Design of Intelligent Electronic Boundary Pile Based on IoT

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Abstract. Boundary pillars are important symbols of the junction, and at present, the most common way of managing boundary pillars in China is to employ a full-time boundary pillar maintainer in order to maintain the pillars themselves better. Damage to or loss of reference materials such as the "borders" can cause considerable problems in resolving boundary disputes and controversies.

In recent years, the Geographical Information System (GIS) has been in a stage of rapid development, both theoretically and in terms of application. With the advancement of network information technology and the increasing maturity of GIS technology, WebGIS combining the two has gradually been widely used in various industries, while the Internet of Things (IoT) is also developing rapidly, on which a more complete set of intelligent electronic boundary pillars based on IoT technology has the theoretical basis to emerge.

1. Design background

Boundary pillars are an important marker for range management, an important basis for determining boundary violations and an important element of supervision by industry authorities. There are six main types of boundary pillars: land boundary pillars, railway boundary pillars, water conservancy boundary pillars, road boundary pillars, natural landscape protection boundary pillars and farmland protection zone boundary pillars. China's current boundary pillars are used in various fields, and more than 31,400 boundary pillars signed by the State Council have been buried in nearly 490,000 km of land administrative area boundaries at the provincial and county levels. It can be seen from this that the demarcation of large land boundaries, down to the demarcation of road areas, plays a vital role in the management of all fields in China.

Figure 1. Common types of boundary pillars.
However, at present, the product development and application of intelligent electronic boundary pillars in China is relatively small, and many problems are difficult to discover in a timely manner in the case of manual supervision, so with the application and development of the Internet of Things technology, the application of intelligent electronic boundary pillars has gradually become possible. Like intelligent electronic boundary pillars collect GNSS positioning information, that is, they can sense the surrounding state, can have the functions of damage alarm, cross-border intrusion monitoring, snapshot, etc., can effectively supervise the border and regional scope, in this context, this paper designs a set of intelligent electronic boundary pillar design based on the Internet of things.

2. Overall design
The intelligent electronic boundary post designed in this paper is an electronic system based on STM32 chip with multiple sensors + positioning system preloaded inside. The independence of the boundary piles, their long standby time and their energy-saving, environmentally friendly properties.

Among them, the communication module set up by the project has strong communication function, which can realize the interconnection of the network and the information of the boundary pillars, and apply the hybrid wireless network technology to make the boundary pillars standby when there is no situation, link at a low rate, wake up when there is a situation, carry out high rate link, and transmit the signal in real time, so as to realize the low power consumption and energy self-supply of the electronic boundary pillars, and make the boundary pillars send an alarm through the network back to the upper computer when there is an emergency. The electronic and automated nature of the boundary pillar function.

3. Module selection

3.1. Micro control unit
In this project, the Microcontroller Unit (MCU) is the core of the system, basically each module has to be controlled by the MCU in order to work, and the co-ordination between the various modules also requires the coordination of the MCU. In order to meet the design requirements of the electronic boundary post, the microprocessor is the STM32, an ARM CortexM processor-based microcontroller from STMicroelectronics, which combines high performance, real-time, digital signal processing, low power consumption and low voltage, while maintaining high integration and ease of development. It meets the needs of this project.
3.2. Power supply modules
For the power module of this project, a solar panel and battery pack and a backup lithium battery pack have been selected. The solar panel converts solar energy into electrical energy and transports it to the battery for storage. In order to convert the electrical energy into efficiency, monocrystalline silicon solar cells are used in this design, and to ensure that the battery can be charged smoothly, the operating voltage of the solar cell is preferably 1.5 times the voltage of the battery; the battery has the function of storing and releasing electrical energy. The battery is required to have an appropriate capacity, which is sufficient to ensure night street lighting and to prolong the life of the battery. The battery should work in conjunction with the solar cell and the load in a complementary way. Li-ion battery packs are rechargeable, safe and reliable, easy to dismantle and install, and can supply power to the system in a timely manner in rainy and cloudy weather, and can also be easily replaced in special circumstances to facilitate maintenance.

3.3. Hybrid communication modules
3.3.1. Communication basics. The basis of communication in this project is the quality of data transmission between networks by wireless means, which is commonly known as wireless network protocol.
Wireless transmission protocols play a vital role in order to ensure the security of the data in the wireless transmission of a terminal. Some common wireless technologies are infrared, Bluetooth, GPRS, CDMA1X etc.

There are many mature and widely used wireless network protocols, such as IEEE802.11xWLAN WLAN protocol, IEEE802.15.1Bluetooth protocol, IEEE802.15.4WPAN protocol, IEEE802.16WiMax broadband wireless MAN standard and so on. IEEE802.11x and IEEE802.15.4 are two of the more widely used wireless network protocols, and the basis for communication in this project is these two types of protocols.

3.3.2. WIFI-Mesh networks. A wireless mesh network is a type of wireless broadband access network that uses distributed thinking to build a network that allows users to have high-speed wireless access to the internet at any time and from any place, and is a technology developed from ADhoc networks. A wireless mesh network, consisting of meshrouters (routers) and meshclients (clients), whose meshrouters form the backbone of the network and are connected to the wired internet network, is responsible for providing the meshclients with a multi-hop wireless internet connection. A wireless mesh network, also known as a 'multi-hop' network, is a new wireless network technology that is completely different from traditional wireless networks and is a dynamic self-organising, self-configuring, self-healing network.

3.3.3. Introduction to ZigBee networks. ZigBee wireless communication technology is a network technology developed for Internet communication based on the way bees communicate with each other. Compared with traditional network communication technology, ZigBee wireless communication technology shows more efficient and convenient characteristics.

Common ZigBee protocol stacks or operating systems are the freekz protocol stack, the contiki operating system, the Z-Stack protocol stack and the TinyOS operating system, but we decided to use the mainstream Z-Stack and OSAL as the solution for the wireless acquisition node control network.

The CC2530 is TI’s System-on-Chip solution for IEEE 802.15.4/RF4CE/ZigBee applications, combining the performance of leading RF transceivers, an industry-standard enhanced 8051 CPU, in-system programmable flash memory, 8-KB RAM and many other powerful features. Four different flash versions are available: CC2530F32/64/128/256, each with 32/64/128/256KB of flash memory. The CC2530 has different operating modes, making it particularly suitable for systems with ultra-low power requirements. Short transition times between operating modes further ensure low energy consumption. In summary, it can be seen that the CC2530 is perfectly suited to the task of building low-power control networks for wireless transmission systems.

Figure 5. ZigBee wireless communication diagram.
4. Summary
The smart electronic substation designed in this paper uses STM32 processor for the main controller, which has the features of high integration, low price and easy development. The software part integrates functions such as BeiDou positioning, environment perception, damage alarm, photo taking, inspection and wireless data transmission. Under normal circumstances, the ZigBee network is used in low-rate link mode to send signals once every time unit. When a signal is detected, the Wi-Fi network is used in high-rate link mode to wake up the camera and send signals in real time, entering a state of high power consumption to achieve extreme power consumption, which enables extra-long standby and work, and can therefore be used in many scenarios. It has a certain practical value to replace traditional manual maintenance of boundary pillars in order to ensure the safety of the maintainers, improve the efficiency of boundary pillar work and reduce the maintenance costs of boundary pillars.

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