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Application of Fuzzy Recognition Neural Network Algorithm in Fatigue Detection

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Abstract: With the rapid implovement of the transportation industry, traffic accidents have become one of the difficult problems faced by various countries. Statistics show that driver fatigue is one of the vital causes of traffic accidents. The problem of driving fatigue has attracted the attention of many people in the world. Western developed countries have invested huge manpower, financial resources and material resources, and extensively carried out research work on driving fatigue. Effectively monitoring and preventing fatigue driving is of great practical significance for reducing traffic accidents and ensuring the safety of drivers. With the rapid implovement and application of computer, it has become the mainstream direction of fatigue detection to judge the driver's fatigue state through various algorithms by using the head image of the driver captured by the camera. In this paper, the fuzzy recognition neural network algorithm is adopted, and the extracted fatigue characteristic parameters are sent to the FNN for fatigue recognition. The input parameters, that is, the nodes of the first layer of the neural network, have only one output, and the output value represents the fatigue level.

1. Introduction

In recent years, with the increasing number of vehicles and the increasing complexity of road traffic conditions, traffic accidents occur frequently, which pose a great threat to people's lives and property [1]. At present, the most convenient and practical method is to adopt non-contact detection technique, but it is inaccurate to identify the driver's state only by a single fatigue symptom, and the existing fatigue detection technique rarely can effectively integrate various information to solve this problem [2]. Fatigue detection technique has always been a hot spot and an vital direction in the domain of automobile safety research, and it is an vital research aspect for domestic and foreign automobile manufacturers to improve automobile safety. Its research spans many disciplines such as computer vision, ergonomics, biomedicine, psychology and pattern recognition [3]. The method adopted in this paper is fuzzy recognition neural network algorithm. Fuzzy neural network (FNN), which combines the characteristics of fuzzy logic and neural network, is superior to fuzzy logic and neural network in the general sense, and offers a potential possibility for solving the control problems of uncertain nonlinear systems [4]. Using FNN to solve the problem of driver fatigue identification will be an effective attempt. With the continuous implovement of economy and the

progress of automotive electronics, the fatigue monitoring system will be constantly improved and improved, which will play an vital role in promoting the implovement of automotive safety [5]. In addition, the research and implovement of fatigue monitoring system with independent intellectual property rights has vital realistic consciousness for promoting the implovement of China's automobile modernization and enhancing the competitiveness of domestic automobiles [6].

2. Manuscript Preparation

2.1 Definition of Fatigue

Fatigue is a very complex physiological phenomenon, which can be generally divided into psychological fatigue and physiological fatigue. Psychological fatigue (also called mental fatigue) is characterized by inattention, slow reaction, low mood, decreased work efficiency and increased error rate. Both Chinese and western medicine have put forward their own views on fatigue theory, but all roads lead to the same goal [7]. And they all stay in the basic theory, and there is still a big gap from the practical application. Physiologically, fatigue is manifested by decreased muscle tension and weakness of limbs. Psychological fatigue and physical fatigue often appear at the same time [8]. In fact, the mechanism of fatigue may be caused by the comprehensive influence of various theories. People's central nervous system is in charge of people's attention, thinking, judgment and other functions. Whether mental or physical, the first and most sensitive reflection is the fatigue of the central nervous system, followed by the corresponding fatigue of the reflex motor nervous system, which is manifested as the blockage of blood circulation, the exhaustion of muscle energy, the production of lactic acid and the destruction of dynamic stereotypes [9]. In the process of human daily work and labor, some metabolites (lactic acid, adenosine, etc.) will gradually accumulate in the body tissues and blood, thus affecting the normal metabolic process [10]. The stimulation of human-computer interface to meridians and acupoints can be divided into benign stimulation and malignant stimulation. Benign stimulation is helpful to regulate the circulation of blood in meridians and viscera, while malignant stimulation can lead to local blockage of meridians or imbalance of blood circulation in meridians, affecting the normal physiological functions of viscera.

If you rest in time after a long time of labor and thinking, the fatigue substances will gradually decrease, thus making the human body out of fatigue [11]. In the process of mental and physical labor, the energy materials in the body are gradually consumed and not replenished in time. After the reserve energy in the human body is gradually exhausted, the human body will feel tired. Under driving conditions, there are three kinds of stimulating factors on the interface between people and seats: pressure stimulation, vibration stimulation and heat stimulation [12]. In different situations, they can be a good stimulus or a vicious stimulus. When human beings are engaged in long-term mental and physical labor, neurotransmitters and neuromodulators in the central nervous system will protect the human body, so as to prevent the human body from being damaged due to overwork.

2.2 Fatigue Detection Technique

In view of the harm caused by fatigue driving and the loss caused by fatigue driving, governments of various countries, relevant enterprises and institutions, as well as the research on fatigue detection pay special attention to it. As fatigue driving is one of the main causes of traffic accidents, foreign scholars have already studied the detection methods of fatigue driving in the early 20th century. However, due to the limitation and the level of science and technique at that time, the detection method of fatigue driving has not made much progress for a long time. The research results of traffic accident statistics show that traffic accidents are related to drivers' active safety

factors. However, the driver's active safety factors include many complex, changeable and deterministic factors, or have complex relationships such as time delay and nonlinearity, so it is difficult to analyze and control them with the usual control theory. Until the last 30 years, thanks to the implovement of sensor technique, information processing technique, artificial intelligence and other research domains, the research on fatigue driving has also made remarkable progress.

The fatigue detection method based on driver's physiological index can collect the fatigue parameters reflecting driver's fatigue more accurately and reliably, thus having higher detection accuracy. However, the driver needs to wear sensors to collect EEG, electrooculogram and other signals on his body, which makes the driver feel uncomfortable, indirectly affects the normal operation of driving, and sometimes blocks the driver's vision. Driving fatigue detection based on driving behavior refers to analyzing the driver's fatigue state by counting the rotation angle and amplitude of the steering wheel, the frequency and strength of the brake pedal and the gas pedal being pressed during driving. It is a non-contact detection method to realize fatigue driving detection by using vehicle behavior characteristics. It is mainly through comparing and analyzing the vehicle characteristics such as vehicle track, vehicle speed change, steering wheel rotation amplitude, vehicle track deviation, and distance in front of the vehicle when the driver is tired with those of the normal driving vehicle. Fatigue driving detection based on vehicle driving characteristics refers to indirectly estimating the driver's fatigue state by measuring the vehicle's driving speed, turning angle and deviation angle from the lane.

3. Application of Fuzzy Recognition Neural Network Algorithm in Fatigue Detection

3.1 Fnn

Artificial intelligence (AI) technique has been developing rapidly and breaking through constantly, which has increasingly attracted the attention of the society and the government and brought a lot of convenience to human life. The research of artificial network is mainly to directly simulate the structure and function of human brain. Although this research once fell into a trough in history, it has quickly become a “hot spot” in information science, cranial nerve science and mathematical science since its revival in the early 1980s. The combination of fuzzy logic and neural network is one of the key technologies to realize machine intelligence and one of the frontier directions in the domain of international artificial intelligence. It is of great significance to the implovement of expert systems, intelligent computers and intelligent machine systems with fuzzy information processing and associative learning mechanisms. The classical neural network model is shown in Figure 1.

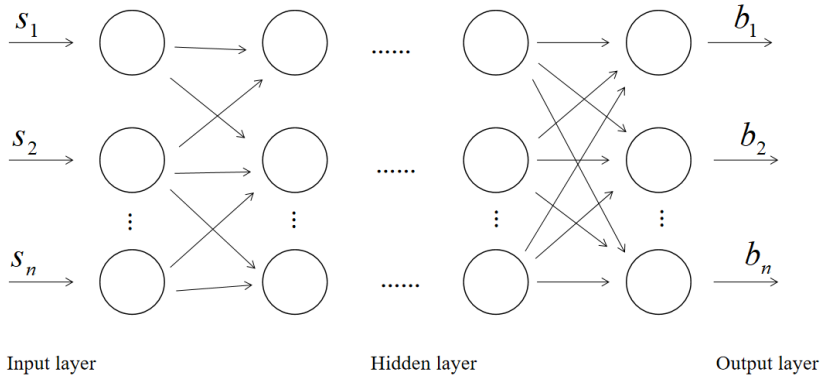

Fig.1 Classical Neural Network Model

The characteristics of artificial network determine that one of the most vital values of its research

is its intelligent application, and it is very difficult to realize this value simply by studying neural network, so it is necessary to organically combine intelligent science with the research of neural network. FNN is based on artificial neural network, which introduces fuzzy mathematics theory to deal with some information that traditional mathematics can't describe. Fuzzy theory and neural network are two very active research contents in the domain of artificial intelligence in recent years. FNN is the combination of fuzzy theory and neural network. It combines the advantages of neural network and fuzzy theory, and integrates learning, association, recognition, self-adaptation and fuzzy information processing. Fuzzy neurons are shown in Figure 2.

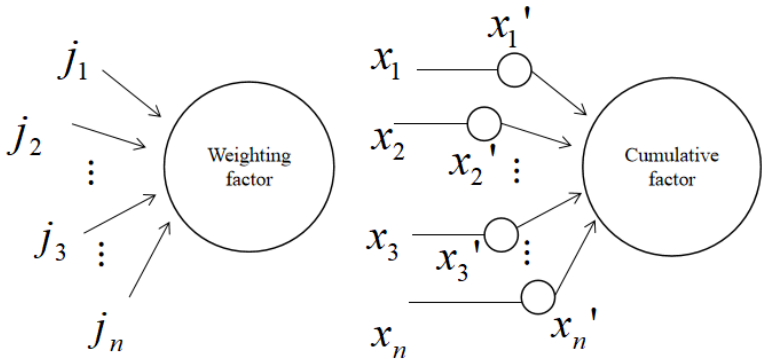

Fig.2 Fuzzy Neuron

Ordinary artificial neural network has powerful functions of self-learning, self-adaptation and association, but it is inconvenient to deal with fuzzy information. FNN is obviously different from ordinary artificial neural network. FNN has clear reasoning and can use expert experience. In the process of sample processing, its requirements for samples are low. In the process of weight learning, as few weights as possible change to speed up the learning speed. In the proposed learning algorithm, only a smaller number of weights need to be corrected in each step, which makes the learning speed faster, the learning accuracy higher, and the concept clearer and easier to understand.

3.2 Fatigue Identification System Based on Fnn

In this paper, the fuzzy reasoning system is used to make “intelligent” decisions by using human experience. Most driver fatigue detection algorithms simply divide the state of eyes into two categories: open and closed, ignoring the objective fact that fatigue is gradually generated, so it is not reasonable. The extracted fatigue characteristic parameters are sent to the FNN for fatigue identification. The input parameters, that is, the nodes of the first layer of the neural network, have only one output, and the output value represents the fatigue level. Certain parameters in the FNN are: the number of fuzzy partitions of each input component, the center and width of each fuzzy partition corresponding to the fuzzy function, and the output weight of the last layer. Fatigue itself is a rather vague concept, so it is difficult to analyze it with an accurate analytical model, and it is not reasonable to simply divide the driver's state into normal and tired. As a preliminary experiment, the face has a small inclination to make it easy to recognize. The collected video files are decomposed into frame images, processed by median filtering and denoised, and then input to the computer. Once the number of fuzzy partitions is determined, the number of points and connections of the whole network are determined, and the parameters to be learned are only the center and width of each fuzzy function and the output weight of the last layer. Because human fatigue itself is a vague concept, it is difficult to describe it by analytical model. A prominent feature of fuzzy reasoning is that it can transform people's experience into automatic control strategies, and it can make effective decisions for objects that are difficult to establish mathematical models. The FNN

given above is also a multi-layer feedforward network in essence, so the learning algorithm of adjusting parameters can be designed by imitating the feedforward network with the method of error back propagation.

4. Conclusions

With the increasing of all kinds of traffic accidents, the search for effective means to reduce traffic accidents has increasingly become the focus of attention of governments all over the world, and fatigue driving is one of the vital causes of traffic accidents with casualties. Therefore, the research and implovement of monitoring system to monitor and prevent drivers' fatigue driving has attracted the attention of governments and research institutions. Fuzzy neural algorithm is used to detect the driver's condition by extracting several fatigue parameters, which has a good effect. It is found that the detection result of fuzzy control depends on the formulation of fuzzy control rules to a great extent, and it needs to be tested and verified in different individuals, and the fuzzy control rules should be constantly modified and improved. There are still many problems that we need to explore and solve in this domain, but we believe that after unremitting efforts and sweat, we will be able to overcome difficulties one after another and win the final victory.

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