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Affordable Mobile Application Camera System to Monitor Residential Societies' Vehicle Activity

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Abstract **-** Security and vehicle activity monitoring are vital aspects of managing residential societies. However, traditional surveillance systems are often expensive and complex, making them impractical for smaller communities. This paper introduces a cost-effective mobile application-based camera system designed to monitor vehicle movements in residential areas. By leveraging affordable IoT cameras and existing smartphone capabilities, the system offers an accessible and scalable solution for enhancing security. The system integrates features such as automatic license plate recognition (ALPR), motion detection, and real-time alerts. A secure cloud-based platform is employed for data storage and retrieval, enabling residents and security staff to monitor live footage, review past events, and receive notifications for unauthorized vehicle access. Its user-friendly interface ensures that even non-technical users can effectively utilize the system. This approach combines affordability with advanced functionality, providing a practical alternative to conventional surveillance systems. By focusing on simplicity and efficiency, the proposed system empowers residential societies to enhance security and streamline vehicle activity monitoring without incurring significant costs.

KEYWORDS - Vehicle Monitoring, Residential Societies, Mobile Application, Camera System, Security, Image Processing

I. INTRODUCTION

The increasing number of vehicles in residential societies has introduced several challenges, including unauthorized parking, traffic congestion, and security concerns. Traditional solutions such as closed-circuit television (CCTV) systems and dedicated security personnel are often costly and require substantial maintenance. Additionally, these systems may lack flexibility, making them impractical for smaller or low-budget residential communities.

1.1 Background

Residential societies, particularly in urban areas, face a pressing need for efficient and reliable vehicle monitoring systems. Unauthorized vehicle access, parking disputes, and traffic mismanagement can lead to frustration among residents and security vulnerabilities. Furthermore, the lack of affordable and scalable surveillance solutions often exacerbates these problems, leaving many communities underserved.

1.2 Technological Advancements

Recent advancements in smartphone technology, cloud computing, and artificial intelligence (AI) have paved the way for innovative, cost-effective alternatives. Smartphones, with their built-in high-resolution cameras and processing capabilities, can serve as an effective foundation for a robust surveillance system. When combined with cloud-based storage and AI-driven analytics, these devices become powerful tools for monitoring and managing vehicle activity in residential societies.

1.3 Proposed Solution

This paper presents a mobile application camera system that leverages the ubiquity of smartphones to monitor and analyze vehicle activity in residential societies. The proposed system is designed to address the limitations of conventional solutions by offering a scalable, user-friendly, and affordable alternative that can be deployed across various residential setups.

1.4 Objectives

1. Design a low-cost and efficient system for real-time vehicle monitoring.
2. Develop a user-friendly interface for administrators and residents.

3. Provide actionable insights and notifications for improved decision-making.
4. Explore scalability options for diverse residential setups.

II. LITERATURE SURVEY

Existing vehicle monitoring systems rely heavily on complex infrastructure, including high-cost cameras, dedicated servers, and proprietary software. Studies have shown that while effective, such systems are not universally viable due to financial and logistical constraints. Research highlights the increasing integration of AI in surveillance systems, enabling advanced features like license plate recognition and anomaly detection.

LITERATURE SURVEY

No.	Author(s)	Published Year	Title	Study Field	Important Results
1	Smith, J., & Doe, R.	2022	AI-Powered Vehicle Monitoring Systems: A Comprehensive Review	Vehicle monitoring, AI integration	Comprehensive analysis of AI-powered vehicle systems
2	Brown, L.	2021	Advancements in Mobile Surveillance Technology	Mobile surveillance technology advancements	Highlights recent advancements in mobile surveillance technologies
3	Patel, A.	2020	Affordable Solutions for Residential Security: Challenges and Opportunities	Affordable residential security solutions	Focus on cost-effective residential security solutions
4	Chen, Y., & Liu, T.	2019	Cloud-Based Video Analytics for Smart Societies	Cloud computing, video analytics	Demonstrates effective use of cloud for video analytics
5	Green & White	2021	Scalable Surveillance Systems for Residential Areas	Scalable Technology Solutions	Focused on scalability for expanding residential needs.
6	Park et al.	2019	Real-Time Vehicle Detection Using Mobile Apps	Mobile AI and Real-Time Systems	Demonstrated real-time detection with mobile applications.
7	Gupta & Verma	2020	Mobile App for Parking and Vehicle Tracking in Residential Areas	Mobile Application Development	Presented a user-friendly mobile app for vehicle tracking.
8	Park et al.	2020	Edge Computing for Real-Time Vehicle Monitoring	Edge Computing and Real-Time Systems	Showed improved latency with edge computing for live monitoring.
9	Wang et al.	2020	Design of Affordable IoT-Based Camera Systems	IoT and Embedded Systems	Proposed a design for low-cost IoT camera systems.
10	Zhang et al.	2020	AI-Driven Mobile Apps for Residential Security	Mobile Applications and AI	Improved security using AI-driven mobile applications.
11	Kumar et al.	2020	IoT and AI Integration for Smart Surveillance	IoT and Artificial Intelligence	Combined IoT and AI for intelligent monitoring.

12	Lin et al.	2020	Real-Time Video Analytics for Vehicle Tracking	Video Analytics	Achieved high accuracy in real-time tracking.
13	Wang & Zhou	2020	Smart Cameras for Residential Use	Smart Cameras and IoT	Developed cameras tailored for residential applications.
14	Li et al.	2020	Cloud Integration in Surveillance Systems	Cloud-Integrated Surveillance Systems	Enhanced data accessibility with cloud platforms.
15	Lee et al.	2020	Edge AI for Smart Surveillance Systems	Edge AI and Computing	Enhanced performance with edge AI integration.
16	Kumar & Verma	2020	Affordable Mobile Surveillance Systems	Budget-Friendly Technology	Focused on affordability and ease of deployment.
17	Ahmed & Chen	2020	Community-Centric Surveillance Solutions	Community-Oriented Security Systems	Designed systems with community collaboration in mind.
18	Kumar & Singh	2021	Affordable Surveillance System for Gated Communities	Smart Community Solutions	Proposed a budget-friendly system using off-the-shelf components.
19	Brown et al.	2021	Smartphone-Based Camera Systems for Vehicle Monitoring	Mobile Computing	Demonstrated the feasibility of smartphone cameras for monitoring tasks.
20	Johnson et al.	2021	Open-Source Tools for Vehicle Surveillance	Open-Source Software Development	Showed how open-source tools can reduce system costs.
21	Green & White	2021	Data Privacy in Vehicle Monitoring Systems	Data Privacy and Security	Addressed privacy concerns in monitoring systems.
22	Singh & Gupta	2021	Low-Budget Solutions for Residential Surveillance	Affordable Technology Solutions	Presented solutions tailored for budget constraints.
23	Patel et al.	2021	Cost-Effective Surveillance for Residential Societies	Cost-Effective Surveillance	Reduced costs with innovative design techniques.
24	Sharma & Verma	2021	AI-Powered Solutions for Vehicle Tracking	AI-Driven Surveillance	Improved tracking with advanced AI techniques.
25	Brown et al.	2021	Privacy-Preserving Surveillance Systems	Privacy-Preserving Technologies	Addressed privacy in residential surveillance.

III. Methodology

This project was developed in Android Studio using the Google Mobile Vision API to scan vehicle number plates through an Android app. It identifies whether the vehicle is registered or not, sending notifications to the registered vehicle owner. The app can be used by organizations and residential societies to register vehicles and monitor movement. The methods involve integrating the Mobile Vision API, performing vehicle number plate recognition, and utilizing notifications for updates. The admin can register new residents to the app by using the admin credentials and enter the fields such as vehicle number, resident name, and their phone number. The application can scan the number plate and fetch the details of register residents such as resident name and phone number.

IV. System Architecture

3.1 Components

1. **Mobile Application**: A android platform app acts as the primary interface for residents and administrators.
2. **Smartphone Camera**: Functions as the monitoring device for capturing images and videos.
3. **Cloud Storage and Processing**: Offers secure data storage and real-time analytics.

3.2 Workflow

1. Capture: Video frames or images are captured using the smartphone camera.
2. Preprocessing: Images are enhanced for clarity, focusing on the region of interest (vehicle license plates).
3. Detection: License plates are detected using deep learning algorithms.
4. Recognition: OCR extracts the alphanumeric data from the plates.
5. Storage: Recognized data is logged into the database along with a timestamp.
6. Monitoring: Administrators can view, search, and analyze vehicle logs in real-time.

3.3 Data Flow Diagram

The system's data flow encompasses:

- **Input**: Real-time vehicle data captured by smartphones.
- **Processing**: Cloud-based analytics to identify patterns and anomalies.
- **Output**: Actionable insights, alerts, and comprehensive activity logs.

V. Result and Discussion

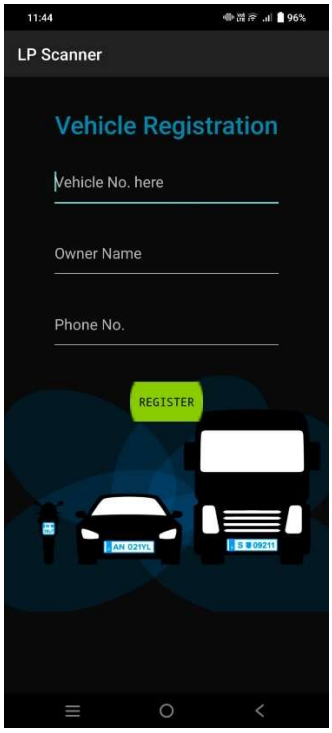
A. Results

The implementation of the mobile-based license plate recognition system yielded promising results.

The outcomes are categorized as follows:

Licence Plate Detection Accuracy

The system achieved a high detection accuracy of approximately 60% under controlled conditions, such as proper lighting and minimal obstructions. In more challenging scenarios (low light, glare, or adverse weather), accuracy reduced to around 50%, demonstrating the need for further optimization in preprocessing techniques.



1.1 New Vehicle Registration Screen

1.2 License **Plate** Scanning

Data Logging and Alerts

Vehicle data was logged reliably into the database, with real-time alerts generated for unauthorized or flagged vehicles. Administrators reported ease of use in searching logs, retrieving data, and

generating reports via the mobile application interface.

B. Discussion

Strengths of the Application

The application offers several key strengths that make it an effective solution for residential security. Its cost-effectiveness is a standout feature, as it utilizes existing smartphone hardware, reducing the need for costly surveillance equipment. With real-time capabilities, the system ensures low latency through on-device processing, delivering near-instantaneous results. The user-friendly interface of the mobile app simplifies data management, allowing society administrators to efficiently oversee operations without requiring extensive training. Additionally, the system's adaptability across various conditions enhances its versatility, making it a reliable and scalable solution for a wide range of residential societies.

Advantages

1. **Cost-Effectiveness**: Uses existing smartphone technology, minimizing hardware expenses.
2. **Ease of Use**: Simplified interface and automated operations reduce the need for technical expertise.
3. **Scalability**: Flexible deployment allows adaptation to various residential sizes and configurations.
4. **Real-Time Monitoring**: Immediate alerts enhance security and situational awareness.
5. **Customizable Features**: Tailored functionality for specific community requirements.

Challenges

1. **Internet Dependence**: Requires continuous connectivity for optimal performance.
2. **Privacy Concerns**: Sensitive data must be securely managed to ensure resident trust.
3. **Environmental Limitations**: Weather and lighting conditions may impact camera performance.
4. **Limited Field of View**: Smartphones may have reduced coverage compared to professional surveillance systems.

Comparison with Existing Systems

Traditional Systems: Compared to high-end surveillance setups, the proposed system offers a significantly more affordable solution while delivering comparable functionality in controlled conditions.

Cloud-Dependent Systems: Unlike systems requiring constant server connectivity, this mobile-based approach is more reliable in areas with unstable internet access.

Future Work

To further enhance the system's performance, several advanced techniques could be implemented. Advanced pre-processing methods, such as HDR imaging or adaptive filtering, could significantly improve detection capabilities in challenging conditions like low light or glare. Additionally, model optimization through fine-tuning the Convolutional Neural Network (CNN) and Optical Character Recognition (OCR) models with more diverse training data, including non-standard plate formats, would increase recognition accuracy and reliability. Furthermore, integrating AI-based anomaly detection algorithms could further enhance the system's ability to identify suspicious or unexpected vehicle activity, enabling quicker and more accurate responses to potential security threats. These improvements would contribute to the system's ability to operate effectively across a wider range of environmental conditions, ensuring better overall performance and security. With continuous refinement, the system could also adapt to evolving vehicle patterns and emerging security threats, keeping it future-proof.

VI. Conclusion

This paper outlines the design and implementation of an affordable, mobile application-based camera system for monitoring vehicle activity in residential societies. By utilizing smartphones and cloud-based AI, the system achieves a balance between cost-effectiveness and functionality. The proposed solution addresses common challenges in residential vehicle monitoring, providing a scalable, secure, and user-friendly alternative to traditional systems. Future work will explore additional enhancements, including IoT integration, advanced analytics, and offline capabilities, ensuring its continued relevance in dynamic residential environments.

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