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Warning of Dangerous Driving Behavior Caused by Drivers and Road Environmental Factors

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Abstract. With the development of the supply-side reform of road transportation in China and the rapid development of public transportation, the pressure of public security management is also increasing. According to the statistics of public transport safety accidents, the number of public transport accidents and deaths accounts for about 1% of the total number of relevant road traffic accidents in China, among which 93% of bus accidents are caused by drivers' traffic violations. And, therefore, in order to predict the dangerous driving behavior of public transportation driver, this project combines the driver factors and environmental factors such as weather, road conditions, using the gradient promotion tree algorithm to forecast the risk in the process of public transportation to drive, to achieve the advance management and intervention of public traffic safety, to avoid major public traffic safety accidents, It provides ideas and deployment direction for public security traffic management.

Keywords. Transport, driver, police, security

1 Introduction

With the development of the supply-side reform of road transportation and the rapid and rapid development of public transportation, the pressure of public security management is increasing day by day. From the statistics of public traffic safety accidents, in the past six years, China's annual traffic accidents in about 200,000, the number of people who lost their lives in traffic accidents in about 60,000, the number of injured is as high as more than 200,000. The number of traffic accidents in China in 2019 was 248,000, up 11% year-on-year, with direct property losses of 1.346 billion yuan. Both the number of public traffic accidents and the number of deaths account for about 1% of the corresponding total number of road traffic accidents in China, among which 93% of bus accidents are caused by drivers' traffic violations. According to data from the Work report of the Supreme People's Procuratorate and the Supreme People's Court, dangerous driving is the most serious crime.

In the process of driving, drivers always get various information from the constantly changing traffic environment through their vision, hearing and touch, and make corresponding responses through information identification, information analysis,

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information judgment and information decision-making [1]. Different information characteristics will produce different psychological reactions and decisions after analysis and judgment by different drivers. The different reactions and decisions of different drivers and the different combinations of road conditions and traffic conditions determine the level of road safety. It can be seen that controlling drivers' unsafe behaviors is an important way to reduce the frequency of accidents and improve driving safety coefficient.

In addition, the uncertainty of the road environment also increases the incidence of dangerous driving. For data display, the summer vacation and flood season are also the peak period of field management in agricultural production in summer, when people tend to go on intensive trips and travel for work and farming [2]. In addition, there are many rain weather and slippery road accidents in summer, which result in high road traffic safety risks and easily lead to fatigue driving, and are prone to mass death and casualty [3]. Therefore, how to timely prevent the occurrence of dangerous driving behavior according to the road environment factors is also worth the police to think.

At present, there are many studies at home and abroad that evaluate drivers' driving behaviors by detecting human physiological and cognitive states. For example, Katsis et al. from Loanina University demonstrated through experiments that drivers' driving fatigue can be significantly manifested by the signal fluctuation of their heart rate and skin conductance, then adjust the physiological condition of drivers to reduce the occurrence of traffic accidents.

In addition, there are also many studies on the impact of environmental factors on driving safety at home and abroad. For example, Satoshi et al. developed an accident severity assessment model based on ordered probit model in order to better understand the impact of weather on accident severity. In this model, traffic characteristics, road conditions, environment and factors related to multiple vehicles, single bikes and bicycles are considered. Combined with the actual data, the results show that in addition to traffic and road variables, several weather variables also have significant influence on the severity of accidents. Feng Zhongxiang et al. analyzed the influence of road environmental factors on the severity of traffic accidents based on the number of traffic accidents, and the analysis results showed that time period and weather had significant influence on the severity of traffic accidents.

The existing studies only select some dimensions of factors to predict and analyze the severity of accidents, and do not combine driver factors with road environment factors, which has certain limitations.

According to the recent studies mentioned above, existing studies do not combine driver factors with road environmental factors, and many domestic and foreign studies only emphasize the influence of one aspect on dangerous driving behavior [4]. And the existing public transport driver monitoring system is not perfect, lack of advance warning and incident records. In terms of policy supervision, relevant policies can not be formulated and implemented until major accidents occur. At the same time, the safety supervision failed to play the role of third-party supervision forces, and the investment in advanced instruments and equipment was low. Therefore, how to build an intelligent real-time warning system based on public transport drivers' emotional factors and road environment factors has become an important topic for police to prevent public traffic accidents in time.

This project will be the driver factors and environmental factors such as weather and road conditions, using the gradient promotion tree algorithm of public transport in the process of driving risk forecast, achieve the result that in time to prevent dangerous

driving behavior, in order to realize beforehand for public traffic security management and intervention, so as to avoid major public traffic safety accidents and provides ideas and deployment direction for public security traffic management.

2 Module Design

According to the needs above, this project intends to construct a based on driver factors and environmental factors of dangerous driving prediction system, through revitalizing the existing police internal data, this project finally confirmed that drivers' data such as mood states of drivers and fatigue driving state, as well as environmental data such as weather and road conditions are selected as data sources to build the model.
This project consists of three modules, namely, driver data acquisition module, environmental data acquisition module and dangerous driving prediction module, whose operation sequence is shown in Figure 1:

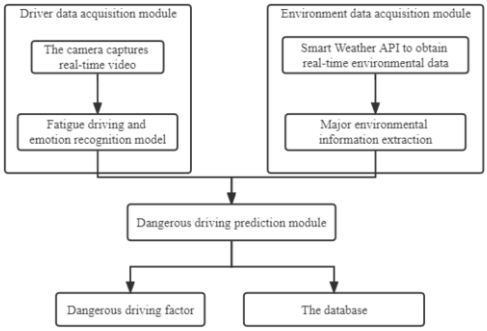

Fig. 1 Project Module Overview.

In the driver data acquisition module of this project, openCV, Dlib, Keras, Tensorflow and other modules in Python will be adopted to call the camera to achieve the acquisition of face data and collect real-time video images. In the environmental data acquisition module, real-time environmental data can be obtained through intelligent meteorological API and main environmental information can be extracted. After obtaining the data, the dangerous driving prediction model is imported to obtain the predicted value of whether dangerous driving is finally possible, and the dangerous driving coefficient is displayed. All the data obtained this time are imported into the database for further analysis.

At present, the mainstream prediction models in the market include Random Forest, Decision Tree, Neural Network, Logistic Regression and Support Vector machine [5], etc. Gradient Boosting Decision Tree (GBDT) in the Decision Tree is selected to build an algorithm model for model training and optimization by testing each model and comparing its prediction accuracy, prediction speed and prediction stability.

After model training, finally confirmed with "weather conditions", "time (hours)", "time (week)", "time (months)", "emotion", "fatigue" and "speed" seven fields as input fields, whether "dangerous driving" as the target field, to extract the effective data, can be more objective and comprehensive to restore the truth of events, Improve data utilization.

Finally, the project plans to present an interface that can reflect the driver's driving state in real time, including dangerous driving coefficient, emotional state, eye, aspect ratio of mouth, mouth state and other parameters, which can intuitively reflect the current driving situation and remind the driver to adjust in time.

2.1 Data acquisition module

Based on the driver information acquisition module and environmental data acquisition module, the project builds a prediction model of dangerous driving behavior for drivers. Among them, “sequential fully-CNN” will be used for emotion recognition [6]. The schematic diagram of the model is shown in Figure 2:

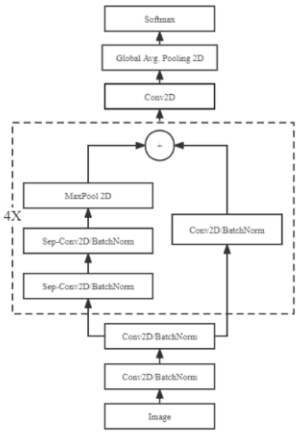

Fig. 2. Model for real-time classification. In FER2013 (35,000) data set of 7 expressions, the model recognition accuracy reached 66%, which can recognize and classify the facial movement features of eight basic expressions, namely, expressionless, happy, sad, surprised, afraid, fearful, angry and disgust, and finally achieve the classification of emotions [7].

The fatigue driving recognition part is to determine whether the driver has the fatigue driving behavior by monitoring the aspect ratio of the eyes and mouth on the basis of determining the key position of the face through the model of emotion recognition part [8]. When the aspect ratio of the driver's eyes is less than a certain threshold, the model will judge that the driver is in the state of eye closure. When the number of eye closing frames exceeds a certain threshold, the model determines that the driver is nodding off and makes corresponding judgment of fatigue driving. When the aspect ratio of the mouth is greater than a certain threshold, the model determines that the driver yawns, and when the number of yawns exceeds a certain threshold, the model makes the judgment of fatigued driving [9]. In addition, when the model can not recognize the driver's face, it is identified that the driver has abnormal driving conditions, and corresponding records are made.

In the module of environmental data acquisition, the project intends to determine the location through the IP address of the system, and at the same time obtain the accurate environmental data information such as weather and road conditions of the location in real time by using API calls.

2.2 Prediction module

The training data set of the prediction model adopts the internal data obtained by the public security system (about 240,000 pieces), including driver information, passenger information, weather conditions, road conditions and other fields (desensitization has been processed). We divided the data set by random allocation in a ratio of 3:7, with 30% of the data as test set and 70% as training set.

After confirming and dividing the data set, we used Gradient Boosting Tree (GBDT) in the Decision Tree to build the algorithm model, and improved the prediction accuracy of the model by adjusting parameters and continuously testing.

GBDT is an integration model, which can be regarded as the linear addition of many base models, among which the base model is CART regression tree [10]. CART tree is a decision tree model. Compared with ordinary ID3 and C4.5, the main feature of CART tree is that it is a binary tree, and the feature value of each node is "yes" and "no". Such a decision tree recursively divides each feature and determines a unique output in each partition of the input space [11].

After desensitization and structured data processing, we have selected the "weather", "time (hours)", "time (week)", "time (months)", "emotion", "fatigue" and "speed" and "accident" eight fields, and use the gradient promotion training tree algorithm of data and model building [12]. Finally, the prediction accuracy of training set and test set reached 82.20% and 81.69% respectively [13].

3 Results

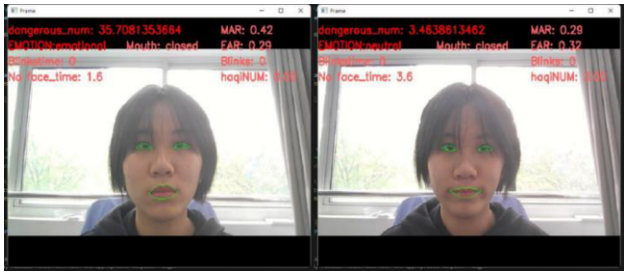

Fig. 3 Program operation effect diagram

As shown in figure 3, "Blinks" are the number of Blinks, which are updated periodically as the program runs; "Blinkstime" refers to the time when the eyes close (not blink); Mouth refers to the state of the Mouth, including open and closed. "EAR" refers to eye aspect ratio; "MAR" refers to aspect ratio of mouth; EMOTION refers to emotional states such as neutral and emotional. "No face_time" refers to the length of time when the face information is not detected; "HaqiNUM" is the cumulative number of yawns; "Dangerous_num" indicates the dangerous driving coefficient (0-100) predicted by the prediction model after real-time data is imported into the prediction model. It can be seen that the changes of each parameter will affect the prediction of the model's dangerous driving coefficient in real time. When the emotional state is neutral, the score of the dangerous coefficient is significantly lower than that of emotional.

Finally, the operation mechanism of the dangerous driving warning system proposed in this project is as follows: the driver installs the product on public transport and keeps the product running continuously; The police terminal can access the product, supervise the running state of the product in real time, and provide relevant data (driver information, road condition information, etc.) for the product. When the driver side product monitoring may be driving to the danger of the driver, the dangerous driving coefficient is more than the set value, alert the driver's driving condition, at the same time the data uploaded to the public security, the police after the data analysis, to decide whether the driver's driving condition of intervention, such as to pull over, its replacement driver, etc.; In addition, the data would be stored in a database, and constantly to update the model iteration, and gather more information, such as the driver whether happened traffic accident, whether to have criminal record, whether traffic congestion, etc., enrich and optimization model, the data scale after reaching a certain degree, in different regions using the model of training data in the region, Make products more in line with regional characteristics and related policy requirements. The overall operation logic of the system is shown in Figure 4:

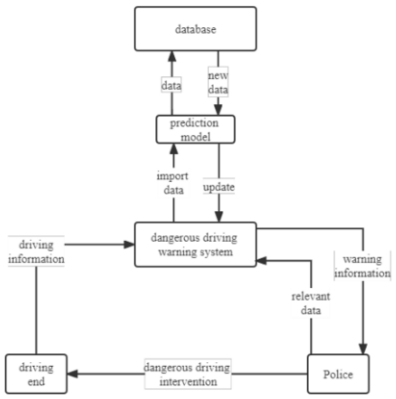

Fig. 4 Schematic diagram of operation mechanism of dangerous driving warning system.

4 Conclusions

Since the Deployment of the Ministry of Public Security to carry out the "four Construction", police organs around the country have seized the opportunity to strengthen information construction around basic information, to create a "big intelligence" work pattern. But up to now, in terms of public transport management, there are still some deficiencies in public transport danger warning research and intelligence collection from the perspective of public security, which makes it difficult to realize immediate supervision and intervention in public transport management.

To achieve public transportation for dangerous driving early warning, this project uses convolution neural network analysis of the driver whether dangerous driving, such as fatigue, emotional, and originally combines the driver factors and environmental factors such as weather and road conditions, and uses gradient ascending tree algorithm to predict the risk coefficient of public transport vehicles in the process of driving,

which provides a new idea for public transport safety management in the new era of police work and builds a management network of public transport vehicles [14].

In the police application, this project has a good application value, to achieve smart police. At the level of proactive regulation and supervision, the traffic management department can determine the driver's driving state and vehicle running condition according to the data returned by the project, as well as the risk coefficient calculated by the system, and determine the vehicle running track based on the road monitoring video to determine whether there is a possibility of danger, so as to implement real-time intervention. At the level of process control, when traffic accident occurs, the police can pass this project the data returned quickly to determine the accident site, quickly mobilize police to the scene to the wounded near the treatment for disposal, such as, the crowd evacuation, traffic channel to prevent casualties caused by treated not in time, or vehicles such as explosion accident caused by secondary damage; In hindsight, when the case is investigated, the data stored and uploaded in this project can record the driver's image information and relevant parameters of vehicle operation at that time, thus providing multidimensional reference data for the police's analysis and judgment, forming a complete chain of evidence, helping to solve the case and "saving" the police from the ambiguous judgment work. To achieve the goal of "Intensify the police by technology" and "Ask technology for police" intelligence policing, actively crack down on illegal and criminal activities, improve the efficiency of solving crimes, safeguard the safety of people's lives and property, maintain social stability.

Of course, there are some deficiencies in our research. Firstly, due to the limitation of data set size and field, we cannot cover all the subjective and objective factors that may affect the driving state of drivers, thus affecting the accuracy of the results to some extent. In addition, in the selection and use of the algorithm, considering the practicality of the system in police work and other needs, the algorithm we choose is relatively more stable, which can not take into account the innovation of the algorithm.

With the continuous advancement of social change and the increasingly frequent technological innovation, the use of surveillance video, artificial intelligence and big data for police forecasting will play a more important role in the future. When the data collected in this project reaches a certain scale, it can provide data support for the study of public traffic accidents by relevant police departments, deeply analyze the causes of public traffic accidents, and carry out corresponding rectification work to prevent public traffic accidents and improve passenger travel safety. At the same time, after the project is widely spread throughout the country, the public transport management network with provinces and cities as units can be constructed, and the database dedicated to each region can be constructed to make the model more consistent with regional characteristics, achieve more accurate prediction and analysis, and explore the factors affecting the smooth operation of public transport in different regions.

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