IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 15, Issue 1 Ser. II (January 2022), PP 31-38
www.iosrjournals.org

Research Status and Progress of Fatigue Driving Detection Methods for Agricultural Machinery

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Abstract: *China is in the process of transformation and upgrading from traditional agriculture to modern agriculture. The mechanization level of crops is constantly improving, and the types and quantities of agricultural machinery are increasing year by year. Fatigued driving is one of the important causes of agricultural machinery accidents, and fatigue driving detection of agricultural machinery has become a research hotspot. This paper reviews the definition of fatigue and driving fatigue, and two methods for fatigue detection, namely the subjective test and objective test, the former including subjective since the evaluation method and subjective evaluation method, which include testing the driver's physiological characteristics, behavioral characteristics, vehicle movement characteristics, and multiple information fusion methods, and summarizes the advantages and disadvantages of various testing methods, It provides an important basis for the study of fatigue driving detection of agricultural machinery in China.*

Key Word*: agricultural machinery production safety, fatigue driving, fatigue detection, development trend*

Date of Submission: 07-01-2022 Date of Acceptance: 22-01-2022

I. Introduction

In 2020, China will have 204 million sets of agricultural machinery and equipment, and the total power of agricultural machinery will reach 1.056 billion kW;; The comprehensive mechanization rate of crop cultivation and harvest in China has reached 70%, and agricultural machinery has become a necessary tool for agricultural economic development. The rapid development of agricultural modernization has promoted the rise in the number and types of agricultural machinery, and the demand for agricultural machinery drivers has increased.

Driving agricultural machinery is a special work, which has high requirements for the driver's technical ability. The agricultural machinery driver should not only control many components in the cab but also carry out appropriate operation tasks according to the field conditions at any time. Due to the seasonal characteristics of field operation, when carrying out the agricultural operations in a short time, the agricultural machinery driver should maintain a highly concentrated mental state during the operation. Overload operation makes the driver very easy to be in a state of fatigue, which will cause serious safety accidents.

Combined with the concept of fatigue driving, this paper analyzes the causes of fatigue driving, summarizes the research and development of fatigue driving evaluation systems and detection methods according to the performance of fatigue driving, to provide a reference for the research of fatigued driving in the field of agricultural machinery, improve the driving safety in the field of agricultural machinery, and promote the healthy and rapid development of agricultural production.

II. Fatigue driving of agricultural machinery

II. I. Fatigue and fatigue driving concept

Fatigue is a transitional stage from an awake state to sleep state. It is a subjective uncomfortable feeling with abstraction and uncertainty[1,2]. Fatigue is related to working hours, personal physical state, external environment, and other factors. It generally occurs under the action of long-term continuous operation, physical and mental consumption, or psychological pressure. It is specifically manifested in the reduction or loss of physical function, alertness, attention, judgment, and other abilities[3,4]. At present, although scholars at home and abroad have studied fatigue for a long time, there is still no specific definition of fatigue in the academic community.

Fatigue driving of agricultural machinery refers to the phenomenon that the driver subjectively feels tired when driving and operating agricultural machinery for a long time and continuously, resulting in the imbalance of physiological function and physiological function of the driver, and the decline of perception ability, decision-making ability and operation control ability. In this case, the agricultural machinery driver does not get rest and is still operating the agricultural machinery[5,6].

II. II. Causes of fatigue driving of agricultural machinery

With the increasing use of different vehicle types, the frequency of fatigued driving gradually increases. Fatigue driving also exists in the field of agricultural machinery driving. The main reasons for this phenomenon include:

i. To compete for agricultural time and pursue interests, agricultural machinery drivers maintain a highly concentrated mental state for a long time and continuously;

ii. The cab space is small and there are many operating elements. The driver's behavior is limited by the seat, and the driver's muscles are constantly tense;

iii. The driver focuses on and quickly responds to all kinds of information from the external environment. His mental state is tense and lasting. Once the driver is a little relaxed, it is very easy to feel tired and sleepy;

iv. Agricultural machinery drivers have long driving experience, strong driving confidence, and low attention to slight fatigue.

II. III. The external manifestation of fatigue driving of agricultural machinery

When the agricultural machinery driver is tired driving, it will have corresponding performance in psychological and physiological aspects. At the same time, the driving performance of agricultural machinery will also have deviation because the operation is different from that under non-fatigue state.

i. When the agricultural machinery driver is in a state of fatigue, the driver's psychological performance is: the driver's feeling, perception, thinking, judgment, will and other aspects have varying degrees of influence, the cognitive functions such as attention, perception, and motor control ability decline, and even the phenomenon of mental trance[4].

ii. In terms of physiology, agricultural machinery drivers blink frequently, yawn, doze, nod, frown, the rise of eyebrows drives the upper eyelids to open reluctantly, the corners of the mouth to fall, the bite is not tight (the mouth bends downward and the corners of the mouth contract inward), the facial muscles contract abnormally, the facial muscle tissue is loose and contract abnormally, and the emotional expression is reduced.

iii. In terms of the performance of machines and tools, due to the slow operation of the agricultural machinery driver, the decline of control ability, misoperation, and other reasons, there will be deviation of the operation track of machines and tools, sudden emergency stop or abnormal acceleration and deceleration of machines and tools, failure to slow down in time or too small turning radius when turning on the ground or road during sowing, tillage or tractor transportation.

III. Fatigue evaluation system

Fatigued driving is an important research content, and the establishment of a specific evaluation system helps to promote the development of this research. Therefore, domestic scholars have explored the problems that fatigued driving is not easy to quantify, mainly through the establishment of models to concretize the research on fatigue driving and improve the accuracy of the research.

Wang Lianzhen[7] and others conducted quantitative research on the fatigue driving state. With the help of one-way ANOVA, they tested and analyzed the changes of various factor indexes, determined the relationship between the influencing factor indexes of driving fatigue and driving time, and established a feasible and effective index calculation model based on Fuzzy Comprehensive Evaluation based on K-means cluster analysis. Zhao Guang[8] and others analyzed the influencing factors affecting road safety, screened and determined the main factors affecting driving safety such as driver's ability, determined the hierarchical judgment and weight assignment of the influencing factors according to the fuzzy comprehensive evaluation theory, realized the quantitative research, and constructed the fatigue driving risk model based on BP neural network theory, which can evaluate the driving risk. Gong Guocheng[9] studied the fatigue driving modeling, processed the experimental data by using Gaussian normalization and other related algorithms, and obtained the threshold range between normal and fatigued driving by medical Markov model and information entropy, which provides theoretical guidance for the establishment of fatigue driving model.

IV. Fatigue driving detection method

Fatigue detection is an important content to prevent and reduce fatigue driving. According to the research progress at home and abroad, fatigue driving detection methods are mainly divided into subjective and objective categories[10]. Subjective detection methods include subjective self-assessment and subjective other assessment, and its core lies in the standardized questionnaire form; Objective detection method includes driver's physiological characteristics, behavior characteristics, vehicle parameters, and a variety of information fusion.

IV. I. Subjective detection method

The subjective evaluation method includes the subjective self-evaluation method and the subjective other evaluation methods. The difference between them lies in the different evaluators. The subjective self-assessment method is mainly that the driver expresses his fatigue feeling before, during, and after the driver's operation, and adopts the fatigue scale specially formulated for the driver's subjective fatigue feeling to analyze and judge whether the driver is tired and the degree of fatigue according to the driver's expression content and the completed fatigue scale[11]. Subjective other evaluation method refers to allowing experts to judge the driver's fatigue state on the driver's facial expression, facial characteristics (blinking, yawning), head and neck posture, and driving behavior[12].

The fatigue self-assessment scale was studied earlier in foreign countries. The Japanese Institute of industrial health developed the fatigue conscious symptom questionnaire, which was modified into the job fatigue symptom self-assessment scale (WRFFQ)[13]. Smets[14] put forward the Multidimensional Fatigue Scale (MFI-20), which puts forward five dimensions, including general fatigue, physiological fatigue, psychological fatigue, emotional fatigue and decreased vitality. In addition, there are Stanford Sleepiness Scale (SSS), Karolinska sleepiness scale (KSS), Pearson, and Byars fatigue self-examination[15]. Most of the domestic fatigue assessment scales are revised based on foreign scales and in line with the actual situation of our country. The Dundee stress state scale revised by Dou Guangbo[16] is helpful to the driver's fatigue characteristics and the change of driver's stress during driving and has high reliability and validity.

The subjective evaluation method has the advantages of simple operation, low cost, and less interference; The subjective self-assessment method is affected by the individual differences and of drivers. The questionnaire items are many and fuzzy, which interferes with the driver's self-assessment; The subjective evaluation method lacks the unified evaluation standard of experts; Its reliability and validity are low, so this kind of method can only be used as an auxiliary detection method.

Ⅳ. Ⅱ. Objective detection method

Ⅳ. Ⅱ. Ⅰ. Detection method based on driver physiological parameters

The detection method based on the driver's physiological parameters mainly uses various physiological signal sensors to obtain the driver's physiological parameters related to fatigue, to judge the driver's fatigue state and fatigue degree. Common physiological signals include EEG, ECG, EMG, RSP, GSR, skin temperature, pulse, blood pressure, etc.

Ⅳ. Ⅱ. Ⅰ. Ⅰ. Detection based on EEG

EEG is considered by many researchers as the most reliable fatigue evaluation index, which is called the "gold standard" for detecting fatigue states. It can directly measure the neural activity state of driver's brain[17]; With the change of driver's fatigue during driving, the θ Wave and δ The waves vary greatly, α Wave and β Small wave variation; The frequency range and meaning of each band in EEG are shown in Table 1[18]. By analyzing the difference of EEG signals between awake and fatigue, the driver's fatigue state can be judged.

Table 1: Frequency range and meaning of each band in EEG signal

Band	Frequency range	Meaning
α	8-13Hz	The adult range is 50μV, it is obvious when you are relaxed or closed your eyes and awake.
β	14-30Hz	5-20μV.Occurs when concentration or emotional tension
θ	4-7Hz	10-50μV.It increases with the increase of cognitive activities, which is related to the attention control mechanism, learning and memory function.
δ	0.5-4Hz	20-200μV. It is called sleep wave, which appears in adults' sleep state with low frequency and large amplitude.
γ	>30Hz	The frequency band with the largest frequency is related to attention and is not common in the awake state.

Brookhuis[19] et al. Analyzed the EEG signals of drivers under different driving conditions by simulating the EEG signals collected by drivers and found that α The correlation between wave and fatigued driving is high. Jos Ém[20] et al proposed to use wearable single-channel EEG equipment to obtain the EEG data of the driver from alert to fatigue state and analyze its change law. Combined with the results of the subjective scoring method, it is proved that the equipment can effectively detect the driver's fatigue state. Gao Li[21] of Beijing University of Technology found the ratio of EEG power spectrum through simulated driving experiment $(\alpha + \theta)/\beta$. It can quantitatively describe the driver's fatigue state. The higher the value, the more serious the fatigue degree is. Xue Lei[22] of Jilin University recorded the EEG signals of drivers from waking to fatigue and compared the average power ratio of EEG power spectrum to $F_1=(\alpha + \theta)/\beta$ And $F_2=\theta/\beta$. As a characteristic index to evaluate the level of fatigue driving; Combined with the results of subjective evaluation, the fatigue state is divided into four levels, and the characteristics of fatigue state are classified and identified by support vector machine. The experimental results show that this method can effectively identify drivers' different degrees of fatigue state.

Ⅳ. Ⅱ. Ⅰ. Ⅱ. Detection based on ECG

ECG signal is also a very important physiological signal in the analysis of driving fatigue. ECG signal will decline regularly in the state of fatigue. Researchers have shown that heart rate (HR) and heart rate variability

(HRV) can directly measure driving fatigue; Heart rate (HR) index can reflect the physiological and psychological load of different job requirements, but there are many interference factors; Heart rate variability (HRV) can reflect the driver's mental fatigue and physical fatigue. Mehler[23] et al. Used the analog driver to collect the driver's ECG. Through the analysis of the ECG center rate, it was found that the heart rate index increased significantly with the increase of operation difficulty. Through the research on the driver's mental state and heartbeat law, Walter[24] et al. Found that the faster the driving speed, the more the driver's heartbeat times, and the heartbeat significantly slows down during fatigue. They believe that the change of heart rate index can effectively detect driving fatigue. Through the simulated driving experiment, Zhao Xiaohua[25] found the change law of ECG signal with driving time, obtained the comprehensive evaluation indexes by using the method of principal component analysis, obtained the direct change law between various indexes and fatigue state, and came to the conclusion that the state of fatigue driving is described by the change of ECG signal. Xu Lisheng[26] et al. Proposed a fatigue detection algorithm based on short-term ECG signals. The algorithm combines the features extracted by convolutional neural network and the time-domain and frequency-domain features of the R-R interval sequence and classifies it by random forest classifier. This method not only shortens the detection time but also has high accuracy.

Ⅳ. Ⅱ. Ⅰ. Ⅲ. Detection based on EMG

According to different electrode acquisition methods, EMG signals can be divided into needle electrode EMG signals and skin surface EMG signals (sEMG), in which skin surface EMG signals (sEMG) can reflect the changes in muscle function during exercise. After the surface EMG signals are processed and analyzed, the average power frequency (MPF), median frequency (MF) Electromyography (iEMG) and root mean square (RMS) are important indicators to reflect muscle fatigue. To explore the fatigue driving situation of long-distance drivers, Hostens I[27] and others found that the EMG value increased and the average power frequency decreased after fatigue through the experimental analysis of their sEMG. By studying the change curve of MPF value, Wang Tianbo[28] found that when muscle fatigue began to appear, it was accompanied by the rapid growth of MPF value. When the growth trend of MPF value gradually slowed down, the driver's muscle was in a state of fatigue. When MPF value began to decline, the driver's fatigue degree increased, which verified the effectiveness of the EMG signal in evaluating physical fatigue.

The detection method based on the driver's physiological parameters can directly and reliably reflect the actual fatigue state of the driver in the driving process, and its detection accuracy is high. However, the sensor equipment is expensive and the detection cost is high, and the signal acquisition is easily interfered with by external signals. Contact sensors can make the driver feel uncomfortable, affect the line of sight and interfere with normal operation. This kind of method is difficult to popularize and apply in the actual driving process.

Ⅳ. Ⅱ. Ⅱ. Detection method based on driver behavior characteristics

The method mainly uses computer vision technology to process the captured driver image data, obtain the fatigue characteristic parameters, and then judge the fatigue state of the driver. Driver's behavior features mainly include facial features and movement features. The driver's driving state can be judged by the abundant facial feature information of the driver in the fatigue state. Researchers at home and abroad have applied computer vision technology, image processing technology, and deep learning technology to the detection of fatigue driving.

A large number of researchers have carried out a series of research on fatigue detection based on facial feature parameters. M. A. puspasari[29], a foreign researcher, studied the eye indicators under long-time driving conditions to reflect the driver's fatigue degree, verified the fatigue level of eye indicators with Karolinska Sleep Scale (KSS) as a subjective parameter, and divided the eye indicators and KSS into fatigue stages through descriptive statistics, Support vector machine (SVM) is used to classify the fatigue state. Fang B[30] proposes a fatigue detection method based on multi facial feature fusion algorithm, which comprehensively analyzes various facial states such as blinking, yawning and head offset, to improve the reliability of fatigue driving detection. Yang et al[31]. Detects the face through multi-task cascaded convolutional neural network, determines the driver's eye area according to the face proportion relationship, uses the parallel neural network of convolutional neural network, and residual neural network to identify the driver's eye-opening and closing state, and judges the driver's fatigue state according to PERCLOS standard.

Zhang Nana[32] judges the driver's fatigue state by the driver's head posture based on the key points of the face. The experimental results show that the real-time performance and accuracy are good. Qu Haoran[33] studied driving behavior detection. Using the characteristics of non-contact and small interference of machine vision, PERCLOS fatigue parameter and blink frequency fusion method were selected to detect fatigued driving and telephone driving. The whole process from face location to eye feature extraction was studied and realized, with strong real-time performance and high detection accuracy. Some researchers believe that the driver's hand motion characteristics can also be used as one of the ways to detect driving fatigue. Yuanhui[34] realized the driver fatigue detection method based on hand tracking, tracked and located the driver's hand position by using the template matching method, explored the changes of hand center coordinates under the driver's fatigue state, and judged the driver's fatigue state.

The way to detect the driver's behavior characteristics will not affect the driver's normal operation, will not interfere with the driver's realization range, and the non-contact acquisition will not cause a psychological burden. It is convenient to detect the driver's fatigue state in real-time, and has a good development prospect. However, this method also has some problems. The fatigue detection algorithm is complex, the detection time is limited by the performance of the calculation unit, and the detection results are also easily affected by light conditions, individual differences of drivers, and so on.

Ⅳ. Ⅱ. Ⅲ. Detection method based on vehicle motion parameters

The detection method based on vehicle motion parameters refers to the method of using sensor equipment to obtain vehicle motion parameters. There are differences between vehicle motion parameters under fatigue driving state and normal state, and then judge the driver's fatigue state through the different analysis of various indicators. This method is an indirect method to detect driving fatigue[35].

Marie havlikova[36], a foreign researcher, collects and analyzes the amplitude spectrum of driving trajectory during driving fatigue through driving simulation experiments. Mohan[37] obtains the vehicle state information through the inertial measurement unit and accelerator pedal sensor, classifies the fatigue characteristic data by ANN, and judges the driver's fatigue state. Meng Chai et al[38]. Studied the steering wheel state to detect the driver's sleepiness. Firstly, 11 characteristic parameters related to the steering wheel are obtained through the driving simulator. Secondly, four significant fatigue features are selected by the method of analysis of variance. Finally, the multi-level ordered logic model is constructed to judge whether the driver is in the fatigue state. Liu Yangyang[39] uses multiple sensors to extract multiple characteristic parameters such as vehicle pedal, steering wheel operation, and vehicle speed to judge the driver's fatigue state.

The detection method will not interfere with the driver's operation, and the acquisition equipment can be more compatible with the vehicle, which is convenient for the installation of sensors; However, this method has many interference factors, is easily restricted by vehicle model, actual road condition information and driving habits has poor real-time performance, and has poor accuracy in judging the degree of fatigue; In addition, it is also important for the driver to ensure driving stability in the face of emergencies. The driver's driving stability is poor, resulting in driving conditions under a quasi fatigue state, leading to fatigue misjudgment. Although this method has many limitations, many researchers integrate vehicle behavior characteristic indexes with other types of characteristic indexes to construct a multi-information fusion detection method, which improves its robustness and reliability.

Ⅳ. Ⅱ. Ⅳ. Detection method based on multi-information fusion

To sum up, any fatigue testing method has its advantages and disadvantages, as shown in Table 2. Therefore, current researchers gradually tend to collect, process, and analyze data synchronously based on multiple information fusion methods.

Table 2: Comparison of advantages and disadvantages of fatigue testing methods

Test method	Advantage	Inferiority
Subjective evaluation method	Simple operation and low cost ；	Subjective consciousness is too strong ;
Physiological parameters	Objective, reliable and accurate ；	Affected by electromagnetic interference, it is invasive to the driver and the cost is high;
Driver behavior characteristics	Non-contact, informative ；	Large individual differences;
Vehicle motion parameters	Strong safety and no interference to the driver。	High false-positive rate, high cost, and many interference factors.

In the process of studying fatigue driving, the driver's physiological information, driving behavior information, and vehicle behavior information are integrated, the information is complementary to each other, and the driver's fatigue state is determined from different angles. In addition, with the development of deep learning technology and its application in many fields and achieved remarkable results, many researchers apply deep learning technology to the detection of fatigue driving.

Sasikumar S[40] and others realize the fatigue detection system integrating the driver's facial characteristics, physiological characteristics, and vehicle behavior characteristics. The system obtains the fatigue threshold by analyzing various characteristic indexes. When the driver reaches the set fatigue threshold, the alarm system will give an audible reminder. Craye C et al[41]. Found the correlation between the audio data related to fatigue, and fused the audio and image, heart rate, steering wheel, and pedal characteristic parameters to evaluate the driver's fatigue state. With the development of deep learning technology, researchers have proposed the method of using a neural networks to extract fatigue characteristics and data fusion. The fatigue driving early warning system was designed by Zhao et al[42]. Discriminates fatigue driving by analyzing characteristic parameters such as steering wheel angle, driver grip strength, and heart rate, and establishes a data analysis system based on fuzzy c-means clustering theory. Finally, the KNN classifier is used to establish the relationship between the characteristic index and fatigue degree.

Zhou Lingxiao[43] fused EEG, ECG, and eye movement features based on a support vector machine and artificial neural network to detect the driver's fatigue driving state. The system can detect the driver's fatigue state in real-time and give early warning in time. Hou Lei[44] fused EEG signals with image signals at the decision-making level, constructed a fatigue detection model, studied the fatigue recognition of comprehensive features and single features, and found that the effect of comprehensive features is better than that of single features. Based on the ensemble learning of the weighted average method, Bian Jun[45] fused the eye features and pulse signals at the decision-making level to identify the driver's fatigue state. Liu Yiqing[46] proposed a fatigue detection method integrating face detection and driver behavior detection. The fatigue discrimination model was constructed by integrating driver face features and action features and combined with the PERCLOS index. Li Xiang[47] proposed a fatigue detection method based on speech multi-features. According to the speech data collected in the fatigue state, a multi-feature fusion classifier is constructed to identify whether the driver is in the fatigue state.

V. Research on fatigued driving in the field of agricultural machinery

The research of fatigue driving detection in the field of agricultural machinery started late and achieved relatively few results. The particularity of agricultural machinery operation, the diversity of agricultural machinery types, and the complexity of the agricultural machinery operation environment have greatly deepened the difficulties in the research of fatigue driving, which has not deterred all kinds of agricultural colleges and universities. To expand the research of fatigued driving to the field of special driving, improve the application of fatigued driving in different fields and increase the safety of agricultural machinery driving, Domestic universities and research institutions are constantly committed to the research on fatigue detection of agricultural machinery driving and have achieved some research results in the field of agricultural machinery driving.

Professor Kong Degang's team at Northeastern University is studying the correlation between drivers' physiological parameters and fatigue. Kong Degang studied the variation rule of tractor driver's heart rate with time under different operating conditions and determined the fatigue degree of the driver under different operating contents according to the increased rate of heart rate[48]. Su Jintao[49] continued his research in this field. By analyzing the change law of the driver's heart rate increase rate and the tractor seat vibration acceleration, it is found that the driver's fatigue increases with the increase of vibration acceleration. Tian Xiaofeng[50] described the fatigue degree of lumbar muscles of agricultural machinery drivers according to the change law of EMG signals of lumbar vertical spine muscle and multifidus muscle of agricultural machinery drivers. With the increase of operation time, the root means square value of lumbar EMG signals increased and the average power frequency decreased. Zhu Rongxin[51] used a multi-channel physiological signal acquisition instrument to collect the ECG signals of combined harvester drivers in normal operation. After analyzing three kinds of indicators based on the time domain, frequency domain, and nonlinear dynamic analysis, he concluded that ECG signals can effectively distinguish driving fatigue. Through the simulated driving experiment, Zhao Xiaohua[52] found the change law of ECG signal with driving time, obtained the comprehensive evaluation indexes by using the method of principal component analysis, obtained the direct change law between various indexes and fatigue state, and came to the conclusion that the state of fatigue driving is described by the change of ECG signal.

Lu Wei[53] of Nanjing Agricultural University proposed a tractor driver fatigue detection algorithm based on convolutional neural network (CNN) facial feature recognition, solved the interference of light on image data by using gamma brightness correction algorithm and wavelet packet algorithm, and recognized and located the driver's facial region based on face color model algorithm, The captured facial image information is input into a neural network for learning, to realize the fatigue state detection of tractor driver. Liu Weikun[54] of Jilin Agricultural University proposed a method based on machine vision to recognize the eyes and face of tractor drivers, used the Gabor filter to deal with the problem of uneven illumination, used the Haar feature method to extract facial features, used horizontal and vertical integral projection to locate the eye area, and used PERCLOS p80 standard to judge the fatigue state of tractor drivers. Chen Qiang and Dai Jun[55] of Suzhou University studied the detection of fatigue driving behavior of agricultural machinery drivers and proposed a strong classification set detection method combining Haar-like features with multiple weak classifiers trained by AdaBoost algorithm. CNN model was used to detect the driver's closed eye state, and the PERCLOS method was used to judge the fatigue state. The accuracy of this method was as high as 95.1%.

VI. Summary

The research on fatigue driving detection methods at home and abroad shows diversified development. The research on detection methods is based on automobile driving, mainly including driver physiological parameter detection, behavior feature detection, vehicle motion parameter detection, and multi-information fusion detection. With the gradual formation of automobile fatigue driving theory, scholars at home and abroad have made in-depth research on agricultural machinery fatigue driving and achieved some research results. At present, the fatigue driving of agricultural machinery is based on theoretical analysis and experimental detection. With the help of sensors and other detection devices, the reliability of fatigue detection of agricultural machinery is improved, and the detection technology has made a research breakthrough. However, there are still some problems in the fatigue detection of agricultural machinery, such as inaccurate classification, lack of unified scientific evaluation standards, and low adaptability of the detection device in a complex environments. Therefore, it is necessary to continuously deepen the research on detection technology and detection algorithm, establish a fatigue driving database, and develop high-precision non-contact detection methods, which will become an important research trend. Carrying out in-depth, high-efficiency, and accuracy research on fatigue driving detection can better adapt to the complex environment of agricultural machinery operation and the requirements of detection accuracy, and provide safety guarantee for the development of agricultural production, It is in line with the new agricultural production environment with the rapid development of agricultural mechanization and large demand for agricultural machinery production.

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Ping Zhang, et. al. “Research Status and Progress of Fatigue Driving Detection Methods for Agricultural Machinery.” *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS),* 15(01), 2022, pp. 31-38.