Research on Control System of Intelligent Socket based on Internet of Things

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Abstract: Along with the development of technology and improvement of people's livelihood, more and more people pursue high-quality and high-tech life. In recent years, intelligent mobile device, intelligent household device and intelligent wearable device are rapidly developing to meet people's wishes of high-tech life. Among of those, Internet of Things is the signal of developing to be intelligent. Internet of Things is the information carrier based on Internet and traditional telecommunication network, connecting all public physical objects. It can establish communication connection between objects based on Internet. Household everywhere and household electronic products are unified to be intelligent solutions and outlets. It is essential to implement comprehensive intelligence of household appliances. However, in order to connect household appliances and use socket for power, the intelligent management of household appliances can greatly achieved by intelligent management of socket. This paper proposes an intelligent socket design, which can implement simple functional design and execute prototype design and test. Based on this hardware solution, more specific and complex functional design can be executed.

1. Introduction

With the rapid development of China's economy, China's urbanization has entered a new stage. The accelerating urbanization has directly led to the high energy consumption in urban buildings in China. However, for the high energy consumption, only a small number of buildings have adopted effective energy-saving measures to reduce the energy consumption per unit of building area. Especially for China's current power technology, no matter which aspect is very backward. For example, traditional switches are used in the electricity process, and the application of intelligent power technology is also very less, which directly leads to the accelerating energy consumption in buildings. It can be seen that in order to achieve the energy-saving of urban buildings, starting from intelligent power, it is feasible to construct intelligent power system with high efficiency and low costs to solve the large energy consumption and realizer the sustainable utilization.

Intelligent socket plays an important role in the smart power system. By designing new intelligent outlets that can measure voltage, current, effective power, reactive power and power, it can realize intelligent socket functions such as anti-theft, high-temperature warning, over load protection, and timing off. The operating status of the electronic product is detected at any time, and the power of the electronic device in the standby state is cut off, thereby reducing waste of energy. At the same time, different time periods can also be set according to the needs of turning on the electronic device.

2. The Overall Structure of Intelligent Socket Control System based on Internet of Things

Intelligent power system, is to mainly collect environmental information, summarize data, and realize intelligent control of electrical equipment, implement wireless environment parameter monitoring nodes (sensors for temperature, humidity, lighting, and co2), and use electrical appliances such as radios to realize environmental comfort. It mainly includes seven parts: switch, wireless smart socket, smart meter, intelligent gateway, room controller and so on. Figure 1 shows the overall architecture of intelligent power system.

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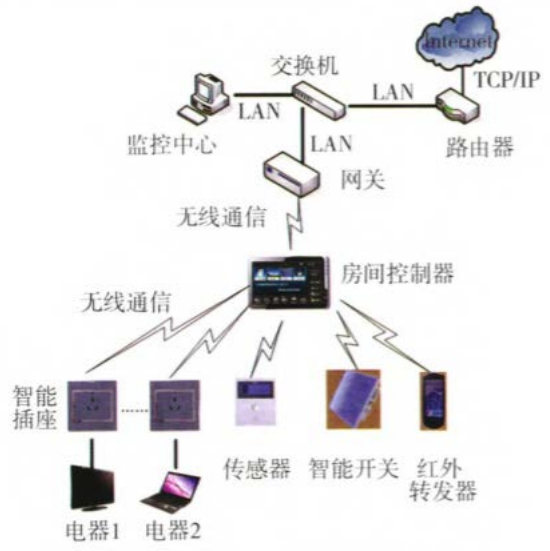

Figure 1 overall architecture of intelligent power system

Intelligent power systems use data acquisition, embedded, wireless communications, computers, and other technologies. The sensors in the system detect indoor environmental parameters and power consumption information, and send them to the indoor controller through the wireless network; the indoor controller is not only a summary of all the sensor information in the room, but also a carrier of the control strategy. The data collected by the room controller is uploaded through the monitoring center, and the data is transmitted through the LAN bus through the router. The network user can obtain information by logging in the environmental information and power consumption in the network building through the mobile phone.

The main function design of system is presented.

Currently, smart sockets such as packaging sockets, ring sockets, and remote control sockets are sold in the market. Partially, these outlets can meet user's needs, with stand-alone function and various drawbacks. It is difficult for users without professional knowledge to judge whether the power consumption of electronic products is based on the analysis of results. Energy consumption is reduced during idle periods to some extent by ring socket, actual power consumption of the electronic device is not fixed and it is inconvenient to use. WiFi, special remote control or mobile phone APP are used to detect the long distance of socket or close and detect the status of operation, with the disadvantage of expensive standby power consumption and complicated usage.

In addition to timing switch and remote control, smart sockets also integrate other functions. The intelligent IoT socket system designed in this paper, integrates all above-mentioned functions, including power connection, power disconnection, power status, wireless control, timing function and deficiencies of socket in current market. For instance, ZigBee wireless communication substitutes WiFi to reduce the power consumption of the system, without lines, fully meet the secure, convenient, comfortable and artistic requirements of intelligent home, report the status change within a certain period of time, and prevent the hidden risks of power system to family members and assets through excessive current. Specific functions are listed.

Firstly, wireless communication. Bi-directional wireless communication with low complexity, low power consumption and low costs is equipped with ZigBee technology. The wireless communication of intelligent socket with convenient network management can realize the change of indoor wiring structures, additional wiring, and wireless connection of intelligent device. In order to realize the information communication with intelligent socket, it supports various kinds of remote control device such as computer and mobile phone.

Secondly, control function. The intelligent socket realizes the current and control the power supply of socket through relay. The household equipment include air-conditioner, electric rice cooker, electric water heater and so on.

Thirdly, monitoring function. It can realize the real-time monitoring of various electrical

parameters, such as voltage, current, electricity power and so on. Users can know the electricity power of electrical equipment from action information on socket, and analyze the loading status and action to provide the standards of power consumption for users.

Fourthly, protection function. In the real-time monitoring of power consumption, if power electricity or voltage is too high, power will be disconnected, so as to ensure the safety of people and equipment.

Fifthly, automatic power-off in standby. It is to save the energy consumption of electronic products and relative equipment in the status of standby, totally excluding the high power consumption of household appliances.

3. Hardware Design of Intelligent Socket System based on Internet of Things

The hardware design of intelligent socket system based on Internet of Things is illustrated in six aspects: structure, power supply, power acquisition, on-off circuit, wireless communication and temperature acquisition.

3.1 The structure of intelligent socket

The structure of intelligent socket is shown in Figure 2, including MCU, wireless communication, power measurement and temperature detection.

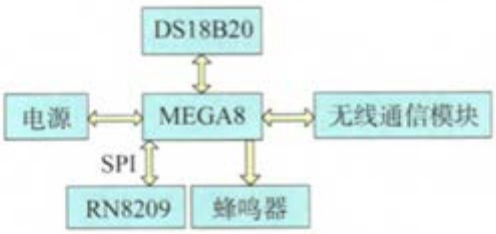

Figure 2 The structure of intelligent socket

3.2 Power supply module

Power supply module adopts switch power circuit to avoid the inconvenience by frequent change of battery. Compared with general stable power supply, AC supply has advantages of low costs, high efficiency, long life and low energy consumption. Its core chip TNY254P has wide range of voltage input to ensure the stability of circuit; switching frequency can efficiently reduce the electromagnetic interference; the output power of transformer can reach 2.5W to ensure the normal operation of circuit. The power supply module is shown in Figure 3.

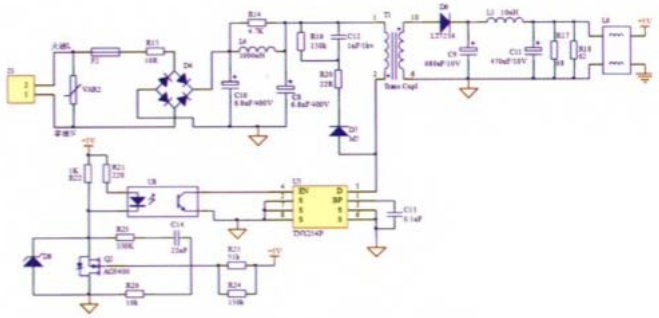

Figure 3 The power supply module

3.3 Power acquisition module

The module of power acquisition acquire the ineffective parameters of voltage, current, active power and reactive power of single-phase circuit. In order to collect rn8209 power measurement core, iec62053- 22:2 is adopted to support processor of three specifications and spi and usart outlets of communication, with characteristics of small capacity, high precision and strong function.

In current acquisition, the input of firing line passes through 0.56μQ manganese-cuprum resistor,

the voltage decreases, and the two ends of manganese-cuprum resistor are connected with position-negative analog pin of current channel A through the resistance of 1k – 1. In this process, the current effective value of 24-bit can be read from register and current value can be obtained from data processing.

Voltage can also be obtained in the mode of differential input, and null-line is 496 kω- resistance. In order to reduce the resistance in-line connection of power in complex number, resistance of 1 kn defeats the positive voltage of channel, voltage input performs analog input, and circuit channel is negative. The analog terminal passes along 1k.

Current channel B obtain the current in null line through current transcoding. Compared with current value from A channel, if there is difference, it shows the energy flow. Active power and reactive power are obtained by reading the register.

3.4 The on-off circuit

The switch circuit of intelligent switch is realized by sound controller, solving strong and weak electricity insulation and realizing the switchover of sound controller by photocoupling. Photocoupling realizes the switchover of “electric signal-optical signal-electric signal” and avoids the overvoltage by the switchover of electric signal and optical signal. The largest load of intelligent switch is 16a, which can effectively control the high-power machines, such as air-conditioner and microwave oven.

3.5 Wireless communication

The intelligent socket adopts 433 wireless communication module. Compared with Bluetooth, WIFI and ZigBee, it has feasibility of lower price, long-distance transportation and high quality, and it can be used for secondary development.

The core chip of 433 module integrates low-cost UHF transceiver C1101 of configurable modem. The modem support various modulation formats at a largest transmission speed of 500kbit/s. The forward error in-built in modem can be turned on to improve the performance. CC1101 can be used as low-IF receiver, RF signal received can be enlarged in low-noise amplifier and medium frequency is integrated into frequency conversion. In IF, I/Q signal is digitalized by ADC, so all automatic gain control, precision frequency filtering, demodulating bit/packet synchronization are digital signal. The transmitter of CC110 is directly composed by rf frequency. Thus, the electrical synthesizer frequency is a phase-shifting device that generates a signal from i and q10 generated by a full chip lcvco (voltage controlled oscillator) and a down-conversion mixer in receive mode.

433 module interacts with the microcontroller in spi communication mode. The data transmitted is sent externally by 433 module. All modules can receive data and data can be transmitted. 433 is an unvarnished transmission module. Therefore, when two adjacent modules are simultaneously transmitted to the outside, the wireless detection conflicts occur. The carrier detection method is adopted, and the decision that the protocol stack leads to the priority of communication can effectively solve the problem.

3.6 Temperature acquisition

If DS18B20 chip is adopted, the range of temperature is from 55 degree to 125 degree, and the precision is -10 ~ + 85℃. In addition, external power supply is unnecessary because DS18B20 can directly release energy from single-wire communication line. When the temperature is abnormal, the buzzer will ring.

4. Software Design of Upper Computer

The PC software platform uses C# development language, SQL: SERVER database, manages data, and uses Visual Studio software tools to create code. Graphical management SQL Server Management Studio Express makes it easy to develop user data such as resource data and dynamic development for key enterprise data platforms. The host computer analyzes, stores, prints, reminds, displays graphics, and controls the next computer through data transmission.

In designing software, the human interface is very important to communicate directly with users. In the friendly Manmaxin interface, it is required to faithfully reproduce the state of the controller and display the collected parameter information correctly. The entire human interface includes node selection, node control, power, voltage, and current active power display, and each screen can be switched to each other. Of course, the artificial interface suitable for the user can be designed according to the user's habits, which is flexible. In the IoT application, the collected sensor node information is displayed, providing embedded intelligent control. The software is mainly composed of data transceiver unit and display unit.

Data transceiving refers to data transmission and reception of the embedded gateway. The two TCP/IP Socket programming are connected by wireless network, used as a host and communication server by the embedded gateway, and the upper computer acts as the connection initiator. The display unit uses C# Windows. For the form application that works on the Net Framework, once an abnormality is found in the room, the display interface changes the color of the text to remind people. At the same time, the data chart is drawn with the auxiliary device. This is easy to monitor, clear and intuitive, and easy to use.

5. The Calibration and Test of Intelligent Socket

5.1 The calibration of intelligent socket

The power measurement module needs to use RN8209G chip to perform parameter correction before measuring the power parameters to improve the accuracy of the power collection parameters. The RN8209G power measurement module has been calibrated by a standard meter.

5.2 The test of intelligent socket

After calibration, the bulb is connected to the intelligent socket for testing. The on-off function of intelligent socket to be tested can effectively control the on-off status of the bulb and measure parameters such as voltage and current.

6. Conclusion

An intelligent socket based on Internet of Things is designed, equipped with the functions such as stolen power acquisition, intelligent controlling, and high-temperature warning, which can effectively solve the low-power risk and high power consumption. The intelligent socket can be efficiently applied in the construction of intelligent power system, to powerfully support the implementation of control strategy. The control system of intelligent socket is studied in this paper from four perspectives for reference.

Acknowledgement

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