Digital Image Processing Technology in Design and Development of Automatic Sorting System for Energy Meter Recovery

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Abstract. In order to solve the problems of low sorting efficiency and poor quality caused by manual sorting in traditional electricity meter recovery, this study adopts digital image processing technology to construct an automatic sorting system for electricity meter recovery based on artificial neural network. Firstly, the basic requirements of system construction are analyzed in detail, and then the principle and method of image recognition of artificial neural network are introduced in detail. On this basis, an overall framework of automatic sorting of electricity meter recovery is constructed. Finally, the functional modules are designed and applied, and Azure database is built through SQL Server platform, so as to realize the system application of this research. The final application shows that the automatic sorting system constructed by this study has simple interface and easy operation, which can greatly improve the efficiency and quality of the electricity meter recycling and sorting, and has certain practical significance for the development of the state grid industry.

Key words: Electricity meter recovery; Automation; Artificial neural network; Sorting system

1. Introduction
With the rapid development of Internet information technology, state grid technology has been greatly improved. In recent years, various engineering transformation and fault repair have produced a large number of recycled electricity meters, and there is a huge amount of engineering to sort the massive recycled electricity meters. The traditional manual sorting method has low efficiency and low sorting accuracy, which can’t meet the needs of intelligence, automation and standardization in the current Internet era. Therefore, it is necessary to combine the current rapid development of high-tech means and information technology to improve the automatic sorting efficiency of recycling electricity meters. In order to improve the efficiency of automatic sorting of electricity meters, many scholars and experts have done a lot of research, and some research results have been obtained. Hanlu Liu et al proposed a sorting device based on digital power amplifier for disassembling electricity meters. This sorting...
device reduces the workload of sorting personnel and improves the sorting efficiency of disassembling electricity meters to a certain extent [1]. Yuecheng Li et al proposed the design and application of intelligent sorting and storage system for disassembly electricity meters, which adopted the method of optimizing the sorting process and gave full play to the intelligence and automation level of the functional sorting system, laying a foundation for the recycling and sorting of electricity meters [2].

In recent years, with the development and popularity of digital image processing technology, image segmentation, image compression, image classification and recognition and other image processing technology has been widely used in many fields, such as aerospace, medical and industrial fields and so on. Among them, the artificial neural network pattern classification in the image classification and recognition technology is more and more in the image recognition, its super learning ability has gradually been widely concerned, and replaced the traditional pattern recognition method. Based on this, combined with the experience of the above scholars, this study applies the artificial neural network to the electricity meter recycling and sorting system, constructs an automatic and intelligent recycling and sorting system, designs and applies its functional modules, and finally builds a database to realize the construction system of this study. This system can improve the efficiency of electricity meter recycling and sorting and reduce the manual sorting workload, so as to promote the development and progress of smart grid industry.

2. Analysis of system design requirements
The rapid development of artificial intelligence technology promotes the improvement of electricity meter technology, and intelligent electricity meter is gradually widely used, but at the same time, it also increases the measurement and quantitative work of electricity meter. At present, all kinds of engineering transformation and fault repair have produced a large number of recycled electricity meters, and there is a huge amount of engineering to sort the massive recycled electricity meters. The traditional manual sorting method has low efficiency and low sorting accuracy, which can not meet the needs of intelligence, automation and standardization in the current Internet era.

In this study, the sorting process of the recycling electricity meter is deeply analyzed, and an automatic sorting system based on artificial neural network is designed. The system is divided into sorting system and sorting system. First of all, the initial sorting of the disassembled meters should be satisfied, and the sorting information should be recorded and analyzed, and then according to the actual needs of customers using the meters. The construction system should meet the basic requirements of practicability, security and expansibility [3]. The old table sorting system should have the function of information processing system to realize the planning and management of sorting tasks, so as to effectively improve the sorting efficiency and quality.

3. Principle of artificial neural network
The basic principle of artificial neural network (ANN) is to analyze and judge information by simulating the information processing mode of human brain [4]. Its network structure is characterized by multiple hidden layers. Among them, deep learning in artificial neural network is the research focus in the field of machine learning, which is the most widely used and most successful machine learning method at present.

Convolutional neural networks (CNN) belong to a class of representative algorithms of deep learning [5]. The network is suitable for processing one-dimensional time-domain sequence data and image data. Compared with other neural networks, CNN can learn the original data efficiently and quickly, so as to extract the specific features of the data, namely, it has the ability of representational learning. CNN is widely used in computer vision, natural language processing and other fields. The network has four characteristics, which are local awareness, weight sharing (convolution operation), pooling processing and multi-convolution kernel operation. Among them, the convolution operation is an operation that defines two integrable functions for the convolution operation [6]. It mainly includes two kinds of operation methods, namely continuous and discrete convolution operation.

Let \( f(x), g(x) \) in the real domain, be integrable, and the new function \( f(x) = (f * g)(x) \) be the
The convolution of \( f(x) \) and \( g(x) \) is the sum of functions, where, \((f * g)(x) = (g * f)(x)\) and \((f * g)(x)\) are integrable.

Continuous convolution operation is expressed in Formula (1):

\[
J(x) = (f * g)(x) = \int_{-\infty}^{\infty} f(a)g(x-a)da
\]

The discrete convolution operation is expressed in Formula (2):

\[
J(t) = (f * g)(t) = \sum_{n=-\infty}^{\infty} f(n)g(t-n)
\]

Among them, the convolution operation method in the convolutional neural network CNN is discrete convolution, which can easily deal with discrete data problems in actual measurement. In this study, the one-dimensional sequence data and image data of the recovered electricity meter were processed by means of the features of the convolutional network, so that the original data could be learned efficiently and quickly, and the specific features of the data could be extracted, that is, it has super characterization learning ability [7].

4. Overall system architecture
The automatic sorting system based on artificial neural network is mainly divided into sorting system and sorting system. Through the sorting system, the disassembly meter is sorted initially, and then the sorting information is recorded and analyzed. Then, according to the actual demand of customers, the recorded and collected monitoring data of the collected electricity meters are sorted according to the standards of the sorting system, so as to improve the automatic sorting efficiency of the collected electricity meters. The overall framework of the system is shown in Figure 1.

As can be seen from Figure 1, the sorting information upload mainly transmits the sorted data information through Internet technology, and the sorted data information will finally be transmitted to MDS and SG186. At the same time, Web Service technology and SQL Service technology are used to deliver tasks and information to the sorting pipeline of the old table, so as to obtain the sorting data of the old table [8].
5. Function design and implementation of automatic sorting system for energy meter recovery

5.1 Design of automatic sorting function of electricity meter recovery
Sorting system is mainly divided into two functional modules, namely task management and information management. Among them, the main function of task management is to manage the working process of sorting and recycling electricity meters, which is specifically reflected in the sorting task management of electricity meters, the manual input of electricity meter information, the warehouse management of recycling electricity meters, the management of unrecyclable electricity meters and the daily recording work of electricity meters, etc. [9]. Information management is to record, monitor and manage each parameter information of the recycling electricity meter, and set and adjust parameters of the sorting system in time by recording data information.

The sorting system is divided into several functional modules, mainly for the sorting task of electricity meters, the quantity of electricity meters to be recovered, the quality record of electricity meters to be removed, and the detection of electricity meters to be removed.

5.2 Realization of automatic sorting system for electricity meter recovery
In order to realize the application of the automatic sorting system of electricity meter recovery built in this study, Azure database is built for cloud storage of massive electricity meter information. The database is realized through SQL Server platform, and the Internet information technology and cloud computing are used to store massive information, replacing the traditional storage method of electricity meter. To further expand the storage space of electricity meters, real-time data information of various electricity meters can be provided to realize resource sharing and application integration.

5.2.1 Setting up Azure database
For information storage through Azure data, the first step is to register a new account on Microsoft Azure website, and purchase a data storage service through this account after successful registration. The specific steps are as follows:

1. Select a new database. After registering this account successfully, log in and select new database on the platform page.
2. Create a server. After the database is created, the server creation function is displayed. If you select this service, subsequent login accounts can directly log in to the server and view information.
3. Establish a firewall application on the server. By establishing a firewall to protect the information in the database, prevent Trojan viruses and hackers from damaging the database information [10].

Once the database is set up, it can be accessed through SQL Server links, Visual Studio links and the query editor in the Azure portal.

5.2.2 Realization of automatic sorting system for electricity meters
After the database is successfully built, log in to the automatic sorting system of electricity meters. The login interface is shown in Figure 2. As can be seen from Figure 2, the login interface is very simple. You only need to enter the registered account and password, and then enter the verification code to complete the login.
Figure 2. Login interface of intelligent table automatic sorting information management system

After login successfully, you can enter the energy meter automatic sorting information management system. The menu bar displayed on the left side of the system interface has a number of information processing functions, such as inventory query, plan management, return management, report management, personal management and other 11 functions. The right side is the information display column, which shows the data analysis of each fault type, and can clearly see the various problems existing in the recycled energy meter, such as communication problems, measurement problems, appearance problems, and display problems.

Figure 3. Sorting task management interface

As can be seen from the figure above, the menu bar of the automatic sorting information processing system for electricity meters is simple and easy to operate. In the sorting task management interface, the sorting information of recycled electricity meters can be visually seen, namely, the total number of electricity meters to be dismantled, the number of electricity meters to be sorted, the number of electricity meters to be repaired after the successful detection of electricity meters to be dismantled, and the number of electricity meters to be scrapped. The interface shows the number of the sorting task, the manufacturer, the distribution status of the sorting electricity meter and so on. If you want to view the detection information of each disassembled electric meter, you can view it through the hidden function in the sorting task interface, and you can see the specific information such as appearance detection and error test of the disassembled electricity meter.
6. Conclusion
In this study, according to the characteristics of the current sorting of electricity meters, the digital image processing technology is adopted to construct an automatic sorting system of electricity meters based on artificial neural network. After designing the functional modules, the Azure database was successfully built and the application of the construction system in this study was realized. The final application shows that the interface of the automated sorting system constructed by this study is simple, easy to operate, and can greatly improve the efficiency and quality of electricity meter recycling and sorting. It reduces the uncertain factors of manual sorting and makes the sorting work of recycling electricity meters more standard. Thus, it improves the sorting management level of the recycling electricity meter, which is of great significance to the sorting research of the recycling electricity meter. This research still has some shortcomings, need to improve the system, improve the application performance of the system.

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