

Retraction

Retracted: Application of AI Image Recognition in the Omnidirectional Monitoring System for Power Transmission Lines

Advances in Multimedia

Received 15 August 2023; Accepted 15 August 2023; Published 16 August 2023

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their

agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] S. Zeng, J. Jia, T. Ma, B. Jia, and X. Duan, "Application of AI Image Recognition in the Omnidirectional Monitoring System for Power Transmission Lines," *Advances in Multimedia*, vol. 2021, Article ID 3073248, 7 pages, 2021.

Research Article

Application of AI Image Recognition in the Omnidirectional Monitoring System for Power Transmission Lines

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Received 12 August 2021; Accepted 12 October 2021; Published 30 November 2021

Academic Editor: Zhendong Mu

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With the continuous advancement of social economy, electric power, as an essential resource, plays an important supporting role for the development of industry and the lives of residents. As electric power itself is dangerous to a certain level, it is crucial to use the electric power rationally and ensure the safe application of electrical equipment. In this paper, AI image recognition technology is introduced to establish a comprehensive monitoring system for power transmission lines. Through the control of the potential risks of the transmission lines, emergency treatment of power transmission lines is implemented, which has provided an application support for the safe use of power equipment. Simulation experiments have verified that the image recognition technology based on AI can support omnidirectional monitoring of power transmission lines effectively.

1. Introduction

With the advancement of social economy, the demand for electric power resources has become more and more urgent [1, 2]. Hence, an increasing number of power transmission lines have also been constructed year by year. Due to the influence of natural and man-made factors, power transmission lines can have various types of problems. Therefore, it is extremely important to guarantee the real-time monitoring of power transmission lines so as to protect the relevant power equipment [3, 4].

The construction of the ubiquitous Internet of Things (IoT) for electric power has been carried out in an orderly manner. In the inspection of power transmission lines, which are the main medium for power transmission, the application of intelligent detection devices is also increasing [5]. Among them, video surveillance devices are extensively installed on the towers of power transmission lines because they can help grasp the conditions on site accurately through video, pictures, and other means. Therefore, they have been widely promoted and applied as an essential means of auxiliary patrol inspection for power transmission lines, identification of potential hazardous points, and prevention of damage by external forces [6, 7]. The primary function of

the traditional video monitoring devices is to complete the transmission of pictures and videos back during the work period and implement the analysis and judgment of the status of the power transmission lines through the algorithm at the back end and the manual processing and identification. Due to the limitation of wireless bandwidth, it is difficult to meet the real-time response requirements. In view of the potential hazardous points that are subject to the damage by the fleeting external forces, the lag in the response speed can lead to serious consequences [8].

How to screen out the useful information, avoid the congestion of the wireless network due to a large amount of data transmission at the front end, and reduce the difficulty of the subsequent inspections has become a tough problem in the power transmission line monitoring work at present. If preprocessing is carried out in the equipment at the front end and computing power is added to the monitoring equipment at the front end, only the mobile hazardous targets at the front end are screened out and analyzed, and the effective target is directly analyzed and judged. In this way, the relevant problem can be solved effectively [9, 10].

In view of the limitations described above, AI image recognition technology is introduced in this paper to establish a system architecture for omnidirectional monitoring

of power transmission lines. The key and difficult points related to the monitoring system are sorted out, and the practical application in the power transmission lines is selected to provide the theoretical and practical support for the subsequent monitoring.

1.1. AI Image Recognition Technology. As security has become an increasingly vital feature and more monitoring devices have been deployed in the corresponding scenes, the application fields of intelligent image analysis are also expanding constantly. Its characteristics are the establishment of mapping between the images and the attributes, the “interpretation” of the content of the relevant images through the computer recognition and analysis, and the full mining and recognition of the corresponding image information. For example, in terms of the public security system, it is about the recognition of the license plate number of illegal vehicles; in the field of unmanned payment, it is about the application of payment by facial scanning [11].

In terms of deep learning, it is about applying the related acquisition equipment and computers to simulate the “perspective” of human beings so as to implement the comprehensive collection and preprocessing of external information. Through the input of the audio, video, and other information acquired, the existing samples in the computer are used for comparison, processing, and analysis to implement the detection, analysis, management, and identification of the sample targets and finally obtain the corresponding result of judgment.

In terms of the monitoring of power transmission lines, the analysis requirements are mainly reflected in two aspects as the following: intelligent judgment of problems and early warning in a timely manner. Therefore, it is necessary to establish a more comprehensive sample data set, a more efficient model, and the corresponding simulation fitting technology to ensure the relevant image learning and recognition capacity.

1.2. Image Retrieval Technology Based on Content. In the intelligent analysis of the images, firstly, it is necessary to carry out the corresponding interpretation and extraction of the contents from the relevant images (such as color, texture, shape, and other typical contents) in addition to in-depth mining and exploration based on the existing knowledge [12, 13]. If the corresponding search and extraction are carried out directly without processing the relevant images, it can increase a lot of work load, and the efficiency can be decreased at the same time. Hence, how to effectively extract the corresponding image interpretation information quickly and accurately is still a key point and bottleneck in image analysis at present.

It is due to the limitations as well as key and difficult points described above that industry experts have introduced the search method based on the image features; that is, image data are transformed into feature data for the corresponding matching, management, and retrieval. If an image has reached a certain range in the threshold value, it

can be considered that the image matches the feature of the existing sample and can be used as a candidate image.

As shown in Figure 1 above, the process of image search based on the characteristic content can be represented in detail. After the image is introduced to the process as input, firstly, the features of the corresponding input image are extracted and stored in the existing image database. The extracted image feature parameters are also stored in the feature parameter database, and the corresponding feature parameters are used to carry out comparison with the parameter in the existing feature database and the classification analysis based on the corresponding clustering method [14]. This type of feature value classification has not only improved the classification efficiency, but also improved the efficiency and accuracy of the search. In the searching for images, the feature parameters should be extracted based on the corresponding requirements, and the corresponding matching is carried out based on the feature parameters and the feature parameter database to implement the re-search of the image and extract the corresponding images as required [15].

With the continuous development and improvement of online monitoring hardware equipment, software platforms, and network support, monitoring has shifted from the traditional image capture, storage, and management to the intelligent image analysis, knowledge mining, decision support, and so on. That is, it has shifted from the acquisition of static data to the push of dynamic knowledge, and the analysis methods and models have become more and more mature and sophisticated. On the other hand, the intelligent analysis of images has also reduced the work intensity of the personnel at the grassroots level, improved the corresponding work efficiency, and implemented online monitoring [16, 17].

In terms of the monitoring of power transmission lines, on the one hand, traditional and conventional monitoring can be carried out on a fixed range to prevent damage from external factors. On the other hand, online monitoring can help identify the problems in real time or quasi-real time, which can improve the efficiency of emergency response and ensure the safety of power transmission lines [18–20].

The corresponding online monitoring device is taken as an example. Figure 2 shows a flowchart of specific image intelligent analysis work, which can be divided into monitoring equipment, characteristic parameter processing, image push, and other parts based on the actual situation. After the equipment at the front end collects and obtains the corresponding image, it can be put in the existing image database. Based on the process in Figure 1 below, the feature parameters are placed in the corresponding feature parameter database as well. If there are corresponding equipment in the original database, it can be considered that there is corresponding monitoring equipment; if not, it can be considered that there is no corresponding monitoring equipment.

After the cooccurrence matrix is obtained, the feature quantity of the image texture is calculated on this basis and the texture of the image is often represented by using feature quantities such as entropy, contrast, correlation, and energy.

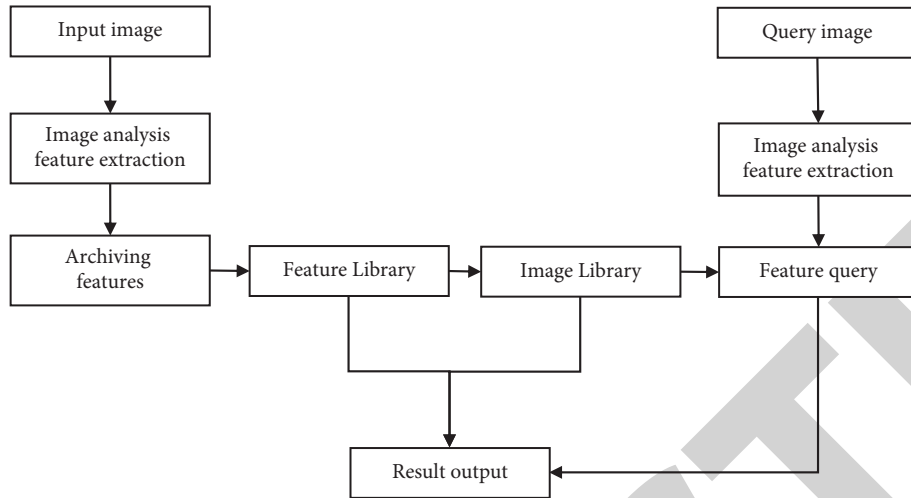


FIGURE 1: Flow chart of the image search based on the content.

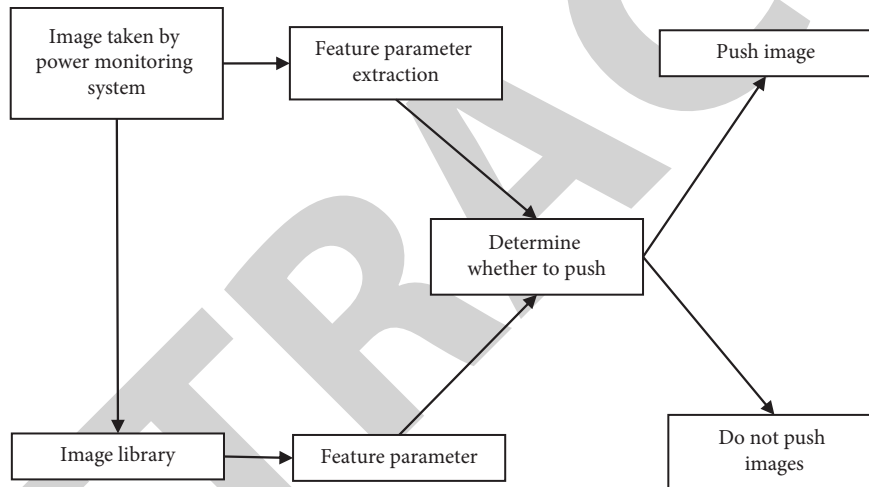


FIGURE 2: Work flow chart of the intelligent analysis of the images.

Entropy: It refers to the measurement of the randomness for the amount of information contained in an image. When the pixel values in the cooccurrence matrix present the greatest randomness or all values are equal, the entropy is the largest. Hence, the entropy value can be used to indicate the complexity of the gray scale distribution of an image. The larger the entropy value is, the more complex the image is. The specific calculation is shown in the formula as follows:

$$Ent = \sum_i \sum_j p(i, j) \log p(i, j). \quad (1)$$

Contrast: It is also referred to as contrast grade, which measures how much local changes there are in an image and how the values of the matrix are distributed, which can reflect the depth and clarity of the texture in an image. The deeper the texture groove is, the greater the contrast is, and the more prominent the effect is; on the contrary, the smaller

the contrast is, the shallower the groove is, and the more blurred the effect is. The specific calculation is shown in the formula as follows:

$$Con = \sum_i \sum_j (i, j)^2 p(i, j). \quad (2)$$

Correlation: It is also known as homogeneity; it is used to measure the similarity of the gray level of an image in the row or column direction. The larger the value is, the greater the correlation is. Specifically, correlation is calculated based on the formula as follows:

$$Corr = \left[\frac{\sum_i \sum_j ((ij)p(i, j) - \mu_x \mu_y)}{\sigma_x \sigma_y} \right]. \quad (3)$$

Energy: It refers to the sum of the squares of the elements in the gray level cooccurrence matrix. It is a measure of the stability of the image texture gray scale, which can reflect the

thickness of the texture and the uniformity of the gray scale distribution in the image. The greater the energy value is, the more stable the current image texture is.

2. Mobile Edge Computing Technology

In the so-called mobile edge computing, an open platform close to the sensing device or data source is used to provide the corresponding mobile computing services by using mobile, computing, and network open platforms.

2.1. Mobile Edge Computing. Mobile edge computing is used to configure the optimal solution based on the actual requirements to further protect the network security and user privacy, and at the same time, it can flexibly configure the corresponding software, hardware, and network to reduce the delay and eliminate other problems.

2.2. Analysis of the Working Mechanism. For the purpose of implementing the monitoring and recognition of the moving objects, an AI algorithm for electric power is established. Through the background modeling and the subsequent multilayer neural convolutional network construction and sample optimization, the transformation of objects from image to data perception is implemented. The mobile samples are analyzed and screened out through the front end. Combined with the calculation of the intelligent computing unit, such as infringement of the delineated edge area, tracking and feedback are carried out at the front end in a timely manner. If there is no abnormal situation, it will be excluded in the algorithm optimization and identification, and it will not be taken as a monitoring object. In this way, it can avoid uploading a large amount of invalid information to the cloud and therefore effectively improve the transmission efficiency.

2.3. Identification of the Algorithm Recognition Object. Through AI recognition and algorithm settings, the objects of power transmission lines can be identified. For the purpose of meeting the current requirements to prevent damage from external forces, the identification of foreign objects at the front end in offline construction vehicles and wires can be carried out. At the same time, the line body can be identified through the settings, such as the identification of foreign objects in the bird's nest of the iron tower and abnormal hardware. If an abnormal situation is identified, the data information thus acquired will be matched based on the fast prevention algorithm, and the potential hazardous risks will be analyzed and processed accordingly. The pictures of potential hazardous risks are captured and uploaded to the cloud through the wireless network to carry out further analysis, and the inspectors are notified to deal with the identified issues in real time by means of system alarms or WeChat prompts.

The practical applications have demonstrated that the construction machinery and equipment bodies around the passage protection area can be identified accurately from the

pictures recognized based on the algorithm, which is of great help to the management and control of all hazardous points and the elimination of any potential risk.

2.4. Accuracy of Algorithm Recognition. Through the research and analysis of the hazardous construction points near the power transmission lines, it can be known that the main objects that may cause damage to the lines are the mobile crane boom, the construction excavator, the fixed tower crane, and so on. Through the front-end devices, the critical values for the edge of the passageway and the intruding objects can be set. When the intruding object exceeds the critical value, the system can eliminate other types of nonhazardous potential risks more effectively, and the accuracy of identifying the intrusion hazards can reach more than 95%. In addition, it can issue an alarm and notice accurately. Combined with the simple manual identification in the later stage, the monitoring and early warning requirements can be met properly. Through the pictures sent back by the front end, the construction machinery near the passage area can be marked and prompted, and the segmented image of the mobile machinery can be generated accordingly. In view of the other interfering objects (such as the street lights and the steel pipe components), the two can be first identified and then screened out by the front end algorithm, which has reduced a lot of work load for the subsequent artificial determination of the hazardous points.

In terms of the positioning and recognition of the circuit body, fittings, and insulators, the settings of the monitoring values are combined with the vertical and horizontal infinite rotation of the camera. In this way, the accuracy rate can be kept stably above 90%. In case there is an abnormality, an alarm will be issued through the back end, which can meet the requirements for the patrol inspection of the equipment.

3. Architecture of the Online Monitoring System for Power Transmission Lines

3.1. Software Architecture. In the omnidirectional monitoring of power transmission lines, first of all, it is necessary to consider how to carry out the online monitoring, on-site monitoring, and how to send the corresponding data back to the data-monitoring center for timely and effective protocol disposal. In this paper, the architecture of the omnidirectional monitoring system for power transmission lines is established, which can be divided into an IoT perception layer, a network transmission layer, a platform software layer, and an application display layer in general.

- (1) IOT perception layer: It mainly includes the IoT sensing equipment for various power transmission lines, which are mainly used to collect, manage, and consolidate the corresponding data of the power transmission lines. Its main feature is to use the online video equipment as a data consolidation point for the collection of business data from various related power sensors. For example, the data of wire temperature measuring sensors and current measuring sensors can be collected and consolidated to

the data center by using the corresponding IoT sensing technology, transmitted through the network, and pushed to the back end for management analysis in a unified manner.

- (2) Network transmission layer: It mainly includes communication and other network equipment such as private power transmission network, power transmission channel, and optical fiber network to provide a reliable, stable, and safe transmission medium for the online monitoring of the power transmission lines.
- (3) Platform software layer: It is mainly used for the unified management, dispatching, and online monitoring of the corresponding power equipment, which can implement the unified acquisition of data.
- (4) Application display layer: This layer is directly used by users and serves as an external demonstration of the functions of the system based on technologies such as the Internet of Things (IoT) and big data through the packaging, management, and invocation of the corresponding algorithms to support the analysis and omnidirectional monitoring of power transmission lines.

3.2. Software Function

3.2.1. Periodic Patrol Inspection of Power Transmission Lines. The periodic patrol inspection function for power transmission lines is the core function of this system. Users can make use of the camera to replace the routine power transmission line patrol work on site and can mark the pictures as normal or abnormal.

When the inspector is carrying out the patrol inspection work on the transmission lines, the management page on the power transmission line inspection will pop up, and the on-site terminal will upload the picture of the related tower to the master station. The inspector can analyze the uploaded picture for each component of the tower and make the corresponding annotation for normal or abnormal situations.

3.2.2. Patrol Inspection of Power Transmission Lines Based on Scenes. The patrol inspection of transmission lines based on scenes is a typical application scenario in this solution, which allows the customization of different transmission lines, areas, frequencies, inspection focuses, and other related inspection tasks in view of the patrol requirements for power transmission lines in different scenes. In this way, it can implement typical applications for different scenarios, which meet the requirements of the smart application of inspections at the front line; the patrol inspections of common scenes include three-span inspections; patrol inspections in case of typhoons, floods, fires, and icing; and guarantee of electric power supply.

3.2.3. Intelligent Analysis. Intelligent analysis includes intelligent diagnosis and intelligent early warning. Among them, intelligent diagnosis refers to the platform that has the

capacity of scene recognition and diagnosis of the intrusion of foreign bodies in the pictures taken by the monitoring system.

In the digital video surveillance and image recognition system, first of all, the video stream needs to be intercepted and saved in real time, and then the relevant image recognition work such as image preprocessing, image feature extraction, and event judgment needs to be carried out, as shown in Figure 3.

3.2.4. Intelligent Linkage. The online monitoring system for power transmission lines has the function of intelligent linkage between equipment devices and between services. The function of intelligent linkage between devices refers to the linkage function supported by the platform for a variety of front-end devices or equipment between systems under the platform. In case of the occurrence of an abnormal situation, the system can link the associated devices intelligently for coordinated control.

3.2.5. Assistance in Decision Making. The online monitoring system for power transmission lines has the capacity to carry out big data analysis and provide assistance in decision making. In addition, it can perform statistical analysis on massive monitoring data, the own operating data of equipment, and fault diagnosis results based on different dimensions such as time and region. Based on the statistical analysis, it can quantitatively evaluate the incidence of failures, the level of potential hazardous points in key areas, and the operational risks of routes and passageways to assist managers in making business decisions.

4. Simulation Experiment Analysis

For the purpose of testing the application capacity of the omnidirectional monitoring system in the patrol inspection of the practical power transmission lines, a 1000 kV trunk line in the suburb and a 220 kV line in the urban area of a certain city are selected to deploy the monitoring video system for the relevant transmission lines. The monitoring area is nearly 600 km², which covers 25,300 km power transmission lines and 500 base towers. The specific transmission lines under intelligent patrol inspection include thirteen 1000 kV lines and twenty-five 220 kV lines.

Based on the features of the key monitoring areas, the corresponding monitoring objects are divided and used as monitoring samples, and hardware devices of the omnidirectional monitoring system are installed accordingly. In this way, the monitoring and automatic omnidirectional monitoring of electrical equipment such as ground conductors, iron towers, insulator strings, and other devices can be implemented, and the corresponding defects and problems can be automatically analyzed so that the information of hardware with problems can be uploaded in a timely manner.

After the sensor data such as tower micrometeorology, inclination angle, and cable temperature are collected, communication is made with the video monitoring device based on the LoRa protocol of the Internet of Things (IoT). The

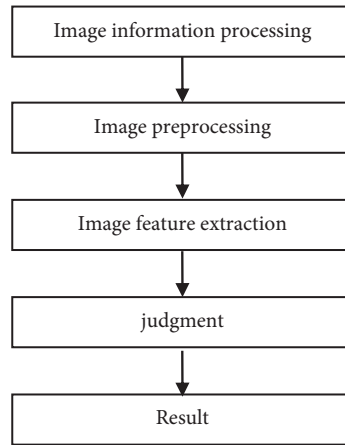


FIGURE 3: Treatment process of image recognition.

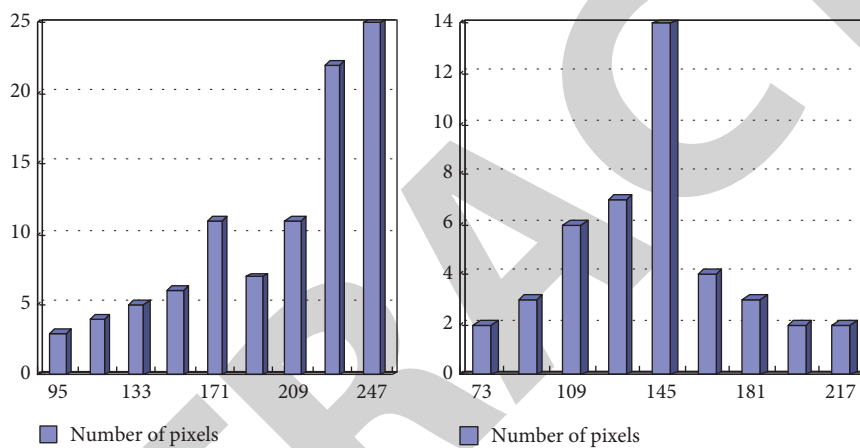


FIGURE 4: Histogram for the statistical analysis of equipment abnormality.

monitoring center of the power company deploys an online monitoring system for the power transmission lines to achieve unified management and control of all monitoring points.

The signal lights of electric power equipment mainly include red, yellow, green signals, and so on. The color characteristic value can be calculated based on the corresponding histogram. The color characteristics mainly include feature indexes such as mean value and mean square error, as shown in Figure 4, that is, the statistical analysis of the feature values of red light on and off in the signal lights of power equipment based on the AI image recognition technology. From Figure 4, it can be known that when the red light is on, the range of the values taken for the characteristics is about 225–255, and the maximum of the pixel value is about 132; when the red light is off, the range of the values taken for the characteristics is about 68–180, and the maximum of the pixel value is about 21. Based on this statistical law, whether there is a problem with the power equipment can be determined accordingly.

5. Conclusions

In view of the requirements for effective business operation in the online patrol inspection of power transmission lines, the AI image recognition technology is introduced in this paper to sort out the working features in the omnidirectional

monitoring of power transmission lines. Through the establishment of the architecture of an online monitoring system for power transmission lines and the implementation of its utilization, online monitoring is carried out on the power transmission lines in a certain city based on the efficiency and accuracy of AI image recognition. The simulation experiments have indicated that AI image recognition technology has effectively supported the application of the omnidirectional monitoring system for power transmission lines, and, at the same time, the system has the advantages of good safety, solid reliability, and high efficiency.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgments

This research study is sponsored by the State Grid Corporation of China Science and Technology Project Funding.

The name of the project is Research on Intelligent Management and Control Technology of Distribution Network Terminal Equipment Detection, project number TSS2020-15. Thanks are due to the project for supporting this article.

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