vehicle detection.
- Provides real-time monitoring of vehicle movement for faster security response.
- Detects and reports speeding violations, promoting safer driving.
- Notifies guards of violations.
- Offers a mobile-friendly web app for guards to access vehicle information.

Individual Roles

Cheshta Biala: Data modelling, UI Design, Speed Monitoring Algorithm Development
Khushi Agarwal: Database Design, Speed Monitoring Algorithm Development, Backend Development
Chirag Mohan Gupta: Full Stack Development, Reporting and Analytics API, Integration Testing
Aditya Singh: Data modelling, ANPR Algorithm Development, Vehicle Tracking Algorithm Development
Samarjeet Singh: Frontend Development, ANPR Algorithm Development, Vehicle Tracking Algorithm Development

Course Subjects

- Object Oriented Programming
- Database management Systems
- Machine Learning
- Data Science Applications: NLP, Computer Vision And IOT
- Software Engineering

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