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Research on Road Rage Detection System Based on Multi-feature Fusion

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ABSTRACT

The influence of driver's rage on driving safety is one of the centers of traffic accident research. Road rage is a common potential factor affecting driving safety. Real-time monitoring of driver's emotional state and timely intervention measures can effectively reduce the incidence of traffic accidents. At present, the reliability of driver emotion recognition based on single consistent factor for road rage needs to be further improved. Therefore, based on the multi-feature fusion method, this paper proposes a recognition method of driver's road rage emotional state that integrates facial expression, driving control, voice text and physiological characteristics, and proposes the analysis of fusion strategy. In order to improve the reliability and implementability of road rage symptom judgment, this paper studies the state identification methods of road rage and integrates the characteristics of road rage. The focus of this study is to solve the key problem of insufficient reliability of road rage recognition based on facial expressions through the combination of multiple features and multiple data, aiming at the defects of the study on the single feature of road rage, and effectively improve the accuracy of road rage state emotion detection.

KEYWORDS

Road Rage Emotion; Facial Expression; Frequent Operation; Multi-Feature Fusion

1. INTRODUCTION

According to the data analysis of traffic accidents that have occurred, most traffic accidents are caused by human factors, and human driving emotions account for the largest proportion [1]. With the development of intelligent connected cars, the intelligent cockpit of cars can effectively solve the problem of emotional loss of control that occurs during the driver's driving. According to statistics, more than 30% of drivers suffer from road rage or driving anxiety, and there is a rising trend. In order to avoid traffic accidents caused by road rage, it is necessary to accurately detect drivers' emotions while driving and respond to them in time [2]. Road rage is very harmful. In-depth study of road rage will not only help reduce traffic accidents and improve road safety, but also promote drivers' mental health and build a harmonious society.

At present, researchers mainly assess whether driving behavior is related to road rage through behavioral observation, psychological testing, design of relevant questionnaires, physiological indicators monitoring and other ways.

The detection system of the intelligent cockpit can improve the safety factor of driving and the comfort of driving experience, thus reducing the human factor of road traffic accidents. Road rage is usually manifested by changes in the driver's language and demeanor, pulse changes and sudden changes in driving behavior. The road rage detection system based on multi-modal fusion can judge

the driver's emotions by facial recognition, heart rate information monitoring and vehicle driving information monitoring.

However, there are still some problems in the research work, such as low detection accuracy, incomplete information fusion, subjectivity and limitation of evaluation criteria. In order to solve the above problems, we propose a road rage detection system based on multi-modal fusion technology. In this paper, the multi-modal road rage detection system based on multi-modal data acquisition, emotional feature extraction and recognition will be analyzed and studied.

2. MULTIMODAL DATA ACQUISITION AND FEATURE EXTRACTION AND RECOGNITION

Compared with traditional questionnaire survey and real-time observation of drivers, multi-modal feature recognition can identify drivers' road rage in real time by combining facial expressions, language, physiological signals, etc. This method has high accuracy and reliability. Road rage recognition based on facial expressions is generally based on the analysis of the driver's eye narrowing degree, mouth opening and closing ratio, etc., to judge the driver's emotional state. Road rage recognition based on voice is generally based on the driver's tone, volume, speech speed, etc., to judge their emotional state. Road rage recognition based on physiological signals is generally conducted to judge the emotional state of drivers by analyzing their ECG, breathing, pulse and other physiological signals [3]. By collecting these data, deep learning technologies, such as convolutional neural network (CNN) and short term memory network (LSTM), are used to extract drivers' emotional features and obtain a more accurate road rage recognition system.

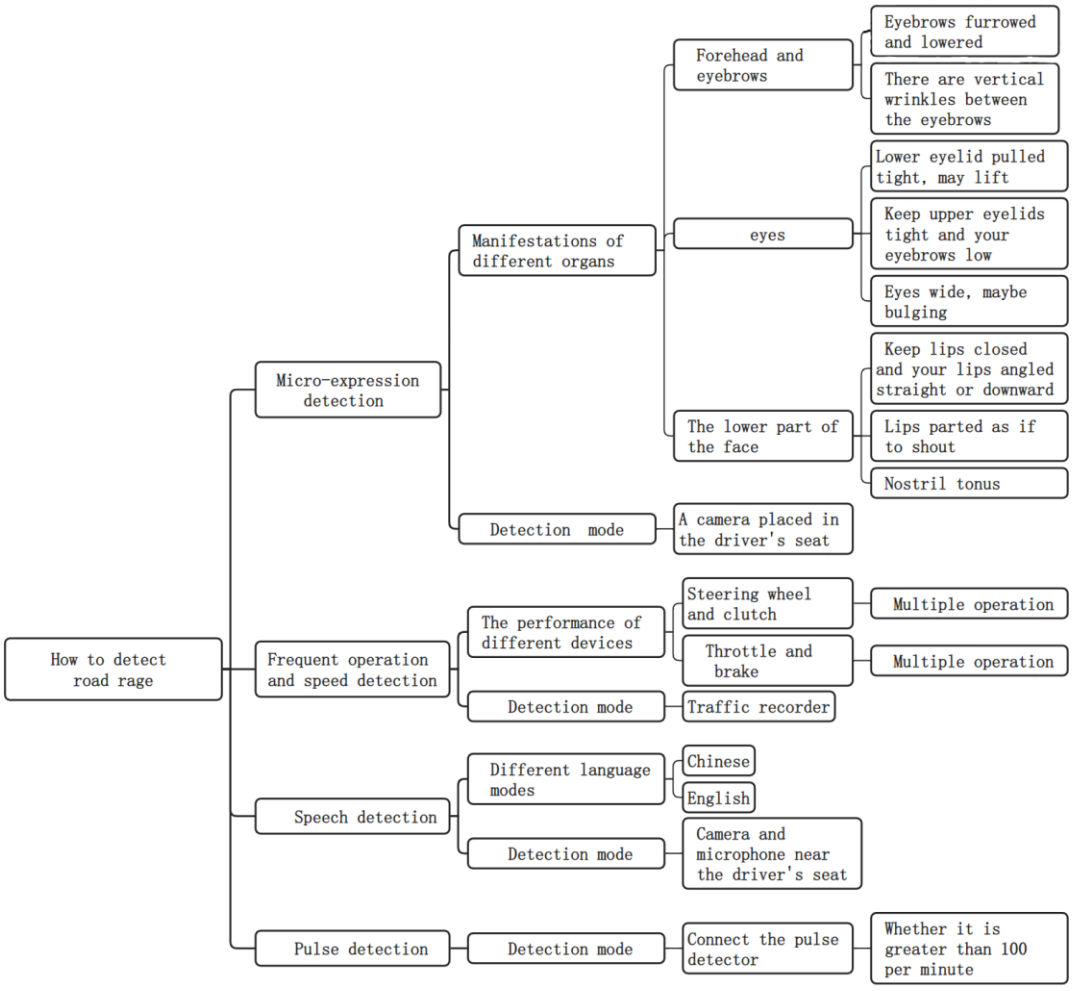

Figure 1. Multi-feature recognition of road rage

2.1. Facial Expression Recognition Technology

Through the capture and recognition analysis of the driver's facial expression features during driving, it can effectively judge whether the driver is in the state of road rage. At present, there have been some studies on road rage expression recognition based on facial expressions [4].

By collecting information on the driver's facial feature point positioning, eye-eyebrow distance ratio and mouth opening and closing ratio, AdaBoost face detection algorithm based on Haar features is used to detect facial features, and integrated regression tree algorithm is used to locate facial feature points. The eye-eyebrow distance ratio and the mouth opening and closing ratio were calculated, and the driver's driving emotion was judged effectively by facial expression. Shiplu Das et al. obtained real-time data on facial expressions and head movements, including eyelid closure duration, blinking patterns, and head orientation. The image data is preprocessed, the deep learning model is used, and the CNN-LSTM network is combined to analyze and detect the driver's driving state through facial expressions [5].

Some researchers have proposed an expression recognition algorithm based on multi-layer perceptron, which is suitable for low-complexity expression recognition of embedded devices, and successfully deployed it to the actual system, and realized real-time monitoring of driver anger through data set training and model optimization [6].

To sum up, the technology combining facial expression recognition technology and video image recognition technology can effectively detect drivers' driving emotions and identify road rage more accurately.

2.2. Speech Feature Recognition Technology

Voice feature recognition is also an important method in road rage recognition. By processing and analyzing the driver's voice signal, the voice signal expressing the driver's emotion can be obtained, so as to judge whether the driver suffers from road rage. Speech signal processing technology includes speech feature extraction, speech signal enhancement, speech emotion analysis and so on. In the aspect of speech feature extraction, the commonly used features include Meir frequency cepstrum coefficient, inverse Meir frequency cepstrum coefficient and Gammatone cepstrum coefficient. These features can reflect the spectrum information and speech speed of the voice signal, so as to analyze the driver's emotions more accurately. In addition, speech signal enhancement technology is used to improve the quality of speech signals, including denoising, enhancing and other operations. Voice de-emotion analysis is to classify the driver's emotions by analyzing and modeling the characteristics of voice signals, so as to identify the emotion of road rage.

The researchers constructed a deep learning recognition algorithm for anger emotion based on speech features, and established a decision model integrating convolutional neural network and multi-head self-attention mechanism, which can better distinguish emotion categories and improve the robustness of the system, including MFCC, IMFCC and GFCC. This model establishes a "road rage" emotion diagnosis system based on speech features [7]. Some scholars have proposed a road rage recognition method for drivers that integrates facial expressions and voice signals. Convolutional neural networks are used to process the voice signals, and the voice signals and face information are fused and analyzed to improve the accuracy of road rage recognition [8]. Foreign scholars Miaomiao D and others proposed to use voice recognition technology to accurately measure drivers' trust in autonomous vehicles, and use backward propagation neural network to train the extracted voice feature data to verify the effectiveness of driver's voice recognition and improve the accuracy of voice feature recognition technology [9].

To sum up, the road rage recognition method based on voice features includes voice signal collection and processing technology, and the road rage recognition model is established through the collected voice data. The voice signal processing technology is used to extract and enhance the driver's voice

signal, and the road rage emotion recognition model is used to effectively monitor the driver's driving emotion. These methods provide effective technical support for road rage monitoring.

2.3. Physiological Signal Recognition Technology

The collection and recognition of physiological signals are also important methods for road rage detection. Physiological signals include ECG signal, respiratory signal, skin electrical signal and so on. The analysis of these signals can reflect the driver's emotional state and driving situation. Therefore, through real-time collection and analysis of drivers' physiological signals, road rage can be effectively captured and traffic accidents caused by it can be reduced.

Chinese researchers have improved the accuracy and comprehensiveness of road rage recognition by fusing multi-modal information from physiological signals, EEG signals and driving behavior data. This method has been effectively verified in the simulated driving experiment, which can accurately identify the driver's anger emotion, and establish the mechanism model of driving risk under the influence of anger emotion by analyzing the driving behavior under anger emotion, providing theoretical support for driving safety [10]. Liang Qin built a driver's emotion recognition model based on ECG, respiration and pulse signals through the actual collected driver's emotional physiological data during driving. This model can accurately classify the driver's emotions into four types: calm, happy, sad and fear, and can accurately identify different emotions. This study studied the driver's emotion recognition and explored the driver's emotion regulation methods to provide the basis for safe driving [11].

Foreign researchers Verma K G et al. proposed a multi-modal fusion framework based on multi-resolution analysis to improve the accuracy of anger emotion recognition by combining physiological signals of different modes. Using the data from DEAP database, it is found that this method can effectively improve the accuracy of emotion classification, with an average accuracy of 81.45%, and the accuracy of depression emotion recognition is the highest, reaching 85.46%. This model greatly improves the accuracy and comprehensiveness of anger emotion recognition [12].

Research has shown a strong correlation between physiological signals and emotional states. Therefore, through the analysis and processing of physiological signals, the mapping relationship between physiological signals and emotional states can be established, different emotions can be classified, and special emotions of road rage can be divided, so as to more accurately monitor and score drivers' driving conditions and improve driving safety.

3. MULTI-DATA FUSION DESIGN

3.1. Multi-feature Fusion Strategy

Because of the limitations of single information and many subjective factors, the accuracy of road rage identification is often low. Therefore, multiple recognition research is carried out by selecting appropriate fusion strategies.

The appropriate fusion strategy has an important impact on the improvement of the recognition accuracy of drivers' road rage. The analysis is based on the existing research literature. First, the setting of the original data layer: the original data includes the driver's driving record text, the image of angry expression, the audio of insulting speech, the pulse sensor data, etc. Secondly, information extraction layer: through statistics, text analysis, image processing and other methods to extract features, such as speech word model, image feature vector and so on. The four patterns matching road rage symptoms were extracted and counted, respectively, Ne, Np, Nl and Ni. Third, the data transformation layer: converting data into a format suitable for analysis. If Ne is greater than the maximum value of Nemax, E=1; otherwise, E=0. If Np is greater than Npmax, P=1; otherwise, P=0; if Nl is greater than Nlmax, L=1; otherwise, L=0; If Ni is greater than 100 times per minute, then I=1,

otherwise I=0. Finally, the data analysis layer: the extracted different information is weighted and fused to determine road rage and implement interventions.

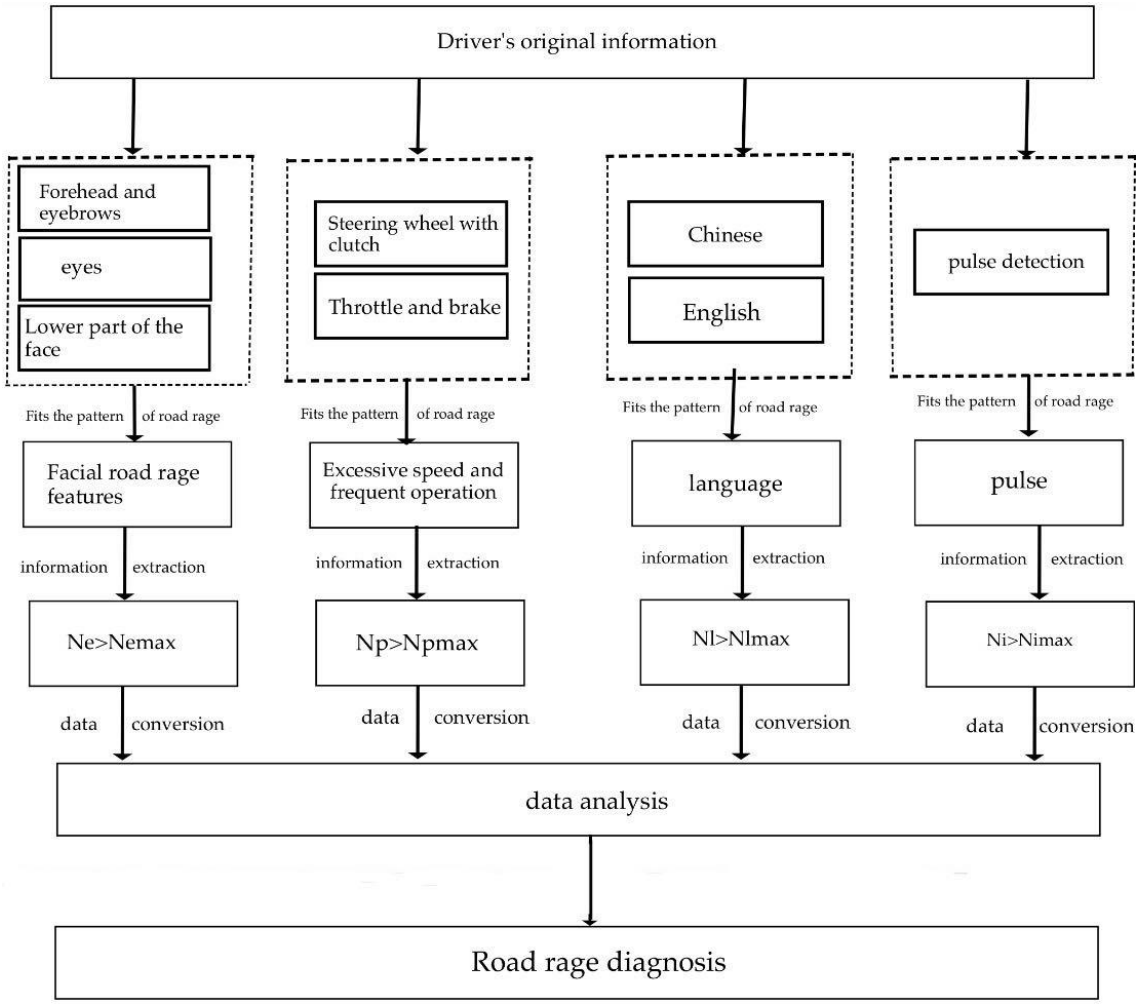

Figure 2. Road rage multi-feature fusion

3.2. Weight Allocation in Road Rage Tests

In the importance ranking of road rage features, weight distribution was applied to determine the degree of influence of different features on the prediction results. Reasonable weight allocation can improve the accuracy of decision and generalization ability.

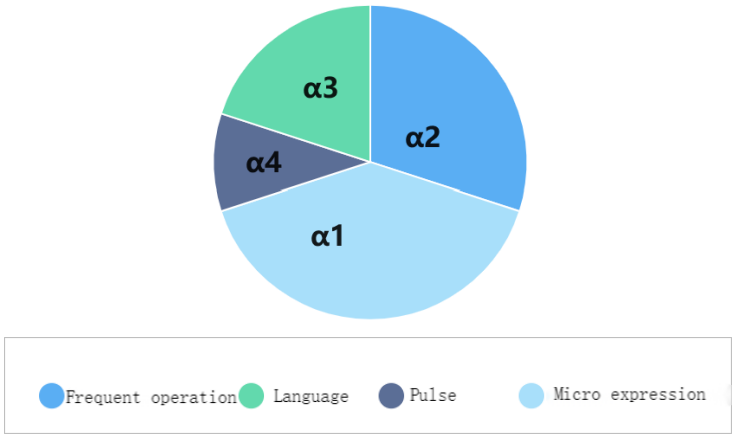

Figure 3. Weight distribution graph

Weight value assignment: micro expression-α1, frequent operation-α2, language-α3, pulse-α4

3.3. Assess Road Rage and Intervene

Dimension evaluation: 1 is set as yes, 0 is set as none, and road rage intervention is carried out by using formula dimension greater than a certain value.

Formula: sum=E×α1+P×α2+L×α3+I×α4

E - Micro expression

P- Frequent operation

L-language

I-pulse

When the total sum is greater than 50%, the driver is judged to be road rage

Intervention method: If the sum value is > 50%, the driver is identified as road rage, and the driving state is changed to automatic driving.

4. CONCLUSION

In the research of road rage recognition, multi-feature fusion technology plays a crucial role. It combines the characteristic information of different modes to improve the accuracy and reliability of road rage identification. For example, the integration of facial expression and voice emotion can provide rich emotional information, physiological signals can reveal the driver's emotional state from the internal physiological response, and video images can intuitively capture the driver's angry behavior. The integration of these features enables the recognition system to comprehensively judge whether the driver is in a state of road rage from multiple angles, thus greatly improving the accuracy of recognition. But there are the following shortcomings,

(1) This paper can only extract parts of facial apparent features, ignoring other supplementary auxiliary features, and there are certain differences in facial expressions of different drivers. At the same time, the feature recognition of voice road rage is only in Chinese and English, which has major defects, so the feature extraction of road rage is not comprehensive enough. In the subsequent research, we should consider combining facial apparent features and neural network methods to extract features. Moreover, multi-language recognition system is added to improve the accuracy of road rage identification.

(2) Without the support of experimental data, the weights of each anger feature need to be optimized. Only reasonable weight allocation can effectively integrate the four road rage features of facial expression, driving control, voice text and physiology to ensure the reliability and applicability of road rage discrimination.

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