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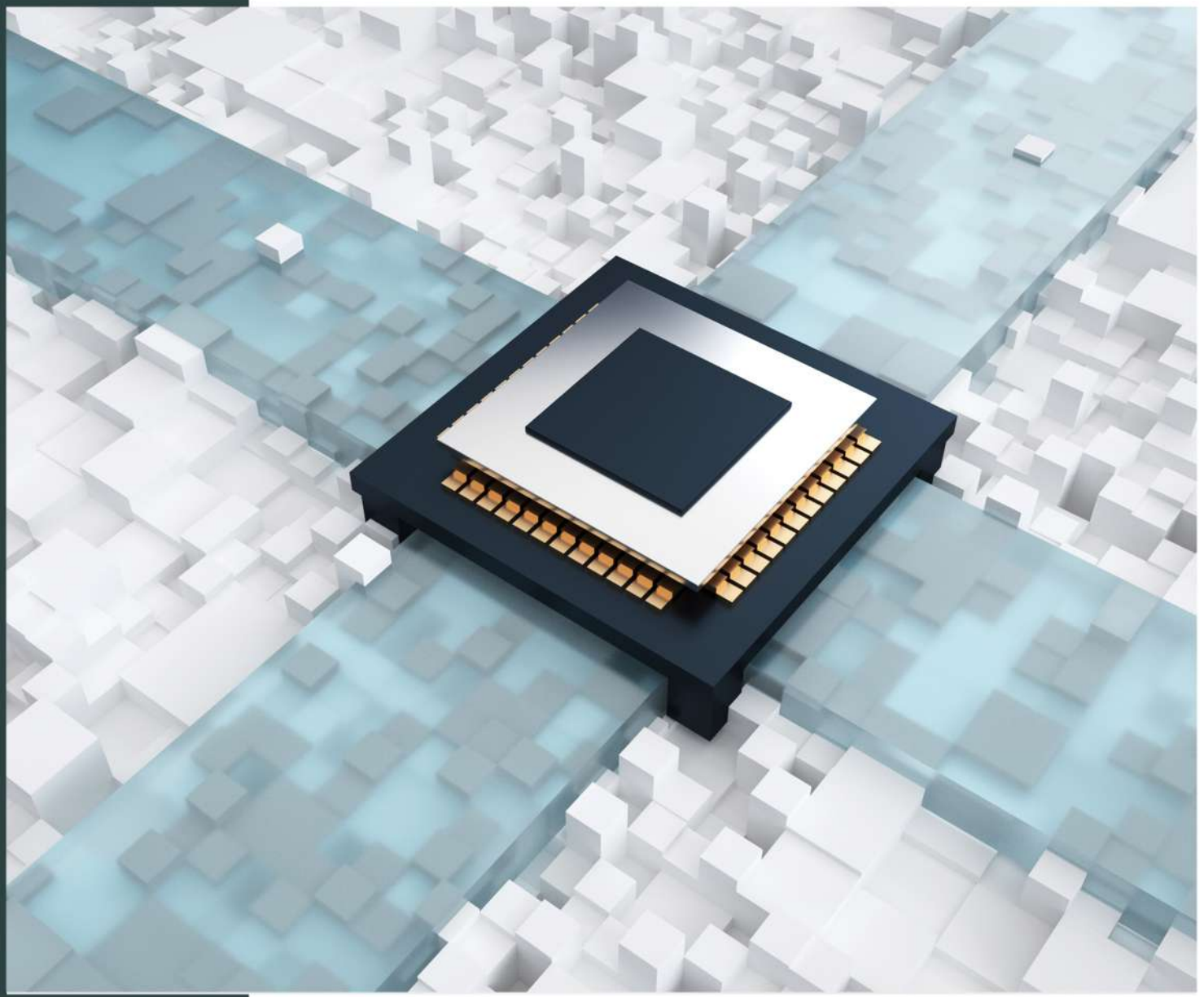

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Multi-factor Comprehensive Prediction of Delay Time through Congested Road Sections

Yuhang Wu[1*] Tong Jiao[2] Binggang Li[3]

1. School of Mining Engineering, North China University of Science and Technology, Tangshan, Hebei, 063210, China
2. School of Construction Engineering, North China University of Science and Technology, Tangshan, Hebei, 063210, China
3. School of Information Engineering, North China University of Science and Technology, Tangshan, Hebei, 063210, China

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ABSTRACT

The navigation software uses the positioning system to determine the traffic conditions of the road sections in advance, so as to predict the travel time of the road sections. However, in the case of traffic congestion, the accuracy of its prediction time is low. After empirical analysis, this paper establishes a multi-factor synthesis by studying 7 factors: traffic flow, number of stops, traffic light duration, road network density, average speed, road area, and number of intersections the prediction function achieves the purpose of accurately predicting the transit time of congested road sections. The gray correlation coefficients of the seven factors obtained from the gray correlation analysis are: 0.9827, 0.9679, 0.6747, 0.8030, 0.9445, 0.8759, 0.4328. The correlation coefficients of traffic volume, number of stops, average speed, and road congestion delay time were all about 95%, which were the main influencing factors of the study. The prediction needs to be based on functions. This paper fits the main influencing factors to the delay time of congested roads. It is found that the delay time varies parabolically with the traffic flow and the number of stops, and linearly with the average speed. Because the three impact factors have different weights on the delay time of congested roads, demand takes the weight of each factor. Therefore, the gray correlation coefficients occupied by the main influencing factors are normalized to obtain the weights of three of 0.340, 0.334, and 0.326. The weighted fitting function is subjected to nonlinear summation processing to obtain a multi-factor comprehensive prediction function. By comparing the original data with the fitting data and calculating the accuracy of the fitting function, it is found that the accuracy of each fitting function is close to 0, the residual error, the relative error is small, and the accuracy is high.

1. Introduction

In recent years, many countries are developing a real-time monitoring system capable of intelligently detecting traffic conditions. Some of them have achieved certain results. Regarding the determination of traffic congestion, Andrea et al. Used GPS trackers and smartphones to identify traffic in 2017. Congestion and accidents [1], Bauza and Gozalvez detected road traffic congestion based on the information exchange between vehicles and

**Corresponding Author:*
Yuhang Wu,
School of Mining Engineering, North China University of Science and Technology, Tangshan, Hebei, 063210, China;
E-mail: 2358198850@qq.com.

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vehicles, vehicles and infrastructure nodes in 2013 [2], but after inspection, they found that they have built a section on urban traffic flow The accuracy of travel time prediction models is not very high. Existing navigation software often uses GPS on taxis installed with this software to obtain real-time data to determine road conditions. However, in actual road conditions, there are many other factors For example, under the influence of other factors such as road network density, road area, number of intersections, traffic volume, average speed, number of stops, traffic light duration, etc., causing road traffic jams, the speed will be slow, so that the data obtained by people to estimate the speed Has a very large error.

In China, many experts and scholars are also engaged in the research of urban road traffic flow and delay forecasting. Among them, Professor He Guoguang of Tianjin University [3] and Professor Yang Zhaosheng of Jilin University [4] have achieved outstanding achievements in this field. They based on multi-dimensional time series and intelligent neural network, a more accurate model for predicting travel time of urban traffic flow sections was established. In addition, Xu Xuemeng, a graduate student of the University of Electronic Science and Technology of China, and her tutor Professor Liu Qiang [5] published intelligent traffic flow prediction and multipath. Research on optimization problems, but the accuracy is not very high when their models are used for large traffic flow densities, mainly due to insufficient consideration of traffic delays in their modeling.

Therefore, this paper takes this factor into consideration, first analyzes in detail the various factors that affect the density of traffic flow, finds seven of the main factors through data processing, and uses it as an index to measure the density of traffic flow. The main purpose is to delay time. Use gray correlation analysis [6] to get the weight of each indicator, and select the three indicators with the highest weighting for analysis, and then use the method of fitting [7] to predict the delay time. Accuracy, combining gray correlation and analytic hierarchy process, to obtain a comprehensive forecast delay time balance function, and substituting other examples into the model to verify the wide applicability and non-uniqueness of the model.

2. Objective Optimization Model Based on Grey Correlation

2.1 Data Processing

According to the 2016 Big Data Report on Intelligent Travel [8], this paper gets the ranking of peak congestion delay index in the morning and evening on weekdays.

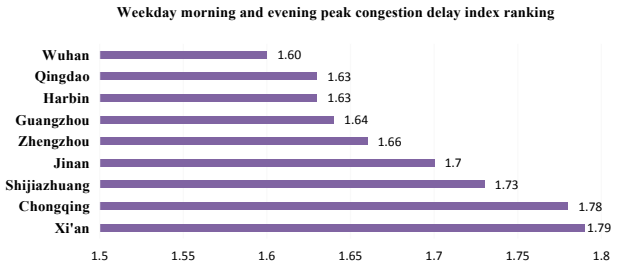

Figure 1. Delayed index ranking during peak periods

Figure 1 shows the morning and evening peak congestion delay time rankings of various cities in the country. It can be seen that the most congested morning and evening peak congestion cities are Xi'an, Chongqing, and Shijiazhuang, and Beijing ranks fourth. In order to make the study representative, this paper chooses the top four cities were selected as the research objects, and the road congestion delay data of each city were randomly selected, and the congested road sections were analyzed in real time.

The common travel modes in life are cars (including taxis), buses, bicycles, and walking. Among them, the impact of each travel mode on the delay time of road trips is shown in Figure 2.

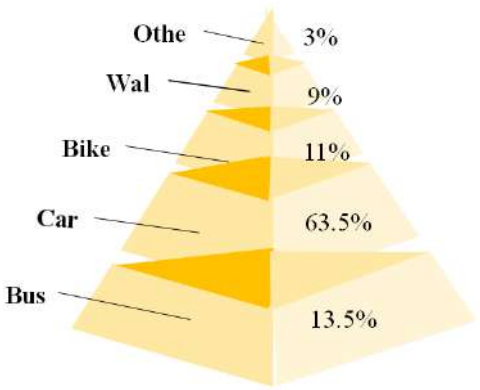

Figure 2. Proportion of travel modes

Figure 2 reflects the proportion of road delays caused by various travel modes. Among them, cars become the main travel mode causing time delays in congested sections, accounting for 63.5% of the total proportion. Therefore, this paper mainly studies the factors that affect the delay time of congested sections and cars. The relationship between the delay times further predicts the delay time of vehicles passing through congested roads.

During the morning and evening peaks of the working day, through the observation of the intersection, the congestion process was found to be five stages: no block, start of block, block, block start to dissipate, and dissipation. . Through statistical analysis, it is found that the morning

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and evening peak delays in the four cities are shown in Figure 3.

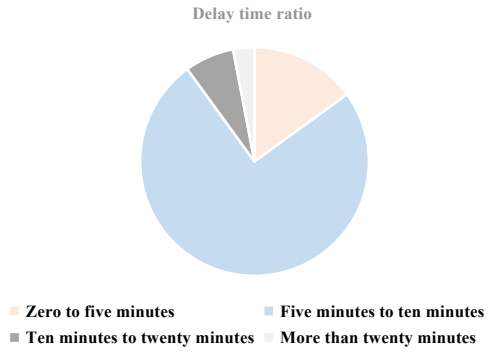

Figure 3. Proportion of delay time

It can be found from Figure 3 that during the morning and evening peak hours of the working day, the driving delay period is concentrated in 5~10 minutes, accounting for 75% of the overall delay time period. Therefore, in this paper, the study is carried out under the condition that the driving delay time is 5~10 minutes.

There are seven factors that affect the delay time during the peak driving period: road network density, road area, number of intersections, traffic volume, average speed, number of stops, and traffic light duration. The research points randomly selected in the four cities are processed and integrated. The data are shown in Table 1 [9].

Table 1. Data integration of factors affecting vehicle delay

Delay time(min)	5.0	7.0	8.0	9.0	10.0
Traffic flow(Vehicle/min)	128.0	170.0	204.0	220.0	248.0
Number of stops(Times/min)	114.0	158.0	172.0	188.0	206.0
Traffic light duration(min)	0.3	0.8	1.0	1.3	1.5
Road network density(article/km^2)	4.0	4.8	5.0	5.6	6.0
Average speed(km/h)	40.0	30.0	25.0	20.0	15.0
Road area(m^2)	120.0	110.0	105.0	100.0	95.0
Number of intersections(article)	6.0	5.0	5.0	4.0	4.0

2.2 Correlation Analysis

Through literature review, this paper finds 7 key factors that influence the delay time through congested road sections: road network density, road area, number of intersections, traffic flow, average speed, number of stops, and traffic light duration. The delay time through the congested section is selected as the reference sequence; the road network density, road area, number of intersections, traffic volume, average speed, number of stops, and traffic light duration are used as comparison sequences, respectively.

$$x_0 = \left\{x_0^{(k)|k=1,2,...,6}\right\} = \left(x_0^{(1)}, x_0^{(2)}, ..., x_0^{(6)}\right)$$

Where k is the point selected by the road segment. Followed by definition $\xi_i * k$, for comparing the number of correlations between the sequence x_1 and the reference sequence x_0 at time K, where $\rho \in (0,1)$ is the resolution factor.

$$\xi_i^*(k) = \frac{\min\limits_s \min\limits_t \left|x_0(t) - x_s(t)\right| + \rho \max\limits_s \max\limits_t \left|x_0(t) - x_s(t)\right|}{\left|x_0(k) - x_i(k)\right| + \rho \max\limits_s \max\limits_t \left|x_0(t) - x_s(t)\right|}$$

In the above formula $\min\limits_s \min\limits_t \left|x_0(t) - x_s(t)\right|$、$\rho \max\limits_s \max\limits_t \left|x_0(t) - x_s(t)\right|$,Do not refer to the minimum difference and the maximum difference between the series and the associated series. When the resolution coefficient ρ is larger, the resolution is larger, and the smaller the resolution coefficient ρ is, the smaller the resolution is. Thus, this paper takes $\rho = \frac{\rho}{2} = 0.5$.

Because the correlation coefficient in the formula is an indicator describing the degree of correlation between the comparison sequence and the reference sequence in each year, there are 6 correlation coefficients, so the correlation coefficient is too scattered, which is not conducive to intuitively reflecting the relationship between the comparison sequence and the reference sequence Therefore, this paper needs to get the average of the correlation coefficient.

$$r_i = \frac{1}{n}\sum_{k=1}^{n} \xi_i(k) \quad k = 1,2,3,...,7$$

The initialization sequence of each data is substituted into the above formula, and the average correlation coefficients of these 7 sequences can be obtained by using MATLAB software, as shown in Table 3.

Table 2. Relevant factor data

r_1	r_2	r_3	r_4	r_5	r_6	r_7
0.9827	0.9679	0.6747	0.8030	0.9445	0.8759	0.4328

It can be seen from Table 2 that the traffic flow, the number of stops, and the average speed have a great impact on the delay time through congested sections, about 95%. The length of traffic lights, road network density, and the number of intersections have a small effect on delay time through congested sections. Less than 80%, so the delay time and traffic volume, the number of stops, and the average speed through the congested roads are

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mainly related to the length of traffic lights, road network density, road area, and the number of intersections.

2.3 Find the Weight of the Main Relevant Factors

Through grey correlation analysis, the traffic volume, the number of stops, and the average speed are selected as the research objects. The correlation coefficients of the three on the delay time through congested roads are 0.9827, 0.9679, and 0.9445.

Therefore, the weights of traffic volume and average number of stops are:

$$w_1 = \frac{0.9827}{0.9827 + 0.9679 + 0.9445} = 0.340$$

$$w_2 = \frac{0.9679}{0.9827 + 0.9679 + 0.9445} = 0.334$$

$$w_3 = \frac{0.9445}{0.9827 + 0.9679 + 0.9445} = 0.326$$

2.4 Perform Data Fitting for Each Factor

By studying the congestion data of Xi'an, Chongqing, Shijiazhuang, and Beijing cars, this paper explores the fitting curves and functions of traffic volume, number of stops, average speed, and road congestion delay time.

After continuous fitting, it is explored that the traffic flow and the delay time through the congested road section change in a quadratic function image. Establish a mathematical fitting model of traffic flow and delay time according to the exploration paper:

$$y = ax^2 + bx + c$$

Parameter estimation observation worthy model:

$$y_i = ax_i^2 + bx_i + c \quad i = 1, 2, ..., n$$

The accuracy of the fit:

$$Q_i = \sum e_i^2 = \sum (y_i - ax_i^2 - bx_i - cx)^2$$

The parameters can be calculated using MATLAB software:

$$a = \text{-}2.222398897\text{e-}05 \qquad b = 0.049238$$

$$c = \text{-}0.86458674168 \qquad Q = 0.10530762$$

Get the model function:

$$y_1 = \text{-}2.222398897\text{e-}05x_1^2 + 0.049238x_1 - 0.86458674168$$

By fitting it, this paper obtains the trend graph of traffic flow and congestion time delay:

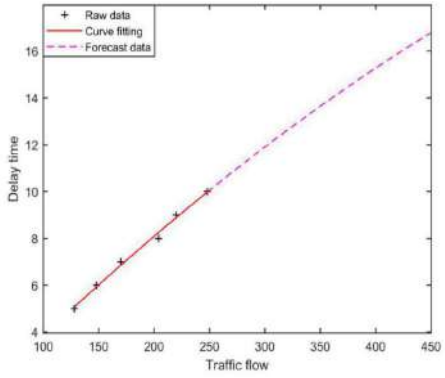

Figure 4. Traffic flow and delay time fit diagram

It can be found from the fitting function that the larger the traffic volume, the greater the probability of congestion and the longer the delay. With more than 250 passing vehicles per minute, road delays can exceed 10 minutes.

By the same reasoning, the fitting curve and function of road congestion delay time, number of stops and average speed are shown in Table 3.

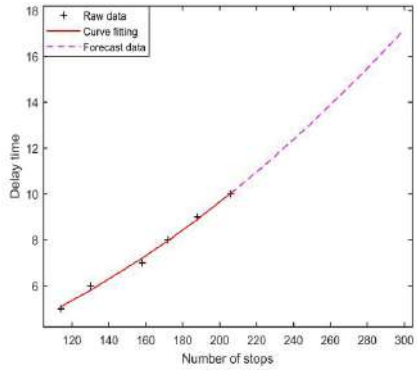

Figure 5. Figure of the number of stops and delays

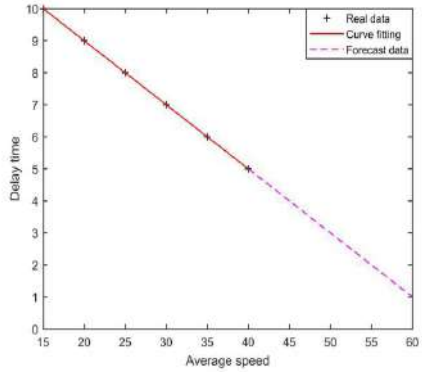

Figure 6. Average speed and delay time fit diagram

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Table 3. Delay time and the number of stops and the average speed

Figure of the number of stops and delays	Average speed and delay time fit diagram
Fitting equation y=1.19264895e-04x22+0.015584332x2+1.7611	Fitting equation y=-0.2x3+12.996
Contrast accuracy Q=0.09768167	Contrast accuracy Q=0.00000096

By fitting the curve and function between the two, it can be found that the more times the car stops, the greater the probability of congestion and the longer the delay. When the car stops more than 205 times per minute, the road delay time will exceed 10 minutes; the average speed is inversely proportional to the delay time. The lower the average car speed, the greater the probability of congestion and the longer the delay. When the average speed of a car is below 15 kilometers per hour, road delays can exceed 10 minutes.

2.5 Multi-factor Comprehensive Delay Time Prediction Function

By fitting three main influencing factors to road congestion delay time, this paper obtains three fitting functions about delay time. Because the three factors have different impact weights on road congestion delay time, this paper assigns a weight to the fitting function. A multi-factor prediction function is obtained to comprehensively judge the delay time of congested road sections.

$$y_{Delay} = 0.340y_1 + 0.334y_2 + 0.326y_3 = 0.340(-2.222398897e\text{-}05x_1^2 + 0.049238x_1 - 0.86458674168) + 0.334(1.19264895e\text{-}04x_2^2 + 0.015584332x_2 + 1.761123) + 0.326(-0.2x_3 + 12.996)$$

2.6 Model Checking

In order to carry out the simulation test, the real-time data of the research point should be substituted into the comprehensive prediction equation to obtain the fitting value of the delay time. Table 4 shows the residuals, relative errors, and step deviations obtained using real data and fitted data.

Table 4. Lative error, grade ratio deviation value data table

Serial number	Original value	Model value	Residual	Relative error	Ratio deviation
1	5	5.0531	0.0531	0.0106	-0.0425
2	6	5.9110	0.0890	0.0148	-0.0742
3	7	7.0194	0.0194	0.0028	-0.0166
4	8	8.0754	0.0754	0.0094	-0.0656
5	9	8.9307	0.0693	0.0077	-0.0616
6	10	10.0026	0.0026	0.0002	-0.0024

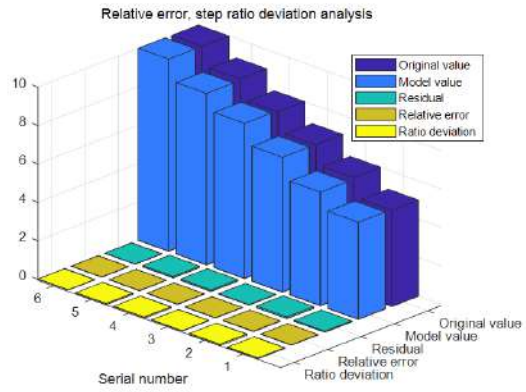

Figure 7. Analysis of relative error and step ratio deviation

After verification, the residual, relative error, and step deviation between the data fitted by the model and the original data are close to 0, which proves that the model has high accuracy and can predict road delays in real time.

3. Conclusion

In this paper, by processing big data of intelligent travel, and combining grey correlation analysis to determine the three factors of traffic flow, number of stops, and average speed play a decisive role in predicting the delay of road congestion. Use the fitting algorithm to process the data of the three main factors to determine the relationship function between each factor and the time required to pass through the congested road. The relationship functions of the three factors are linearly summed to obtain a multi-factor comprehensive prediction function, and the factor data is brought into the multi-factor comprehensive prediction function is used for prediction. It is found that the error of the prediction result is close to 0 through error analysis, which can provide a certain basis for determining the time required to pass through the congested road section.

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Trends of Robot Application——Ethical Response

Lunfei Li*

Jishou University, Jishou, Hunan, 416000, China

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ABSTRACT

With the rapid development of science and technology and the arrival of the information age, computer technology has also gained rapid development, and has a very wide application prospect in the current social environment. But at the same time, robots may also induce a variety of ethical problems, the existence of these ethical problems also affect the sustainable development of robots. This paper mainly aims at the change of robot application trend and related ethical issues, hoping to provide some reference for robot application and development.

1. Introduction

With the rapid development of robot technology and artificial intelligence technology, the scope of robot application is becoming wider and wider, and the types of robots are becoming more and more, which not only brings great convenience to people, but also liberates manpower and improves people's quality of life. But different types of robots will also bring a lot of ethical and moral problems, affecting the continuous research and development of robots. Therefore, it is necessary to strengthen the exploration of the ethical problems that may be caused in the process of robot application, based on the actual situation of society and the prospect of the development of the times, strengthen the value evaluation of the rationality of robot technology, and carry out reasonable ethical regulation on the application of robot in development.

2. Overview of Robotics

Robot refers to the combination of machines and people to produce similar to human physical and mental work of the machine, robots can work according to the artificially set procedures, but also the application of artificial intelligence technical procedures for autonomous work. At present, the robot equipment in the market is divided into three generations, the first generation of robots is mainly through the work flow prepared in advance within the staff, or through the way of teaching and reproduction to carry out activities. The first generation of robots only has the ability to store, remember and repeat work, and lacks the ability to respond to the external environment. The second generation robot has certain intelligence characteristic, but at the same time also needs the technical personnel's help, according to the technical personnel pre-programmed program completes or repeats a certain work automatically. The second generation robot has visu-

**Corresponding Author:*
Lunfei Li,
Jishou University, Jishou, Hunan, 416000, China;
E-mail: 3077338088@qq.com.

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al sensors, sensory sensors, information processing functions and non-visual sensors, which can be called sensory robots. The third generation machines, the artificial intelligence robots, can identify, digest, understand and reason out solutions on their own[1].

3. Robot Ethics

Ethics generally refers to the theory of moral problems, which studies the emergence, essence, development, function, evaluation and law of education and cultivation of morality. Morality comes into being in the interest relationship between nature and all the development and survival of society, which refers to the norms of good and evil in social behavior and the sum of behavioral activities and psychological consciousness. As one of the social ideology, morality is fed back through the living conditions and social material based on certain social and economic relations, while the ethics of studying morality is reflected by all the codes of conduct of people, such as rights and obligations, good and evil, ideal and mission. Robot ethics is an important part of mechanical ethics, which refers to the human-centered ethics on the use and construction of robots. Robotic ethics is an important direction of ethical research and a prominent manifestation of high-tech ethics[2].

With the rapid development of science and technology and the rapid progress of artificial intelligence technology, the scope of robot research is constantly expanding, and the field of application is gradually expanding, which makes the connection between human beings and machines more closely. To some extent, people naturally want robot technology and function to be more and more perfect, so that they can better serve people's life and production. But at the same time, the continuous improvement of robot function and the gradual improvement of intelligent level will also pose a threat to people's safety to a certain extent. How to avoid the negative part of the robot and give full play to the positive side of the robot has become one of the most critical problems in the field of interpersonal relations. Robotic ethics constrains the development of robots by constructing a relevant system of the robot's code of conduct, making them more safe and stable[3].

4. Application Status of Robot

4.1 Application Status of Military Robots

Military robots can be divided into aerial robots, ground robots, space robots and underwater robots according to their applications. Military robots play an increasingly important role in the battlefield. To some extent, the development of military robots is the biggest driver of the development of robot technology. The United States spends more than $6 billion a year on UAV systems used in war, and the investment is increasing year by year. The United States as a military power, robot technology has a significant development advantage. American X47B drones have taken the lead in aircraft carrier take-off and landing, can achieve full autonomous take-off and landing without human manipulation. UAVs have become the backbone of targeted killings and beheadings by national armies, and the United States has also used ground robots to conduct explosive ordnance disposal and indoor reconnaissance missions. Now, the United States has invested a lot of time and material resources in the research of ground transport robots and unmanned transport aircraft. In the future, the United States may take the joint operation mode of man-machine cooperation system as the development goal to study unmanned tanks to compensate for the transportation logistics supply capacity. With the rapid development of high-tech technology, the performance of military forces in the future will become more and more dependent on military robots[4].

4.2 Application of Civil Robots

The rapid development of artificial intelligence technology makes a variety of high-tech equipment emerge in endlessly, robot technology is one of the important applications in the field of artificial intelligence development. Robot more and more rich functions are gradually refreshing people's cognition, through the AlphaGo of big data and deep learning technology can even defeat the master of human go. Boston robots can do backflips and other skills, and brain-controlled robots are increasingly functional. At the same time, the application of robots in daily life is becoming more and more popular. At present, robots have been widely used in automobile manufacturing, lathe processing and deep-sea exploration and other manufacturing industries. Many express delivery companies have gradually introduced a large number of drones and robots to improve distribution efficiency and reduce the input of human resources. The continuous development of science and technology also makes the function of robot more and more perfect, more intelligent and automatic. The lights-out plant operated by the Japanese robot company is completely self-produced by robots and does not need to be regulated, and has achieved good applications in the industrial field. The application of robot technology in the current medical industry also has a good prospect, can be assisted by human manipulation, by the robot to complete high-precision surgery, greatly reduce the op-

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eration accidents caused by human factors, improve the success rate of surgery[5].

5. Ethical Issues in Robotics

With the continuous development of robot technology and artificial intelligence technology, many human characteristics are gradually given to the machine. The robot not only has the tool attribute, but also has the unique existence value, which brings certain threat to the human subjectivity. People also have a certain panic about the development of robots, robots are no longer limited to the extension of human limbs or the enhancement of related human functions, have the ability of reasoning and autonomous decision-making, have human feelings and autonomous will, which may lead to the loss of human subjective status and threaten the survival and development of people. With the rapid progress of modern information technology, the ability of intelligent robot in natural language understanding, creativity, perception and social, has gradually broken through, which has brought great impetus to social development, but also created great material power for people[6].

According to the investigation and research, the robot can infer by logic rules, make reasonable decision and make independent judgment. The development of robots not only needs to solve the traditional ethical problems, but also induces a series of new ethical problems. With the continuous development and wide application of robot technology, the problems of accidents between various machines and people are also constantly appearing, such as the accidents of collision and death of driverless cars and the accidents of accidental injury of children by machines, which affect the safety of people. This kind of robot killing and wounding events gradually threaten people's safety, involving the problem of accident liability determination, whether the designer or the machine is responsible for such events is not specific. Image recognition technology and machine learning technology make driverless cars easy to go on the road, but also bring about the ethical dilemma of machine design thinking. The contradiction between the privacy and data sharing involved in robot data acquisition also brings a series of ethical problems[7].

Military robots have more powerful destructive power than human soldiers. Under the armed of modern science and technology, robots are becoming more and more lethal. Although they can avoid human soldiers fighting in harsh environments and greatly reduce casualties, robots themselves also have no sympathy for human beings and are truly cold-blooded killing machines. Although people can solve this ethical problem by agreeing that robots do not fight humans and that robots fight robots, there are various difficulties in practical operation. The ethical problem of military robots is the most discussed in the research of robot ethics. The main aspects of the research are how to control the destructive power of military robots, how to make military robots more moral than human beings, and how to avoid the indiscriminate killing of innocent people by military robots [8].

First of all, it is necessary to carry on the ethical design to the robot, so that the military robot has a good ethical judgment ability, and can follow the specific ethical norms to avoid ruthless killing, but the setting of specific ethical norms and how to realize computer programs are also the focus of research. In a battlefield environment, even well-trained soldiers can hardly distinguish between combatants and non-combatants. It is also very difficult to make the robot distinguish reliably under the existing technical conditions. Secondly, the control of the degree of autonomy of military robots is also a key problem in the application of military robots. At present, the important trend of military robot research and development in the world is to improve the degree of robot autonomy, but if people give too much decision-making power to the robot, it will be easier to induce the war, and if the robot makes a wrong judgment and causes the war to break out, or the execution error in the course of the war, the distribution of responsibility is a key problem. In addition, it is necessary to limit the time and scope of use of military robots in ethical research, and prohibit them from carrying biological, chemical and nuclear weapons of mass destruction. But to do this requires a wider range of international cooperation, a few countries agree that there is not much application value, the use of military robots needs to be limited by the form of international feedback and the extent of use. The current monitoring treaty is still less content for military robots, the relevant consultation and negotiation is imminent, the research on military robot ethics is a lot of principled and theoretical, in order to truly achieve the international control of military robots, but also need to be more in-depth and detailed exploration, as far as possible to reduce the large-scale damage caused by military robots [6].

There are many types of civil robots, which are widely used in various industries, which greatly liberate the productivity and improve the quality of life of people. Robots are more involved in people's daily life. For example, robots can take care of children and the elderly in home care, effectively deal with family emergency emergencies, and do a good job in handling traffic accidents and fire accidents. With regard to education, children's learning can be mentored, and the handling of robots is more ef-

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fective and scientific than human beings. But at present, robots can not communicate with human emotion, and are relatively weak in emotional perception. In traffic accidents and fire accidents, if the rescue is carried out through the robot, the survival rate of the rescue object can be improved. In the same way, the procedure set under environmental conditions will stipulate that the robot chooses the priority of higher survival rate to carry on the rescue, but under the condition of ethics, the human will usually choose to save the women and children, which is also an urgent problem to be solved in the development process before the future. In the process of people's daily work, more and more robots replace the traditional human work mode into the field of manufacturing and engineering, which greatly saves the production cost and improves the economic benefit. Even in some fields, robots can completely replace the mode of manual work, so how the replaced workers solve their own work needs is also an important problem to be solved in the robot age.

6. Reflections on the Application of Robots

The rapid development of robot technology has brought great contribution to society, but at the same time, it also brings serious threat to the main position of human beings. In the era of artificial intelligence, how to solve a series of ethical problems brought by the application and development of robots is the key problem in the development of robot technology at present. At present, the world has not established an authoritative organization to manage the development and application of robot technology, nor has it formulated a general law to regulate the development of robot technology. Therefore, it is necessary to make feasible laws for the standard control of robot technology, and the robot technology with autonomous thinking and autonomous decision-making ability has not been applied on a large scale in the society at present, and there are not many ethical problems that appear temporarily, but it is still necessary to prevent the ethical problems in advance for the development of robot technology. The legislature needs to take corresponding actions to define a clear scope and create good conditions for the development of robot technology. The use of codes to prevent injury can be prohibited without the approval of the relevant bodies and laws. Law enforcement agencies also need to be empowered to take security action. The rapid development of artificial intelligence technology makes the relationship between robot and human more and more close, and the ethical and moral problems related to the development of robot need to be solved by society, government and individual. At the government level, we need to strengthen the establishment and improvement of the system of relevant laws and regulations, social research workers and experts need to work hard to develop robots with emotion, wisdom and independent discrimination against human beings, and individuals need to strengthen their understanding of robot subjects and enhance citizens' moral and cultural literacy. Through the joint efforts of the government, society and individuals to achieve the harmonious development of human beings and robots.

7. Conclusion

To sum up, the rapid development of robot technology not only brings great convenience to people's life, but also has ethical problems, which brings certain risks to people's survival and development. Therefore, it is necessary to strengthen the research on the ethical problems related to robot technology, do a good job in the ethical design and ethical norms of robots, coordinate the relationship between people and people and between people and robots in the robot age, and create good conditions for the sustainable and stable development of robot technology, so that robot technology can better benefit human life.

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Hybrid Gait Planning of A Hexapod Robot

Ruyi Wang* **Neil Powell**

Department of Electronic and Electrical Engineering, The University of Sheffield, Sheffield, S10 2TN, UK

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ABSTRACT

The adapotation of gaits pattern is a basic and important for the hexapod robot to move stably and efficiently, which depends on the servos of the robot's legs, and also the body structure of the robot.
This paper compares the tripod gait and the crab-inspired gait for a specific hexapod to move forward and move backward; turn left and turn right and integrates the two gaits to apply them under different conditions. The hexapod has three servos on each legs, thus the freedom level of each leg is three-degree. From the comparative experiment, this two gait patterns are suitable for different turning demands.

1. Introduction

Compared with wheeled robot and tracked robot, legged robots have stronger ability to rough terrain and is more flexible in complex environment of disaster rescue and terrain exploration [2]. The hexapod robot has better stability and load capacity among the legged robot, which can achieve various applications in different scenarios, such as lunar exploration, nuclear power plant inspection, etc., with a wealth of gait modes [1,3]. Thus the hexapod is required to keep strong stability and high adaptability. In addition, considering power supply and efficiency, it also needs to coordinate limb and move effectively. Moreover, the torso of the hexapod robot can withstand certain losses, such as in the absence of a leg, it can also complete some commands. Therefore, excellent hexapod design should consider the mechanical structure, gait control, robot autonomy, multi-sensor integration and power supply of the robot.

According to the torso of the hexapod and the distribution of legs, there are rectangular hexapod and hexagonal hexapod, of which each leg is better to have three degrees of freedom [7]. Based on the structure, the movement of the hexapod needs to analyze the trajectory of each leg and inverse its kinematics to calculate steering angles of each motion on legs at real-time [9,11].

However, due to the limitations of the computing power and efficiency of the movement, it is necessary to optimize gait algorithms. Although there are several of advanced algorithms about gait, such as neural network, genetic algorithm and artificial intelligence algorithm, the most common and basic gait control is the tripod. The tripod gait of the hexapod refers to the movement of three legs at the same time, which can achieve fast movement with stability [4]. Many studies have verifies the superiority of the tripod. However, the general tripod lacks adaptability in steering[8], proposed that each leg is regarded as an independent system of the kinematics model of the

**Corresponding Author:*
Ruyi Wang,
Department of Electronic and Electrical Engineering, The University of Sheffield, Sheffield, S10 2TN, UK;
E-mail: rwang46@sheffield.ac.uk.

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gait, and illustrated the crab-inspired lateral movement to move left and move right[5]. The two gaits are suitable for different scenarios.

To optimize gait of the hexapod, this paper initially describes the mechanical structure of the robot, then analyze its kinematics on this basis. In this paper, a modular algorithm is proposed to reduce the computation consumption for move forward and backward. In addition, this paper optimized a turning gait of the hexapod.

2. Structure & Kinematics

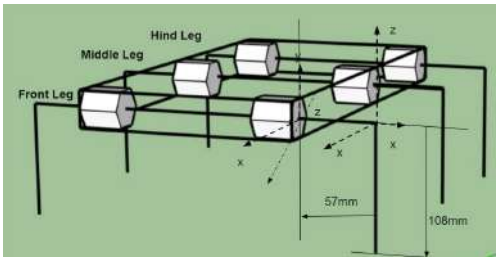
2.1 Hexapod Structure

2.1.1 Mechanical Configuration

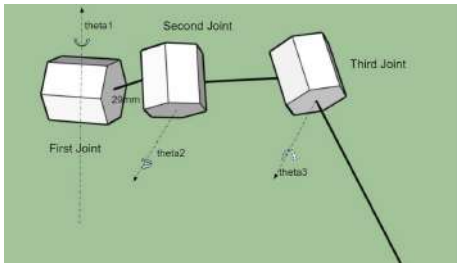
The experimental in this article is a rectangular hexapod robot BH-3 of Lynxmotion in Figure 1, of which each leg has three degrees of freedom.

Figure 1. BH-3 Hexapod

Figure 2 shows the structure model of the hexapod and the dynamic model of a single leg. In the models, the appropriate coordinate systems are introduced, and the size of each part is marked to establish and appropriate inverse kinematics model. The movement range of each joint is recorded in table 1.



(a)



(b)

Figure 2. Hexapod Configuration

Table 1. Move Range of Each Joint

	Front	Middle	Hind
1st Joint	$[-\frac{\pi}{2},\frac{\pi}{2}]$	$[-\frac{\pi}{3},\frac{\pi}{3}]$	$[-\frac{\pi}{2},\frac{\pi}{2}]$
2nd Joint	$[-\frac{\pi}{4},\frac{\pi}{2}]$		
3rd Joint	$[-\frac{3\pi}{4},0]$		

2.1.2 Electronic Hardware

This hexapod is equipped with the SSC-32U servo controller, which supports preloading code and reading the current position and speed of servos, and 18 HS-645MG standard servos. The hexapod changes the rotation angle of each motor to control the joint through code commands to mobilize legs and to move body. In addition, Bluetooth module is added to the hexapod that it can be controlled by communicating with computer.

2.2 Inverse Kinematics

For the motion control of the hexapod, the inverse kinematics of its leg is mainly studied. In a tripod gait, the hexapod maintains three supporting legs at any time, keeping its body parallel to the ground. Due to the kinematics principle and trajectory of each leg of the hexapod are the same or the angle is opposite, we can analyze and calculate the motion of one leg, so as to establish the leg cooperation to mobilize the movement of all legs, so as to simplify the overall kinematics complexity.

2.2.1 Coordinate System

According to the coordinate system and angle shown in Figure 3, taking the right front leg as an example, the angle values of three servos (theta1, theta2 and theta3) on the leg can be calculated.

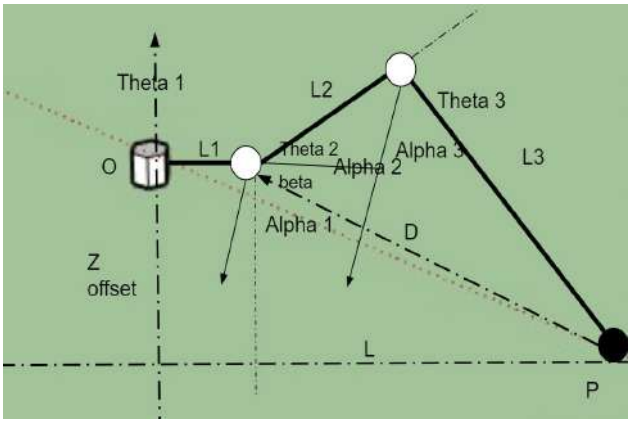


Figure 3. Single Leg Coordinate

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2.2.2 Inverse Kinematics for Tripod Gait

$\theta_i = tan^{-1}\frac{y_i}{x_i}$, i is the number of servo on each leg.

Unlike θ_1, which can be calculated directly, θ_2 and θ_3 have to calculate angles a_1, a_2 and a_3 preliminarily, which are described in Figure 3.

$$\alpha_1 = tan^{-1}\left(D / Z_0\right),$$

$$\alpha_2 = cos^{-1}\left(\frac{L_3^2 - D^2 - L_2^2}{-2L_2D}\right),$$

$$\alpha_3 = cos^{-1}\left(\frac{D^2 - L_3^2 - L_2^2}{-2L_2L_3}\right)$$

3. Gait Design

3.1 Tripod Gait

The tripod gait of the hexapod is presented in Figure 3. The hexapod transfers three legs to lift or to slump. Thus the six legs are divided into two groups, which switch alternately. During the movement, there are always three legs on the ground as support legs.

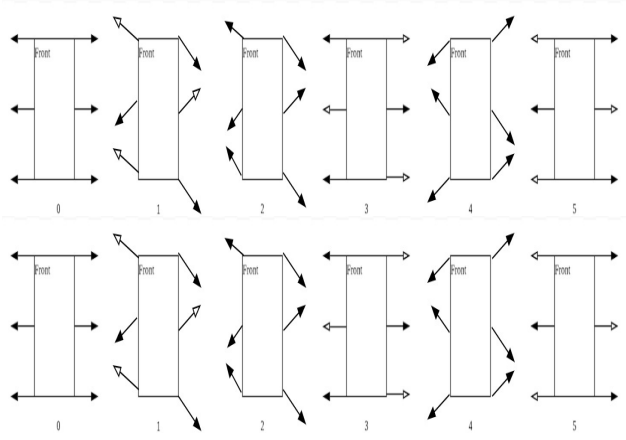

Figure 3. Tripod Gait of Forward Movement

To ensure the stability and reliability of the movement, arbitrary two adjacent legs of the hexapod are not allowed to leave the ground at the same time [6], thus all supporting legs form a stable triangle structure [12]. In Fig 3 the hollow arrow represents swing legs and the solid arrow represents supporting legs. The hexapod can move forward 22cm stably each swing.

The sequence of moving legs forward and backward for tripod gait is the same, the original hind leg can be regarded as the front leg that the backward movement can be completed as Figure 3.

Table 2 illustrates the position of legs for moving forward and backward.

Table 2. Position State

State(x, y, z)	Forward(mm)	Backward(mm)
Lift	(0, 0, 15)	(0, 0, 15)
Swing	(0, 110, 15)	(0, -110, 15)
Support	(0, 110, 0)	(0, -110, 0)

3.2 Turning Gait Planning

The gait of the hexapod changes greatly when turning, where the mechanical structure, steering frequency and the path of the hexapod should be considered comprehensively. The first joints of BH-3 hexapod can rotate at right angles, thus a specific swivel gait is proposed to realize high-speed turning. Moreover, this 3.2.1 Swivel Gait

According to Figure 4, the hexapod moves legs 6 times for once turning, which is less twice than conventional tripod gait. During the turning, two adjacent legs are moved together. However, there are always three supporting legs. In addition, the angular symmetry of the legs provides steering force while maintaining stability, which can be applied to this rectangular hexapod.

Each movement in Figure 4 needs 1 seconds based on initial setting, thus it costs 6 seconds to complete swivel.

The principle of turning left and turning right is exactly the same, but the opposite leg should be mobilized to provide steering force and support the stability of the torso.

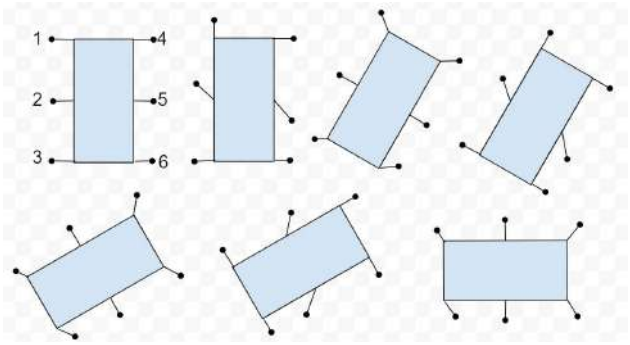

Figure 4. Swivel Gait of Turning Right

The changed position is presented in Table 3 with the rotation angle of joints.

Table 3

Joint State (1st, 2nd, 3rd)	Turn Left(°)	Turn Right(°)
lift	(0, 15, -45)	
Leg 1	(90, 15,-45)	(30, 15, -45)
Leg 2	(30, 15, -45)	(-30, 15, -45)
Leg 5	(-30, 15, -45)	(30, 15, -45)
Leg 3	(30, 15, -45)	(-30, 15, -45)
Leg 6	(-30, 15, -45)	(30, 15, -45)
Leg 4	(30, 15, -45)	(90, 15, -45)

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3.2.2 Transverse Gait

Inspired by the walking pattern of crabs, the robot can walk horizontally [7], both move to right and left without turning, which is more conducive to short-distance and rapid movement of the rectangular hexapod, due to the rectangle is not fully symmetric that it is inconvenient for swivel gait. Thus using transverse gait can improve the efficiency and reduce energy cost to move to left or right for some situations, which is presented in Figure 5.

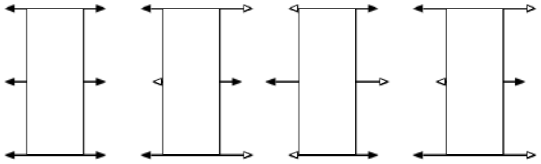

Figure 5. Transverse Gait of Hexapod

The transverse gait mainly relies on movement of the third joints on each leg. The movement of leg2 requires the third Joint on it which changes -15° once. In contrast the leg3 should be change when the hexapod move left.

Table 4

State(x, y, z)	Right(mm)	Left(mm)
leg1, leg3, leg5	(0, 0, 0)	(-30, 0, 15)
Leg2, leg4, leg6	(30, 0, 15)	(0, 0, 0)

In addition, since the hexapod has no gyroscope, it should executes the offset after each phase of motion.

4. Experiment & Result

4.1 System Design of Hexapod Robot

Gait control code is preloaded onto the servo controller. In addition, a controller is generated with MATLAB, which can control the hexapod to move, stop and offset. The hexapod communicates with computer via Bluetooth module, of which the computer sends commands to the servo controller and the hexapod executes responding instructions.

For the experimental hexapod, the SSC-32U transfer the augment into transitional time of the position. For example, it takes 10 seconds to move 90° if the speed value is 100us per second. Considering the efficiency, the pulse width is defined as 1800 microseconds and the speed value is 1000 microseconds.

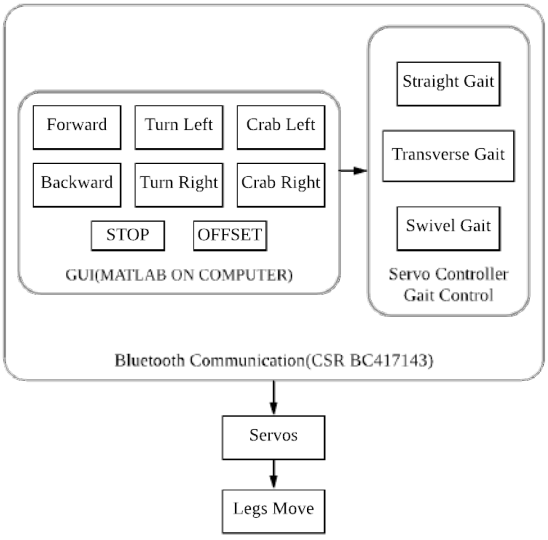

Figure 6. Controller System

4.2 Experiment of Designed Gait

4.2.1 Straight Gait

In the test of the forward and hind legs of the hexapod robot, two gait control methods are compared in the same road section. In the first method, the six legs of the hexapod robot are divided into two groups by using the joint control method. The two groups of legs turn into supporting legs and swinging legs. The inverse kinematics of one leg in each group is calculated, and the other legs directly or reversely quote according to the angle obtained from the calculation results, so as to realize cooperative control. The second method is to calculate the inverse kinematics of six legs, and call each leg separately. According to results of the experiment in table 5, it is obviously that the first method is much more efficient for the hexapod to walk on flat terrain. In addition, the speed and dexterity of the hexapod forward and backward are almost the same.

Table 5. Test Results for Method 1 & Method 2 to Move for 50m & 100m

Flat Path	50 m	100m
M1 Forward	8’22	13’59
M2 Forward	9’54	19’28
M1 Backward	8’49	14’09
M2 Backward	9’58	19’26

4.2.2 Turning Gait

The hexapod is tested for different path planning in the two paths shown in Figure 7. Different gait designs for

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path a) and path b) are recorded in Table 6 and Table 7.

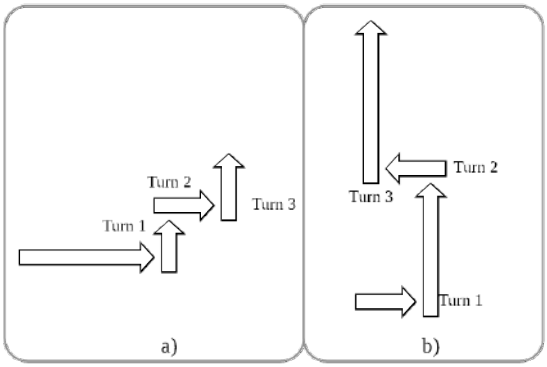

Figure 7. Test Path of Gaits

Table 6. Timing Results for Path a)

a)	1	2	3
Turn 1	Swivel	Transverse	Transverse
Turn 2	Swivel	Forward	Transverse
Turn 3	Swivel	Transverse	Swivel
Time	8’29	5’37	5’20

Table 7. Timing Results for Path b)

b)	1	2	3
Turn 1	Swivel	Transverse	Swivel
Turn 2	Swivel	Backward	Transverse
Turn 3	Swivel	Transverse	Swivel
Time	11’02	13’31	10’12

Obviously, the short-distance steering is more suitable for using the transverse gait, while the long-distance steering is more suitable for the swivel gait.

5. Discussion

5.1 Tripod Gait

The motor rotation angle of the other two legs can be calculated by the trajectory of any leg in the front leg, which reduces computing complexity. However, such a calculation method is not flexible in highly complex terrain.

5.2 Turning Gait

The steering gait proposed in this paper can efficiently complete 45 degree turning and 90 degree turning, and it costs less computing and energy consumption than high frequency steering of 5-degree by 15-degree.

The transverse gait is unsuitable for non-90 degree steering, due to it is difficult to maintain stability in the situation. However, the transverse gait is slower than straight tripod gait, and increases computing complexity. Thus the hexapod should adopt the swivel gait when there is long-distance movement after turning as Figure 7(a), the transverse gait can be implemented for frequently turning in Figure 7 (b).

Thus the two gait can be combined together for turning.

6. Conclusion

This paper introduces the configuration and kinematics of the hexapod, and proposes a special tripod gait control, which determines the trajectories of the other two legs according to the gait planning of one leg. The design reduces computing consumption. Furthermore, a simple swivel gait is proposed and combined with the transverse gait. Thus the hexapod is manipulated to turning and to move smoothly. The experiment result indicates that the hexapod can move following command with designed gait. The gait is suitable for most hexapod robots, and requires less power consumption than conventional method.

7. Future Work

The gait patterns in this paper is convenient for moving forward, backward and turning on known roads, but the motor rotation angle obtained by the inverse kinematics method lacks flexibility and efficiency. In addition, the tripod is short of adaptability to unknown complex terrain and obstacle, where the reactive gait planning can improve it efficiently. In the future, reactive gait planning can be achieved by introducing genetic algorithms or central pattern generator into gait design.

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Multi-channel DMA Based Design of Voltage Monitoring Using Synchronous Frequency Trace-Sampling Technique

Yuan Lei[1*] Li Lei[2] Lei Xia[1] Mingxiang Liu[1] Yueming Cai[1] Jingtao Zhao[1] Mengyue Li[3]

1. NARI Group Corporation (State Grid Electric Power Research Institute), Nanjing, Jiangsu, 210003, China
2. Tianjin Pinggao Intelligent Electric Co. Ltd., Tianjin, 300251, China
3. Nanjing Normal University School of Electrical and Automation Engineering, Nanjing, Jiangsu, 210023, China

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MQX RTOS

ABSTRACT

In order to eliminate the influence of frequency change on real-time voltage acquisition, a low-cost solution of voltage monitoring was proposed using the multi-channel DMA synchronous frequency trace-sampling technique. In-chip resources of the designed voltage monitor were fully utilized in hardware design to reduce external devices. The MQX RTOS was used to perform the functional tasks flexibly and efficiently; especially the Ethernet communication applications and USB device connection were realized using its TCP/IP protocol stack and USB driver. In addition, to ensure the safety of electrical records, data statistics and alarm information management were also implemented through the management of the storage in FLASH. The test results show that the voltage monitor designed in this paper has the advantages of accurate measurement, strong resistance to frequency interference and low cost, and can be widely applied in the field of voltage monitoring in distribution networks.

1. Introduction

With the continuous expansion of the power system scale, the nonlinear, shock and asymmetric loads increase day by day in the power grid. Therefore, whether the voltage can be measured accurately is one of the prerequisites to solve the problem of power quality. However, the voltage acquisition is not accurate due to the fluctuation of power network frequency. To solve this problem, it is urgent to develop measurement equipment with high measurement accuracy, low cost and wide application range [1-2].

The voltage monitor designed in this paper can measure, analyze and calculate real-time voltage, current, frequency, harmonic and other parameters. The daily and monthly statistical data and alarm information of the voltage are recorded, and the data are remote transmitted according to the I1 interface network communication specification of the power supply voltage automatic acquisition system, providing timely and accurate data for power quality management and power load dispatching.

2. Hardware Design of the System

The hardware principle diagram of voltage monitor designed in this paper is shown in Figure 1.

**Corresponding Author:*
Yuan Lei,
NARI Group Corporation (State Grid Electric Power Research Institute), Nanjing, Jiangsu, 210003, China;
E-mail: 404485741@qq.com.

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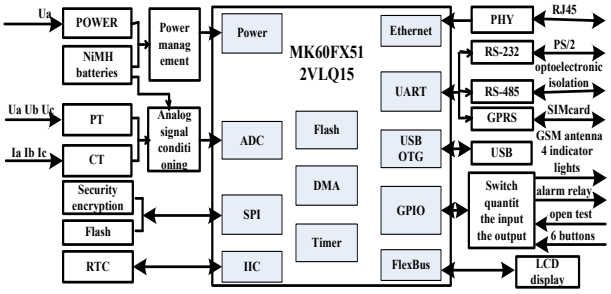

Figure 1. The hardware principle block diagram of voltage monitor

The core processor of the voltage monitor is NXP's MK60FX512VLQ15 based on Cortex-M4 kernel, with a main frequency of 150MHz. It has floating-point operation unit, multi-channel flexible configuration of 32-bit DMA, 1MB Embedded Flash and 128KB RAM, 2 16-bit SAR ADC modules with PGA, FlexBus extension bus, and several timer modules with different functions. It has a extremely rich communication interface. These powerful on-chip resources and rich communication interfaces provide great convenience for device hardware and software design [3].

This voltage monitor designs 600mAh NI-MH battery as backup power supply.Through two SPI interfaces, NR-SEC3000 security encryption chip and SPI-Flash of ST company model M25P32 were extended respectively. Epson's high precision real-time clock module, RX-8025T, is connected via the IIC interface. The MK60FX512VLQ15 incorporates an internal 10/100Mbps Ethernet MAC layer and provides a common MII/RMII interface.

It should be noted that all the devices of the voltage monitor designed in this paper are industrial-grade type selection, which ensures the reliability of its operation from the basic hardware.

3. The Principle and Implementation of DMA Synchronous Follow - Frequency Sampling

The application of DMA（Direct Memory Access） technology in embedded operating system to deal with AD conversion of multi-channel and large data volume can not only avoid the instability of nested interrupt mechanism, but also improve the efficiency of data conversion and reduce the impact on system task scheduling. MK-60FX512VLQ15 is capable of DMA transfers through independent programmable channels allocated internally by different functional modules [5].

In order to realize synchronous sampling of a phase voltage and current (take Phase A as an example), Ua was connected to ADC0_DP0 pin after PT transformation and analog signal conditioning circuit on the hardware, and Ia was connected to ADC1_DP0 pin after CT transformation and analog signal conditioning circuit. It should be noted that the voltage and current signals of the same phase only need to be connected to different ADC modules, and the channels of ADC modules can be flexibly selected according to the specific hardware configuration.

On the software, the DMA function of the TIMER FTM0 of the MK60FX512VLQ15 processor is configured to enabling state, and the two channels FTM0CH0 and FTM0CH1 of FTM0 are configured as the trigger source for ADC0 and ADC1 to start the AD transition. In this paper, the analog sampling is 64 points per week, and the FTM0 clock source is 75MHz. Therefore, the initial calculation formula of FTM0 is as follows:

$$Mod\_Val = \frac{1}{50} \times \frac{1}{64} \times 75 \times 10^6 \approx 23438 \tag{1}$$

The software key statements for the above functions are as follows:

// DMA channel initialization configuration

DMAMUX_CHCFG8 = DMAMUX_CHCFG_SOURCE(24);

DMAMUX_CHCFG9 = DMAMUX_CHCFG_SOURCE(25);

DMAMUX_CHCFG10 = DMAMUX_CHCFG_SOURCE(40);

DMAMUX_CHCFG11 = DMAMUX_CHCFG_SOURCE(41);

//FTM0 initialization configuration

Unsigned int *MOD_VALUE = 23438;*

FTM0_C0SC |= FTM_CnSC_DMA_MASK;

FTM0_C1SC |= FTM_CnSC_DMA_MASK;

FTM0_MOD = MOD_VAL;

The process of using DMA multi-channel synchronous and frequency sampling technology is shown in Figure 2.

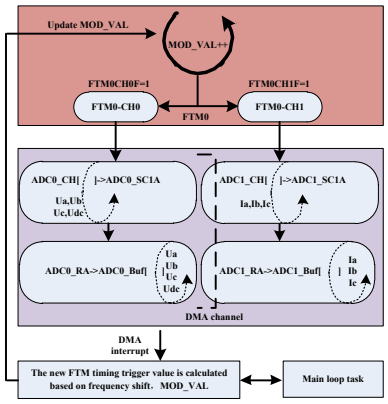

Figure 2. Block diagram of synchronization and frequency sampling based on Multi-channel DMA

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It can be seen from Figure 2 that the device's frequency following sampling is completed by DMA interrupt. In the DMA interrupt service function, the current AC input frequency and the FTM module's overloaded count value are calculated according to the average value of the phase Angle offset of the three cycles calculated in the main cycle. In this way, the next AD conversion is triggered by FTM based on the new count value, thus realizing the real-time tracking of the sampling frequency to the actual frequency.

4. Software Design of the System

The voltage monitor software designed in this paper is based on MQX embedded operating system[4].

According to the functional requirements of the voltage monitor, the software system of the device is divided into six different tasks. Considering the importance, real-time performance and memory occupancy of each task, the corresponding priority and stack space are allocated. The list of installation system tasks is shown in Table 1.

Table 1. The list of installation system tasks

Task Index	Function	Stack	Priority	Name
MAIN_TASK	Main_Task	3000	8	main
ETH_TASK	Eth_task	4000	9	eth
GPRS_TASK	Gprs_Task	5000	9	gprs
DISPLAY_TASK	Dislay_Task	3000	10	display
CHECK_TASK	Check_Task	2000	11	check
USB_TASK	Usb_Task	2000	11	usb

MAIN_TASK is the main task, mainly completing such functions as power-on initialization and self-detection, program upgrade, event recording, data statistics and storage, etc. This task is self-starting and has the highest priority among the five tasks.

EHT_TASK is Ethernet communication task, which can be configured as debugging interface or I1 standard communication interface according to parameter settings. GPRS_TASK is the GPRS communication task. DISPLAY_TASK is a human-computer interaction task. CHECK_TASK is a factory test task. USB_TASK is an upgrade task for U disk program, mainly completing the functions of U disk detection, file detection and reading, etc. In addition, the software is also equipped with a 1ms timed interrupt, which is responsible for handling functions with high real-time and light load, such as timing, running light, counting and other functions. The overall software framework is shown in Figure 4.

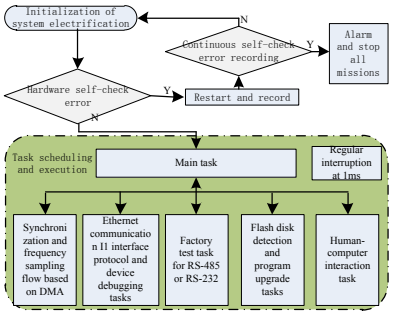

Figure 4. The software principle block diagram of voltage monitor

5. Experimental results and analysis

The developed voltage monitor was tested according to the Standard Q/GQW 1819-2013 Technical Specification for Voltage Monitoring Devices of The State Grid Corporation of China. The test condition is that each input quantity shall be input for 5 minutes, the debugging software shall be set up, and the maximum and minimum values of the measured data of the device shall be recorded within 5 minutes. The test data of frequency conversion are shown in Table 2.

Table 2. The sheet of frequency test data

Standard source AC input		Minimum value (Hz)	Maximum (Hz)	Frequency relative error
220V (100%Un)	45Hz	44.98	45.02	0.44‰
	50Hz	49.99	50.01	0.22‰
	55Hz	54.99	55.01	0.22‰

From the data in Table 2, it can be seen that the tracking algorithm based on DMA interrupt mechanism is very accurate in the estimation of frequency, which lays a foundation for high-precision sampling and calculation of AC volume. The test data table of AC input precision is shown in Table 3.

Table 3. The sheet of AC input precision test data

Standard source AC input		Minimum (V)	Maximum (V)	Voltage relative error
154V (70%Un)	45Hz	153.89	154.12	0.78‰
	50Hz	153.92	154.07	0.52‰
	55Hz	153.87	154.09	0.97‰
220V (100%Un)	45Hz	219.91	220.13	0.59‰
	50Hz	219.95	220.06	0.23‰
	55Hz	219.88	220.08	0.55‰
264V (120%Un)	45Hz	262.83	264.11	0.64‰
	50Hz	262.88	264.07	0.45‰
	55Hz	262.96	264.13	0.49‰

It can be seen from the data in Table 3 that, at room temperature, the relative error of voltage monitor's sam-

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pling calculation on AC volume is within 1‰, and the frequency variation has little influence on the sampling accuracy, and the sampling accuracy and stability are high.

6. Conclusion

The voltage monitor designed in this paper based on DMA multi-channel synchronous and frequency-following sampling has the advantages of high measurement accuracy, strong anti-frequency interference ability and low cost. The use of MQX operating system, using its own Ethernet and USB resources, not only greatly improve the development efficiency, but also ensure real-time and reliability, can be widely used in the field of distribution network voltage monitoring.

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Research on the Application of Big Data and Artificial Intelligence Technology in Computer Network

Hongfei Wang*

Guangxi Economic and Trade Vocational Institute, Nanning, Guangxi, 530021, China

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ABSTRACT

With the continuous development of social economy, science and technology are also in continuous progress, relying on the Internet technology of big data era has come in an all-round way. On the basis of the development of cloud computing and Internet technology, artificial intelligence technology has emerged as the times require. It also has more advantages. Applying it to computer network technology can effectively improve the data processing efficiency and quality of computer network technology, and improve the convenience for people's life and production. This paper studies and analyzes the practical application requirements of computer network, and discusses the application characteristics and timeliness of artificial intelligence technology.

1. Introduction

In recent years, the people's living standards have been continuously improved, and there are more requirements for Internet technology. Artificial intelligence technology has gradually entered the public's field of vision and is gradually applied to life, work, study and entertainment. The research and development of artificial intelligence by scientific researchers continues, and the application of artificial intelligence technology to computer network technology has become a current hot spot. The integration of the two can not only improve the processing capacity of computer information analysis machines, but also greatly improve its flexibility. The application of artificial intelligence to computer network technology has also become a future development trend.

2. Basic Overview of the Era of Big Data and Artificial Intelligence

2.1 The Era of Big Data

Today, when Internet technology is gradually mature, it has been applied to all walks of life, and the Internet has also played an important role. The types and quantities of information involved in production, life and learning are increasing, and the era of big data was born. Based on Internet technology and advanced cloud computing platform, it can quickly process information data, distributed file system and expandable storage system, etc., which require some advanced and effective technologies to process big data information assets. Big data has the characteristics of fast data flow, large data scale, multiple data types and low value density [1].

**Corresponding Author:*
Hongfei Wang,
Guangxi Economic and Trade Vocational Institute, Nanning, Guangxi, 530021, China;
E-mail: Wang1368@163.com.

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2.2 Artificial Intelligence Technology

2.2.1 Definition of Artificial Intelligence

Artificial intelligence is a comprehensive modern technology, based on big data algorithms, it has the content of psychology, linguistics, behavior and computer science, and is the product of the current development of computer science.

Artificial intelligence takes the human thinking operation mode as the reference object and relies on computer technology to drive the operation of mechanical products, make rational judgments and decisions, and solve problems in a timely manner. This is an evolution and upgrade of automation technology. All in all, artificial intelligence technology is an anthropomorphic manifestation of computer network technology, which realizes human-like thinking and can serve in multi-industry logic analysis.

2.2.2 Application Characteristics of Artificial Intelligence Technology

First of all, artificial intelligence technology combines it with computer logic algorithms by imitating the human way of thinking, which can give priority to fuzzy information and reduce the amount of system fault tolerance. Secondly, artificial intelligence can solve problems that traditional algorithms cannot solve, and combine the results with human thinking and preferences to obtain answers that are highly compatible with humans, and meet the needs of intelligent applications in multiple fields. Finally, artificial intelligence technology has self-upgrading and learning functions, which can realize information data upgrade and computational research, and has extremely information processing efficiency [2].

2.2.3 Application Advantages of Artificial Intelligence Technology

It can be seen from the above that artificial intelligence technology has functions such as human-like thinking and autonomous learning. Under the development and construction of computer network, it has the following advantages in application.

First of all, artificial intelligence can help computers realize network data centralization and high-speed information processing, and has important application value in maintaining the stability and pertinence of network information [3].

Secondly, artificial intelligence technology can reduce the frequency of humans operating computers, and can completely replace humans in dealing with some special problems, effectively achieving the goal of artificial collaboration and artificial substitution. With the expansion and extension of the computer network model, the model has undergone hierarchical changes. The multi-thinking ability of artificial intelligence can be applied among multiple management layers.

Finally, the efficient learning ability of artificial intelligence can realize computer network information simulation and result prediction. Artificial intelligence technology can learn and analyze in multiple information layers, obtain key information from a large number of databases, and infer and summarize the evolution of high-level information and data. This method is called the simulation realization of artificial intelligence, which can reduce data occupation, improve computer resource processing and control efficiency, and comprehensively improve the application quality of computer network technology.

In the background of big data era, with the development of computer technology, Internet technology and bionics technology, artificial intelligence technology has emerged. It is an advanced science and technology, which can simulate human behavior and thinking, and has certain ability of imitation, learning, adaptation and organization. The artificial intelligence technology is applied to the machine to realize the intelligence of the machine, thus providing convenience for people's life and production and improving people's happiness index. The application of artificial intelligence technology to computer network technology is an inevitable trend in the future. Transforming the manual operation and search function of computer operation into intelligent operation can not only improve the speed of information acquisition, but also effectively guarantee the information preparation. Moreover, the artificial intelligence technology has strong cooperation ability, and carries out information resources according to the needs of different users Source exchange, improve work efficiency.

3. Application Research of Artificial Intelligence in Computer Networks

3.1 The Application of Artificial Intelligence in Computer Network Security

In the context of the development of computer networks, people's awareness of network information security has also been improved. Today, while artificial intelligence technology provides people with convenience in life, it also brings a greater risk of network information application. In recent years, news about online fraud and online information theft has always been a hot spot of social con-

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cern. The public is highly vigilant about network information security. In order to improve the quality of network monitoring and ensure network security to the greatest extent, it is recommended that relevant departments strengthen network monitoring and management, guarantee the security and scientificity of network information to the greatest extent, and finally realize comprehensive network monitoring and management. Computers can make quick calculations on data that does not have continuity and regularity, so as to derive data algorithms and find potential relationships. However, it is difficult to find the leakage point in the multi-channel information interaction environment only through information processing, and the investigation of abnormal data is difficult, the staff is lack of skills, and the processing accuracy is not high [4].

Artificial intelligence technology can effectively reduce the difficulty of manually querying data and improve the quality of integrated management of network data. For example, an artificial intelligence-based information visit and tracking system can be established to achieve the purpose of automatic search and information reading. In the entire network operation, problematic data can be processed in time, and existing faults can be handled. In addition, artificial intelligence can also deal with the problem of network delay and ensure the operation of computer network information to the greatest extent. Finally, the use of artificial intelligence technology can also reinforce the security system, ensuring the security of user information to the greatest extent.

3.1.1 Application of Smart Firewall Technology

Artificial intelligence has a variety of applications in the field of computer, among which intelligent firewall and intrusion detection technology are its important contents, and the importance of computer operation security is self-evident. Through the application of these two technologies, the information security in the process of computer network operation is effectively guaranteed [5].

Among them, the intelligent firewall technology can effectively intercept some harmful information and emails in the computer network, and prevent the computer from being attacked by viruses and hackers, thereby improving the safety of computer operation. Compared with the traditional firewall technology, its intelligent analysis ability is much higher. Moreover, the intelligent firewall technology and intrusion detection technology can establish a perfect automatic defense function in the computer system, which can automatically prevent the intrusion of a virus-bearing webpage when the computer accidentally browses. It can be seen that the application of intelligent firewall and intrusion detection technology in computer networks not only ensures its safe operation, but also promotes the development of computer networks to a certain extent.

3.1.2 Application of Mining Technology

Since the birth of computer network technology, it has been faced with the test of security problems. This is because the computer network system is open, and there are more and more network viruses and hacker attacks. In order to ensure the security of the computer network, the artificial intelligence technology is applied to the computer system, and attention is paid to data mining and processing. The Internet technology and mining seem to be applied together, the illegal intrusion mode and related data are deeply mined, and the differences among them are compared, and a set of reasonable computer code is formed. The way and way of illegal intrusion are analyzed and confirmed, and the law of intrusion is mastered, so as to effectively improve the security of computer network. What needs to be noted is that because the network system itself has loopholes, we must continue to improve the network system, analyze the illegal intrusion situation reasonably, and timely replace the computer facilities when they are relatively old and backward. In case of illegal intrusion of computer system, through the combination of mining technology and Internet technology, the actual analysis of the invasion can be carried out, and timely processing can be carried out. Meanwhile, the detection of illegal intrusion situation should be continuously increased to establish a set of perfect intelligent prevention and control system, so as to improve the security of computer network [6].

3.2 Application of Artificial Intelligence in Computer Network Management

3.2.1 Expert System Database

Expert system is an important part of artificial intelligence technology. This system has a rich expert database, which uses a lot of expert knowledge, experience and reasoning methods, and stores the known content into the expert database through the Internet technology, and then converts some simple contents into complex programs through artificial intelligence technology the experience of expert system constantly optimizes it, so as to select the most appropriate way to apply to the computer network system, effectively realizing the network management and evaluation work. Expert system database is the most widely used computer network system. It can be said that it is the perfect product of the combination of intelligent tech-

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nology and computer technology. It not only makes up for the lack of capabilities of traditional databases in data processing and artificial intelligence in logical reasoning and data processing. It also improves work efficiency and storage space, making the expert system database an indispensable part of the computer network management system.

3.2.2 Artificial Intelligence Answers

These technologies are also widely used in computer network technology. They are mainly used to answer user questions. After the user gives some specific conditions, artificial intelligence answering technology automatically searches the Internet for the most matching answer. Compared with the previous question and answer method, the artificial intelligence answer only needs a relatively simple instruction to carry on the follow-up screening work, and carries on the analysis and processing to the self search content, thus finding the information the user needs, shortening the information search time and improving the work efficiency. For example, when users hear "just see you in the crowd", they don't remember the song name and singer. If they read these words in the input crowd through the artificial intelligence answer system, they will automatically jump out of the search tag that only sees you in the crowd, and then they can quickly find the song name and singer. On the basis of ensuring the accuracy of the search, the search efficiency is improved.

3.3 Application of Artificial Intelligence in Business Management

Under the economic construction, the application field of artificial intelligence is gradually expanding. It not only plays an obvious role in industrial production, but also has important application value in the construction and management of modern enterprises. First of all, artificial intelligence technology can realize the automatic monitoring and management of the enterprise, which can improve the progress tracking, employee inspection, and work follow-up of its leadership, and comprehensively improve the management efficiency of the enterprise. In addition, the intelligent management method provided by artificial intelligence not only promotes the high-efficiency construction of enterprises, but also achieves the goal of low-cost and high-yield, which is of great value to the comprehensive investment and construction of enterprises. Finally, artificial intelligence technology can realize self-learning through continuous accumulation, and can construct a complete and professional computer network system according to the current status of enterprise construction and development, which can promote the construction of various tasks of the enterprise and comprehensively improve the work efficiency of the enterprise.

4 Precautions for the Application of Artificial Intelligence Technology under the Construction of Computer Networks

4.1 To Ensure the Safety of Information Network Operation

Computer network technology has penetrated into many industries in China. Under the influence of artificial intelligence technology, the problem of network security is becoming more and more serious. From the perspective of the development of network construction, network virus and computer network security management are always in a dynamic game state. With the upgrading of computer network security system, network virus is also updated. In the environment of survival of the fittest, the maintenance and long-term operation of artificial intelligence technology is bound to rely on network information security. How to maintain network information Security is also one of the hot topics that people pay attention to at present.

4.2 Network Operation and Maintenance Management

In recent years, China's computer network technology has achieved rapid development. While meeting the needs of people's life and office, the demand for information and data applications has increased exponentially. On the one hand, the dynamic of information processing is obvious. The introduction of artificial intelligence technology strengthens the management power of computer, and also endows it with more advanced data analysis ability, which plays an important role in promoting the control and improvement of network information security and operation and maintenance quality. How to rationally use artificial intelligence technology, comprehensively improve the automation management of network operation and maintenance, and define the authority of manual supervision and mechanized supervision and inspection are also important problems facing the development of computer network technology [7].

4.3 Screening and Interception of Computer Network Technology

Nowadays, computer network technology has built a number of information sharing and exchange platforms for

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people, and the Internet has become an important channel for people to trade, exchange information and obtain resources. But in such an environment, people can not help suffering from the bombing of network information, such as advertising mail, promotion telephone and network violence, etc., and their personal privacy is leaked inadvertently. In the future, it is also an important direction for the development of computer network technology to use artificial intelligence to reasonably screen and clean up junk information, and to build a scientific and personalized information collection and interception system.

4.4 Equipment Upgrade

With the rapid development of computer network technology, 5g era is coming quietly with the support of mobile communication technology. In the environment of emphasizing upgrading and reform, the corresponding hardware equipment of computer network technology also needs to be updated and iterated. At present, China's artificial intelligence technology relies on advanced computer network and electronic mechanization technology. Only by building an environment of "adequate nutrition" and "suitable growth", can artificial intelligence technology thrive in modern society.

4.5 Construction of Network Evaluation System

In order to realize the intelligent development of network management system, the role of artificial intelligence is also essential. By solving the problems existing in artificial intelligence and expert knowledge base, a network integrated management system is established. The network is constantly changing and has a certain dynamic. Artificial intelligence network management technology can solve the problems in network management. In artificial intelligence technology, expert knowledge base is the summary of the knowledge and experience of experts in different fields, which is input into the system to realize the construction of knowledge base system and form intelligent computer program. If there are problems in a certain field, we can use the experience of experts to solve them, so as to better evaluate the computer network management.

5. Conclusion

In conclusion, artificial intelligence technology plays an important role in promoting computer application security and enterprise comprehensive management. At present, the technology has been deeply applied to industry, agriculture, education, enterprise management, and penetrated into people's life, work and leisure. Artificial intelligence is a kind of symbol, which affirms the development of computer network technology. Artificial intelligence has extraordinary advantages in network security, information processing, network garbage screening and system upgrading. Artificial intelligence also has a good application prospect in computer network technology, which promotes the vigorous development of computer network technology.

In the background of big data era, the role of artificial intelligence is becoming more and more important. The application of artificial intelligence to computer network technology can not only ensure its operation safety, but also improve its network management efficiency. However, at present, the application of artificial intelligence technology in computer network is not mature, so relevant staff should increase the research on intelligent technology to provide greater convenience for the people.

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Contribution: Researchers A and B researched literature and conceived the study. Researcher A was involved in protocol development, gaining ethical approval, patient recruitment and data analysis. Researcher B wrote the first draft of the manuscript. All authors reviewed and edited the manuscript, and approved the final version of the manuscript.

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V. Abstract

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