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Application of robot automation technology based on machine assisted and artificial intelligence in distribution network overhead line engineering

Yi Tan [1], Yunhui Wang [1,*], Xue Li [1], and Meng Li [1]

1 Yunnan Power Grid Co., Yunnan, Kunming, 650400, China

Abstract

INTRODUCTION: The development of artificial intelligence technology in the context of the intelligent era shows vigorous vigor and vitality, and artificial intelligence fusion of robotic automation technology can assist manpower to complete all kinds of difficult operations, distribution network overhead line as the current power transmission lines equipped with the main way for domestic power transmission and regional power safety is of great significance.
OBJECTIVES: In order to reduce the labor intensity of operators, reduce the occurrence of power outages, and ensure the reliability of power supply, we discuss the application of robotic automation technology of machine-assisted and artificial intelligence in the distribution network overhead line project.
METHODS: Distribution network with power operation intelligent robot will grid lines in the wave speed information through the sensor transmission to the computer system, the computer system will grid lines in the wave speed converted to the wave speed of the overhead line, can be mixed lines in the wave speed inconsistent problem to provide a good solution.
RESULTS: At the scene of the work, the artificial intelligence distribution network power-carrying operation robot integrating artificial intelligence technology has a good application effect for the wiring in the distribution network overhead line project.
CONCLUSION: Robot automation technology incorporates the advantages of artificial intelligence, can rely on sensor systems and computer systems to perceive and identify things, and can autonomously control their own behavior, automated processing of complex actions, with a certain degree of perception, planning and collaborative ability, can be applied to the distribution network overhead line project.

Keywords: artificial intelligence, machine-assisted, automation technology, distribution network overhead line engineering.

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Corresponding author. Email: wepsh1547@163.com

1. Introduction

The advent of the intelligent era has given rise to one cutting-edge high-tech production technology after another. Artificial intelligence, as a typical representative of the intelligent era and an important branch of computer science, has undergone rapid development since the 1970s, and is known as one of the three cutting-edge technologies of the new century along with energy technology and space technology. Artificial intelligence applies simulated information data to the daily production activities of society through computer technology, which is equivalent to a computer with human intelligence to achieve a higher level of application effect. Although arising from computers, the scope of AI applications is not limited to the realm of computer science, but is all-encompassing and involves many disciplines in natural and social sciences. The artificial intelligence industry has

shown great prospects for development, and its industry scale has shown a gradual upward trend in recent years.

As can be seen from data, the AI industry scale has grown from 192.8 billion yuan in 2016 to 692.5 billion yuan in 2021, achieving a growth of 399.7 billion yuan in five years, which is more than a threefold increase. In addition to computer technology, the application of artificial intelligence can not be separated from the support of big data, which provides information support for artificial intelligence technology. Robots, as the crystallization of human wisdom, have many connections with artificial intelligence. Before artificial intelligence was created, humans relied on fixed instructions to make robots perform mechanical repetitive work, which made robots only perform some simple and repetitive assembly line work, usually used in industrial production activities. And after the creation of AI, robots seem to be endowed with human abilities to think and learn like humans and perform some high-end and complex tasks and tasks.

As can be seen from the information data, the sales situation of different functional types of robots has shown an increasing trend in recent years, which indicates that there is a huge potential for the development of the consumer market for robots. With the addition of artificial intelligence technology and machine assistance, robot automation technology has been developed and improved, and has good application effects in many fields of engineering. As the power line is an important link in the power system to ensure the smooth transmission of electrical energy, it plays an important role in the operational safety of the power system and the development of the national economy. Therefore, in the era of smart grid, ensuring the safety of distribution network overhead line engineering is beneficial to enhance the stability, safety and power supply reliability of the power system. In this paper, we will study the application of robotic automation technology in distribution network overhead line engineering to ensure the safe operation of the power system.

2. Research Background

As the population continues to grow and the level of national economic development increases, the electricity consumption of the society is also increasing, which puts forward higher requirements for the safe and stable operation of the electric power system. The power line is the channel for power transmission, and is an important link for power transmission. Its riskiness is related to the safety of electricity consumption of residents and society, and the failure of the power line will also pose a threat to the safety of power system operation. Therefore, if there is a security risk in the power line, the fault that occurs should be investigated in the shortest possible time to restore power supply in the shortest possible time. In the context of the smart era, the State Grid Corporation proposed in 2009 to build a smart grid with the strategic goal of striving to raise the level of development of the domestic power system industry to an unprecedented level. The construction of smart grid can, to a certain extent, reduce the risk of equipping complex power grids and ensure the safe transmission of electricity. Distribution overhead lines are an important way of power transmission line equipping, and thanks to the development of smart distribution grid technology, this way of power line equipping has made significant development. Distribution network overhead line yield is shown in Figure 1.

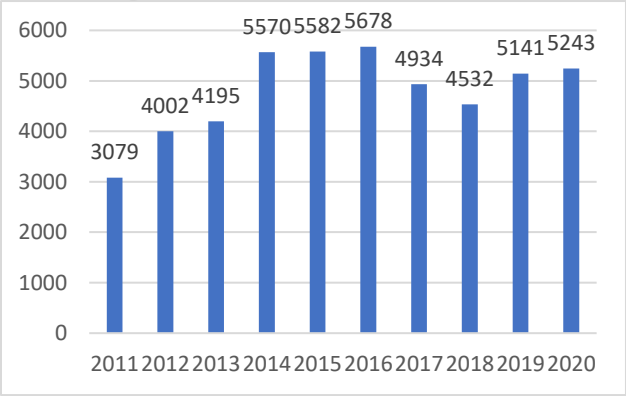

Figure 1. Change of China's distribution network overhead line output, 2011-2020

From the information in Figure 1, it can be seen that the output of distribution network overhead lines shows an overall growth trend. The unfolding of distribution overhead line project requires a certain space, but with the development of social economy and the improvement of urbanization level, the available space range is getting smaller and smaller, and the cost of equipping power grids is getting higher and higher, therefore, the process of building urban power grids adopts various types of power cable equipping methods, which play a great advantage in carrying out power transmission. In some cities, cable lines are buried underground to save available space and to beautify the city. Compared to overhead lines, buried cable lines have structural special features that allow them to transmit larger units of power in the same transmission corridor, while being more secure and reliable. However, underground cables are more expensive to equip, require more time and effort to be consumed during construction, and are a very large engineering task, which is often difficult to achieve for cities with backward levels of economic development. Moreover, the geological landscape in some areas is more complex and difficult to mine. Based on the realistic needs, some cities adopt the way of overhead line cable hybrid line for power transmission on the basis of retaining the original distribution network overhead line project.

The distribution network overhead line project is a huge engineering task with high requirements on the quantity and quality of labor, which brings high engineering costs. Moreover, due to many uncertain and

subjective factors in human construction, line failures are prone to occur in the process of wire overhead, making it difficult to ensure the normal unfolding of the transmission process. In addition, compared with a single structure of high-voltage electric line lines, the structure of the distribution network overhead line grid is more complex, there are many different types of lines, for the fault point of the investigation becomes a problem. The use of manual methods to troubleshoot fault points not only consumes a lot of human resources, but also takes a long time and can cause incalculable outage losses during the repair process. With the help of artificial intelligence technology, intelligent robots for distribution network with power operations are developed and specifically applied to the application of distribution network overhead line grid projects. Compared with manual work, the intelligent robot can be more adaptable to the operating environment, avoiding direct contact between the operator and the charged body, thus reducing human safety hazards and facilitating the reduction of the operator's labor intensity. And it reduces the occurrence of power outages and ensures the reliability of power supply.

3. Materials and methods

3.1. Robot automation technology

3.1.1. Overview of robotics and automation technology

Robotics technology comes from the scientific use of artificial intelligence, and is a product of the fusion of a variety of modern technologies, including machinery, computers, materials, automation technology, communication technology, electronics and so on. This is shown in Figure 2.

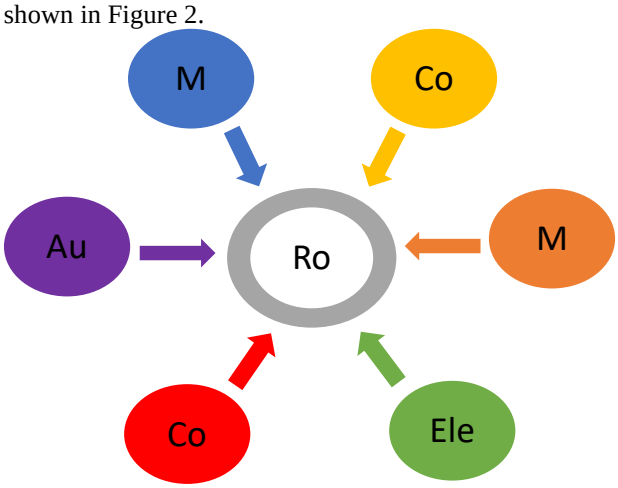

Figure 2. The source of robotics

Robotics is an intelligent product that replaces humans in social and material production activities. Robotics has been applied to many fields, and different kinds of robots have been developed, including medical robots for medical applications, educational robots for teaching, and intelligent robots for distribution network overhead line projects. The annual operating revenues of the robotics and automation industry are shown in Figure 3.

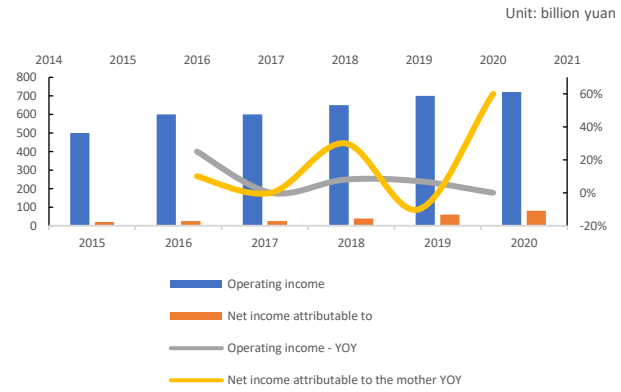

Figure 3. Annual operating revenue/mother's net profit and growth rate of robotics and automation industry

From the information in Figure 5, it can be seen that from 2015 to 2020, the annual operating revenue as well as net profit of the robotics and automation industry shows a growth trend, and the robotics and automation industry has a lucrative development potential. The general form of robot consists of five parts, which are motor unit, body structure, sensor system, computer system, and power supply. The motor, also known as the muscle system, is designed to assist the robot in moving through space; the body structure, usually inspired by the human body structure but not limited to it, can be modified to meet the needs of the job, ranging from human-like robots to "three-headed, six-armed" robots. The sensor system, which is responsible for information and data transfer, can sense the outside world, which gives the robot a unique sensory experience; the computer system, which is similar to the human brain, recognizes and selects things, which is the core of artificial intelligence in robot automation technology; and the power supply, which is also known as the energy system of the robot. Just as humans need to eat in order to provide energy for physical activities, electricity is the energy guarantee for robots to carry out their work.

Robotics incorporates the advantages of artificial intelligence and is able to perceive and identify things with sensor systems and computer systems, and can autonomously control its own behavior, automate complex actions, and possess certain perception, planning, and collaboration capabilities, which can assist humans in completing some non-research-based basic work.

Currently, the most widely used domestic robots are in the industrial production field, and usually, degrees of freedom, motion speed, operating space, load-bearing capacity, action morphology, and position accuracy are the important index variables to be referred to when industrial class robots perform work tasks, as shown in Figure 4.

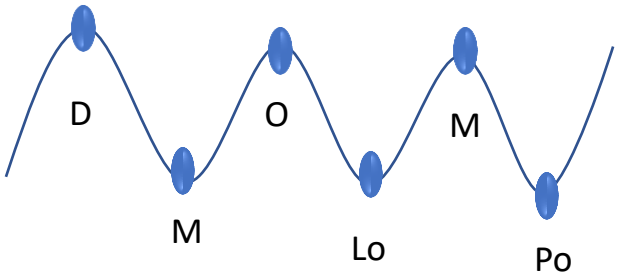

Figure 4. Important indicators to be referred to when industrial robots perform work tasks

Thanks to the development of artificial intelligence technology, industrial robots are able to perform some simple basic actions (such as material handling, sorting, and cargo grasping) in addition to more complex tasks such as packaging, painting, finishing, and cutting of products, which is the characteristic of robotic automation technology that can assist or replace humans in social and material production activities. From the current state of affairs, general-purpose class robots have improved substantially in both capability and cost effectiveness, and are even able to combine other auxiliary devices on end-connected operators, which can be programmed by code through the controller to enable the unfolding of the robot operating system. So improvements in automation technology have led to increasingly comprehensive robot capabilities and the emergence of automated robots with multiple functions, and the trend toward robot segmentation is gradually diminishing.

3.1.2. Automated Robot Control Systems

The control systems of automated robots include AC servo systems, controllers, and advanced control systems for robots. The significance of the robotic arm to the robot is equivalent to the relationship between the arm and human activity. The farthest distance that the robot can reach depends on the length of the robot's robotic arm, which has an important impact on the robot's working range, and the degree of flip of the robotic arm has an impact on the robot's mobility and posture. In a normal state, to give a robot the ability to work properly, it is necessary to equip the robot's manipulator with at least six degrees of freedom, which includes three positional degrees of freedom and three postural degrees of freedom, which means that the robot's manipulator arm should have six AC servo motors for traction braking to control the robot's operation, which is a necessary condition for the robot to be able to start working properly. The AC servo has the characteristic of fast speed, and it is difficult to connect the AC servo with the mechanical structure at high speed, so the speed of the AC servo should be kept within a controlled range by the deceleration of the reducer, so the current servo motor is modified by the staff and combined with the reducer to form a complete servo mechanism. In addition, the domestic use of electric motors has a larger number of applications for AC permanent magnet motors, which reduces the production cost of domestic robots and promotes the rapid development of the domestic robotics industry.

The construction of the robot controller usually consists of a main controller IPC with a 32-bit central processor. The hardware system of the robot in the usual state includes a built-in PUC, an external IPC and a workbench, and the software system includes programming software, safety software, maintenance function software, and software that turns into a function. The control function of the controller determines the robot automation level deeper is the control mode level of geometric model, policy model and dynamic model.

The advanced control of the robot has some functions that are not available in modern control technologies and is able to perform more complex adaptive control tasks, which are new operational techniques different from the classical feedback control techniques. In addition to adaptive control, advanced control of robots also includes variable structure control and intelligent control. Variable structure control, as a control method with a wide range of applications, has simple operational steps and simple application principles. Adaptive control specifically includes model parameter adaption, processor structure adaption, and operating system parameter adaptive control. Different from the variable structure control and adaptive control, intelligent control is a late start, is an emerging discipline arising from the collision of automation control and artificial intelligence, has a certain development prospect and great vitality.

3.2. Distribution network overhead line engineering

As the most common way and form of power transmission, overhead transmission lines are an indispensable part of the power system and play an important role in maintaining the stable transmission of electric energy to ensure the normal use of electricity by residents and industrial production activities. Overhead transmission lines are divided into two main categories according to voltage levels: main network transmission lines and distribution network transmission lines. The voltage level of main network transmission lines is generally greater than 110 kV and can carry out long-distance power transmission. The voltage level of distribution transmission lines is usually not more than 110 kV, and their installation method requires installation

on the towers, which is closer to the transmission distance of the main network transmission lines. Specifically, as shown in Figure 5.

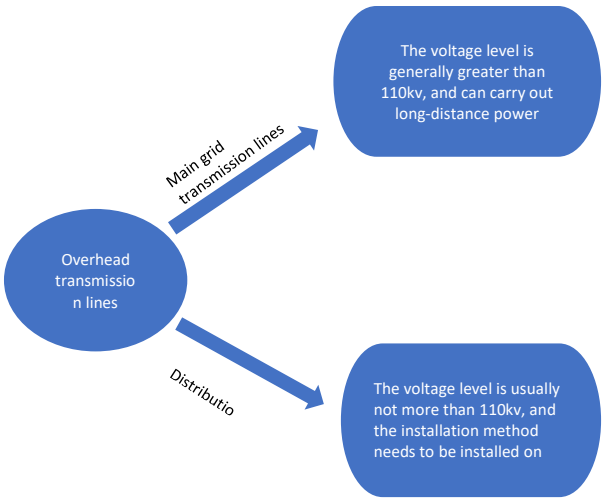

Figure 5. Classification of overhead transmission lines

The DC resistance R and AC resistance R' of overhead lines are calculated as shown in equations (1) and (2).

$$R = \rho C_j \frac{1}{s} \quad (1)$$

$$R' = y_s y_p R \quad (2)$$

In the formula (1), (2), ρ is the resistivity of the wire at 20 degrees, $_{Cj}$ is the stranding factor, $_{ys}$ is the skin effect factor, and $_{yj}$ is the proximity effect factor.

In the common overhead lines in daily life, the main network transmission line is usually composed of five parts: tower foundation, transmission tower, transmission conductor, insulator string, and ground, while the distribution network transmission line is generally composed of four parts: pole device, transmission tower, insulator string, and transmission conductor. Specifically as shown in Figure 6.

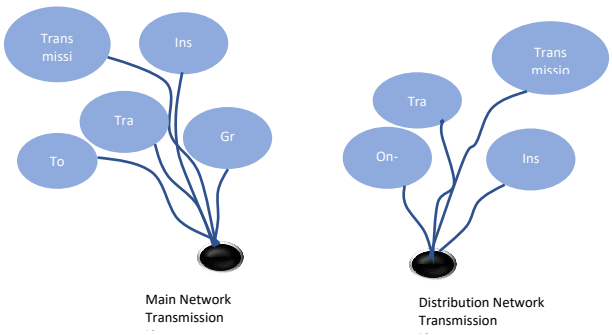

Figure 6. The composition of overhead lines

The structure of the pole tower of the distribution network overhead line is roughly divided into three parts, cross-arms, tower windows, and callouts. As an integral part of the tower, the cross-arms play an important role in supporting the wire, lightning line, installation of insulators and fixtures. Tower window is adjacent to the space formed between the two cross-arms and the tower, is the safety distance left when designing the tower. Hoo high as the lowermost layer of the tower conductor cross-arms below the plane to the tower center installed construction base surface of the vertical distance, determine the height of the tower. For the types of conductors, the common ones in the market are steel core aluminum glue wire LGJ, aluminum glue wire LJ, aluminum clad steel core aluminum strand LBGJ, fiber composite overhead ground wire OPGW. For insulators, according to the force situation can be divided into pendant string, tension-resistant string; according to the material can be divided into glass, ceramic, composite material. The fixtures can be divided into wire clips, connecting fixtures, jointing fixtures and protective fixtures.

In the distribution network overhead line project, first of all, we must have a clear planning goal for the power construction, specifically in the repeated review of the power construction drawings and the full planning of the design ideas and design features of the full understanding, according to the construction plan for standardized operations, in strict accordance with the construction drawings for the construction of lines. Reasonable line construction can not only save more space resources, but also enable the line to play the maximum value of utilization, saving social resources and cost consumption. In the construction progress, for the problems that arise, to timely fault-finding and to solve, in the work of excellence, to avoid greater adverse effects on subsequent projects, and strive to make the construction process of the distribution network overhead line project can be the best guarantee in terms of safety.

The most important part of the project is the laying of resistors. In the laying of resistors, to ensure the safety of the cable and the stability of power transmission, the expected underground depth of the resistor buried shall not be less than 1.2 m. Not only that, the bending radius for the wire should be kept within a reasonable length to avoid damage to the wire. For mechanical construction grounding wire traction operation work, to have precise control over the speed of construction, usually, the traction speed should be set at 0.2 meters per second, the length of the grounding wire is kept below 60 meters. In addition, to regularly overhaul the state of the outer skin of the wire, keep the outer skin in good condition, so that the mechanical construction of the traction run strength control in the appropriate range, to avoid traction force is too large to cause irreversible damage to the wire. For the distance between the grounding wire and the heat pipe, usually keep in 0.8m ~ 1m between suitable, the thickness of the two sides usually have to be set at 0.02m or more. After the distance measurement and control, the resistor

should be protected by the protective layer of the device work to ensure that it will not be affected by the uncertainty of the impact of external forces and cause damage, for the resistor protective layer manufacturing material, you can use high-strength alloy or high toughness fiber, to ensure that the protective layer is solid and reliable, and can resist the high strength impact of external forces.

After completing the above works, the grounding wire and resistor are covered. Before the covering task work is carried out, a complete inspection is needed, focusing on the insulation test of the grounding wire to ensure that the outer skin of the wire has a good insulation effect, so that the whole construction process is safe and reliable. When filling the pits, the filler used in the field pits should be carefully ranked to ensure that the filler is not mixed with stones, metal objects and other hard debris. For the location of construction, clear identification should be made in the appropriate orientation, such as joint locations or corner locations, so as to ensure not only the search for accurate construction locations in the process of carrying out the construction of distribution network overhead lines, but also to improve efficiency and save working time. For the task of ground body placement connection, the concept of construction design drawings should be followed, and the project should be carried out according to the appropriate size. During the construction process, foreign objects identified should be cleaned up in a timely manner, especially the hardware facilities of the device under high temperature and pressure are easily corroded, therefore, protective measures should be taken to keep the device from being corroded.

4. Results and Discussion

4.1. Robot automation technology for distribution network overhead line wiring application

At the site of work, the artificial intelligence distribution network with power operation robot integrating artificial intelligence technology has good application effect for wiring in distribution network overhead line project. First of all, the robot is supported by the bucket arm truck and slowly lifted to the predetermined position by the pulling force of the engine. After the identification and analysis of the image recognition system, the robot can independently identify and predict the position of the wire and determine the approximate position of the wire, and the robot arm equipped with a professional stripping knife can automatically strip the insulating skin of the wire, and after completing the task of stripping the insulating skin of the wire, the robot arm with a high degree of automatic response capability will actively connect the grounding wire clamp and accurately install the grounding wire clamp in the crossbar position, so as to prepare for the subsequent wiring work. After completing the task of stripping the conductor insulation, the robot arm with high automatic response capability will take the initiative to connect the grounding wire clamp and install the grounding wire clamp at the cross-arms position accurately, so as to prepare for the subsequent wiring work. At present, there are not many companies in China that can realize robotic automation of distribution overhead line project completion. Tianjin Chengnan Company used the fourth generation of distribution network with power operation robots, machine assisted manual to complete the 68 km long distribution overhead line project, and it is also the first case in China to apply robotic automation technology to the distribution overhead line project. Compared with the purely manual traditional insulated glove method of distribution overhead line engineering, the machine-assisted distribution network with power robots is easy to operate, which improves the efficiency of the project and saves a lot of unnecessary time, and also greatly reduces the risk of electric shock to the staff, which is beneficial to the personal safety of the staff.

According to the relevant information, in the distribution network overhead line construction site 15 kV distribution network overhead lines, grounding clamps are generally the role of the general line maintenance needs to be tested and hanging ground wire, in order to protect the personal safety of staff. During the completion of the project, the robot will complete the work of insulation masking, so staff do not need to climb to high altitude to carry out the dangerous insulation masking task, but only need to be on the ground through the computer to control the distribution network with power operation robot to work. As a result, the operation time for grounding clamps has been reduced by nearly 50% and the operational risk has been reduced to almost zero. Tianjin Chengnan Company is the largest guarantee company for electricity safety in Tianjin, and an important domestic conference on intelligent electricity safety is held here. Tianjin Chengnan Company teaches other power grid companies the experience of robotic automation technology for distribution network strip operation, and there will be more application cases of robotic automation technology for distribution network processing room in the future.

4.2. Robot automation technology for distribution network processing line circuit fault ranging

For the wiring of the power system, the neutral point is not grounded mode and neutral point grounding mode are the two most common wiring modes. For the former, when the system has a single-phase ground fault state, the line voltage of the system will appear high voltage, line circulation current is small and are capacitive current, resistance is too large easy to make the wire short circuit, then the need to turn off the power to prevent the fault. When the system wiring increases, the capacitive

grounding current can be grounded will be lower than the normal state of current flow, long time state operation will lead to the occurrence of secondary faults, which will pose a threat to the stability and safety of the system. Because the overhead line is always in the bare state, subject to the threat of external uncertainty of impact, such as birds and animals, natural disasters and other threats will cause damage to the epidermis of the overhead line, affecting the safety of the entire line. Because cable lines are compared with overhead lines, there are differences in properties and structures between the two, and are affected by different laying environments, when a fault occurs in the grid line, if not promptly repaired, it is likely to cause permanent failure. Even if the manual trip is taken to deal with the fault, the insulation strength of the fault point is difficult to restore to the level before the fault occurred, this state of reclosing not only can not complete the normal power supply, but on the contrary, will have an impact on the current, the secondary short circuit situation, resulting in the paralysis of the entire circuit system.

Therefore, the ranging of circuit faults is a key task to ensure the normal operation of the entire circuit system. The academic community has a wealth of research results on line fault ranging in a single structure, but little is known about fault ranging in mixed overhead line and cable lines. Because the overhead line and wire wave impedance there is a large difference, the line wave in the overhead line and cable connection between the two transmission is prone to foldback effect, will lead to line wave transmission line anomalies and line wave is blocked and weakened phenomenon, which will cause the wave head of the line wave is difficult to be manually line up. After the installation of the traveling wave detector, the intelligent robot can use the traveling wave detector to check the traveling wave head, and transmit the data to the computer equipment through the sensor, relying on the advantages of artificial intelligence to transfer the information according to the code, so that the robot can be accused of circuit fault detection. For high-voltage line ranging, because the propagation speed of traveling waves in overhead lines can be affected by the size of the current and produce large differences, mixed overhead lines can not be as easy as a single structure of high-voltage line ranging, in the manual ranging will face greater difficulties. Therefore, it is necessary to take advantage of the robot's automation technology to measure the distance of the traveling waves in the overhead line circuit of the distribution network, so as to prepare for the fault detection of the circuit. In addition, the reflected wave in the traveling wave will be propagated by the distribution network close to the grid line will be folded and reflected several times, so that the radiation value of the accepted measurement wave will be weakened and weighed down, and it is very easy to be affected by external interference signals, which will cause ranging errors in the ranging accuracy. The wave line detection technology in robotic automation technology, after matching the grid line, makes a judgment on the distance measurement accuracy according to the reflection arc of the sensor identification line wave and the amount of reflection times.

The intelligent robot transmits the wave speed information of the grid line to the computer system through the sensor, and the computer system converts the wave speed of the grid line into the wave speed of the overhead line, which can provide a good solution to the problem of inconsistent wave speed in the mixed line. After the conversion, the robot selects a single structure overhead line from the equivalent circuit for fault ranging. After having an accurate measurement of the fault distance, it can be converted to the actual line length and thus roughly deduce the location of the fault. Compared with the robot measurement effect, the manual measurement effect will produce a large error, which will have an impact on the accuracy of the final measurement. Therefore, the emergence of intelligent robots has eliminated the shortcomings of manual measurement. The computer system is equipped with a fault search algorithm that searches for fault time points to derive the length of the fault time, and uses the length of each section of the line and the wave speed on each section of the line as known conditions to derive the corresponding fault line length through calculation to facilitate the location of the fault point.

4.3. Robotic automation technology for the inspection of distribution network overhead line engineering

In order to ensure the safe operation of transmission lines, regular inspection of distribution overhead lines is also a part of the project. Overhead lines due to long-term exposure to the field environment, natural conditions are complex and changeable, some areas of high temperature and high humidity environment will make the wire, insulators, gold and other devices are corroded, easy to produce the phenomenon of broken strands, so to ensure the successful completion of the project and the long-term use of overhead lines in the future, the need for regular inspection of the line. Most of the previous inspection methods use human visual inspection or aircraft cruising. The effect of manual visual inspection staff operating experience and personal quality, accompanied by subjective initiative, due to the operator's sloppy often produce missed or wrong inspection phenomenon, and, in some areas of the harsh natural environment will cause damage to the physical safety of staff. As for the aircraft cruise, the domestic technology in this area is not mature, and will consume a lot of material and financial resources. And the generation of power strip operation robots provides help to overhead power line patrol work. The robot has the function of flexible movement and is equipped with a variety of sensors that can detect and identify obstacles and locate them, carry out autonomous operation planning, cross obstacles autonomously, inspect abnormalities in transmission lines autonomously, and the robot that inspects pictures and data will store the

information and transmit it through wireless transmission to complete the work of online replenishment of electrical energy. A new type of transmission line inspection robot has been developed for the inspection of overhead lines in order to better divide the work and strengthen the inspection of power grids. This new robot uses multi-wheeled movement and a composite linkage structure, incorporating artificial intelligence technology to achieve multiple degrees of freedom of movement. The composite mobile mechanism takes the form of multiple mobile accessory units in series, making the robot's mobile mode versatile and flexible. For the operation environment of rugged terrain, the transmission line inspection robot is equipped with a flexible robot hand, which can use its robot arm to clear the roadblocks when facing complex roadblocks, and for the roadblocks that cannot be cleared, it can cross the roadblocks through the working cycle of mechanical grip opening, moving and closing, similar to human climbing skills, showing good application effects in practice.

The structure of the transmission line inspection robot is complex, small, light and flexible, and the difficulty of operation is relatively small compared with other kinds of robots. However, the requirements for accuracy are high, the production design is complex and costly, and the adaptability to harsh environments is poor. When crossing obstacles, it takes longer time and travels slowly due to the complexity and variability of the roadblocks. Therefore, for the power grid company with strong financial strength, can consider the large-scale application of transmission line inspection robot, using the advantages of transmission line inspection robot to replace the traditional manual inspection method, not only can make the work efficiency is improved, but also can carry out multiple angles of detection, improve the comprehensiveness and accuracy of detection, at the same time, also avoid the manual appearance in the harsh operating environment, reduce the staff's labor intensity, to protect the personal safety of laborers.

5. Conclusion

The robot automation technology under the application of artificial intelligence technology has shown great development prospects. Overhead line engineering plays an important role in the safety of power system operation and the development of national economy. In this paper, the application of robotic automation technology in distribution network overhead line engineering is studied to provide research reference to ensure the safe operation of the national electric power system.

In the introduction part of the paper, the definition and application areas of artificial intelligence are firstly introduced. Artificial intelligence, supported by big data as information, is a typical representative of recent emerging technologies. Artificial intelligence provides technical support for the normal operation of robots, and robots are the external expression of artificial intelligence technology, and the combination of the two can have great application value to distribution network overhead line engineering. In the research background section of the article, the importance of power line safety is first explained, and the failure of power lines will affect the safe operation of the whole power system. As the main power grid engineering method, thanks to the robot automation technology integrated with artificial intelligence technology, the intelligent robot for distribution network overhead line operation is developed and specially applied to the distribution network overhead line engineering, which not only guarantees the reliability of power supply, but also helps to reduce the labor intensity of operators and reduce human safety hazards.

In the research methods and materials section of the article, the robot automation technology is introduced from two aspects: overview and control system. The robot automation technology incorporates the advantages of artificial intelligence, which can perceive and identify things with sensor systems and computer systems, and can control its own behavior and automate complex actions, and has certain perception, planning and coordination capabilities, which can be It has certain sensing, planning and collaborative capabilities that can be applied to distribution network overhead line projects. For the introduction of the control system, the article introduces the automated robot control system from three aspects: AC servo system, controller, and robot advanced control system. In Section 3.2, the focus of this paper is on the distribution overhead line project. The distribution network overhead line project is divided into main network transmission lines and distribution network transmission lines, and the components of both transmission lines have common features and differences. In the results and discussion section of the article, the application of robotic automation technology for distribution network overhead line wiring is analyzed first. The distribution network power operation robot can assist the staff to complete the wiring work smoothly, improve the efficiency of the project progress, save unnecessary time consumption, and also reduce the risk of electric shock. Next, the application of robot automation technology for distribution network overhead line circuit fault ranging is analyzed, and the emergence of intelligent robots gets rid of the shortcomings of the previous manual fault ranging accuracy. Finally, the analysis of robot automation technology for distribution network plus overhead line project inspection application, robot inspection has the advantages of the previous human visual inspection and aircraft inspection does not have, and can cross the obstacles independently, even in the face of complex operating environment site can be used freely, with good application effect.

References

[1] Huang Shaoyuan,Zhang Yuxi,Peng Guozheng,Zhao Juan,Zhu Keping,Zhang Heng,Wang Xiaofei. MF-

GCN-LSTM: a cloud-edge distributed framework for key positions prediction in grid projects. Journal of Cloud Computing,2022,11(1).

[2] Liang Yi,Fan Yingying,Peng Yongfang,An Haigang. Smart Grid Project Benefit Evaluation Based on a Hybrid Intelligent Model. Sustainability,2022,14(17).

[3] Buehner V.,Meyer B.,Noglik P.,Simon R.,Kuester M.. Germany's Lighthouse Projects Addressing Cellular Grids, Industrial dSM and Sector Coupling. Water and Energy International,2022,65r(4).

[4] Fotis Georgios,Dikeakos Christos,Zafeiropoulos Elias,Pappas Stylianos,Vita Vasiliki. Scalability and Replicability for Smart Grid Innovation Projects and the Improvement of Renewable Energy Sources Exploitation: The FLEXITRANSTORE Case. Energies,2022,15(13).

[5] Ferreira Bruno,Carriço Nelson,Barreira Raquel,Dias Tiago,Covas Dídia. Flowrate Time Series Processing in Engineering Tools for Water Distribution Networks. Water Resources Research,2022,58(6).

[6] Shinh Sameer,Ball Sam,Anilcumar Bhavik,Wells Harley,Corbett Barry. Finham gas-to-grid plant, UK: delivering a multi-disciplinary renewable energy scheme. Proceedings of the Institution of Civil Engineers - Civil Engineering,2022,175(3).

[7] Vasiljevska Julija,Efthimiadis Tilemahos. Selection of Smart Grids Projects of Common Interest—Past Experiences and Future Perspectives. Energies,2022,15(5).

[8] Gao Lei,Zhao ZhenYu,Li Cui. An Investment Decision-Making Approach for Power Grid Projects: A Multi-Objective Optimization Model. Energies,2022,15(3).

[9] Porcu Daniele,Castro Sonia,Otura Borja,Encinar Paula,Chochliouros Ioannis,Ciornei Irina,Hadjidemetriou Lenos,Ellinas Georgios,Santiago Rita,Grigoriou Elisavet,Antonopoulos Angelos,Cadenelli Nicola,di Pietro Nicola,Betzler August,Prieto Inmaculada,Battista Fabrizio,Brodimas Dimitrios,Rumenova Ralitsa,Bachoumis Athanasios. Demonstration of 5G Solutions for Smart Energy Grids of the Future: A Perspective of the Smart5Grid Project. Energies,2022,15(3).

[10] Yu Chunyi,Abdulrazzqa Mohammed. Engineering project management based on multiple regression equation and building information modelling technology. Applied Mathematics and Nonlinear Sciences,2021,7(1).

[11] Xu Xiaomin,Peng Luyao,Ji Zhengsen,Zheng Shipeng,Tian Zhuxiao,Geng Shiping. Research on Substation Project Cost Prediction Based on Sparrow Search Algorithm Optimized BP Neural Network. Sustainability,2021,13(24).

[12] Zhang Le. Research and application of 3D GIS in the visualization and information management of power grid construction projects. Journal of Physics: Conference Series,2021,2083(3).

[13] [Potenciano Menci Sergio,Bessa Ricardo J.,Herndler Barbara,Korner Clemens,Rao BharathVarsh,Leimgruber Fabian,Madureira André A.,Rua David,Coelho Fábio,Silva João V.,Andrade José R.,Sampaio Gil,Teixeira Henrique,Simões Micael,Viana João,Oliveira Luiz,Castro Diogo,Krisper Uršula,André Ricardo. Functional Scalability and Replicability Analysis for Smart Grid Functions: The InteGrid Project Approach. Energies,2021,14(18).

[14] Ratner Svetlana,Salnikov Anastasia A,Berezin Andrey,Sergi Bruno S,Sohag Kazi. Customer engagement in innovative smart grid deployment projects: evidence from Russia.. Environmental science and pollution research international,2021,29(4).

[15] Xu Haiqing,Yan Huaguang,Deng Chunyu,Kang Jiandong,Li Junhui,Han Xiao. The Exploratory Research on Reform and Innovation of Project Management in Grid Enterprises under the Changing Circumstances. IOP Conference Series: Earth and Environmental Science,2021,831(1).

[16] Chen Tianqiong,Ji Kailin. Research on pricing model of uninterrupted maintenance for distribution network project of power grid enterprise. Journal of Physics: Conference Series,2021,2005(1).

[17] Kang Yanfang,Guo Xiaohan,Xi Xiaojuan,Li Lingyun,Li Dapeng. Analysis of the Impact of AHP-based Power Grid Transmission and Transformation. IOP Conference Series: Earth and Environmental Science,2021,804(3).

[18] Lin He,Gaosheng Rong,Ning Ma,Li Chen,Bo Huang,Xiaofan Guo. Combination forecasting model of equipment and material prices for power grid production technological transformation projects based on unary linear regression and grey theory. IOP Conference Series: Earth and Environmental Science,2021,827(1).

[19] Rakhi Yadav,Yogendra Kumar. Detection of Non-Technical Losses in Electric Distribution Network by Applying Machine Learning and Feature Engineering. JESA,2021,54(3).

[20] Zhang Geli,Wang Hongjin,Zhang Heng,Zheng Yan,Liu Yaqiong. Analysis of power distribution network operation without power cut based on actual engineering data. IOP Conference Series: Earth and Environmental Science,2021,781(4).