Research on data transmission based on power line carrier

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Abstract. In the research of power line carrier data transmission, STC89C52 chip is selected as the core microprocessor and KQ130F carrier module as the receiving and transmitting carrier of the system. The optimization of modulation and demodulation rate and the reduction of bit error rate are realized by improving the programming algorithm in the transmission process. In the analog LED street lamp monitoring system, the PC performs the data transmission test by setting up the hardware test platform through the actual application process of the power line carrier to the terminal control.

1. Introduction

The power carrier communication technology is a special communication one for data or voice transmission using an existing low-voltage distribution line (380 V/220V power line) as an information transmission medium. As an information transmission medium, power line networks are widely distributed. Therefore, the development of power line carrier communication technology has the advantages of low investment, low cost, wide coverage of the power grid, and convenient access. The power line is designed for transmitting 50 Hz alternating current[1]. The carrier channel has many types of noise, complex characteristics, and poor communication environment. It is difficult to directly meet the requirements of carrier communication. At present, in the monitoring and control of urban street lighting in China, there are still some defects such as insufficient regulation ability, no condition monitoring function, and no anti-theft monitoring function. Therefore, the establishment of appropriate monitoring system is an inevitable choice for the overall development of smart cities in the future[2].

In this paper, the outdoor street lamp integrated control system is taken as the simulation hardware test platform. By optimizing the algorithm program, the signal modulation and demodulation efficiency is improved, the bit error rate in the transmission process is reduced, the capacity of data transmission in the channel limit is improved, and the stability and reliability of the overall operation of the system are improved.

2. System principle

2.1. Design principle

In this paper, the design of data exchange mode is to choose polling data exchange mode, and the software design is to choose multi-threading. Each thread correspondingly controls one sub-network, which improves the network data exchange speed, and sets another thread to monitor the PC, timely response to PC control of network terminal equipment. In order to better interact with users, the central controller should be connected to the PC and reflect the running state of the equipment on the grid to the PC in real time for our observation. In addition, the control instructions for the power grid
should also be issued by the PC, so as to facilitate users to better complete the operation of network terminal equipment[3].

In order to realize the control of the terminal LED street lamp system through the power line on the PC side, firstly, the data transmission at both ends is realized, and then the terminal is connected to the LED street lamp system. The PC terminal is the analog integrated control terminal, the single chip microcomputer simulates the MCU central control unit, and the carrier module selects the KQ130F communication module to simulate the modulation and demodulation unit. The control end is connected with MCU by RS232 serial connection and MAX232 level conversion chip.

The single-chip RXD (input pin) is connected to the TX (output) of the carrier module, and the single-chip TXD (output pin) is connected to the RX (input) of the carrier module. After the carrier module processes the data, the power lines are used to transfer data bytes. The transmitted data is demodulated by the carrier module and finally transferred to the single-chip microcomputer, which sends the data to the PWM dimming module, so as to realize the regulation of LED street lamp brightness and other parameters. The RXD (input pin) of the single-chip is connected to the TXD (output) of the PWM module, and the TXD (output pin) of the single-chip is connected to the RXD (input) of the PWM module. The experimental circuit design is shown in figure 1.

2.2. Terminal control system

The core of LED lighting street lamp system controller is STC89C52RD. The STC89C52RD has the advantages of low power consumption, high flexibility and easy operation. It has three 16-bit timer/counter of T0, T1 and T2. And 32 universal I/O ports. P3.0 and P3.1 are connected to the output and input terminals of the power line carrier module respectively. P1.5, P1.6 and P1.7 can be used to control the clock chip. The analog signal of the light intensity sensor can be fed back to the microprocessor by pin P1.2, and the output signal of pin P1.4 can be amplified to start the drive module[4]. The establishment of the overall architecture is a crucial step for the experiment. The overall architecture of the LED street lamp control system is shown in the figure 2.
3. Programming
In order to realize the control of the terminal LED street lamp system on the PC, and the operation condition of the LED street lamp system can also be fed back to the PC control end in time, the communication transmission between the two ends must be realized first. In this experiment, The serial communication mode for data transmission is chosen. Based on the existing communication system algorithm, some redundant operations are optimized as follows[5].

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Figure 2. Schematic design of terminal controller

Figure 3. Program design and core algorithm optimization process
4. Hardware test
After the program is written into the STC89C52 chip of the simulated micro central control unit, in order to test the overall transmission characteristics and channel quality of the system, multiple sets of different byte count data are tested compared with the original algorithm program.

Data sets containing 1622 bytes, 4546 bytes, 10150 bytes, 13638 bytes, and 18833 bytes are tested. It is found that when the number of bytes input exceeds 18333, garbled characters like 00, 00, 00... or 3x, 3x, 3x... (for example, 34, 37, 32...) appear, and the more data is transmitted, the longer transmission time is required. As shown in Figure 4, after optimization, the instantaneous maximum transmission data that the system channel can withstand is increased from 13686 to 18833, and the bit error rate is reduced from 14.8% to 10.7%.

![Figure 4. Data comparison chart before and after system optimization](image)

5. Conclusion
The optimized LED street lamp integrated control system based on power line carrier communication technology has reached the design requirements. It also has the advantages of long-distance communication, easy installation and easy operation. It can effectively complete the remote monitoring of street lamps, improve the channel stability and anti-noise interference ability, and increase the upper limit of data back-transmission, which has achieved the experimental purpose.

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