ingegneria sismica
International Journal of Earthquake Engineering
Anno XLIII - Num. 1 - 2026

Optimization and Application of Artificial Intelligence in Overhead Line Project of Robot Automation Distribution Network

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SUMMARY: *With the development of modern science and technology, automation technology has been gradually applied to various industries, and has gradually begun to realize automatic control. In the process of using this technology, it can not only reduce the investment in human and financial resources, but also greatly reduce the project duration. At present, in the power system, the high voltage power system has been widely used and has achieved good results. High voltage transmission lines are easy to cause accidents, which would directly cause huge damage to the interests of the people and enterprises, so they must be regularly maintained. This paper analyzed the optimization and application of artificial intelligence (AI) in the automatic grid overhead line project, and compared the differences of angle, average speed and communication distance. It was concluded that the average speed of robot automation optimization by using AI was 26.1% higher than that before optimization, and the use of AI can increase the communication distance of robot automation by 25%.*

KEYWORDS: *Artificial Intelligence, Robot automation, Distribution network overhead line project, Robot automation model*

1 Introduction

With the rapid development of AI technology, AI technology has been widely used in various fields. In the robot automation technology, due to the heavy task and great difficulty of aerial work in the grid overhead line project, it is necessary to use Internet technology to simplify the difficult work technology, so as to facilitate aerial work and ensure the smooth operation of the network cable. Robots play an important role in the network patrol work. When the robot is working on the overhead network, it can use its own advantages to carry out fine operation on the network cable, which solves the difficult problem of working at height. However, at present, there are also some technical problems in the work of the robot, such as inflexibility, long mechanical arm, slow movement and so on, so it is necessary to optimize the robot technology.

Many experts have carried out research on robot technology. On the basis of robot research, Yan Yu built a cooperative control system with two working objectives on a closed chain. The stress distribution law on the closed chain was studied, and the simulation test and actual operation results were checked. By mixing the forces and positions of the system, the forces of the system in the closed link were offset each other, and the purpose of reducing the internal force of the system was achieved. Finally, the engineering practicability of this

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https://doi.org/10.65102/is2026346 Published: 30 April, 2026

method was tested by field operation test. If this control method can be implemented efficiently, the working efficiency and stability of the robot would be greatly improved [1]. Jiang Wei aimed to deal with some important technical problems of electric robots in reality. He summarized some important technologies related to it, and carried out in-depth discussion on the important technical indicators of robot in reality, such as operation reliability, operation efficiency and operation quality. On this basis, he proposed a control architecture of the power cable robot with the power Internet of Things as the core to effectively manage the operation and maintenance of the power system, which laid a solid theoretical foundation for the development of the power cable robot [2]. The wide application of robot technology has brought convenience to the development of real life.

Automation technology has been applied in various fields. Joshi Sagar's research contents included: establishing the hydraulic system parameters of the flexible actuator, establishing the standardized mathematical model of the hydraulic system of the flexible actuator, quantifying the correlation between the parameters of the flexible actuator and its dynamic characteristic parameters such as lifting time, transmission frequency, etc. After trial and verification, the above research results were used to optimize and control the components, so that the components have the lightest weight and can meet the requirements of soft external packaging. The measured water pressure response was basically consistent with the simulated value, and the average deviation was within 5.2%. By modeling the software executive mechanism, it can be more applied [3]. Based on wireless sensor networks, Liu Jianming built an information processing system for monitoring, detection, security and interaction of multi-level transmission and distribution systems according to the monitoring and operation requirements of transmission and distribution systems [4]. Valaskova Katarina conducted in-depth case studies on intelligent process planning, cognitive automation and industrial big data processing based on in-depth information, and research and estimation of network production technology [5]. Fragapane Giuseppe sorted out the existing research on logistics planning and management in enterprises. He introduced the planning and regulatory framework to guide managers to make decisions and help them achieve optimal performance. In addition, the future development direction was prospected [6]. Automation technology plays a huge role in production and life.

AI technology plays an important role in the development of Internet technology.

ElMaraghy Hoda studied the impact and preparation of moving to a more sensitive and intelligent adaptive system. It was analyzed and a concrete application example was given. He discussed the new and adaptable new cognitive processing mode and its characteristics, driving and driving factors, and focused on its changes in numbers and cognition, thus putting forward some views and views for the implementation of the evolution of the production system [7]. Javaid Mohd pointed out the main progress and different problems in the realization of industrial intelligence, and expounded its significance in actual production. After in-depth and careful research, there are many advantages in the new production system, and it is necessary for all stakeholders to understand the various automatic control platforms they need [8]. Chea Cheav Por made a comprehensive review of automatic control technology in building assembly and construction, including the latest progress, challenges and future development direction. In engineering, his intelligent construction method with intelligent manufacturing as the core would be more applied to engineering [9]. Gusmao Brissi Sara conducted in-depth research and analysis on those robot systems. The main contents are as follows: the interaction matrix was discussed, and the relevant documents other than the previous papers were discussed in depth, so as to further explore the robot system and lean architecture in the future [10]. Zhang Bo believed that in order to develop a safe, reliable and scalable new generation of intelligent technology, it is necessary to build a

set of intelligent computing methods with strong interpretability and robustness. In order to achieve this, it is necessary to develop the third generation AI technology that is integrated with the existing model in the future [11]. AI technology plays a great role in building automatic control technology.

The above research only studied the phenomena of AI and robot automation grid overhead line engineering separately, without combining the two. Although these studies have certain reference, they are more or less insufficient to prove the conclusion, and there is a certain room for improvement. In order to solve the optimization and application of AI in the overhead line project of robot automation distribution network, this paper analyzed the development status and prospects of AI, as well as the application analysis of the overhead line project of robot automation distribution network. According to the experimental data, by comparing the optimization of AI in robot automation, and by comparing the angle, average speed, and communication distance, it was found that the optimization of AI was better. It can be seen from this that AI can be well applied in the field of robot automation, which has reference significance for future research in other fields of automation.

2 AI and Automation

2.1 Exploration on AI

As a new technology produced with the development of computer science and technology, AI has been widely used in all walks of life. Generally speaking, it is a discipline integrating natural science and social science. In this system, the primary goal is to make a computer have the same intelligence as people, so that it can do what many people need to do. In essence, this technology is a computer, which is used to imitate people's way of thinking and wisdom.

Many experts and scholars have discussed the application of AI, and relevant personnel would explore its development and application in different decision-making areas through AI courses, such as the application of AI technology to robot in policy making and medical field [12]. Professionals found that in early detection, AI plays an important role in disease diagnosis. In addition, these instruments based on AI are now showing more advantages. By creating a multi-disciplinary platform, the importance of all healthcare resources can be recognized. This stage is the biggest challenge to achieve medical equity [13]. The application of AI in various fields has led to the development of AI.

At present, in the power system, the application of AI to the power system can be studied from the following aspects: intelligent technology can make the power system get the best control. Because of the best control of power system, in the process of power system control, in addition to rich professional technical support, there must also be rich design experience. When designing, it is not enough to rely solely on the experience and knowledge of designers. It is necessary to integrate the knowledge and experience of various designers to better complete the design of electrical devices. In conventional electrical devices, this is precisely because of this problem. At present, more and more computers are used in electric equipment. The application of computer technology can not only greatly improve the production efficiency of electric equipment, but also make the design of electric equipment more scientific and accurate. The principle of AI technology is shown in Figure 1.

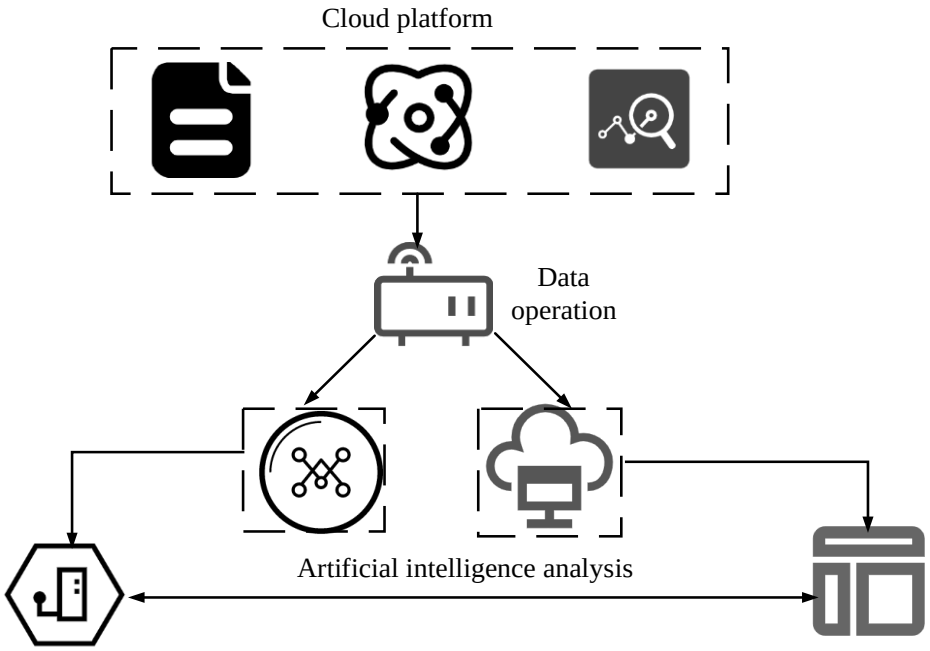


Figure 1: Principles of AI technology

2.2 Application of AI in Robot Automation

AI is also widely used in robot automation technology, which provides an effective technical means for ensuring the safe and stable operation of the power grid and high-quality transmission. Due to the increasingly perfect equipment of the manipulator and the increasingly complex operating conditions, the problem of cooperative action control under the limit conditions has gradually become a key problem restricting the practical application of the manipulator.

Professionals find out the topics related to the application of AI. The specific research contents include teaching robots, which are applied to intelligent teaching. The challenges faced by AI and the future development trend are also discussed [14]. Relevant professionals enable robots to achieve optimal operation by developing automation and AI technologies and AI programs [15].

Robotic technology faces some difficulties. In the future, it is not only necessary to focus on breaking through the dynamics evolution mechanism of robot mechanism in extreme environment, multi-field coupling information fusion in extreme environment, autonomous positioning and error compensation control of robot, but also need to focus on breaking through the motion control of robot and human in extreme environment, hybrid and cooperative control of two-arm forces, dynamic distribution and cancellation of forces in the closed chain of robot and controlled system. The robot automatic transmission process is shown in Figure 2.

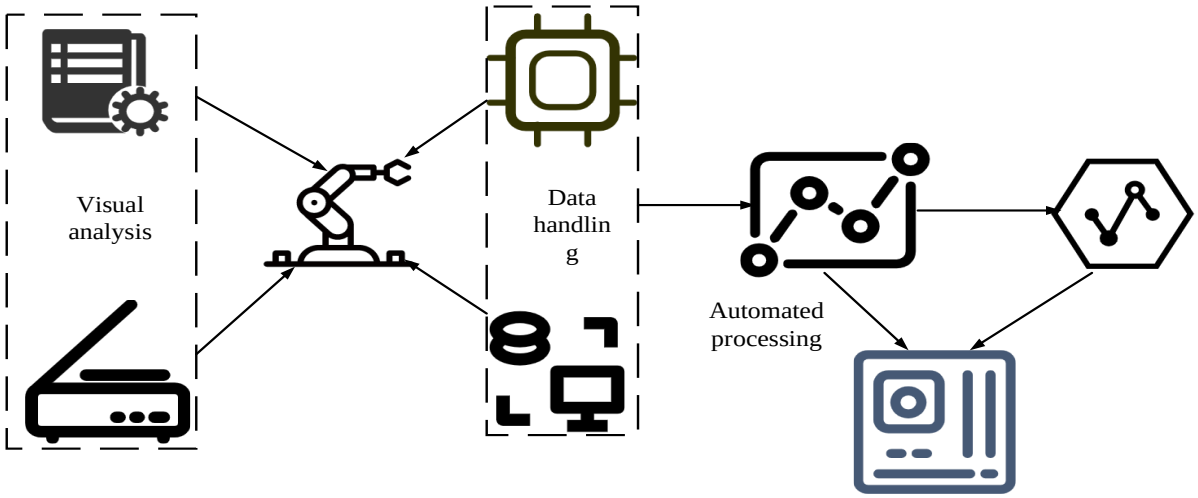


Figure 2: Robot automatic transmission process

2.3 Application of AI Technology in Automation Field

The work of AI technology is carried out under the control of the computer. Data tracking and checking would be carried out during the operation of the computer, which can reduce errors in the calculation, so it can reduce errors in the control of industrial automation. In the overall automatic transmission, if there is no problem with the software, the probability of problems in the application of automation technology in the grid overhead line technology is very low.

The former industrial automation systems were semi-automatic and would consume a lot of manpower. Now with AI technology, it is possible to save a lot of manpower and save a lot of time and effort. In addition, AI can also input all information into the computer, which is simple and efficient. In industrial automation, when a lot of manual control is carried out, some personal problems would inevitably arise, which would lead to a series of unnecessary operations and errors. AI technology is operated by computer, which excludes most external operations. When workers enter a piece of code into the system, the computer would operate according to the code, which can ensure the stability of the system and improve the quality of the computer.

3 Robot Automation Distribution Network Overhead Line Project

3.1 Overhead Line Engineering of Distribution Grid

With the rapid development of economy and cities, urban infrastructure has also developed rapidly. The power system plays an irreplaceable role in the people's life and the development of the national economy. An in-depth analysis of it can improve the quality of life of the people and promote the development of the national economy. In the construction of power grid, the construction of overhead lines is a key step that cannot be ignored. During this period, in order to ensure the construction of the overhead line project, appropriate technical measures must be taken. In particular, when there are many problems in project construction, it is more important to pay attention to the use of technology in project construction.

During the construction of overhead lines in the distribution network, basic skills should be done well, which is the basis for the commencement of all projects. However, due to the relatively large land area, the differences between different regions should be fully considered in the construction of transmission lines, and the corresponding construction should be carried

out according to the actual situation, so as to ensure the completion of high-quality projects. In the distribution network, the tower body is an essential and important facility in the erection of the power system. It plays an important role in the whole power system and is the most important part of the power system. As the tower has the characteristics of long-term service, it is necessary to ensure its rigidity to ensure its stability and life. For its selection, attention should be paid to its construction and type. Under mountainous and flat terrain conditions, it is more appropriate to use reinforced cement columns for the construction and construction of power transmission lines. In the mountains, iron towers are needed to build electric lines. When lapping, appropriate lapping method shall be selected according to the nature of the object to be lapped.

In the construction of low-voltage electrical lines, tension paying-off, tightening and fitting setting are usually used. Attention should be paid to reducing cable loss, and corresponding measures should be taken to minimize cable friction. The use of the tensioning machine can maintain the tension of the wire, so as to maintain a certain safe distance from the inspected object, which can not only ensure the quality of the paying-off, but also effectively carry out more efficient construction. However, its disadvantage is that after each wire is laid, the wire should be temporarily fixed in front of the tensioning machine. In order to prevent the wire from breaking due to vibration and aging, the horizontal tension of the anchor wire should not be greater than the calculated breaking force of the wire. For sub-wires with the same anchoring time, there should be certain differences in tension, so that the wire is staggered up and down.

The work to be done before tightening the wire is to pay attention to the positioning of the wire, so as to prevent slot jumping. The wire should be straightened and leveled before proceeding. The positioning of the linear pressure pipeline has been inspected. If the positioning of the pressure pipeline is improper, it should be inspected after tightening the line. If there is a broken line, it should be inspected again.

During the construction of the overhead distribution network, because the conductors in the transmission network are often at a high position, the lightning protection of conductors in the overhead distribution network is essential. The internal structure of the cable contains some metal materials. Therefore, in thunderstorm weather, the cable is very prone to flash, which has a negative effect on the normal transmission of the cable. When dragging and dropping optical fiber cables, special personnel must be assigned for overall scheduling to ensure the continuity of optical fiber cables and avoid knotting. In addition, the management of optical fiber fusion should be strengthened. During welding, it is necessary to select a suitable place and seal the joint box to prevent external moisture from entering. After the welding is completed, the collection work shall be carried out. The collection process needs to focus on following a standard sequence and start with the splice box, thus ensuring that the overall condition of the fiber in the splice box is good and no distortion occurs.

When installing the grounding body, it shall be laid according to the size of the relevant specifications. If any ground abnormality occurs during the laying, it shall be removed in time. After the completion of the grounding body weld, the weld shall be corroded to avoid accidents caused by other reasons. During the construction of the grounding grid, the resistance value of the grounding grid must be effectively controlled. After the vacuum switch is connected, it must be subject to certain resistance state constraints.

Generally, the line maintenance construction is in the process of line detection and patrol inspection. In case of problems, immediate measures should be taken to ensure the safe operation of the system and prevent potential safety hazards. In the process of power transmission, due to the influence of external pressure, overhaul is often required. Therefore, when sending the command, it is necessary to accurately judge the accident, and then quickly

repair the line and record the relevant work. In the process of a daily inspection, the inspectors are required to be familiar with and master the basic status and operation conditions of the lines to be inspected, which can find out some possible safety problems in time, so as to predict these problems in advance. When carrying out the inspection, we should bring more common tools and building materials. In case of any problem, the construction can be carried out in the shortest time under the condition that the site construction conditions permit, so as to ensure the effective maintenance of the operation safety of the line.

If there is a fault that the patrol personnel cannot build by themselves, it is necessary to report the fault location, equipment and surrounding conditions in a timely manner. Therefore, after receiving the report, the technical and maintenance personnel would make a more scientific and reasonable maintenance plan, and prepare the required materials and equipment. In addition, it is necessary to arrange staff to go to the site for line maintenance in the first time. The process of distribution network overhead line project is shown in Figure 3.

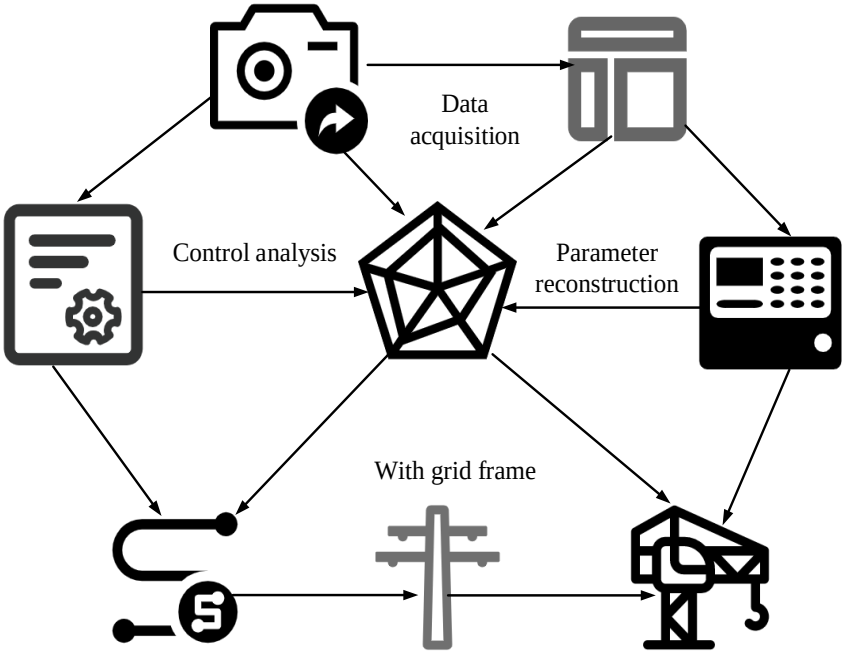


Figure 3: Distribution network overhead line engineering process

3.2 Optimization and Application of Overhead Line Project of Robot Automation Distribution Network

Electric energy is an indispensable energy source in modern industrial, industrial, civil and other fields. In the whole power grid, the power transmission is a very critical step, and most of the power transmission is using high-voltage transmission lines. Its safe operation has important practical significance. In reality, the transmission line has the characteristics of long distance and wide range, and it needs to be transmitted in various forms. Due to the complex terrain conditions and long outdoor time, high-voltage transmission lines are often affected by the harsh environment. If the damaged wires cannot be repaired or replaced immediately, the original small defects or damage would become more and more serious, and would eventually cause very serious damage to the transmission lines.

If the power supply is not smooth, it would bring huge economic and social impact to the power grid. Therefore, it is very important to do a good job in the maintenance of power transmission lines. The power supply company should carry out routine inspection and

maintenance of high-voltage lines, so as to have a comprehensive understanding of the working conditions of transmission lines.

At present, there are two ways of patrol inspection for high-voltage transmission lines: one is manual patrol inspection, and the other is helicopter patrol inspection. Manual patrol inspection is carried out through the visual inspection and glasses of patrol inspection and maintenance personnel. This inspection method is for inspectors. The work of the staff is very heavy, and the work efficiency of the line patrol is very low, but also affected by the geographical environment, climatic conditions and the patrol personnel. Due to the staff's own experience and quality, some safety problems in the detection are not easy to be detected in time, resulting in missed detection and wrong detection. In the aerial patrol, a helicopter is used. On the power transmission line, the staff on the helicopter can use visual technology or aircraft camera. Various abnormal phenomena in the transmission line can be observed and recorded with instruments.

The rapid development of robot arm technology has laid the foundation for the development of the robot arm that can realize the automatic line inspection of power transmission lines. The robot arm of patrol type is used to patrol the power grid, which has higher security and flexibility. The workers just put the mechanical arm up. The automatic device installed on the power transmission line can greatly reduce the workload of the patrol inspection staff, thus improving the work efficiency. In order to achieve an increase in inspection speed, the assurance of inspection quality, and the reduction of maintenance costs for high-voltage transmission lines, it is necessary to improve the productivity of the company in terms of improving the structure of the power grid.

The use of the drag reducer in the air line in the distribution network can effectively control the air line in the distribution network. By adding resistance reducing agent to the overhead circuit of the distribution network, the resistance of the overhead line of the distribution network can be effectively promoted and gradually decreased with the passage of time. In power projects, the application of drag reduction technology to transmission lines needs to be studied from multiple perspectives, such as physics and chemistry. The overhead line of distribution network is weakly alkaline, so its corrosion resistance is very strong, which can improve the lightning protection performance of overhead lines in power projects. The requirements for overhead line engineering of distribution network are shown in Table 1.

Table1: Engineering requirements for overhead line of distribution network

Patrol inspection items	Requirements for patrol inspection content
Network cable environment	Flammable and explosive facilities,Line patrol channel
Conductor measures	Breakage,rustiness,Exposed network cable
Accessory facilities	Monitoring device,Warning Sign

4 AI Robot Automation Model

In the overhead wiring of aerial work, the use of the mechanical arm has played a great role and made the wiring work easier. The kinematic characteristics of the mechanical arm have been studied by using the function method. If the distance between the middle arm and the rear arm of the robot is s, then there are:

$$s = s_1 \sin\theta_1 + s_2 \cos\theta_2 \tag{1}$$

By taking the derivative of the time t on both sides of Formula (1), the motion velocity v

of the arm in the robot can be obtained:

$$v = s_1 \cos\theta_1 \frac{d\theta_1}{dt} - r_2 \sin\theta_2 \frac{d\theta_2}{dt} \tag{2}$$

The angular velocity of the swing arms on both sides of the robot is ω:

$$\omega = \frac{d\theta_1}{dt} \tag{3}$$

The speed of the middle arm can be obtained by combining Formula (2) and Formula (3):

$$v = s_1 \omega \frac{\cos(\theta_1 - \theta_2)}{\cos\theta_1} \tag{4}$$

By taking the derivative of time t, the acceleration a is:

$$a = -s_1 \omega^2 \left[\frac{\sin(\theta_1 - \theta_2)}{\cos\theta_2} + \frac{s_1}{s_2} \cdot \frac{\sin^2\theta_1}{\cos^2\theta_1} \right] \tag{5}$$

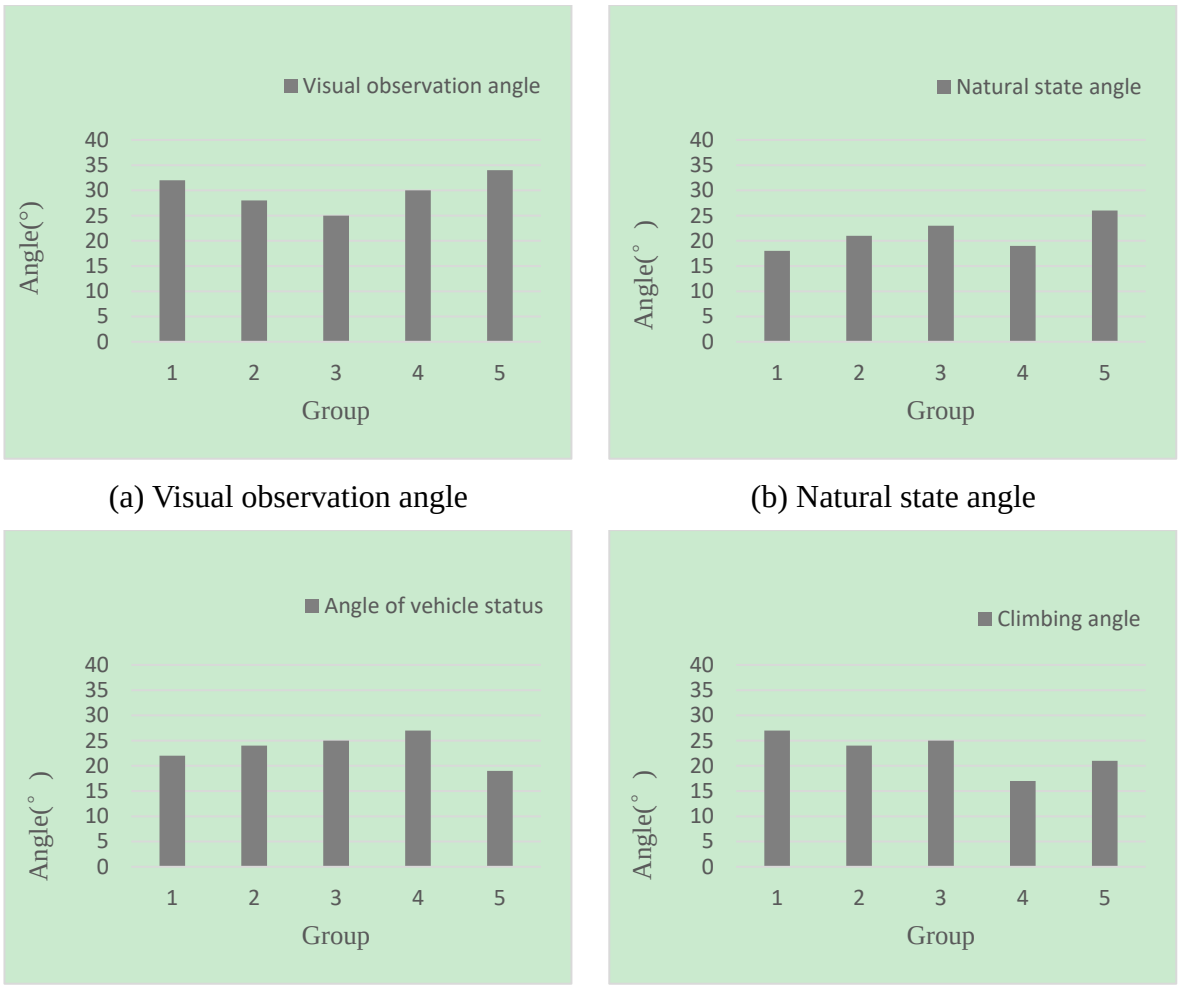
According to the AI robot model, the maximum optimization of overhead distribution network engineering can be achieved.

5 Experimental Data of AI Robot

Five groups of robot data were selected. The climbing angle, average speed and communication distance were recorded and analyzed by timing. By recording and comparing data, the effect evaluation of AI algorithm on robot automatic operation was analyzed.

5.1 Angle

The test was conducted on the test line, and five groups of data were selected. From 0 to 40 degrees, the slope climbing stability test shall be carried out every 5 degrees, and the time shall be recorded to determine whether there is sliding phenomenon. If there is no sliding phenomenon, the landslide can be stabilized. The tilt angles of visual observation angle, natural state angle, vehicle state angle and climbing angle were compared. The comparative analysis of various angles is shown in Figure 4.



(a) Visual observation angle (b) Natural state angle

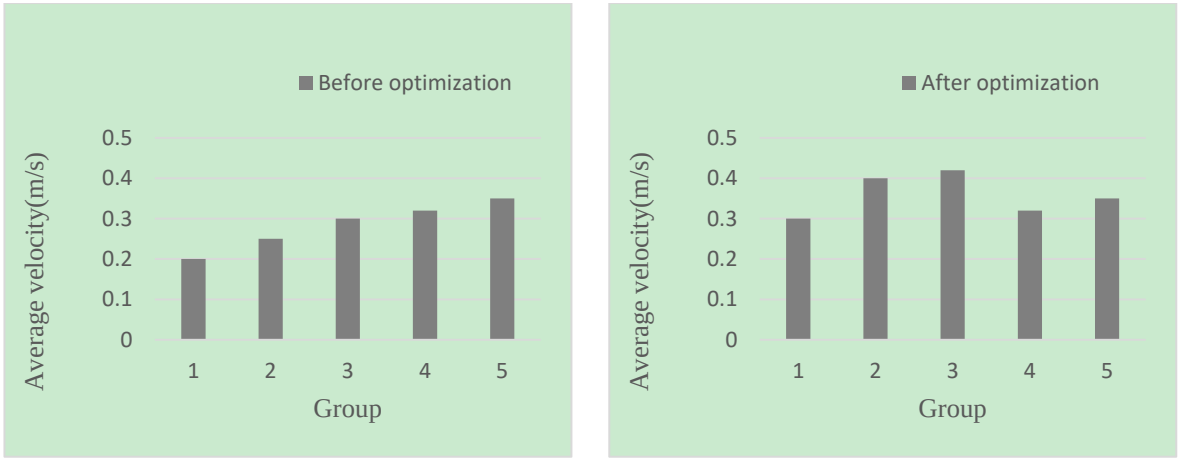
(c) Angle of vehicle status (d) Climbing angle

Figure 4: Comparative analysis from various angles

Figure 4a shows the angle value of the naked eye observation angle, with the highest value of 34°, the lowest value of 25°, and the average value of 29.8°. The overall data fluctuated slightly. Figure 4b shows the angle value of natural state angle, and the overall angle value was between 18° and 26°. Figure 4c shows the angle value of the vehicle with the angle value in the range of 19°~27°. Figure 4d shows the slope angle of the climbing angle, which was between 17° and 27°. The recorded data included the angle value observed by the naked eye and the angle value calculated by the meter ruler measurement. The angle value was recorded here for four angles. Through the comparison of the four angle values, it can be seen that the maximum climbing angle of the robot was 27°. The robot can walk normally on a gentle slope below 25 degrees, but when it exceeds 25 degrees, it is easy to slip. Therefore, it is necessary to take some anti-solid measures for the robot.

5.2 Average Speed

The measurement was carried out on the straight test line. By controlling the diameter of the line, the power was adjusted to the maximum, the test was conducted and the stopwatch was used for timing. The average speed was calculated and recorded, and the effect of robot automatic operation before and after the application of AI was compared. The average speed comparison of robots before and after AI optimization is shown in Figure 5.



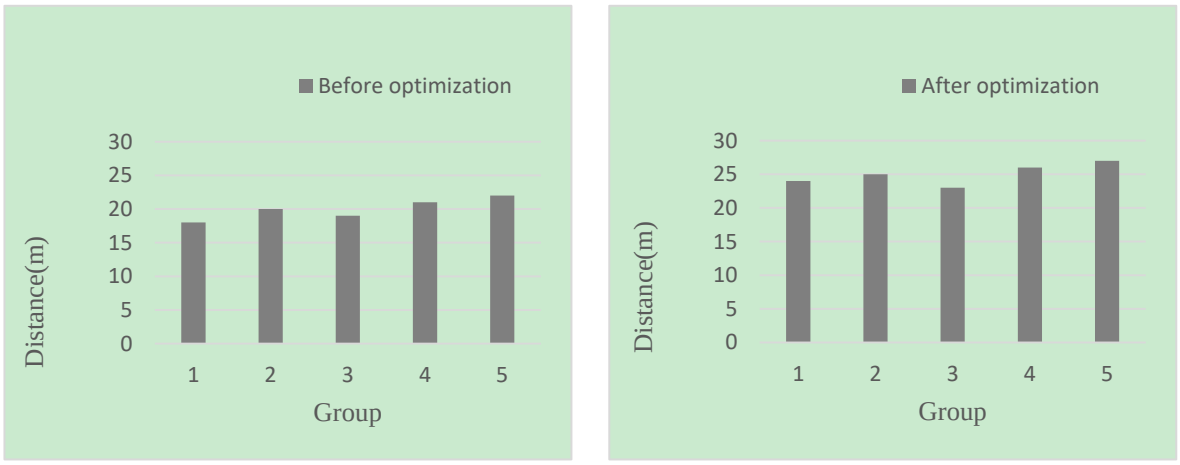
(a) Before optimization (b) After optimization

Figure 5: Comparison of robot average speed before and after AI optimization

Figure 5a shows the average speed of the robot before optimization. The minimum average speed of the robot was 0.2m/s and the maximum was 0.35m/s; the average value was 0.284m/s, and the overall speed was low. Figure 5b shows the average speed of the robot optimized by AI. Compared with that before optimization, the overall speed increased; the overall speed was within the range of 0.3m/s~0.42m/s, and the data change was small. The average speed of robot automation optimization using AI was 26.1% higher than that before optimization.

5.3 Communication Distance

The gap between the communication distance of the robot before and after using AI optimization was tested, and the communication status was tested from near to far. The comparison of robot communication status before and after AI optimization is shown in Figure 6.



(a) Before optimization (b) After optimization

Figure 6: Comparison of robot communication state before and after optimization by AI

Figure 6a shows the communication distance of the robot before optimization using AI. According to the general trend of Figure 6a, the communication distance before optimization was within the range of 18m~22m, and the overall data was low. Figure 5b shows that the

communication distance of the robot optimized by AI was between 23m and 27m, and the automatic communication distance of the robot was increased by 25% by using AI.

To sum up, through the analysis of experimental data, it was found that when testing robots, the use of AI to test robot automation had improved in terms of angle, average speed and communication distance, and AI had played a huge role in the optimization of the robot network empty frame project.

6 Discussion

This paper introduces an automatic inspection robot model which can be used on high voltage ground wire, cross cable obstacles and climb iron tower. Due to the complexity of the patrol environment, the theory and experiment carried out under the specific patrol conditions have achieved good results, but there is still a big gap between the goal of replacing the manual patrol with the skilled patrol personnel. Due to the complexity of the patrol environment, the theory and experiment carried out under the specific patrol conditions have achieved good results, but there is still a big gap between the goal of replacing the manual patrol with the skilled patrol personnel. The work carried out in this paper was based on the condition that the inspection robot and the cable were both rigid bodies, and the cable and some components of the robot had high flexibility. Therefore, in order to be closer to the real environment, it is necessary to build a rigid-flexible coupling model for in-depth analysis.

At present, the system has realized the crossing of all obstacles on the ground wire. However, in the face of large angle adjustable tension tower, the system still has some difficulties, and further development needs to be further improved. Through the test of the prototype machine, because the installation and connection of the inspection robot is very difficult, it is necessary to develop an auxiliary mechanical device from the ground to the ground. During patrol, the middle of the two iron towers is likely to fail. At this time, it is necessary to develop a search and rescue robot to rescue the patrol robot. The development of patrol robots is not only to walk on the railway, but also to add more detection devices in the future, so that it can be combined with robots to achieve self-check and self-repair.

7 Conclusions

With the rapid development of power engineering, the use of overhead lines in distribution network is becoming more and more common. The number of overhead lines is also gradually increasing, and the transmission technology is also constantly being optimized and improved. Transmission lines play a key role in the normal operation of the power grid and the power transmission between power plants and substations. In the process of transmission line construction, it is necessary to build some important links and grasp the characteristics of line installation in combination with the specific situation of the project. This can reduce various problems in the construction to the minimum, and strengthen the construction technology, so as to ensure the construction of each road. This paper introduced the development of AI and the principle of robot automation technology. Based on the analysis of the application prospect and technical analysis of the overhead line project of the distribution grid, a robot automation model was proposed. Through the analysis of experimental data, it was found that the angle, average speed and communication distance of the robot in this model were optimized. The application of AI technology has improved the engineering technology of robot automation overhead line in distribution network, which has reference significance for the application of AI in other fields in the future.

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Acknowledgements

Quzhou Guangming Power Engineering Co., Ltd. Science and Technology Project“Research and Development of the Function for Branch Lead Connection in Double-Circuit Overhead Lines for Live Working Robots” (861103Y202111002)

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