Research on the application of dangerous driving detection on the highway based on computer vision

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Abstract. Dangerous driving on the highway is a significant safety hazard, and existing highway cameras are not used to detect whether drivers are fatigued or distracted. To inform the police of dangerous driving vehicles promptly,In this paper, we propose a complex driving detection system on the basis of YOLO network.The YOLOv8s algorithm is used for real-time analysis, effectively improving detection accuracy and caters to the need for lightweight design. The system combines the characteristics of highway camera settings with distributed cluster deployment, solving the defects of detection blindness and target loss and achieving the function of distributed clustering to detect drivers of passing vehicles. The system can provide adequate support for traffic police to intercept dangerous drivers on highways and give theoretical guidance for the future intelligent transformation of road traffic through experimental verification.The technology could also be rolled out to cover urban roads and additional transportation networks to further ensure traffic safety.

Keywords:YOLOv8, artificial intelligence, deep learning, fatigue driving detection.

1. Introduction

Fatigue driving and distracted driving are both known as dangerous driving. In fatigue driving and distracted driving, the driver's reaction speed, judgment, and coordination are significantly reduced, which seriously affects the driver's ability to deal with unexpected situations in driving and leads to serious traffic accidents. According to statistics, fatigue driving is one of the main causes of serious traffic accidents[1].Therefore, building a real-time detection system for fatigue and distracted urging is essential to prevent hazardous high-speed driving. The mainstream products on the market determine whether the vehicle has dangerous driving behaviour by detecting steering wheel operation and drivers' status—cars' real-time analysis of the driving chemistry regulation through the steering wheel corner rate[2]. However, the accuracy is lacking and overall the generalizability is not high.Although the detection based on the driver's breathing and other physiological indicators has high precision[3], it is too bulky to wear and does not have practicality.

Therefore, this paper proposes a detection system based on the behavioural characteristics of the Yolov8 algorithm[4], which can determine whether a driver has distracting behaviour by detecting cell phones, cigarettes, and aquariums[5]. Scoring the driver's status by catching blink frequency and yawn times, then issuing alerts to vehicles with scores below a threshold. Assuming that the system is embedded in highway cameras, a complete detection closed loop will be formed by networking multiple nodes. Since this system can be directly ported to existing highway cameras without requiring vehicles or drivers to carry other specialised equipment, it has high practical value.

2. Methods and Materials

2.1 SOLUTION

The current illegal disposal mainly focuses on the dangerous driving behaviour after it occurs, and such removal is lagging. This paper proposed a system based on YOLOv8 for real-time detection of drivers on highways[6], which mainly targets distracted personnel and fatigued driving behaviours to mark and send warnings to the surrounding traffic police. The system can achieve the purpose of timely detection and early interception of dangerous driving vehicles.

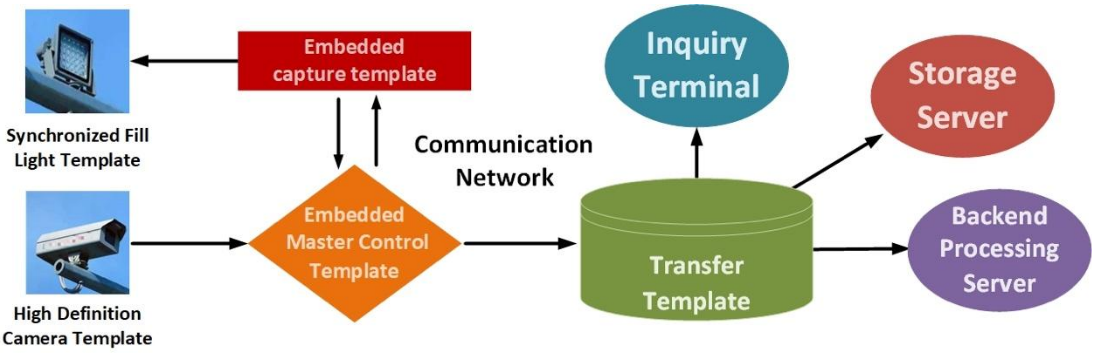


Fig. 1 The preliminary idea of the system

2.2 YOLOV8 NETWORK

YOLO is a fast and compact open-source object detection model. It exhibits superior performance and exceptional stability in comparison to other networks[7]. At the same time, It pioneered the concept of being an end-to-end neural network capable of predicting both an object's class and its corresponding bounding box. Thanks to its consistent advancements and enhancements, YOLO has become a preferred framework for object detection among computer vision engineers. The diagram below illustrates the composition of its network structure.

YOLOv8 features a state-of-the-art backbone and neck architecture for improved signature extraction and object detection performance compared to previous versions, and the use of unanchored Ultralytics head further improves detection accuracy and efficiency. YOLOv8 is available in five different sizes: Nano, Small, Medium, Large and Ultra Large[8]. The smaller model has 11.2 million parameters and 128.4 ms CPU ONNX, which considers both the accuracy and speed of detection. Consequently, this paper employs YOLOv8s. Its network structure is composed as shown below.

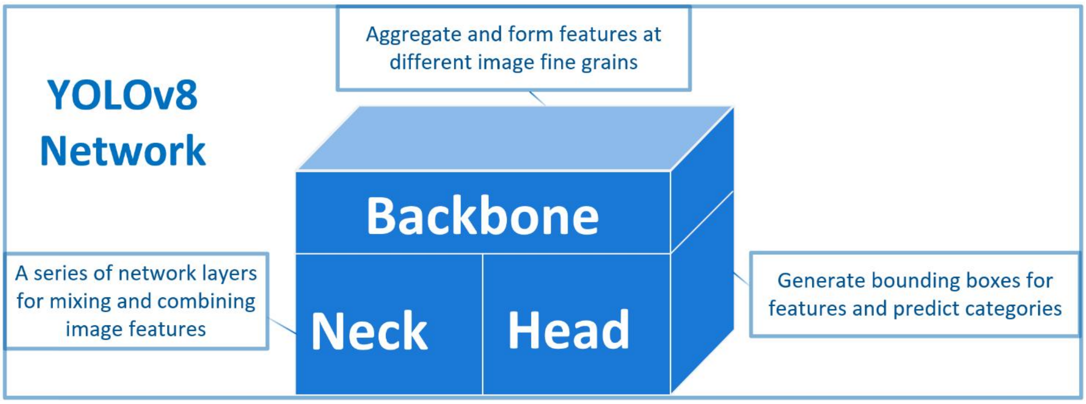


Fig. 2 YOLO Network(a)

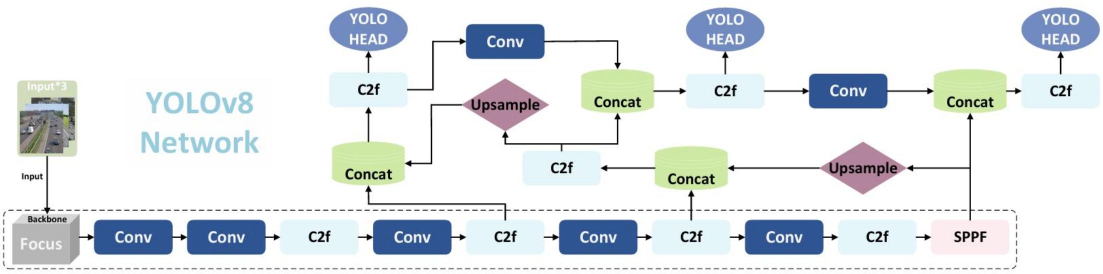


Fig. 3 YOLO Network(b)

2.3 METHODS COMPARISON

The camera will capture the driver's face picture and compare it with the ID photo comparison population database. Then, the identification information based on the driver's ID photo will notify the driver to receive education or punishment. The camera records the driving process through the radar equipment to measure the speed[9]. Finally, the speed measured by the radar is superimposed on the recorded pictures of the camera.

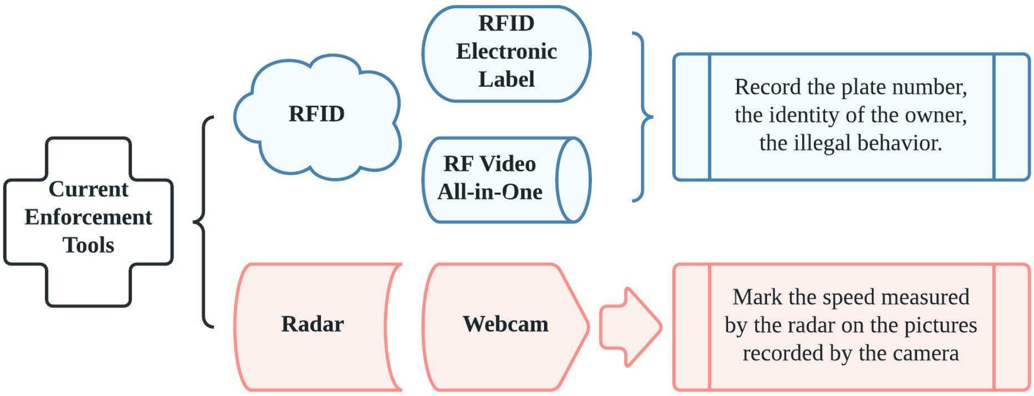


Fig. 4 Existing high-speed enforcement tools

When law enforcement monitoring detects a passing vehicle, it will mark the car and driver simultaneously and call the corresponding model to evaluate the driver's status. If the rating reaches the established threshold, the system will send a warning to law enforcement agencies and keep track of the dangerous driving vehicle. If the number of signs reaches the preset value, the neighbouring traffic police will intercept it.

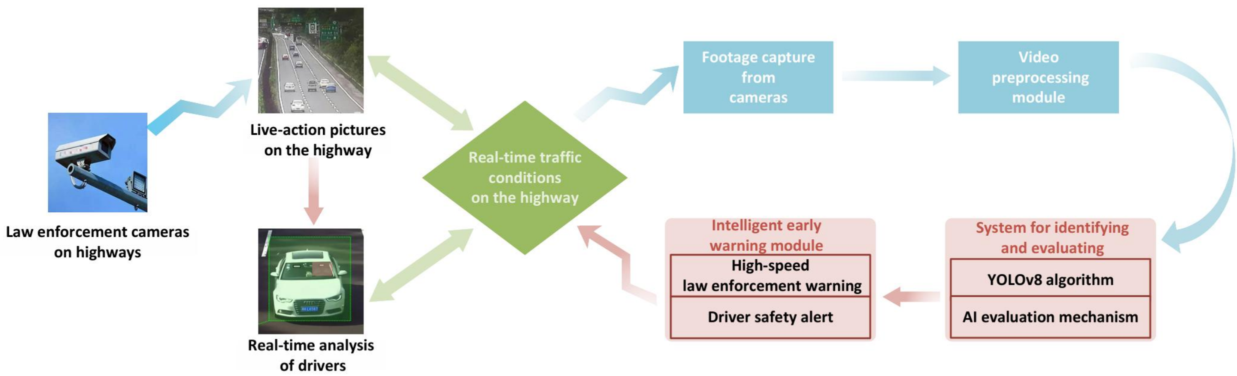


Fig. 5 The framework of the warning system based on YOLOv8

2.4 APPLICATION SCHEMATIC

Integrated within Intelligent Roadside Devices, the system captures the driving position of passing vehicles via web cameras. It analyses the driver in real-time with the YOLOv8 algorithm. In warnings, information about cars with dangerous driving behaviour will be given to nearby traffic police. When the number of vehicles noticed reaches the threshold, the police will intercept it. The framework is shown in figure 6.

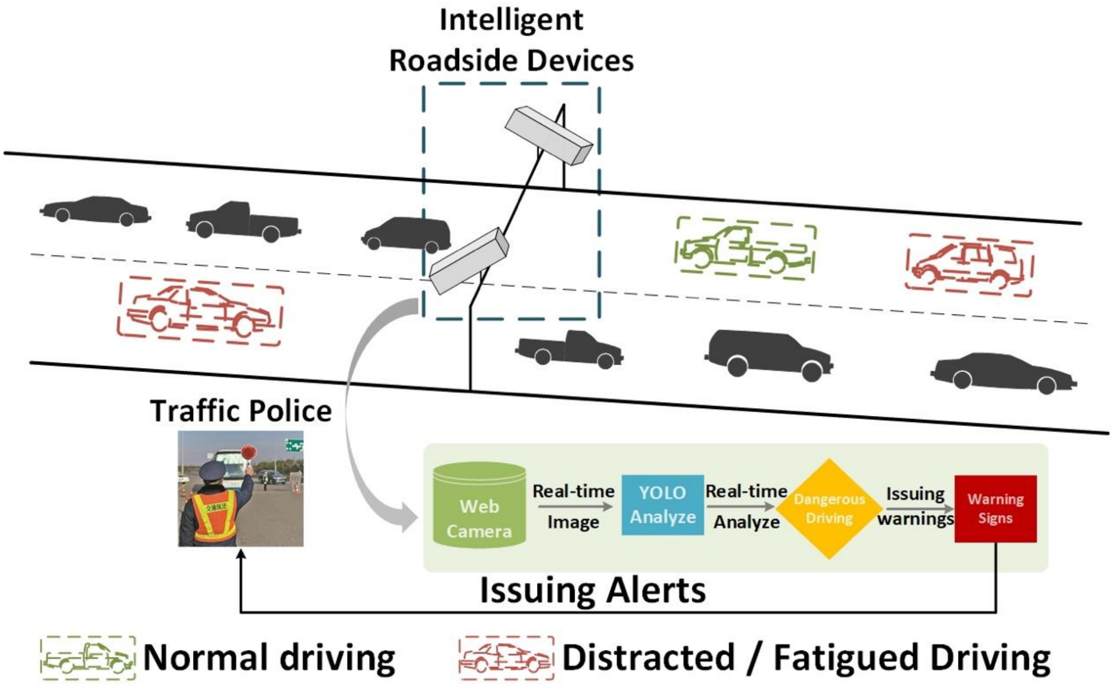


Fig. 6 System operation

2.5 UNDERLYING OPERATIONS

The figure below illustrates the system's operational flow. The situation will be recorded in the system database when a driver is judged as driving dangerously. If the altered vehicle is warned at multiple detection points, the system will prompt the traffic police to stop it. The system will compare the driver's facial information with the face recognition system while analysing their characteristics. If the driver is judged to have dangerous driving behaviour, an alarm will be issued, and records will be uploaded.

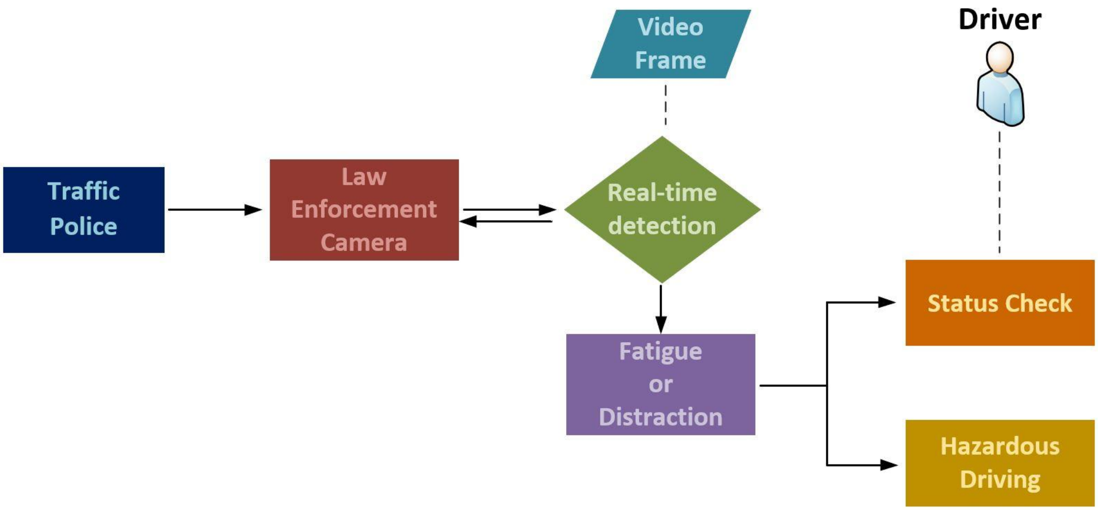


Fig. 7 Underlying operation logic

2.6 FATIGUE DRIVING EVALUATION MODEL

Perclos is used as the system's scoring parameter to rate whether a driver is driving fatigued. The system records the driver's blink/yawn frequency over the last 200 frames and calculates it using the formula shown in figure 8. When Perclos is below a threshold, the driver will be recorded as driving fatigued.

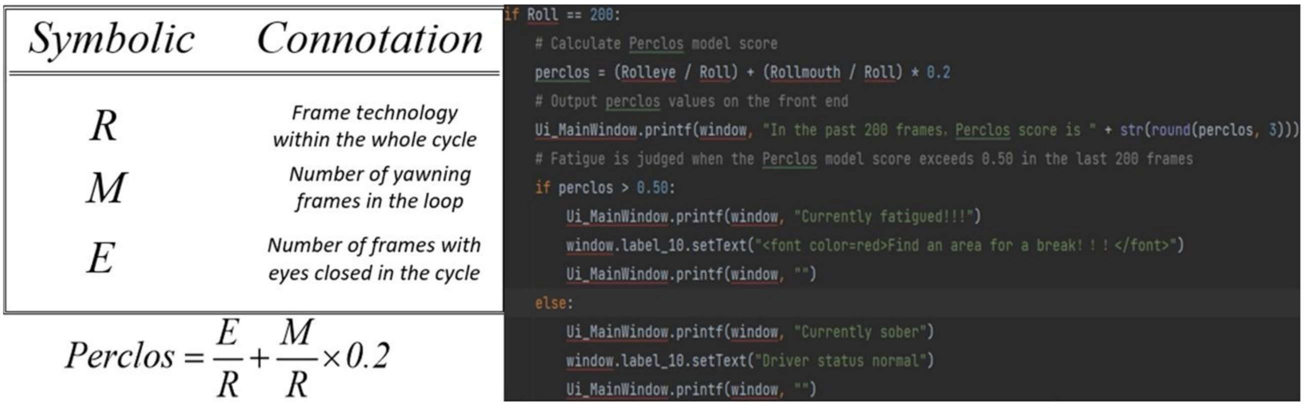
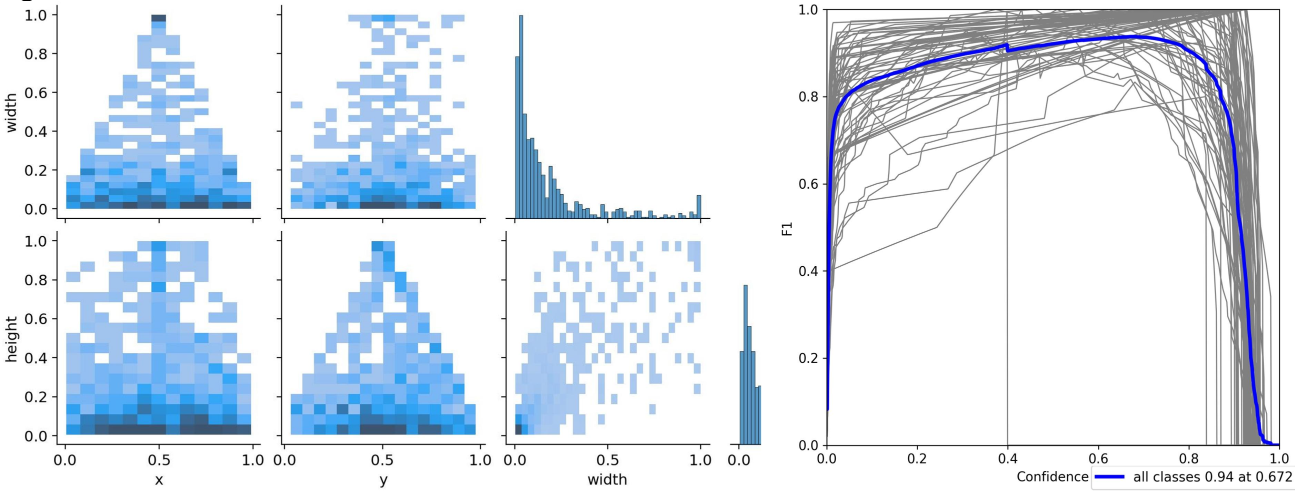


Fig. 8 Scoring formula and Codes representation

3. Results

In the training phase of the detection model, the dataset was trained for 500 training rounds to obtain the model with high recognition accuracy. The training results are shown in the following figure.



(a) **(b)**

Fig. 9 Dangerous driving detection model training results

The system will mark the outline of people's eyes and mouths when detecting the face in the test. As shown in Figure 9, recording the number of yawns and squinting will determine whether there is fatigue driving according to the pre-set scoring formula. The same alert will be released after detecting cell phones and water glasses.

Fig. 10 Dangerous driving detection

4. Summary

This paper presents a highway dangerous driving detection system that leverages the capabilities of computer vision. The system utilizes the lightweight yet efficient features of the YOLOv8 framework to provide timely and accurate visual warnings for traffic police. In order to cope with the challenges posed by high-speed vehicles on the highway, the system incorporates a distributed cluster deployment strategy. This strategy enables concurrent monitoring of multiple highway sections, effectively overcoming issues such as blind spot detection and target loss.

The experimental results demonstrate that the system achieves a high level of accuracy in danger detection but also maintains a swift reasoning speed, thus fulfilling the critical requirement for real-time detection.In addition, the distributed cluster deployment architecture introduced in this paper holds immense potential for applications beyond highways, including urban roads and other intricate traffic networks.As a next step, we will plan to further enhance our deployment strategy for distributed clusters, integrate multi-source data, enhance real-time interaction functions, and seek cross-field cooperation to promote the continuous progress of traffic safety technology.

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