Research on Intelligent Recognition Technology of Power Consumption Characteristics Based on AdaBoost Model

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Abstract. The iterative development of intelligent, information and industrial society puts forward more stringent requirements for power system. However, the current perception and prediction of power consumption characteristics are still based on empirical data, lacking of intelligent and lean perception. Based on this, this paper first analyzes the development status of intelligent recognition tech of user's electricity consumption characteristics and behavior, then studies the process of intelligent recognition of electricity consumption characteristics based on AdaBoost model, and finally verifies the intelligent recognition tech of power consumption characteristics based on AdaBoost model.

Keywords: Intelligent Recognition, Power Consumption, AdaBoost Model

1. Introduction
With the iterative development of social economy, the demand and consumption of electric energy are increasing. With the development of AI tech, it has been widely used in many fields. Among them, the intelligent algorithm represented by AdaBoost algorithm can significantly improve the accuracy of classification model, and can significantly reduce the production difficulty of the model and the requirements of data samples [1]. On the other hand, as an important supporting energy to ensure the steady growth of social economy, electric energy have many advantages. At present, more than half of China's energy is provided by electric energy. It can be seen that stable power demand guarantee has become an important factor related to national development and people's livelihood.

In addition, with the iterative development of intelligent, information-based and industrialized society, the society puts forward more stringent requirements for the power system in several aspects as shown in Figure 1 below, which makes it necessary to comprehensively identify and grasp the information of each link of the power system in the whole life cycle of power generation, transmission and use. In this context, it is necessary to further optimize and upgrade the monitoring ability and information identification ability of power system and industry, so as to realize the intelligent and real-time perception of power consumption characteristics, so as to further optimize and adjust, and promote the intensive utilization of resources and the efficient use of electric energy.
In addition, the intelligent recognition of power consumption characteristics needs to build a powerful compliance monitoring information system to realize the dynamic perception and scientific prediction of power system status. This requires the establishment of a perfect and systematic model to analyze the change and development law of power consumption characteristics, so as to scientifically predict the power consumption load, dynamically adjust and optimize the power grid capacity. However, the current perception and prediction of power consumption characteristics are still mainly based on empirical data, lacking of intelligent and lean perception, so there is an urgent need for reform. The intelligent algorithm model represented by AdaBoost algorithm reduces the requirement of data samples, which is conducive to the intelligent recognition of power consumption characteristics. Therefore, it is of great practical value to study the intelligent recognition of power consumption characteristics based on AdaBoost model.

2. Current status of intelligent recognition tech for user's electricity consumption behaviors

2.1. The necessity of intelligent recognition of consumers' electricity consumption behaviors

First of all, the intelligent identification of user's electricity consumption characteristics and behaviors is of great value to realize the bidirectional flow of information in smart grid, and to realize the efficient sharing of data among safety monitoring and data acquisition, energy management and distribution network management. With the continuous increase of social electricity demand, as shown in Figure 2 below, in the future, the intelligent identification of power grid users' characteristics can effectively solve the problems such as information island caused by large number of users and wide area, and insufficient release of power grid data value [2]. It can be seen that the development of smart grid and the realization of the healthy and sustainable progress of power information is to carry out the intelligent recognition of user's electricity consumption characteristics and behaviors.

![Figure 1](image1.png)

**Figure 1.** Social performance requirements for power system.

![Figure 2](image2.png)

**Figure 2.** Development status and trend of social electricity demand.
2.2. Development status of intelligent recognition tech for electricity consumption behavior

Intelligent identification and perception of users' electricity consumption behavior is an important part of smart grid construction and grid service system construction. Therefore, it is necessary to realize the organic construction of AMI standard and intelligent electricity bidirectional interactive operation mode, as well as to effectively analyze the relationship between power consumption environment and power consumption mode. With the continuous optimization of AI algorithm, the intelligent recognition of user's electricity consumption characteristics has certain basic conditions, but the effective interactive service and intelligent electricity service system has not been established.

In this context, a non-invasive intelligent identification method of electrical load has been studied in depth. Compared with the traditional intrusive load identification method, the scheme has several typical advantages as shown in Table 1 below. It not only has stronger operability and maintainability, but also has lower application cost.

| Items                  | ILM       | NILMD     |
|------------------------|-----------|-----------|
| Implementability       | Medium    | High      |
| Cost-effective         | Poor      | Good      |
| Reliability            | Low       | High      |
| User acceptance        | Poor      | Good      |
| User coverage          | Small     | Wide      |
| Data integrity         | Medium    | Good      |
| Accuracy               | Good      | Medium    |

2.3. Technical framework of intelligent recognition of power consumption characteristics

At present, the technical framework of intelligent recognition of power consumption characteristics is shown in Figure 3 below. Based on the intelligent recognition of user's power consumption characteristics, it is helpful to provide high-value information and data of electricity consumption characteristics for grid enterprises and power institutions. Therefore, it has important social practice value to provide scientific decision-making and basis for power institutions and grid enterprises to carry out grid adjustment, power optimization and power grid management.

![Figure 3. Architecture flow of intelligent recognition of power consumption characteristics.](image)

3. Intelligent recognition of power consumption characteristics based on AdaBoost model

3.1. Intelligent recognition algorithm of user's electricity consumption characteristics

The intelligent recognition algorithm of user power consumption characteristics needs the support of AI algorithm, so as to meet the needs of pattern recognition of user power consumption characteristics. The collection and recognition of power consumption characteristics need to build a feature database, so as to realize the comparison between the change characteristics of user's power consumption state and the database, so as to further enhance the effectiveness of feature recognition of power consumption behavior types [3]. In order to improve the accuracy of intelligent recognition of user power consumption characteristics, the adaptability of location equipment identification needs to be
further improved. As an AI algorithm, AdaBoost algorithm model can effectively set the recognizers of training set, so as to enhance the recognition ability and accuracy.

3.2. Training data set of AdaBoost algorithm model

AdaBoost algorithm can dynamically change the data distribution based on the accuracy rate of sample recognition after training, so as to improve the overall recognition accuracy. Then, the weight of each sample is further assigned, and the re assigned weight data is used in the training process of the lower recognizer [4]. In addition, the trained recognizers are fused organically to generate the final decision recognizer. The intelligent recognition of power consumption characteristics based on AdaBoost model needs to establish a feature database to train the recognizer. Secondly, the training level of power consumption characteristic data set includes:

$$T = \{(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)\}$$  \hspace{1cm} (1)

In which, $$x_i \in X \subseteq \mathbb{R}^n$$, $$y_i \in Y = \{-1, 1\}$$, and the number of iterations is $$M$$; $$x_i$$ represents the load characteristic, and $$y_i$$ represents the label corresponding to the load characteristic [5]. And regarding of the working state of the equipment: 1 indicates the stop state, and 1 represents the working state. The weight distribution of initial training samples is as follows:

$$D_1 = \{w_{1,1}, w_{1,2}, \ldots, w_{1,n}\}, w_{1,i} = \frac{1}{n}, i = 1, 2, \ldots, n$$  \hspace{1cm} (2)

In order to complete $$M$$ iterations, the training data set with weight distribution $$D_m$$ is used to learn and get the weak recognizer $$G_m(x)$$ [6]. Then the recognition error rate of $$G_m(x)$$ on the training data set is calculated:

$$e_m = \sum_{i=1}^{n} w_{m,i}I(G_m(x_i) \neq y_i)$$ \hspace{1cm} (3)

For the calculation of the weight of $$G_m(x)$$ in the strong recognizer, there have:

$$\alpha_m = \frac{1}{2} \log \frac{1-e_m}{e_m}$$  \hspace{1cm} (4)

Finally, the enhanced recognizer is obtained:

$$F(x) = \text{sign} \left( \sum_{i=1}^{n} \alpha_m G_m(x) \right)$$  \hspace{1cm} (5)

Among them, $$F(x)$$ is the recognizer which can identify the equipment with different electrical characteristics, and $$x$$ is the sample data. The enhanced recognizer can be used to identify the new sample data and obtain the state information of user power load.

4. Verification of intelligent recognition tech of power consumption characteristics based on AdaBoost model

4.1. Data preparation for verification of intelligent recognition tech

In order to verify the recognition efficiency and effect of the intelligent recognition tech of power consumption characteristics based on AdaBoost model, it is necessary to build an environment close to the actual user's power consumption characteristics as far as possible, so as to lay an environmental foundation for identifying the working states of various electrical loads and simulate the data of
various load states. Secondly, it is necessary to collect the data of user's electric load in the simulated environment, which includes not only the data of single appliance, but also the state information of multiple appliances. In the process of data acquisition, it is necessary to store the data by screen capture.

In addition, in the data preprocessing level of user power consumption characteristics, it is necessary to record and observe the key data such as voltage and current, and determine the final data calculation sample. In the data acquisition level of single electrical appliance, it is necessary to record the state change data of single user load based on the classification of user load status. However, the acquisition of state changes of multi electrical appliances needs to be carried out in complex power consumption environment, in order to realize the accurate identification of user load characteristic state changes by using AdaBoost algorithm.

4.2. Recognition of power consumption characteristics based on AdaBoost model

The intelligent recognition of power consumption characteristics based on AdaBoost model is based on the collection of user's electricity consumption characteristics data, and realizes the intelligent perception of power consumption characteristics in the actual operation process. The sensing algorithm based on AdaBoost model will continuously monitor the change of load data, and compare the status with the information in the database. If the identified results and the results in the database reach the threshold value range, it will be judged that the state changes of the user's power load under a certain feature.

5. Conclusion

In summary, the intelligent algorithm model represented by AdaBoost algorithm reduces the requirement of data samples, which is conducive to the intelligent recognition of power consumption characteristics. The intelligent algorithm represented by AdaBoost algorithm can significantly improve the accuracy of classification model, and can significantly reduce the production difficulty of the model. In this paper, through the research on the development status of intelligent recognition tech of user's electricity consumption characteristics and behavior, the necessity and technical framework of intelligent recognition of user's electricity consumption characteristics and behavior are analyzed. Through the analysis of the process of intelligent recognition of electricity consumption characteristics based on AdaBoost model, the intelligent recognition algorithm of user's electricity consumption characteristics is studied. Through the research on the verification of intelligent recognition tech of power consumption characteristics based on AdaBoost model, the recognition events of power consumption characteristics are analyzed.

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