Study on the Design of Intelligent Electricity Anti-Theft System with the Help of Internet of Things

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Abstract: In order to solve the problem of low probability of traditional anti-stealing electricity system, one intelligent anti-theft system based on Internet technology is designed from the aspects of hardware and software technology. Based on traditional systems, the hardware systems includes iot sensor devices and master wave deployer, and the operating mode and internal structure of electric energy meters and data transmission devices are changed, besides, based on the data collected by hardware equipment, the identification index of electricity-steal-stealing behavior is set up. By calculating the judging index of electricity-steal-electricity, to know whether the users of the power system have the behavior of electricity stealing and, to calculate the amount of electricity stolen, to find the position of electricity-steal-electricity, so as to realize the anti-theft function of the software. Through the system test experiment, the intelligent anti-theft electricity system can prevent users from stealing power and reduce the economic loss of power supply enterprises.

1. Introduction

Directing at the behavior of electricity-steal-electricity, the electric power companies need to study the corresponding anti-theft system to punish users for their previous behavior of electricity stealing and also prevent users from continuing to steal electricity. At present, for the management of electric power supply enterprises, theft-prevention work is an important content. In the case of frequent power consumption and power theft, the application of anti-theft technology in anti-theft system can provide good support for the benign operation of the whole power network. Power companies' anti-theft strategies include the application of special electric energy metering box and instrument box, the wiring from the low-voltage output end of the closed transformer to the meter, and the selection of a new generation of multifunctional intelligent meters. Besides, through the corresponding hardware device to achieve the use of two-way measurement or anti-top instrument, but its disadvantages are high price, high cost, and inconvenient installation, furthermore, a variety of user instruments are not suitable for long-term online inspection of the working state. At present, the anti-theft system based on the analysis of power consumption characteristics has made some achievements in the research of electricity theft behavior and anti-theft work, including the anti-theft system based on power recovery technology. In addition, through the calculation and analysis of the circuit loss, the anti-theft system can achieve good electricity anti-theft effect through the previous application of the anti-theft system, but the analysis of the power consumption is actually not a completely incorrect electrical problem. Science and technology Internet combined with the relevant detection devices is applied in the traditional electricity anti-theft system to determine whether the user has the behavior of electricity-steal-electricity and help solving the problem of electricity-steal-electricity.

2. Design of the Intelligent Electricity Anti-Theft Hardware System

The hardware system of the Internet of Things technology used to optimize the intelligent electricity anti-theft system is mainly used to provide initial data to realize the software function, meanwhile, the hardware devices of the hardware system can also be used as hardware support to realize the function of stopping the system at home.

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2.1 Sensor Devices of Iot

The function of IOT sensor devices is to collect the materialized consumed power by users in the power network under with the real-time changing of various parameters. The Internet installed in the intelligent electricity anti-theft system includes laser scanner, converter, infrared sensor, etc. connected according to the connection mode in diagram 2.

The operating principle of pyrolytic point infrared sensor is to use the infrared ray emitted from the power grid system to change the working environment temperature of the power grid,meanwhile, the change of charge caused by temperature change of power network is transformed into electrical signal, which is output via the display device of the internet sensor and has very strong imperceptibility.

2.2 Intelligent Ammeter

The intelligent ammeter is the most basic metering element in the electric energy measurement in the power grid and the intelligent mutual inductance ammeter is used in the system of intelligent electricity anti-theft. The working principle and access mode are shown in diagram 3.

2.3 Instrument Box Opening Monitor

Only two types of the Internet will be set up in the instrument box.When the value is 0, the instrument box is closed; when the value is 1, the instrument box is opened. When the monitoring device on the instrument box is working, once the value of the IOT sensor device jumps to 1, the video information captured by the monitor will be immediately transmitted by the network to determine whether the person is one maintainer or staff, which information will be uploaded to the management center. If not, the nearest power inspector must notify the station so that to improve the intelligent management level of the anti-theft system of the general low-voltage power customers.

2.4 Data Transmission Module

The output transmission device used in the traditional Ant-light sensing hardware system is the optical fiber transmission with the advantages of fast optical transmission and stable data transmission, but the data type of uniform transmission is needed, moreover, only one transmission line can be supported by one transmission line.In order to solve the limitations of optical fiber transmission device,GPRS technology is an Internet-domain single technology that enables packet radio service transmission, and the selected transmission medium is still the optical fiber transmission medium. The composition of the serial port is set as 1-dimensional RS485, 2-directional RS 232, and the data form of the serial port is set as 8-bit data bit and 1-bit stop bit.

3. Design of Intelligent Electricity Anti-Theft Software System

3.1 Set Up the Discriminant Index of Electricity Stealing Behavior

By analyzing the shift of warehouse caused by the user's electricity consumption behavior, the corresponding electricity anomalies are put forward. In order to improve the accuracy of the identification of electric larceny, the discriminant index of electric larceny is set up as the diagram 4.

As can be seen from the diagram, the identification index of electricity stealing includes non-balance ratio of voltage, non-balance ratio of current, non-balance ratio of power factor. According to multiple discriminant indexes, we can judge whether there is abnormal power consumption or power theft, and determine the corresponding measures.

3.2 Detection of users' Abnormal Electricity-Stealing Behavior

The diagram 5 shows the intelligent electricity-stealing identification and detection procedure

According to the identification processing of the diagram, select the appropriate number of operations into application. Make the parameter data into a covariance matrix, and determine the number of observation points in N power grids. At the observation time T, the time series vector xi

of the cloud top parameters can be obtained. The time series matrix obtained from the operational parameter data collected from the observation point is as bellow:

$$X_{n\times t}=\begin{bmatrix} x_{t1} \\ x_{t2} \\ \mathrm{M} \\ x_{tn} \end{bmatrix}_{n\times t}$$

The columns of the matrix are treated as single individual with N-dimension extracted from the totality, and the covariance matrix of the corresponding sample can be expressed as:

$$S_N=\frac{1}{N-1}\sum_{b=1}^{N}(x_b-\bar{x})(x_b-\bar{x})^*$$

According to the formula, the generation of electricity-stealing-electricity can be determined by the spectral distribution and eigenvalue density function. During a suspicious period, calculate the power consumption of the suspected user, calculate the value of the associated electricity theft identification index, and determine whether the user has the electricity-stealing behavior. Formula 3 shows the calculation of the voltage's imbalance ratio corresponding to the users.

$$dvun=\frac{avedev(u)}{mean(u)}$$

In formula 3, Avedev (u) represents the mean absolute deviation of three-phase voltage, while mean (U) shows the flat mean of three-phase voltage. The lower the calculated value is, the lower the probability of the user's power network abnormity will be. Then the abnormal situation of AC voltage is further analyzed according to the model in diagram 6.

If the AC voltage is verified to be abnormal, it is necessary to further calculate the current imbalance rate index. Formula as below:

$$dlun=\frac{avedev(\mathrm{I})}{mean(\mathrm{I})}$$

The parameters avedev(I) and mean(I) in the formula respectively represent the average absolute deviation and the average value of the current.Based on the calculation results of multiple judgment indexes, the detection results of abnormal electricity-stealing behaviors of users are obtained through formula 7.

m(normal)= p(A1)+ r × ε × q(A1)

m(suspected)= p(A2)+ r × ε × q(A2)

m(abnormal)= p(A3)+ r × ε × q(A3)

m(X)= 1 - m(normal)- m(suspected)- m(abnormal)

In the formula, m represents the evaluation result that integrates the detection results of multiple electricity consumption indicators; p (Aj) is the probability distribution of normal, abnormal and suspected electricity consumption feature;q (Aj) is the average value of several features 14; r and ε represents the normalized constant and characteristic confidence respectively.

3.3 Intelligent Calculating of Electricity-Stealing Quantity

The electricity-stealing quantity is the line loss of the power grid corresponding to each user. Line loss formula is as below:

$$S_t=\sum_{i=1}^{m}W_{gi}-\sum_{i=1}^{m}W_i$$

In the formula, W_{gi} and W_i are respectively the useful power and generating power of several load bus bar, and then take new calculation according to the meter data after electricity-stealing behavior, the line loss value got at this time is the line loss after electricity theft. Formula as below:

S′ t= St×(1 - Pi× k)

In the formula, the k is the electricity theft ratio on bus bar i and its value result is related to the

result of m(X).

Generally, the form of power grid electricity is the form of power flow from the power supply path to each user of the power grid. When the electricity loss at any node of the transmission line, the corresponding transmission line appears to be a line loss. According to the above principle, the power circulation place is located in the opposite direction of the power supply flow, and the user of the node corresponding to the line loss is the electricity stealer. The operation data of power supply, detection results of abnormal electricity stealing behavior of users, calculation results of electricity theft, and the result of the location of electricity-stealing nodes are integrated to realize anti-power theft. In the case that the user is judged to be engaged in electricity theft, in order to control the voltage of the user's corresponding grid node below 0V, the starting function is used to stop the power supply of the power network for the user. The statistical information and the hardware equipment of electricity theft are fed back to the electric instrument box of the user to realize the electricity anti-theft function of the system.

4. Conclusion

To sum up, the intelligent electricity anti-theft system based on Internet of Things technology designed in this paper can timely and accurately screen out the electricity users conforming to the characteristics of electricity theft, which has the electricity anti-theft rate as high as 99.4% with good application effect and guarantee a normal power supply order.

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