KytraTech

AI-Powered Traffic Violation Monitoring System

KW-20

OVERVIEW

The AI-based Traffic Monitoring, Management, and Violation Enforcement System is a comprehensive solution that enables authorities to automatically detect, record, and process traffic violations through camera footage.

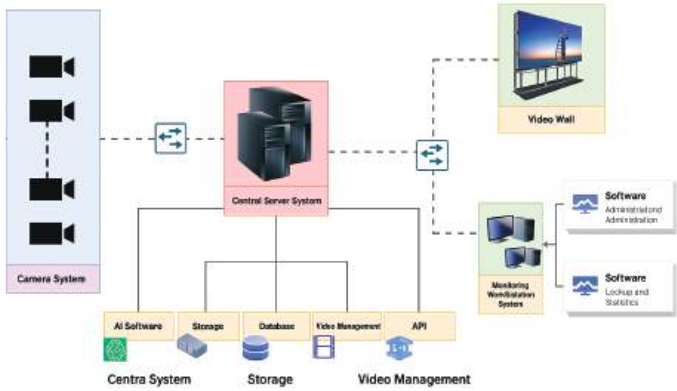
Leveraging AI Computer Vision, real-time video analytics, and a centralized data management platform, the system enhances the efficiency of traffic law enforcement, optimizes human resources, and ensures transparency and objectivity in violation handling.

The platform is deployed on a high-speed transmission network infrastructure, operating 24/7 with the capability to analyze hundreds of video streams simultaneously, meeting the demands of Smart City surveillance and Intelligent Transportation Systems (ITS).

KEY OBJECTIVES

- Vehicle detection and classification from image and video sources
- License plate recognition (LPR) using AI-based computer vision
- Automatic detection and alerting of traffic violations, including:
  - *Detection of red-light violations*
  - *Detection of lane marking violations*
  - *Detection of lane misuse or improper lane change*
  - *Detection of wrong-way driving*
  - *Detection of illegal parking or stopping*
  - *Detection of entry into restricted or prohibited zones*
- Violation Management Support:
  - *Enables authorized personnel to review, reject, or validate detected violations, and synchronize violation data with external systems.*
  - *Each violation record includes comprehensive evidence data: violation type, vehicle images, violation video clips, location, timestamp, and vehicle license plate number.*
  - *Provides open API/SDK interfaces for integration and data sharing with other software platforms and applications.*
  - *Supports bulk printing of violation notifications for enforcement purposes.*
- Detection of license plates listed on watchlists or hotlists
- Support for data storage, retrieval, and statistical reporting on traffic violations
- The traffic monitoring and enforcement software system is an automated, 24/7 operational platform that enables continuous tracking and surveillance of vehicles through an integrated network of cameras.

ARCHITECTURE



Architecture diagram of the Traffic Surveillance and Enforcement System

The AI-based Traffic Surveillance, Management and Enforcement software comprises camera devices, high-speed transmission network infrastructure, and the surveillance & enforcement
applications installed on the central servers. The system also includes a video wall (multi-screen display) at the operations center.

SYSTEM PROCESS

- Data Collection: Cameras capture image data and transmit it to the central server system.
- Processing and Analysis: The central server analyzes the collected data. When an event or violation occurs, an alert is displayed on the monitoring screen and the data is recorded.
- Data Storage and Management: All data is stored in the storage system and database for long-term management.
- Monitoring and Historical Data Retrieval: Operators can monitor live images and alerts on display screens or search historical data from the storage and database systems. Data is displayed according to user-defined layouts and filters.
- Vehicle Monitoring: Analyzes live camera feeds to automatically detect vehicles, read license plates, and identify traffic violations in real time.
- Event Packaging: Each detected event is encapsulated into a structured record containing key information such as event type, timestamp, location, event images, and video evidence.
- Event Management: Allows users to search, add, edit, or delete event information, and categorize events for more efficient management and tracking.
- Violation Management: Provides users with multi-dimensional statistical reports and interactive visual dashboards for monitoring and analysis of violation data.
- System Administration: Supports multi-user access with configurable role-based permissions and hierarchical management; automatically logs all user activities and system interactions for security and audit purposes.

KEY FUNCTIONS OF THE TRAFFIC MONITORING AND VIOLATION MANAGEMENT SYSTEM

System Administration

- User Role Configuration: Allows administrators to add, modify, and delete user permissions within the system.
- Camera Management: Enables configuration and organization of cameras by location, supporting flexible monitoring network management.
- Violation Type Management: Allows users to add, edit, or delete violation types, and configure corresponding penalty amounts for each specific violation.
- System Log Monitoring: Provides access to system activity logs, recording all user operations, including:
  - *Login / Logout*
  - *System configuration changes*
  - *Violation processing actions*
  - *License plate verification*
- Detailed User Activity Information, each log entry includes:
  - *Username*
  - *Timestamp*
  - *Operation type*
  - *Affected data area*
- All user activity logs are stored for one year for auditing and security purposes.

Monitoring, Alerting, and Processing

Monitoring

- Connect and process multiple cameras simultaneously on a single server
- Automatically detect violations, generate alerts, and perform data storage operations
- List of violation events detectable by the system:
  - *Detection of red-light violations*
  - *Detection of lane marking violations*
  - *Detection of improper lane usage*
  - *Detection of wrong-way driving*
  - *Detection of illegal parking or stopping*
  - *Detection of entry into prohibited roads*

- Additional features supported by the software:
  - *Traffic flow analysis*
  - *Detection of license plates or persons on the watchlist*
- Display real-time processed video streams. Allows viewing of individual camera feeds after AI processing, in which detected vehicles are:
  - *Framed with bounding boxes.*
  - *Displayed with license plate information.*
  - *Color-coded to distinguish between different vehicles or statuses.*
  - *Labelled with the corresponding violation type*

Alerting

- Real-Time Violation Monitoring: Allows receiving live violation data. Violations are continuously updated in chronological order, with the newest entries displayed at the top.
- Allow identification and alerting of violations and watchlist objects using audio and visual signals at the operation center or through the Mobile App (iOS/Android).
- Display the camera location where the violation is detected on the map.
- Search and display violation lists. Enables data search by license plate number, time, or target object.
- Display vehicle movement direction on the map.
- Mobile App Monitoring Support (iOS/Android):
  - *Enable users to receive alerts.*
  - *Preview violation images directly on mobile devices.*

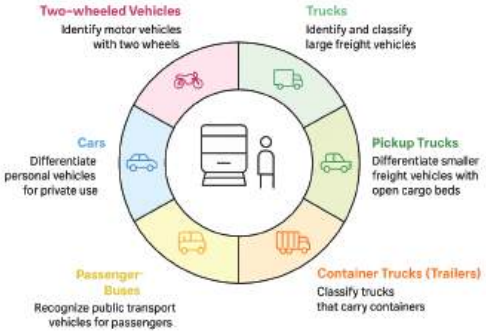
Processing

- When a traffic violation is detected, the system allows viewing and storing detailed violation information:
  - *Type of traffic violation*
  - *Vehicle images (three images: before, during, and after the violation)*
  - *Video evidence of the violation (5–20 seconds, or as configured)*
  - *Location, timestamp, and license plate number of the violating vehicle*
- Violation information can be printed as multiple A4-sized penalty forms, including:
  - *Violation details*
  - *Overview image showing the vehicle clearly*
  - *Close-up image showing the license plate clearly*
  - *Name of the enforcing authority*
  - *GPS coordinates*
- Print violation notifications to be sent to vehicle owners according to the Ministry of Public Security's official form
- Print violation submission forms to local police offices (ward, commune, or township) according to the Ministry of Public Security's official form
- Support bulk printing for a large number of violation notifications
- Pending Violations: Allows approving individual violations or batch approval of multiple violations.
- Violations in Process: Displays a list of ongoing violation cases. Each case allows actions such as printing notifications, printing submission forms, marking as non-violation, or submitting for approval and closing the case.

- Non-Violation Cases: Displays a list of cases marked as non-violation, with the option to revert status to “violation confirmed.”

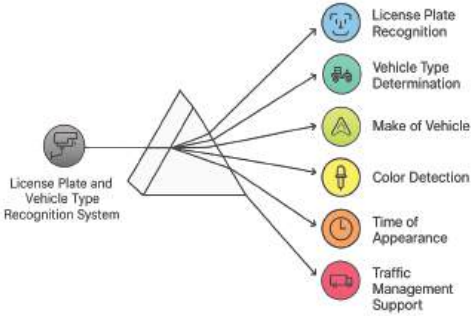
Vehicle Classification and License Plate Verification

- Identify and classify major types of vehicles moving on the road into categories such as trucks, tractors, passenger buses, cars, and motorcycles.



Vehicle Classification

- Automatically detect and recognize vehicle license plates within the camera’s field of view.
- Provide detailed data for each vehicle, including license plate characters, plate color, vehicle type (government, service, civilian, military, diplomatic, foreign, international, or official-use), vehicle make, color, and timestamp of appearance.



License Plate and Vehicle Recognition

- License plate recognition accuracy under clear and non-distorted plate conditions:
  - *Cars: ≥ 95% during daytime and ≥ 75% at night*
  - *Motorcycles: ≥ 85% during daytime and ≥ 70% at night*
- Allow searching and displaying recognized license plates.
- Allow editing license plate data and saving the updated results for each record, with automatic synchronization of plate information to pre-configured external systems.

Violations Management

- System administration functions.
- Functions for monitoring and handling violations.
- License plate approval functions.
- Blacklist license plate management functions.
- Reporting and statistical functions.

- Summarizing and analyzing historical data by type of traffic violation and type of vehicle on the digital map.
- Exporting violation reports by road segment, intersection, or administrative area.
- Reporting and classifying detected violations that require further investigation.
- Summarizing the violation frequency over time for a specific vehicle.
- Summarizing violation detection results within an administrative area or a selected region on the map, including:
  - *Total number of cases*
  - *Analysis of the proportion of each type of violation*
  - *Identification of violation hotspots*
  - *Trend charts showing the increase/decrease of each violation type*
  - *Comparative charts of violations between communes/wards*
  - *Charts analyzing violation time frames*
- Management information for each violation event includes at minimum:
  - *Time (Time Range, Timestampe)*
  - *Location*
  - *Violation type (may include multiple violations at the same time)*
  - *Evidence images at the violation moment*
  - *Video evidence of at least 5 seconds*

Blacklist Management

- Blacklist Management: Allows adding, editing, and deleting license plates from the blacklist (a list of vehicles belonging to monitored or high-priority subjects).
- Blacklist License Plate Alerts: Enables detection and alerting of blacklisted vehicles through audio and visual notifications at the command centre or via the mobile application (iOS/Android), while simultaneously displaying the camera location where the violation or detection occurred on the map.

System Configuration & Integration

- Supports expansion and connection with existing systems or external systems via API and HTTP.
- Allows customization and scheduling of system operation time.
- The user interface includes English, Vietnamese language support.

Statistical Reporting and Analytics

- Violation Statistics Reports by:
  - *Time range*
  - *DateTime (dd/mm/yyyy)*
  - *Area or camera location*
  - *Violation type*
  - *Total number of violations*
  - *Total fine amount*
  - *Total number of processed cases*
  - *Total number of unprocessed cases*
  - *Violation ratio charts*
  - *Vehicle type*

- Violation Handling Reports by:
  - *Violation time*
  - *Processing time*
  - *Name of the officer handling the case*
- Detailed User Activity Information Includes:
  - *Username*
  - *Timestamp*
  - *Operation type*
  - *Affected data area*

Remote Access via Mobile Devices

- Secure Remote Login:
  Allows remote login via mobile devices when network conditions and information security requirements are met. Access to all other system functions requires valid username and password authentication.
- Logout Handling:
  Upon logout, the system disconnects from the server and displays the login screen.
- Violation List Display:
  By default, the system displays the list of detected violations within the current day.
- Real-Time Violation Monitoring:
  Provides real-time display and alerts for new violations using audio and visual notifications.
- Violation Details:
  Enables users to view detailed information, images, and video evidence of each violation.
- Violation Processing:
  Allows authorized users to update records and perform violation handling actions.
- License Plate Verification:
  Supports searching vehicles by license plate, time, and location.
- Violation History Analytics:
  Aggregates and analyzes violation history by type, vehicle category, and geographic location on a digital map interface.
- Report Generation:
  Exports violation reports by traffic route or administrative area for management and enforcement purposes.