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**Abstract:** In order to promote the process of social modernization, the traditional street lamps are also moving towards intelligent development. However, the existing street lamps mostly use a single LED lamp or high-pressure sodium lamp, which can't cope with the complex road conditions in China. The designer proposes to install the monitoring system on the street lamp, design the fine artificial intelligence light distribution and color temperature regulation scheme, add the functions of positioning, alarm, repair, pollutant and rain and snow monitoring, and realize the data interaction between the street lamp and the user and the manual intervention of the user when necessary through the infrared Bluetooth Internet of things and other technologies. The design is developed, simulated, debugged and tested on Arduino hardware and software platform. The results show that the design is reasonable and feasible.

## 1. Introduction

At present, due to the many traffic conditions and wide coverage in our country, the simple high-pressure sodium lamp or LED lamp are often used in different road sections and different traffic flows. Most of the LED street lamps are about 5500k light source, which has higher luminous efficiency and more energy saving. However, the color temperature of 5500k light will make people very cold and dazzling in vision, , which will lead to over vision and reduce driving safety. In addition, in rainy and foggy weather, the penetration ability of this kind of light is poor, which also affects people's travel safety. The traditional high-pressure sodium lamp light color temperature in 2800k, will not produce dizziness, in the rain fog environment, its light penetration ability is stronger, but energy consumption is serious. Therefore, the development of a kind of streetlight which combines the advantages of two kinds of streetlights is not only energy-saving and not dizzy, but also has strong penetration ability in the environment of rain and fog, which has far-reaching significance for national construction, traffic safety and improving energy utilization rate.

Moreover, the location of the street lamp is fixed and in the core area of the road, if the function of positioning and alarm is added to the street lamp, it will greatly facilitate the contact between the masses and the police and the determination of the location by the police when the accident occurs. It also helps to solve the cases of the lost elderly and the abduction and sale of children. Therefore, the development of positioning and alarm functions on street lamps will be a new direction of intelligent street lamp research. In this paper, Arduino single-chip microcomputer will be used for intelligent design of traditional street lamps to achieve intelligent dimming, one key alarm, energy saving and safety features.

## 2. Solar Charging

In the solar street lamp system, the battery charge and discharge control strategy will directly affect the performance of the system. The charging methods of lead-acid battery include constant current charging, constant voltage charging, constant voltage current limiting charging, two-stage charging and three-stage charging. Choosing a proper charging method can not only prolong the service life of the battery, but also improve the charging efficiency [1]. In this paper, super capacitor is used as energy storage element of photo-voltaic power generation. Super capacitor is a new type of energy storage element with energy density and power density between battery and electrostatic capacitor. It has unique advantages in the application of energy storage element in pulse power supply [2]. The MPPT algorithm is used to automatically adjust the output voltage and current of the solar panel. When the light changes, it can automatically keep up with the change, so that the output power of the solar panel always remains the maximum value corresponding to the light at that time. Combined with DC-DC buck circuit, the super-capacitor is charged. Thus, the charging efficiency and energy utilization rate of the super farad capacitor can be improved.

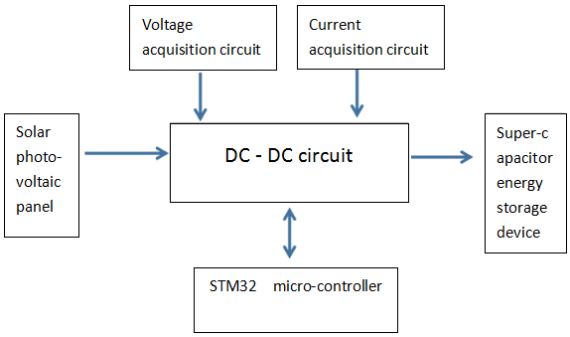


Figure 1. Charging structure diagram of ultra-capacitor

As shown in Figure 1, STM32 micro-controller is used to charge the photo-voltaic power generation system. The input end of DC-DC circuit is connected to solar panel, and the output end is connected to super capacitor bank energy storage device. Through each port of DC-DC circuit, the required voltage and current data can be collected and calculated for maximum power point tracking. MPPT algorithm is used to find the maximum power point of solar panel in the changing environment (such as luminosity and temperature).

## 3. Lighting Control And Environmental Monitoring

### *3.1. Dimming Principle*

This design uses PWM dimming driving power scheme, and adds a color temperature adjusting circuit in the back-end circuit of the power supply. The color temperature adjusting circuit uses PWM switch dimming mode to adjust the on-time ratio of cold white LED array and warm white LED array, so as to realize color temperature adjustment. The structure block diagram is shown in Figure 2.

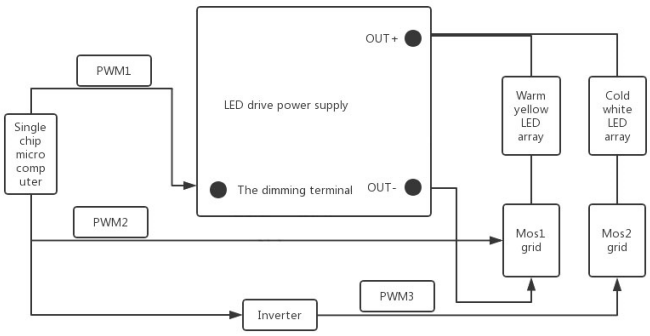


Figure 2. Structure diagram of automatic dimming and color tempering system

In order to achieve color temperature regulation, a cold white LED array and a warm white LED array with close on-off voltage drop are connected to the power output in parallel. Power switch MOS1 and MoS2 are used to control the on-off of the cold white LED array and the on-off of the warm white LED array respectively. Pwm2 signal is connected to the gate of MOS1 to control the on-time of cold white LED array. Pwm2 is connected to the gate of MoS2 to control the on-time of warm white LED array. Pwm2 is high power level, pwm3 is low level, so cold white LED array is on, warm white LED array is off, and vice versa. Adjust the duty cycle of pwm2 to adjust the on-time ratio of cold white LED array and warm white LED array in unit time, so as to achieve the effect of accurate change of light color temperature on demand.

### *3.2. Realization Of Traffic Flow Monitoring And Dimming*

In this design, e3f-20c1 counter laser sensor is used to simulate vehicle flow. Insert the pin of the laser sensor into the bread plate, and set the function key program of the laser sensor module in Arduino IDE as follows:

```
if (minute_test == minute_1)
  {
    if (!mixly_digitalRead(pipe))
    {
      delay(10);
      while (!mixly_digitalRead(pipe))

      {
      }
      car_num = car_num + 1;
    }
  }
  else {
    minute_test = minute_1;
    car_num = 0;
  }
```

Through the recording of the laser sensor, it is specified that when the number of passes exceeds 10 times / min, pwm3 is low level, pwm2 is high level, and the warm white LED array is on. When the number of passes is less than 10 times / min, pwm2 is high level, pwm3 is low level, and the cold white LED array is on. The record of the counter laser sensor is refreshed every minute. The advantage of this design is that the white LED lights can save energy when the traffic flow is small, and the yellow LED lights can reduce the driver's visual fatigue when the traffic flow is large.

### *3.3. Environmental Monitoring*

#### *3.3.1. Air Quality Monitoring*

In this design, gp2y1010au dust sensor is used to measure the air quality. Gp2y1010au dust sensor is very effective in detecting very fine particles, such as cigarette smoke, and is a commonly used air purifier system. The device has a very low current consumption and can carry sensors up to 7VDC. The output voltage is directly proportional to the measured dust concentration, and the sensitivity is

0.5v/0.1mg/m3. The principle is shown in the figure below. There is a hole in the center of the sensor that allows the air to flow freely. The LED light is emitted directionally. The content of dust can be determined by detecting the light refracted by the dust in the air.

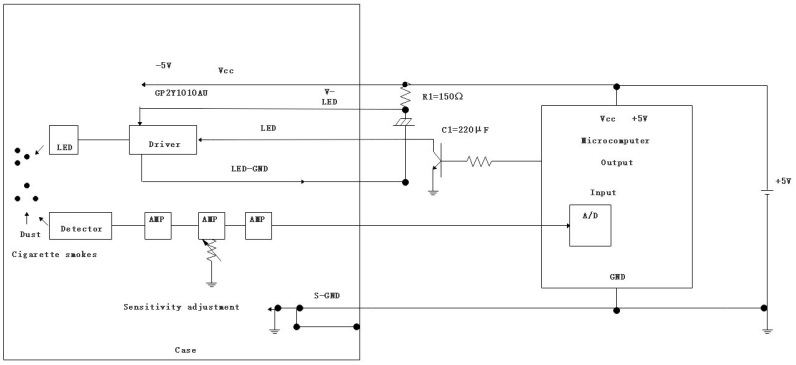


Figure 3. Schematic diagram of dust sensor

Because the density of dust is relatively low and the result of collection is intermittent, so we need to add filter algorithm. In this paper, we use mean filter, limiting filter and other filter algorithms to achieve filtering. Generally, it works with 5500k color temperature of light. Under the conditions of fog, haze, dust, and other adverse weather conditions, the system will distribute the collected data in gradient. The processor will accurately allocate and adjust the corresponding color temperature value of the light, so as to enhance the penetration of the light emitted by the street lamp and the visibility of the road, so as to improve the driver's driving safety.

*3.3.2. Raindrop Monitoring*

Considering the low visibility of the road in rainy and foggy weather, the rain drop sensor can be installed on the street lamp. The schematic diagram of the rain drop sensor is shown in Figure 4, and the model is si7021. In severe weather conditions such as rain, snow, freezing, etc., collect temperature, humidity, rain and other data, the system will collect the data for gradient distribution, and the processor will accurately distribute the light and adjust the corresponding color temperature value [3,4]. It makes the light emitted more suitable for human visual senses, which is conducive to reducing the visual fatigue of passers-by and improving people's ability to observe in the distance. In addition, the SCM sends the string "it is training!" to the app through the Bluetooth module.

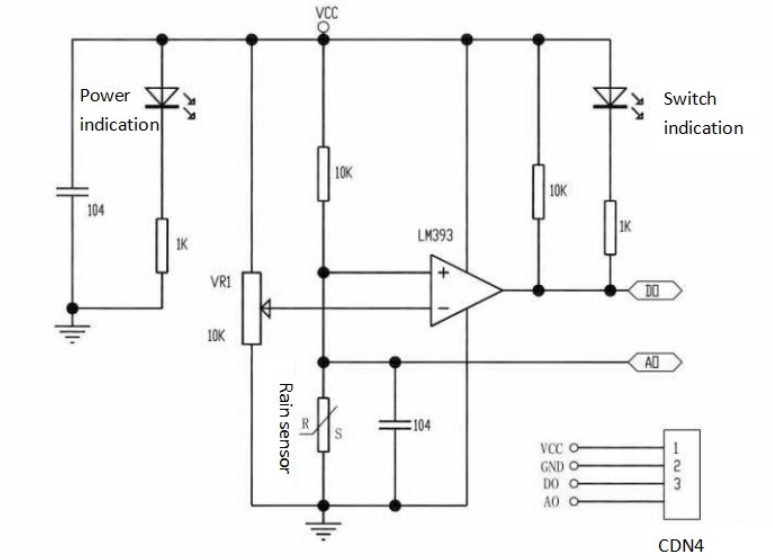


Figure 4. Schematic diagram of raindrop sensor

## 4. Realization Of Human-computer Interaction

The test of Bluetooth wireless terminal based on Arduino mainly includes Bluetooth connection test. Human computer interaction module test includes data acquisition test and touch screen click test of Android mobile phone. The data acquisition test needs to start the terminal and connect with the app by using Bluetooth of smart phone. First, put the Arduino, smart-phone and other terminals in the Bluetooth area, and obtain the Bluetooth name and password in the area. Then input the corresponding name and password in the Bluetooth module configuration page (the default name is bug, and the password is 1234). When the device is successfully connected to the mobile app, the corresponding information of human-computer interaction can be seen from the user interface of the smart phone for artificial dimming.

## 5. Monitoring And Alarm Settings

Because the position of street lamp is relatively fixed and in the core position of the road, it only needs to install a monitoring camera and intercom module on the intelligent street lamp to realize real-time alarm. The background will send the position intercom and monitoring content to the police, which is conducive to the rapid and accurate acquisition of the location of the incident to understand the incident and improve the efficiency of the police. And monitoring, positioning and alarm functions will greatly facilitate the lost elderly[5], abducted children and strangers from other places to effectively contact the police in case of accidents. It will provide a new way to crack down on cases of child trafficking and the loss of the elderly. The street lamp is based on the design of single lamp node, and the controller has the wireless networking communication function. When the intelligent street lamps (thousands of them) with the controller are installed in a single area (town, campus, street, park, square, etc.), all the intelligent street lamps independently form a tree or mesh wireless network. One of the intelligent streetlights has a controller configured as a coordinator, which is responsible for the establishment, maintenance and management of the network. Other intelligent street lights are configured as routers or terminal devices according to the road conditions and the distribution of street lights[6]. They are added to the network established by the coordinator through channel scanning. All streetlight nodes in wireless network can communicate with each other and transmit data to each other. The structure of the monitoring system is shown in Figure 5.

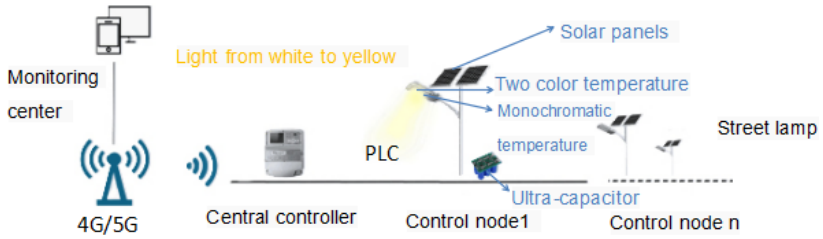


Figure 5. Schematic diagram of monitoring system structure

## 6. Equipment Debugging And Testing

### *6.1. Circuit Design*

In this paper, the use of isolated fly-back circuit has the advantages of least devices used, low cost, high power density, electrical isolation, easy to achieve multiple output, providing voltage withstand protection and so on. It is suitable for low-power power devices below 150 W, while LED lighting generally uses low-power power power devices. This paper uses fly-back circuit as the main circuit and Arduino mega2560 as the control chip. Arduino mega2560 has 54 digital I / O pins (15 can be used as PWM output), 16 analog inputs and 4 UARTS, Compared with 14 digital input / output pins (6 can be used as PWM output), 6 analog input pins and 16 MHz crystal oscillator of Arduino UNO, the controller will be used as the carrier of the automatic management system to control all the devices

involved in this paper due to the huge improvement of the number of pins. The circuit design flow chart is shown in Figure 6.

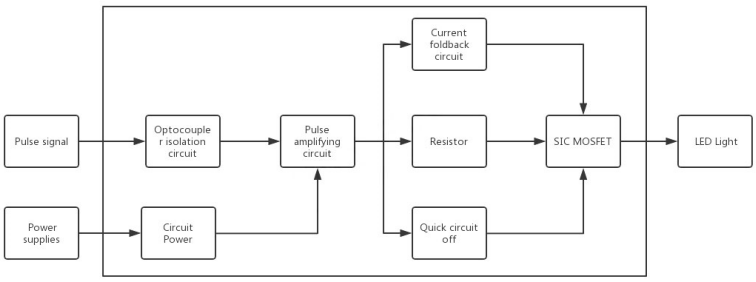


Figure 6. Circuit design flow chart

*6.2. Commissioning And Testing*

In order to verify the rationality of the device design, this paper will use Bluetooth serial port tool to test the feasibility of the device alarm function, query and match the Bluetooth address of the device through Bluetooth on the PC side, adjust the Bluetooth communication baud rate of the device through Bluetooth serial port tool after pairing, and read the data of the PC serial port. The Bluetooth communication baud rate used in this paper is 11520, and the connection is obtained by scanning The serial port is CH07, run the equipment, press an alarm function key, you can find that the Bluetooth serial port operation interface displays the information sent by CH07 serial port, which proves that the design of equipment alarm function is reasonable and the operation is normal. The Bluetooth serial port operation interface is shown in Figure 7.

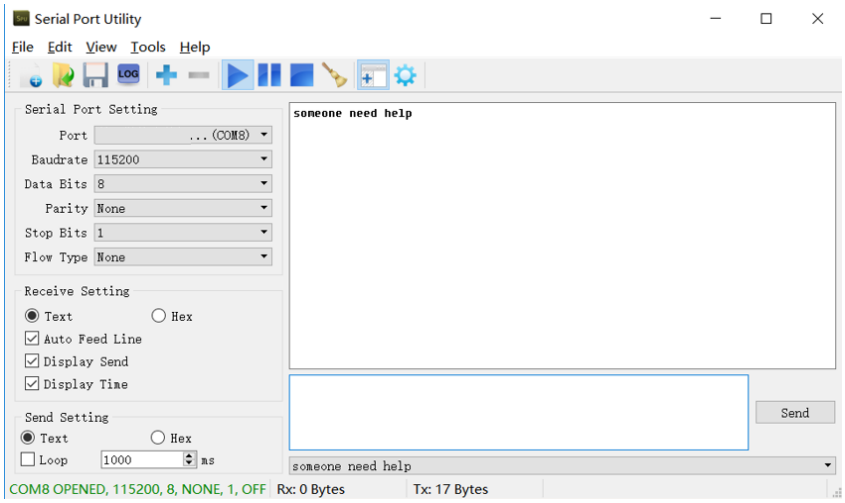


Figure 7. Bluetooth serial port adjustment attempt

## 7. The Conclusion

In this paper, an intelligent street lamp based on Arduino is designed, which includes super capacitor charging, LED automatic control, street lamp network monitoring, environment monitoring and user-side equipment interaction module. The modules are tested. During the test, the mega2560 single chip microcomputer is connected with 5V voltage. The single chip microcomputer starts normally. After the user connects with the device through Bluetooth, the user displays the operation interface. The Bluetooth function can be realized. Through the simulation of the traffic flow conditions by the laser sensor, it is found that the automatic dimming system is normal. The user can send a string signal to the device through Bluetooth according to the traffic flow, and switch the automatic dimming to the

manual dimming. The device meets the expected effect, which proves that the design scheme of this paper is feasible. The open source development platform Arduino can be used for the intelligent development of traditional street lamps. Because the compiling language of Arduino is open-source, if the Arduino MCU can be used in the street lamp industry, the development of intelligent street lamp will be greatly accelerated.

**References**

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