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Design of Charging Station Information Monitoring System based on CAT.1

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Abstract

Intelligent charging station information monitoring system is significant to the construction of intelligent charging stations. A charging station information monitoring system is designed based on 4G CAT.1. Sensors are used to detect different information like electricity usage and positioning. A rely is also used to control the charging station by receiving remote control signal from cloud platform. After debugging, the system can realize the remote information monitoring.

Keywords

CAT.1; Charging Station; Remote Monitoring; Cloud Platform.

1. Introduction

With the attention to the environment, "Carbon neutrality" and "Carbon peaking" have become the focus of global attention. [1,2] With the increase of car ownership, how to effectively control the total carbon emissions of the automotive industry is of great significance to comprehensively achieve the goal of carbon neutrality. One of the effective means is to increase the proportion of energy-saving and new energy vehicles significantly. With the vigorous development of the new energy vehicle industry, the new energy vehicle charging pile, as the supporting infrastructure of the new energy vehicle, has been far behind the development of the new energy vehicle industry. The difficulty of charging directly hinders the development and further promotion of the new energy vehicle industry. The problems mainly focus on the following aspects, such as inadequate information management of charging stations, serious shortage of charging facilities and idle conditions, untimely maintenance, and etc., which greatly affect the user experience. IoT technology can be used to connect vehicles, people, and charging stations. By connecting the charging station to the server, operators can access and manage the charging station remotely. Information of the charging stations like voltage, current, and power can be monitored in real-time to grasp the usage of the charging station.

To achieve remote monitoring of charging stations, the following technologies are involved, including wireless communication, positioning and cloud platform. [3-7] In terms of wireless communication technology, the new generation Cat. 1 technology has the characteristics of high reliability, low latency, low power consumption, low cost and medium speed. Due to its seamless compatibility with existing 4G infrastructure, there is no need to upgrade the hardware and software of the base station. The signal strength can be effectively guaranteed, which makes it more suitable for the needs of medium speed applications such as intelligent charging stations. Compared with NB IoT and 5G, Cat. 1 has more obvious advantages in signal coverage and price. For charging stations, positioning is particularly important. Users can easily find the nearest available charging station. The Air530 module is suitable. This module adopts an integrated RF baseband design and integrates functions such as DC/DC, LDO, LNA, RF front-end, baseband processing and power management. It has ultra-high performance and can work effectively and accurately even in weak signal areas. To achieve remote monitoring, The T-LINK

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cloud platform is used, which supports multiple protocols and provide functions such as exceeding threshold alarms.

An intelligent charging station information monitoring system is designed using CAT.1 technology in this paper. Positioning and remotely monitoring are considered to meet the actually needs.

2. Hardware Structure Design

2.1. Overall Design

The specific design is provided in Figure 1.

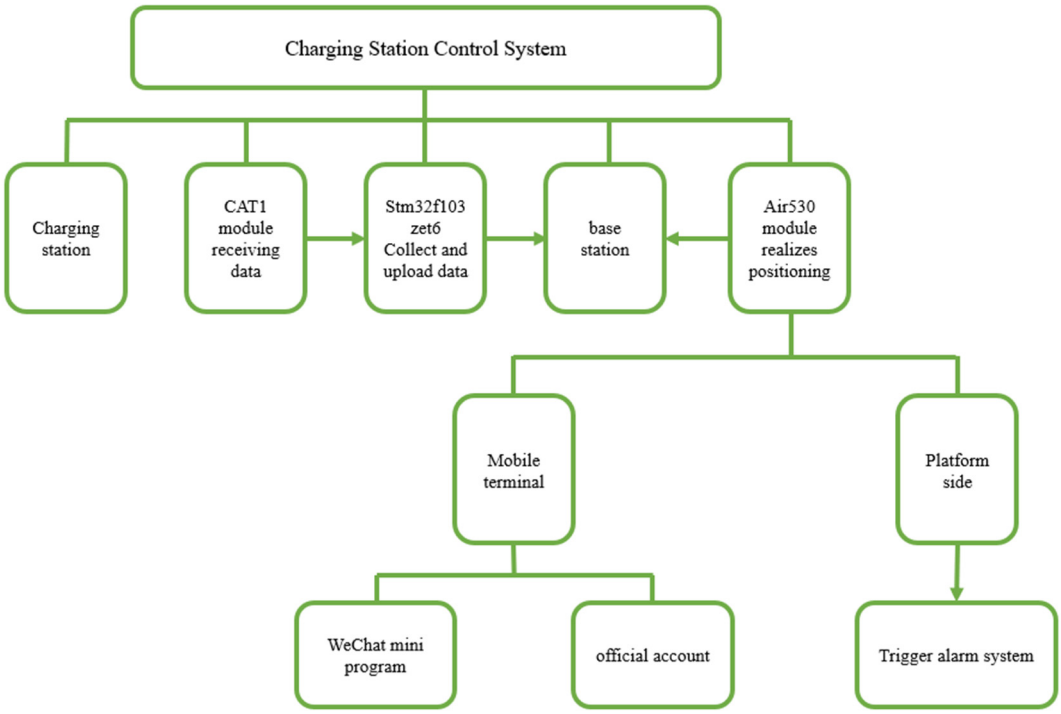

Figure 1. System structure diagram

The entire system consists of three parts: charging station information monitoring system, base station and cloud platform. The charging station information monitoring system includes the control chip stm32f103zet6, CAT.1 communication module, Air530 positioning module, relay, and INA226 electricity signal monitoring module. The control chip collects the electricity signal and positioning information of the charging station. The information is transmitted to the base station through the communication module. The information is passed to the cloud platform server through the base station. Control signal can be sent from the cloud platform. Through the base station, the signal is received by CAT.1 module. The control chip read the signal and control the charging station through the relay.

2.2. Information Collection Circuits

For intelligent charging stations, monitoring of electricity usage and position is essential. The circuits are shown in Figure 2.

As shown in Figure 2(b), INA226 receives the electricity signal through the VIN- pin. After processing, the signal is transmitted to the control chip through the IIC interface.

As shown in Figure 2(b), the GPS antenna is connected to the Air530 module through the GPS_ANT pin. The GND pin is grounded. 1PPS provides pulse signal to indicate GPS signal. The

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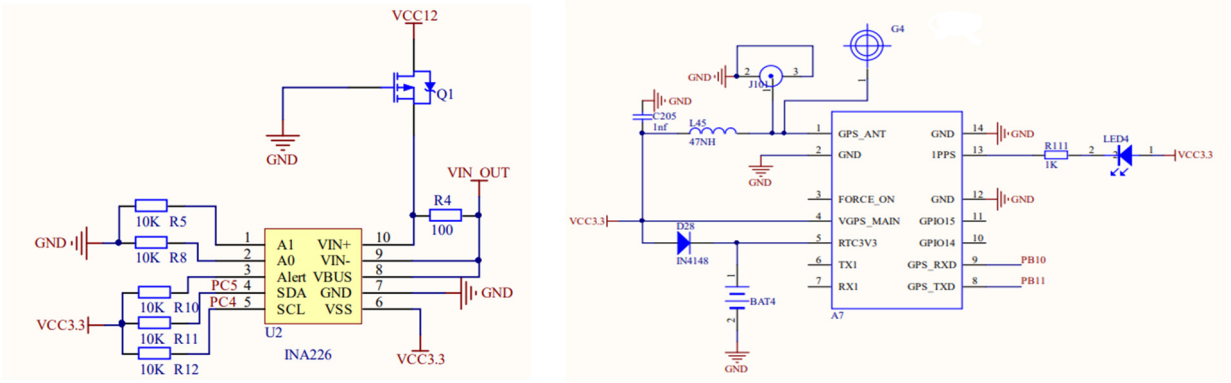
VGPS_main is connected to the power supply, with the range of 2.8-4.2V. A backup power supply is necessary, otherwise the module will not work. The RTC3V3 pin is used to provide backup power supply, with the range of 2.8V-3.3V. When the pin is not connected to the backup battery, it is necessary to connect to the same power supply with VGPS_main. The module is connected to the control chip through a serial port, with a default baud rate of 9600bps.



(a) Electricity usage collection circuit (b) Position collection circuit

Figure 2. Information collection circuits

2.3. Communication Circuit

The communication circuit is shown in Figure 3. A FS704U chip is selected.

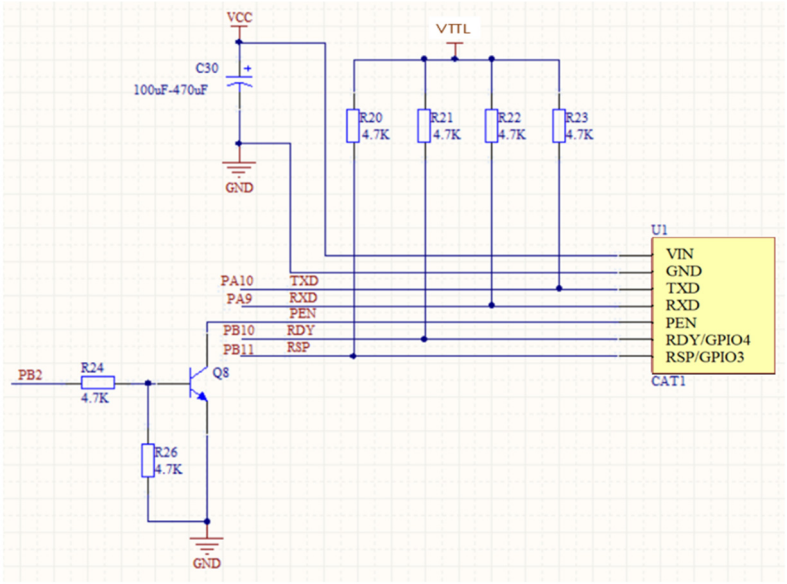


Figure 3. Communication circuit

As shown in Figure 3, the CAT.1 module is connected to the control chip through a serial port. VIN pin is connected to a 3.3V power supply to supply power to the module. Generally, the pin should maintain normal operation by adding a resistor of 4.7KΩ and pulling it upwards. For PEN leads, when the power supply is VCC=5V, the GPIO of PEN and MCU can be directly connected. When VCC>5V, a transistor drive circuit needs to be added to control. The power supply is turned off when PEN is low. RDY refers to the connection status pin, which defaults to high level (3.3V). Low level indicates successful connection, connecting to the PB10 pin of the MCU. RSP defaults to restoring the factory set pin and connecting to the PB11 pin of the MCU.

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3. Software Design

3.1. Main Program Design Flowchart

The main program design flowchart of the system is shown in Figure 4.

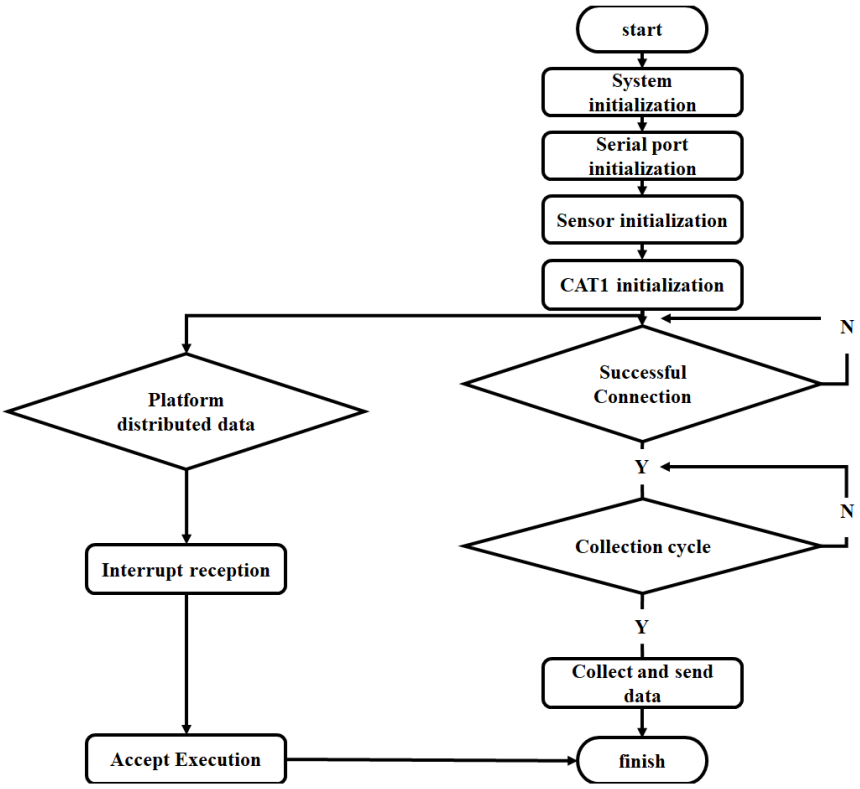

Figure 4. Software flow chart

After initialization, the connection will be checked. If the platform is connected successfully, Electricity usage and position information are collected. The data is sent to the cloud platform through 4G Cat.1 module. If the communication module receives the data which is sent by cloud platform, interrupt will be enable and the data will be received.

3.2. Information Collection

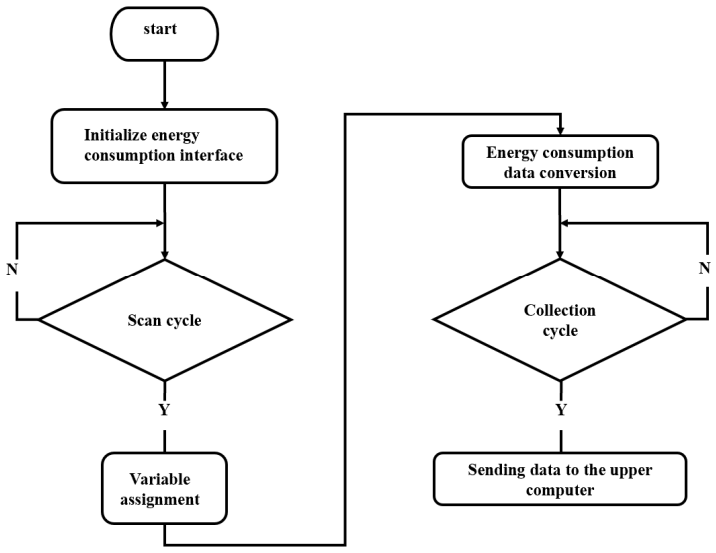

Figure 5. Flow Chart of Energy Consumption Collection Data

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The data collection process is shown in Figure 5. During the sampling process, the newly collected data will replace the old data. When the uploading cycle is reached, the data will be uploaded.

4. Results

The system is shown in the Figure 6.

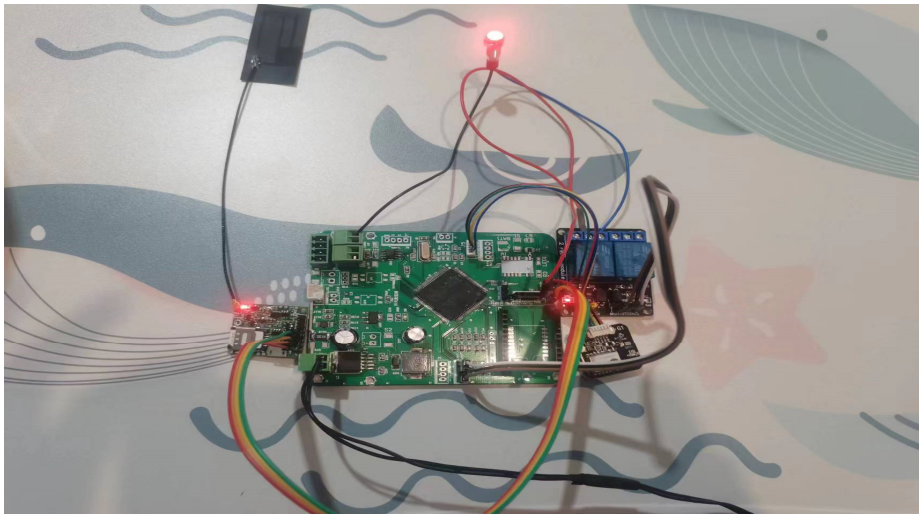

Figure 6. System debugging

As shown in Figure 7, the Air530 module is connected to a GPS antenna. GPS positioning information is used to determine the location of the new energy vehicle charging station. The specific location information can be viewed on the TLINK platform.

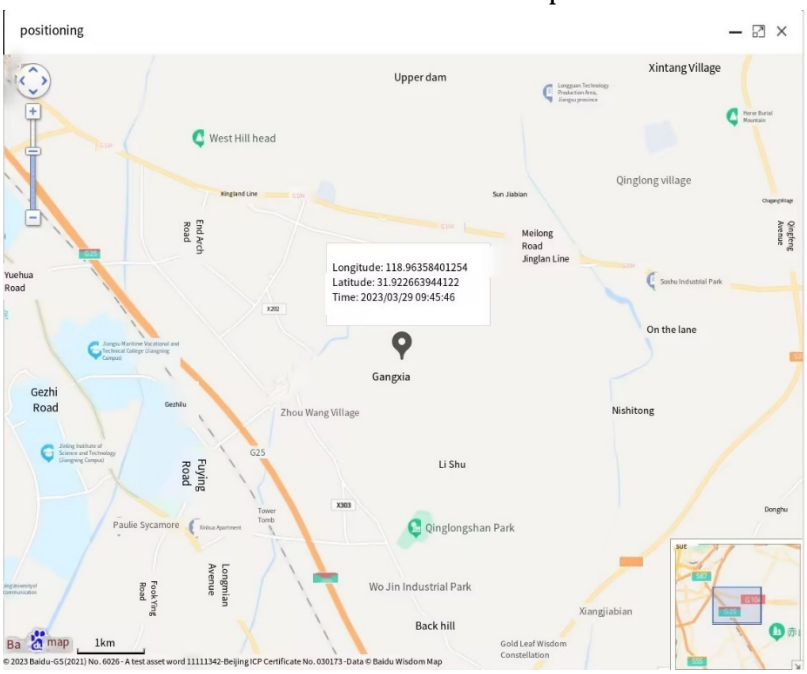

Figure 7. Suspicious object monitoring and alarm

The electricity usage information can also be viewed on the platform. From the power variation curve in Figure 8, it can be seen that the maximum value of power is 0.9W during this process. The minimum value is 0W. The average value is about 0.73W. The cumulative value is 29.28W with the difference 0.9W.

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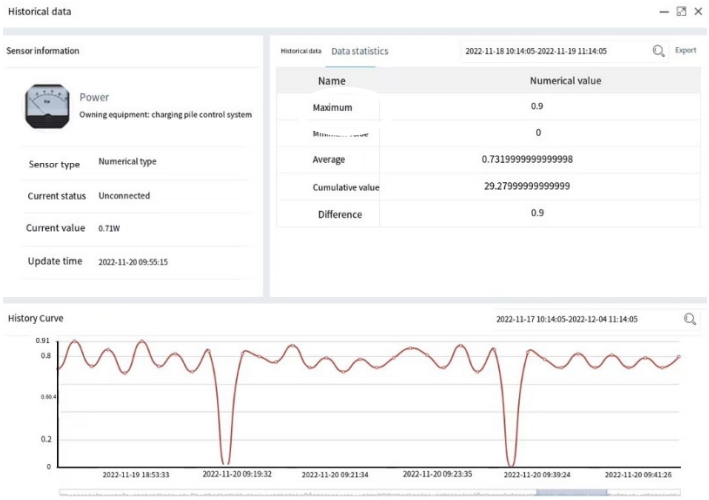

Figure 8. Electricity usage

5. Conclusion

A charging station information monitoring System is designed based on CAT.1 communication module. Information including electricity usage and positioning information can be monitored remotely. The control chip read the signal from cloud platform and control the charging station through the relay. The system is helpful to realize the intelligent charging station.

Acknowledgments

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