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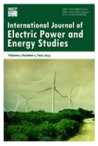

Design of Intelligent Street Lamp System Driven by New Energy Sources

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ABSTRACT

The streets, large and small, are full of street lights, which light up the way home when night falls. But tens of thousands of street lamps consume a lot of energy. The non-renewable energy on the earth is limited, so in order to protect our earth and enable the sustainable development of the earth, this paper designs and develops an intelligent street lamp system driven by new energy sources. Different from the traditional single power supply mode, the street lamp mentioned in this paper uses solar energy, wind energy and ceramic piezoelectric machinery to provide electricity to the street lamp. Solar power is generated when the sun is full, and wind power is generated when there is no sun. The mechanical energy of a car passing through piezoelectric ceramics can also be used to generate electricity in special weather conditions when there is no wind or sunshine. A variety of power generation methods have solved the malpractice of new energy source street lamps relying on weather conditions. And the system can display the power of the storage battery in real time, and light it automatically when night falls. It is an efficient multi-source drive intelligent new energy street lamp.

KEYWORDS

New Energy; Wind Energy; Weather; Street Lamps; Solar Energy; Piezoelectric Ceramics; Multi-Sources.

1. RESEARCH BACKGROUND AND SIGNIFICANCE

According to incomplete statistics, the current number of street lamps in China is about 30 million, although these street lamps have the function of decorating the city and illuminating the road. But its annual electricity consumption is also huge, the average annual electricity consumption reaches 260 billion kilowatt-hours (kWh), which is a large energy consumption. In fact, not only street lamps, various industries have a lot of consumption of electricity and energy [1]. In order to cope with the environmental pressure caused by the growth of energy consumption, our country is making great efforts to develop new energy, reduce our dependence on coal and increase the proportion of renewable energy. And implemented a series of energy conservation and emission reduction policies and standards to encourage industry, construction, transportation and other industries to implement energy conservation measures and improve energy efficiency [2].

The traditional new energy street lamps use a single way to convert it into electricity. For example, when the solar street lamp encounters the rainy season, it has been cloudy and rainy without the sun for more than ten days, so the solar energy will not work. It can be seen that the utilization rate of traditional single new energy street lamps is greatly affected by weather conditions.

From the above analysis, we can see that the power consumption of street lamps is huge, so it is necessary to use new energy to power supply in order to achieve the purpose of saving resources. But at present, the traditional new energy street lamps often use a single energy supply, which is affected

by the weather. At present, China is also vigorously promoting the development of new energy, so it is very necessary to develop a new energy multi-source-driven intelligent street lamp system. The street lamp system is powered not only by solar and wind energy. Piezoelectric ceramic equipment is also installed above the road, and when the car passes through the road, the piezoelectric ceramic equipment is rolled to produce deformation and the mechanical energy is converted into electric energy. The road section system uses a variety of ways to power supply to solve the shortcomings of traditional single new energy street lamps affected by the weather.

2. OVERALL DESIGN OF INTELLIGENT STREET LAMP SYSTEM DRIVEN BY NEW ENERGY SOURCES

The street lamp system charges the lithium battery through wind energy, solar energy, piezoelectric ceramic mechanical energy and other ways. The Arduino main control board connects the output port of the circuit and lights the street lamp through the day and night detected by the photosensitive module. The OLED screen displays the current charge of the lithium battery in real time. Connect the phone to the WiFi and open the software to see the charge of the lithium battery in real time.

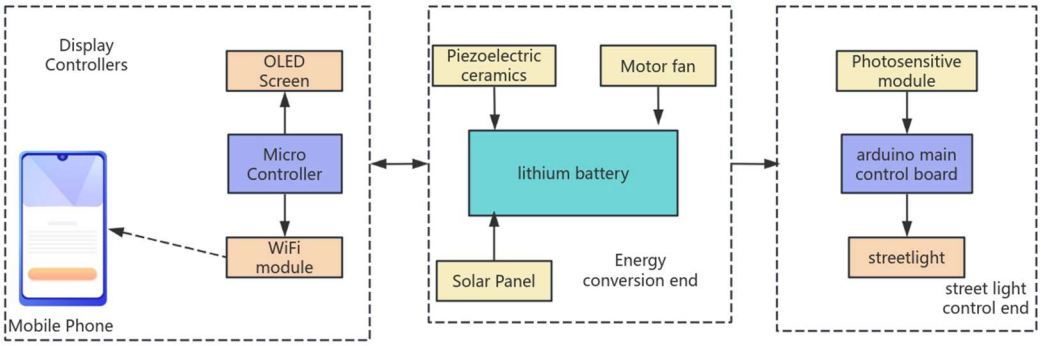

Figure 1. system block diagram of intelligent street lamp

As shown in figure 1, the system block diagram of new energy multi-source street lamp is composed of display control terminal, energy conversion terminal and street lamp control terminal. Each part is described below.

(1) the display control terminal is composed of mobile phone, OLED screen, WiFi module and single chip microcomputer. The single-chip computer obtains the electricity data information of the energy conversion terminal through the serial port, then controls the OLED screen module to display the related data information and shares it to the mobile phone through the WiFi module.

(2) the energy rotating end is composed of piezoelectric ceramic, motor fan, solar panel, boost module, lithium battery charging module and so on. Through the circuit connection design, the mechanical energy of piezoelectric ceramics, the solar energy of solar panels illuminated by sunlight and the wind energy of wind-driven motor fans are converted into electricity needed for street lamp operation and stored in rechargeable lithium batteries.

(3) the street lamp control terminal is composed of arduino main control board, photosensitive module and street lamp. The street lamp control terminal provides power operation by the energy source conversion terminal. When the photosensitive module detects that it is dark, the main control board controls the street lamp to turn on.

3. HARDWARE DESIGN

In order to make the new energy multi-source street lamp system work properly, software and hardware are indispensable parts. Figure 2 shows the hardware design of the energy conversion terminal and display control terminal in the new energy multi-source street lamp system.

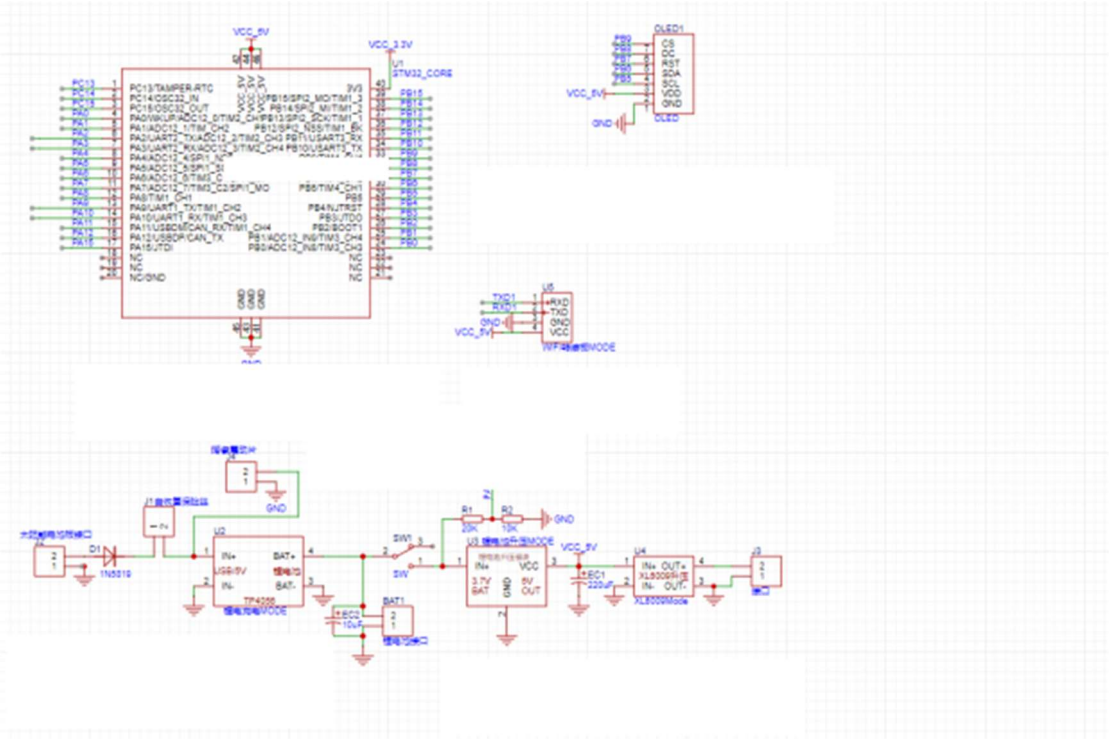

Figure 2. hardware design diagram of energy conversion terminal and display control terminal

The solar panel interface, piezoelectric ceramic interface and fan motor interface are connected to the IN interface of the lithium battery charging module, and then the BAT interface of the lithium battery charging module is connected to the battery to charge the battery. Then one end of the lithium battery is connected to the IN interface of the boost module, and the voltage required by the control end of the street lamp is output through the OUT interface of the boost module.

Figure 3 shows the hardware design of the street lamp control terminal in the new energy multi-source street lamp system. The A1 signal pin of the Arduino is connected with the signal pin of the photosensitive module to read the light intensity. Arduino's digital pin D2Magi D3 is connected to the positive pole of the street lamp to control whether the street lamp is turned off or on.

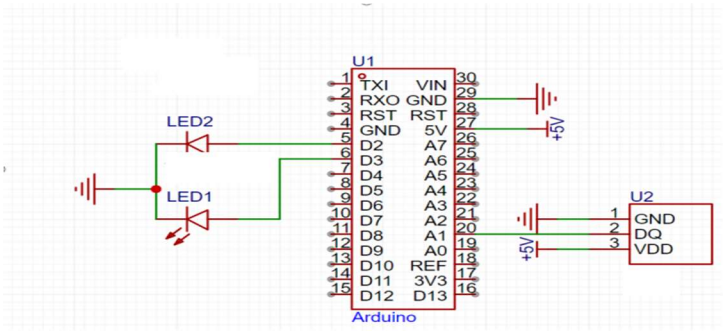

Figure 3. hardware design diagram of street lamp control terminal

4. SOFTWARE DESIGN

The hardware provides the foundation for the new energy multi-source street lamp system, and the software provides the brain soul for the system. In this system, by programming for 51 single-chip microcomputer, the voltage of lithium battery is measured many times, and its average value and percentage of electricity are calculated. Controls the average voltage and percentage of electricity displayed on the OLED screen. Set the network name and password of the WiFi module, and send the average voltage and percentage of power to the WiFi module. Figure 4 below is part of the C language program diagram of 51 single-chip microcomputer.

```
#include "my_include.h"
unsigned int i;
char dis0[128];
char dis1[32];
char dis2[32];
u16 reaData_01 =  123;
u16 reaData_02 =  234;
unsigned char readCount =0;
float sumVoltBat=0,midV=0;
float voltBat=0;
unsigned int batterQc=0;
void My_ESP8266_SendStrStr(USART_TypeDef* USARTx, const char *str);

int main(void)
{
   USARTx_Init(USART1,9600);//
//   USARTx_Init(USART2,9600);

//   My_KEY_Init();
//   My_LED_Init();
          My_ADC_Init(ADC1)

   buzzer = 1;
   delay_ms(100);
   buzzer = 0;
```

Figure 4. 51 partial C language program diagram of single-chip microcomputer

Use Mixly software to program the Arduino nano main control board in the system. Mixly software is a graphical programming software, the way to use is very simple [3]. By reading the value of the photosensitive module in the A1 pin,when the value is less than 200, it means it is dark, turn on the street lamp, otherwise turn off the street lamp. Figure 5 below is the Arduino nano program diagram.

5. PHYSICAL PRODUCTION

(1) the drawing of the circuit board is handed over to the factory to make the PCB board. The following figure shows the physical diagram of the PCB board.

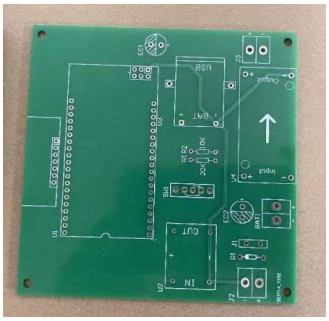

Figure 5. physical diagram of PCB board

(2) the hardware is welded to the board to complete the assembly test effect.

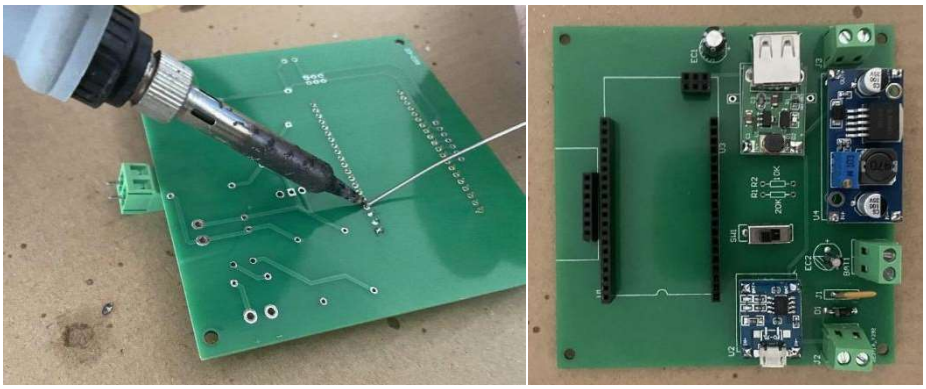

Figure 6. production process diagram

build the physical model and finally complete the finished product.

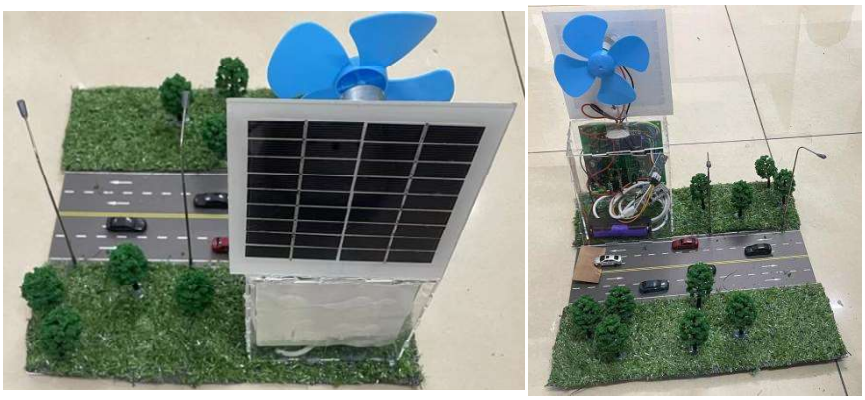

Figure 7. final product diagram

6. TEST EFFECT OF INTELLIGENT STREET LAMP SYSTEM

Table 1. trial data sheet

Solar power generation (Wh)	**Wind power generation (Wh)**	**Piezoelectric ceramic power generation (Wh)**	**Battery voltage (V)**	**Percentage of charge (%)**	**The length of time the street lights have been on (hour))**
15.2	5.3	4.6	11.8	85	8.3
16.0	4.8	2.3	12.1	87	8.1
14.7	5.6	7.8	11.7	84	8.6

In order to test the performance of the new energy multi-source drive intelligent street lamp system in practical use, including its energy conversion efficiency, the accuracy of electricity monitoring and display function, as well as the automatic switching function of the street lamp. Simulate the real

weather indoors. Sunny, cloudy and windy days. And simulate the traffic flow in urban and suburban areas.

During the trial, we recorded the data of the system every day, including solar power generation, wind power generation, piezoelectric ceramic power generation, battery voltage and battery percentage, etc. The specific data are as follows:

Analysis of trial results.

(1) Energy conversion effect: solar and wind energy perform well in sunny and windy weather, and the power generation is relatively stable. The power generation of piezoelectric ceramics is greatly affected by the traffic flow, but the overall power generation is relatively stable.

(2) Power monitoring and display: the OLED screen can accurately display the battery voltage and the percentage of battery power. The WiFi module successfully transmits the data to the mobile phone, and the user can check the working status of the street lamp system at any time.

(3) Street lamp automatic switch: after the photosensitive module detects dark, the street lamp is turned on automatically, and the running time is stable for about 8 hours to meet the lighting demand at night.

The performance of the new energy multi-source drive intelligent street lamp system is stable during the trial period, which can effectively use the mechanical energy converted from solar energy, wind energy and piezoelectric ceramics to supply power, the electricity monitoring and display function is accurate, and the street lamp automatic switch function is reliable. The system is suitable for the lighting needs of urban and suburban roads, and has high practical value and promotion prospect.

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