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BLURSHIELD

A Real-Time Vehicle Tracking and Anonymization System for Privacy-First Surveillance

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Abstract: In today's privacy-sensitive urban and security environments, surveillance systems must balance monitoring effectiveness with data protection. Blurshield is a privacy-preserving vehicle tracking system built using YOLOv8 for real-time object detection and integrated with a web-based interface and Flask API backend. This system dynamically blurs detected vehicles in video feeds, ensuring privacy while maintaining surveillance effectiveness. With high detection accuracy, intuitive user controls, and scalable architecture, Blurshield addresses the growing demand for ethical, real-time surveillance solutions.

Index Terms - YOLOv8, Vehicle Tracking, Real-time Object Detection, Privacy-Preserving Surveillance, Flask API.

I. INTRODUCTION

Privacy is increasingly a critical consideration in modern video surveillance systems. As urban areas become more monitored and security threats evolve, it is essential to protect sensitive data while maintaining effective surveillance capabilities. Blurshield addresses this dual challenge by integrating state-of-the-art object detection technology (YOLOv8) with a web-based interface to deliver a real-time, privacy-preserving vehicle tracking system.

II. METHODOLOGY

2.1 YOLOv8 for Detection

YOLOv8 is utilized for real-time object detection due to its superior speed and accuracy. It enables efficient detection of multiple vehicles in diverse environments, including varying lighting and weather conditions.

2.2 Flask API for Processing

The backend is powered by Flask, which processes incoming video frames, executes the detection model, applies Gaussian blurring, and returns anonymized outputs.

2.3 Web-Based Interface

The web interface provides an intuitive and interactive frontend. Metadata is securely stored, and the system ensures smooth user interaction and control.

III. SYSTEM ARCHITECTURE AND DESIGN

Blurshield's architecture combines edge computing readiness and cloud compatibility. It supports single and multi-camera setups and incorporates role-based access control to manage sensitive data. GPU acceleration ensures low-latency performance even under high data loads.

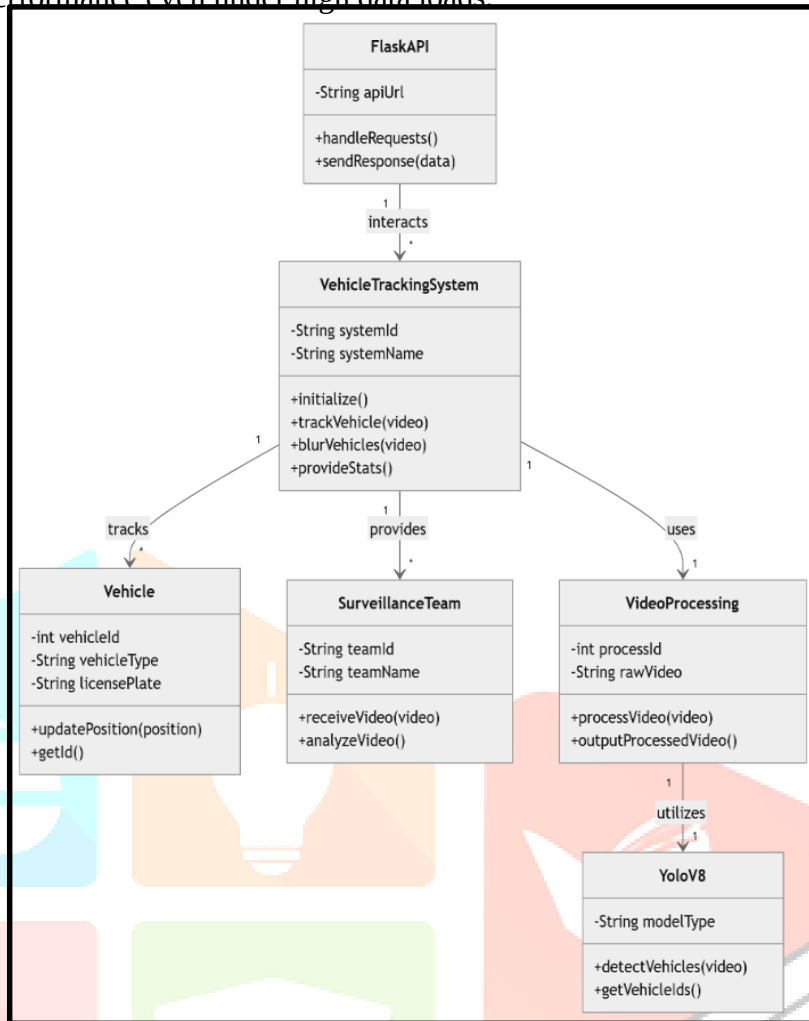


Figure 1 system diagram

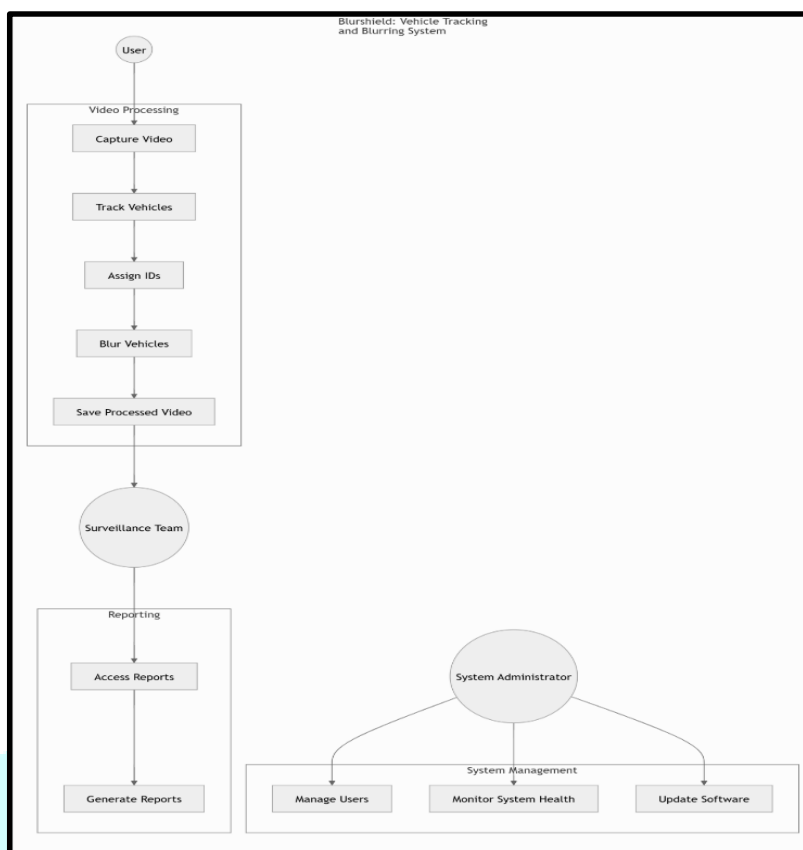


Figure 2 workflow diagram

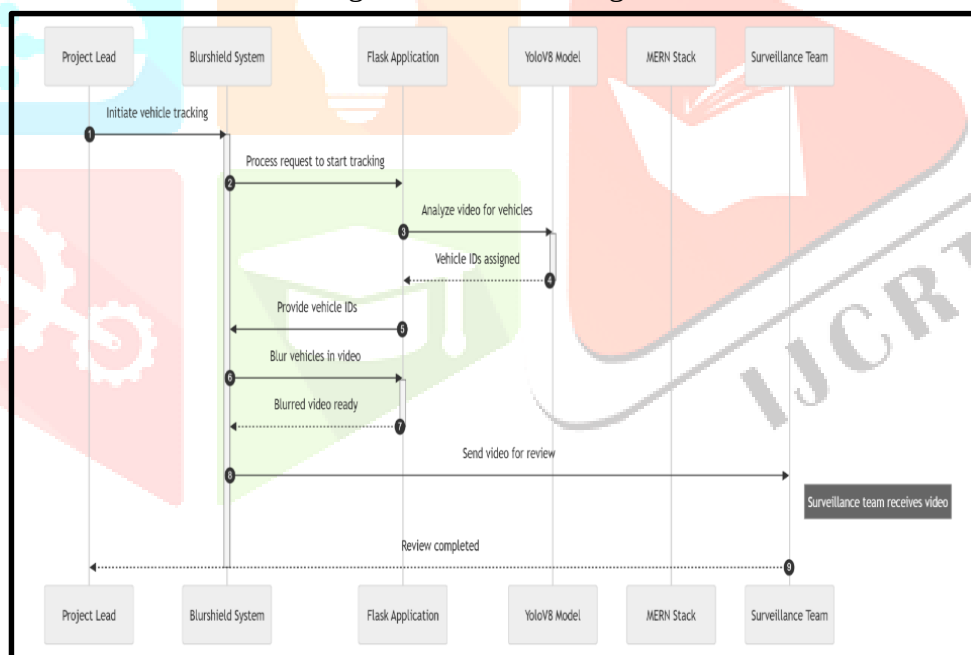


Figure 3 sequential working diagram

IV. RESULTS AND DISCUSSION

Performance testing demonstrated high accuracy in vehicle detection and minimal latency during real-time operation. Video feeds from urban highways and military convoy simulations validated the system's ability to anonymize data without degrading surveillance quality. The user interface enabled secure access and control, proving Blurshield's effectiveness in practical deployment scenarios.



Figure 4 highway video feed

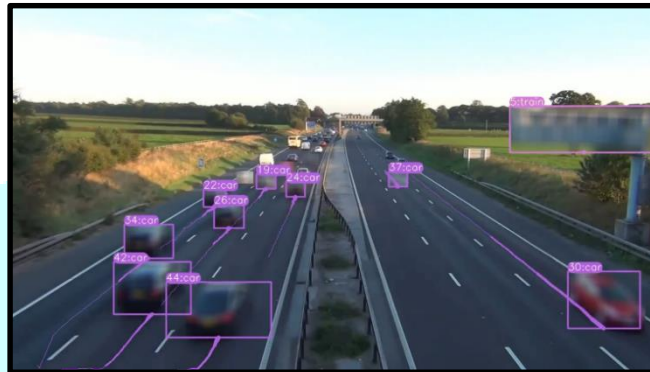


Figure 5 highway video using blurshield



Figure 6 army convoy video feed



Figure 7 army convoy using blurshield

V. LIMITATIONS

- Dependence on GPU for performance.
- Latency in high-traffic scenes.
- Complex integration with legacy surveillance systems.
- Potential privacy risks from deblurring advancements.

VI. IMPACT OVERVIEW AND FUTURE WORK

6.1 Scalability and Interoperability

Blurshield's architecture is designed to scale with varying surveillance needs, from single-camera installations to multi-camera deployments in large urban areas. It seamlessly integrates with existing video surveillance systems, offering compatibility across different setups. This interoperability allows Blurshield to function within diverse environments and ensures that the system can grow alongside evolving security requirements.

6.2 Traffic and Law Enforcement Applications

Blurshield's vehicle detection and anonymization capabilities make it highly suitable for law enforcement and traffic monitoring applications. In urban areas, traffic authorities can use Blurshield to monitor vehicle flow and detect patterns without compromising individual privacy. Law enforcement can utilize Blurshield in sensitive scenarios, such as monitoring high-risk areas or tracking vehicles of interest, while ensuring that innocent individuals' data remains anonymized. By providing real-time insights into vehicle movement, Blurshield supports proactive traffic management, helps reduce congestion, and assists in responding to incidents more effectively.

6.3 Real-Time Incident Detection and Alert System

Adding real-time incident detection capabilities could allow Blurshield to identify unusual vehicle behavior, such as erratic driving or illegal parking. An alert system could notify relevant authorities of potential security risks or traffic incidents, enabling rapid response. Integrating real-time alerts with Blurshield's anonymization process would allow authorities to respond effectively without compromising individual privacy, further enhancing the system's value in high-security areas.

6.4 Expanded Platform Accessibility via Mobile and Web Applications

Developing a mobile application for Blurshield would enable users to access and monitor video feeds conveniently from smartphones, enhancing flexibility for operators on the move. A mobile interface could provide alerts, anonymized feeds, and system controls, empowering users to manage surveillance tasks from any location. This expanded accessibility would be particularly useful for security personnel who need real-time data access in the field. By incorporating these future enhancements, Blurshield has the potential to evolve into a more comprehensive and flexible solution for privacy-preserving surveillance. These advancements will extend its applicability across multiple domains, from smart city initiatives to high-security areas, further reinforcing its position as a valuable tool for real-time, privacy-focused vehicle tracking and monitoring.

VII. CODE METADATA

Table 1 code metadata

C1	Current code version	v.1.0.0
C2	Permanent link to the code/repository used for this code version	https://github.com/AmanSayyad789/Blurshield
C3	Permanent link to reproducible capsule	https://doi.org/10.5281/zenodo.15272031
C4	Legal code license	MIT License
C5	Code versioning system used	Git
C6	Software code languages, tools, and services used	Python, Flask, YOLOv8, Github.
C7	Compilation requirements, operating environments, and dependencies	Installation of Python v3.13.3 libraries, ultralytics, numpy, and matplotlib.
C8	If available, link to developer documentation/manual	https://github.com/AmanSayyad789/Blurshield/blob/main/README.md
C9	Support email for questions	arman.sayyad789789@gmail.com

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