Energy-saving solution based on the Internet of Things electronic boundary pile

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Abstract. As an important tool of scope management, boundary pile is also an important basis for judging boundary violations and an important means for the supervision of industry authorities. However, the external environment where many boundaries are located is so bad that it is difficult to measure the manpower and material resources wasted in manual inspection and maintenance management every year. In view of this situation, a new type of boundary pile is designed in this paper, which can accurately locate the specific location of the problem by collecting GNSS (Global Navigation Satellite System) positioning information, and can also collect the surrounding state by carrying sensors, so as to save a lot of manpower and material resources for inspection.

1. Introduction

The purpose of this paper is to combine the boundary pile with the intelligent sensor module to complete its normal operation. Then through the reasonable setting of the basic structure of the electronic boundary pile, complete the layout of the infrared sensor, angle sensor, temperature sensor and other modules, combined with the signal processing control technology, so that the boundary pile can perceive the surrounding environment in real time. And judge the occurrence of special circumstances. The real-time positioning of the main boundary pile is carried out through the Beidou / GPS system to realize the main boundary pile to control the surrounding area boundary pile. Finally, the Internet of things is used to realize the energy saving and intelligence of electronic boundary piles.

Figure 1. Effect picture of intelligent electronic boundary pile
2. Design background
In 2017, the General Office of the CPC Central Committee and the General Office of the State Council issued a number of opinions on delineating and strictly abiding by the Red Line of Ecological Protection, and called on all localities and departments to conscientiously implement them in the light of reality. The red line of ecological protection is an important institutional innovation of environmental protection in China. The red line of ecological protection refers to the strict protection of spatial boundaries and management limits in the functions of natural ecological services, environmental quality and safety, and the utilization of natural resources, so as to maintain national and regional ecological security and sustainable economic and social development. To protect the health of the people. Implement the boundary of the ecological protection red line by intelligent and information means, and set up unified and standardized signs on the basis of boundary demarcation to ensure that the ecological protection red line lands accurately and the boundary is clear. It is of great significance to implement and promote the work of strictly abiding by the red line of ecological protection.

As an important tool of scope management, boundary pile is also an important basis for judging boundary violations and an important means for the supervision of industry authorities. At present, the boundary piles in China are used in various fields, and more than 31,400 boundary piles signed by the State Council are buried on the land administrative boundaries at the provincial and county levels of nearly 490000 km.

Thus it can be seen that boundary piles play a vital role in the management of all fields in our country, from the delimitation of land boundary to the delimitation of highway area.

3. Project introduction
This project combines the boundary pile with the intelligent sensor module to complete its own normal operation. Then through the reasonable setting of the basic structure of the electronic boundary pile, complete the layout of the infrared sensor, angle sensor, temperature sensor and other modules, combined with the signal processing control technology, so that the boundary pile can perceive the surrounding environment in real time. And judge the occurrence of special circumstances.

In addition, the real-time positioning of the main boundary pile is carried out through the Beidou / GPS system, and the surrounding area boundary pile is controlled by the main boundary pile, which greatly reduces the energy cost needed for surveying and mapping longitude and latitude, and through the hybrid wireless network technology, the information transmission of the main boundary pile to the background and the centralized management of the boundary pile in the background are realized, which greatly improves the supervision efficiency and saves the supervision cost.

Figure 2 shows the effect of intelligent electronic world pile connection.
This project will explore the best location and distribution of smart boundary pillars to achieve the maximum use of energy. At the same time, setting the main pile to supervise the boundary piles within a certain range, and only install the main pile on the host computer interactive module, which can greatly save the average resource loss of each boundary pile.

4. Energy-saving technology realization plan

4.1. Design and construction of electronic boundary stake sensing module

With regard to the selection of electronic boundary pile sensing module, we choose the standard type of temperature sensor DSP18B20 and angle sensor MPU6050 on the market, so as to adapt to most of the environmental conditions and ensure the standardization of each module. The intelligent electronic boundary pile system needs to design a reasonable distribution mode in order to achieve the purpose of better management effect by using the least number of boundary piles. With regard to the selection of the design model of the boundary pile, our preliminary idea is to set up all the functional modules in all the piles to detect the temperature, angle and other environmental information of the location. Based on the requirements of the energy conservation scheme, we finally choose to divide the boundary pile into the main pile group and the secondary pile group, the main pile group carries the positioning module and the environmental monitoring module, while the secondary pile group only retains the alarm module, and each main pile is responsible for the management of each secondary pile in the area.

The information transmission between primary and secondary piles depends on WIFI-Zigbee network. Compared with the original scheme, the present scheme can not only ensure the functional integrity of each electronic boundary pile, but also reduce the problems of excess materials and low energy efficiency.

The function diagram of the main pile and secondary pile of the electronic boundary pile is shown in figure 3.

4.2. Intelligent electronic boundary pile transmission model

Designing a low-power transmission model is the core content of this system design. The model needs to be based on the computer to collect data on all boundary posts in a given area and minimize power consumption.

Through the investigation of the existing communication technology, it is found that the multi-point transmission model like boundary post is suitable to use hybrid wireless network propagation technology for transmission. By setting up the main pile and the secondary pile, the transmission mode of the main
pile transmitting information to the computer and the secondary pile transmitting information to the main pile is completed, and WIFI and Zigbee are used to complete the transmission mode of low power consumption and intermittent high power transmission between the pile and the computer. When each pile is in non-condition mode, keep low-power propagation. When an intrusion occurs, the boundary post in this area sends out an alarm signal and sends intrusion address information to the computer in high-power transmission mode.

This method can better complete the design of the overall low-power transmission model. The transmission model of main pile and secondary pile is shown in figure 4.

![Figure 4. Transmission model diagram of primary pile and secondary pile.](image)

4.3. Big Data "Cloud Platform"
Cloud platform technology is a new data processing technology, which has the characteristics of large data volume, various data types, low value density, high commercial value and fast processing speed. The information of the wet temperature of the external environment, the information of its own address location and the collection and control of the information of the primary and secondary pile groups are a lot of work. The cloud platform technology can be used to collect and deal with the current situation. It provides accurate and real-time data for the study of how to intelligently control and apply to different complex conditions.

The main functions of the "cloud platform" include: viewing the relevant parameters of each sensor; viewing the relevant parameters of the current information transmission interval of the main pile and the longitude and latitude of the boundary pile; through the sharing of big data, it has guiding significance for the future platform design and the processing and control of the current platform design, at the same time, it makes the platform more in line with the definition of energy saving, to achieve the best intelligent control according to the current situation, and so on.

5. Project energy saving innovation
5.1. Establish a boundary control mode based on intelligent boundary posts to reduce the energy consumption of manpower inspections
In the past application of boundary piles, the marking and warning of the solid piles were often used to achieve the purpose of demarcation. However, it did not consider the waste of daily manpower inspections and the theft of boundary posts. The research of this subject is that without relying on the external environment, the intelligent boundary stakes can transmit information through sensors in all-
round perception and warning, so as to achieve the intelligent and efficient supervision of the demarcated area. At the same time, the setting and interconnection of the primary and secondary stakes solve the problem. Under the premise of ensuring that the location of the main pile is located, the warning conditions and environmental information of each sub-pile are determined to be transmitted to the upper computer via the main pile, thereby further reducing the cost of configuring a positioning system for each boundary pile. To maximize the use of existing materials, thereby saving energy.

5.2. Propose an optimization model for the distribution of boundary piles to improve energy efficiency
In the traditional research on boundary piles, only the singular utilization of boundary piles is used, and the singular utilization often has the problems of low efficiency and insufficient energy application. This project comprehensively considers the maximum range of information received by sensors and the maximum distance of information transmission between primary and secondary piles from two aspects, namely coverage and transmission distance. However, it is the core content of this project that the specific layout of boundary stakes and the setting of primary and secondary stakes can be used to maximize the efficiency of use. By alternately changing the parameter settings of the two and continuously experimenting, the maximum use efficiency is finally obtained without affecting the normal function. By establishing related models, we can obtain models that can meet different weather and geographic environments (mainly research on mid-latitude geographic environments), which can make the project more survivable and commercializable. The optimal proportion achieves the maximum energy utilization on rate and the optimal utilization efficiency.

5.3. Design high and low efficiency conversion modes to reduce signal transmission energy consumption
In the previous research on intelligent boundary stakes, the high energy consumption of the device has always been a problem that needs to be solved. In this research, we plan to adopt the form of high-efficiency conversion of boundary stakes to achieve the purpose of reducing energy consumption. When the sensor does not receive a position change or boundary intrusion, the boundary pile adopts a low energy consumption mode, and the primary and secondary piles remain dormant; when the sensor receives a foreign object intrusion or a change in its displacement, the boundary pile immediately switches to a high energy consumption mode, and the primary and secondary piles After information exchange, the environmental information and location address of the invaded land boundary are transmitted to the host computer via the main pile, and the land boundary pile sends out warning information and reminds the monitor to monitor the area. This high-low-efficiency conversion mechanism ensures the low-energy consumption mode of the boundary stakes in daily no-conditions and the warning function under conditions.

5.4. Realize cloud platform monitoring to reduce daily supervision costs
Research on efficient and intelligent management models and remote control of the Internet of Things are the hottest topics in the 21st century. This research group plans to use the powerful analysis ability and intelligence of big data to realize a more intelligent and automatic monitoring mechanism in the form of a cloud platform. Thereby reducing the cost required by daily supervisors, and realizing a more intelligent and humanized monitoring mechanism, reducing energy waste, and achieving energy-saving effects.

6. Conclusion and prospect analysis
This project designs an intelligent electronic boundary pile based on the Internet of things technology. By optimizing the basic structure of the electronic boundary pile, reasonably arranging and using proximity sensors, image sensors, acceleration sensors, etc., and combining with the signal processing control technology, the boundary pile can perceive the surrounding environment in real time and judge the occurrence of special cases; by applying the Internet of things technology to the electronic boundary pile, the positioning module and wireless transmission module are designed.
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References
[1] Yang Dongqing, Tang Shiwei, et al. Translation. Database system concept [M]. Beijing: Machinery Industry Press, 2000.
[2] Huang Xingyuan, Tang Qin. Introduction to Geographic Information System [M]. Beijing: Higher Education Press, 1989.
[3] Ma Zengqiang, Yan Yan, Jing Haiming. Data acquisition system based on GPRS Research [J]. Microcomputer Information, 2005(14):104-105.
[4] Zou Sheng, Feng Shiguang, Pan Guofu. Zhonghaida ZNetVRS calculation software is available in Application analysis of Beidou foundation reinforcement system [J]. Surveying and Mapping Bulletin, 2015 (2):138-139.