

# An intelligent umbrella design scheme based on NodeMCU

Yiyang Cai, Chunyan Zhang, Nichen Niu

**Abstract**— The paper analyzes the characteristics of the existing traditional umbrellas, and takes the basic needs of users as the starting point. From the aspects of “functionality” and “structural design”, the traditional umbrellas are optimized and improved. Under the premise of fully considering the cost, reliability and volume of the umbrella, the NodeMCU single-chip microcomputer is used as the control component, which adds night lighting and weather forecasting functions to the traditional umbrella. The umbrella handle of the umbrella was redesigned, and the A-shaped umbrella structure was designed. This smart umbrella enhances the safety and convenience of users, and the solution is practical, contributing to the optimization of traditional umbrellas.

**Index Terms**— convenient, NodeMCU, umbrella, safe

## I. INTRODUCTION

Umbrella is one of the indispensable tools in human life. However, the function of traditional umbrella has been limited to "rain" or "shade", and its function is relatively simple. Moreover, the traditional umbrella is not properly held, and its single-handed one-handed grip design makes the user's umbrella posture under a laborious lever.

Based on the two problems of “less function” and “unreasonable holding method” of traditional umbrellas [6], this paper proposes a smart umbrella based on NodeMCU. It is hoped that through the design and research of the new smart umbrella, the user's grip posture will be improved, and the practical function of adapting to the environment will be added to the traditional umbrella.

## II. TWO MAJOR PROBLEMS EXISTING IN TRADITIONAL UMBRELLAS

### A. Functional single

Traditional umbrellas only provide the function of “rain” or “shade”. When pedestrians are exposed to low light conditions such as night or cloudy (Fig.1), traditional umbrellas not only fail to provide the function of ambient lighting, but also may limit the user's field of vision due to the shading of the umbrella surface, increasing the user's danger.

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At the same time, umbrellas are an essential tool for homes, and the market retention rate is extremely high. The advantage of making traditional umbrellas intelligent can directly affect everyone's daily life and improve people's travel habits. It can be seen that adding functions to traditional umbrellas is an irreversible trend.



Figure.1 rain at night

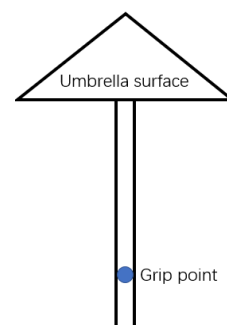


Figure. 2 schematic diagrams of traditional umbrella structure

### B. Unreasonable design structure

The structure of a traditional umbrella is shown in figure 2. A traditional umbrella can be represented as a holding point, a handle, and a conical face.

Assuming that the user's holding point is the fulcrum and the umbrella surface is the load, according to the lever principle, this mechanical model belongs to a laborious lever model: in the actual use process, the user needs to spend extra force to resist the pressure from the umbrella surface.

It is worth emphasizing that the pressure given by the umbrella is accompanied by a positive proportion of wind in the use environment. For traditional umbrellas with larger umbrellas, the added pressure is greater. And the whole umbrella structure is extremely easy to damage when the wind force in the actual environment is complex and changeable.

For the reasonable demands of users who want to get larger umbrella surface area and more comfortable holding position, the design of unreasonable holding method of traditional umbrella has to increase the burden of users. This design undoubtedly contradicts the actual requirements.

From the perspective of ease using, using a traditional umbrella must occupy the hand resources of one hand. For users who are riding (Fig.3), the occupation of hand resources means the need to hold the handlebar with one hand, which is likely to cause serious traffic accidents.

When the wind force is large and complex and changeable, due to the existence of laborious lever, the force of only one hand can no longer maintain the normal posture of holding the umbrella, and it is necessary to hold the umbrella with both hands (as shown in Fig.4). In this relatively common windy weather, the shortcomings of the traditional umbrella structure are obvious.



Figure.3 Cycling with an umbrella



Figure 4 man in the wind of traditional umbrella structure

### III. INTELLIGENT UMBRELLA DESIGN SCHEME BASED ON NODEMCU

#### A. Overview of overall scheme

Functional aspect: NodeMCU<sup>[1]</sup> microcontroller is adopted as the control unit in this scheme, which adds two additional functions: "night lighting" and "weather forecast" for the traditional umbrella.

By installing LED lamp sets, the umbrella is able to illuminate the front road in the case of insufficient light, which increases the safety of users when using. Using the WIFI module integrated by NodeMCU, the port of receiving the weather information provided by the API of "Baidu Weather" was programmed in Lua language, so that the single chip could understand the future weather changes, and the future weather conditions were intuitively displayed on the smart umbrella with LED lights of different colors.

Mechanical structure aspect: This plan proposes to design a "A" shape with shoulder-back umbrella handle structure, which can completely free the user's hands while increasing the umbrella structure. This umbrella handle structure takes the shoulder back as the fulcrum and USES the whole back as the support. It converts the laborious lever of an umbrella with only one hand into a labor-saving lever to reduce the user burden.

The opening method of A word is relatively simple and novel, which can guarantee the opening rate in the actual use. The device has simple appearance, simple main functions and easy installation. When the two supporting ribs of the A-line umbrella are closed, the size of the A-line umbrella is no different from that of the ordinary folding umbrella, and the weight is slightly heavier than that of the ordinary umbrella. It is within the range of acceptance.



Figure.5 LED lighting



Figure.6 18650 battery

#### B. "Night lighting" function implementation

Install several LED lighting sets (Fig.5); Three 18650 rechargeable lithium batteries are used as power supply (Fig.6). Single chip microcomputer of NodeMCU is used for logic control (Fig.7); The ship button and the photosensitive resistor are used as the two switch modes of manual and automatic (Fig.8 and Fig.9).

By adjusting the threshold of the photosensitive resistance, the smart umbrella can automatically switch the lighting set according to the current environment.



Figure.7 NodeMCU



Figure.8 Photoresistor module

#### C. "Weather Forecast" function implementation

One possible way to get future weather information for smart umbrellas is to use the WIFI module to connect with the free Baidu weather API<sup>[7]</sup> and return the expected weather information through the Baidu weather API.

Compared to the traditional W5100WiFi module with Arduino development board, NodeMCU can not only save the development time, but also lower cost and higher reliability. The comparison between the two schemes is shown in the table below.

Table 1 comprehensive comparison of the two schemes

Items	NodeMCU	Arduino <sup>[4]</sup>	Result
Cost	23RMB	127RMB	NodeMCU is better
Volume	17cm <sup>2</sup>	33cm <sup>2</sup>	NodeMCU is better
Language	Lua <sup>[3]</sup>	C	NodeMCU is better
IO	48	32	Both meet demand

As can be clearly seen from Table 1, if NodeMCU<sup>[2]</sup> is adopted as the scheme of control unit, the hardware cost can be effectively reduced by 84% and the volume reduced by nearly 50%. Besides, NodeMCU adopts Lua language development. Lua language has inherent advantages in writing API ports and processing data in Josn format compared with class C language. As an interpreted language, Lua can submit HTTP requests directly in accordance with the standard documentation of the Baidu weather API, while Arduino's c-like language requires extra attention to data types and string types, which will take a lot of time.

Although NodeMCU is superior to Arduino scheme in terms of development difficulty, since Arduino is a very common single-chip development board, its reference materials and reference documents are far more than NodeMCU, which requires extra time to collect data.

#### D. "Weather Forecast" function implementation

In the figure 9: 1. Canopy supporting member; 2. Hinge support of the canopy supporting member; 3. Connecting rod; 4. Expansion rod; 5. Slide block; 6. Hinge base rotating shaft; 7. Guide groove; 8. Expansion rod; 9. Intermediate expansion rod; 10. External boss of slide block; 11. Fixed end of nylon cord slipper; 12. Umbrella bone fixation hole; 13. Guide groove; 14. Hinge base rotating shaft; 15. Nylon cord; 16. Telescopic rod guide groove; 17. Fixed end of nylon thin rope extension rod; 18. Fixed end of nylon cord slipper; 19. Telescopic rod connecting shaft sleeve; 20. Belt groove.

The main pole of the umbrella is supported by the canopy, the opening mechanism of the canopy, and the fixing mechanism of the shoulder.

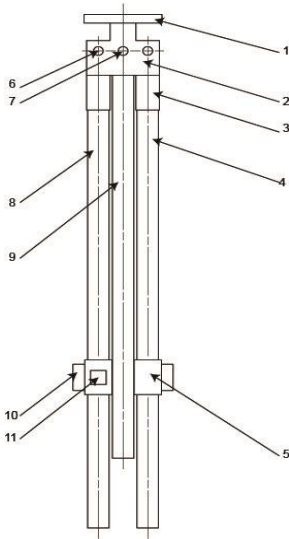


Figure.9

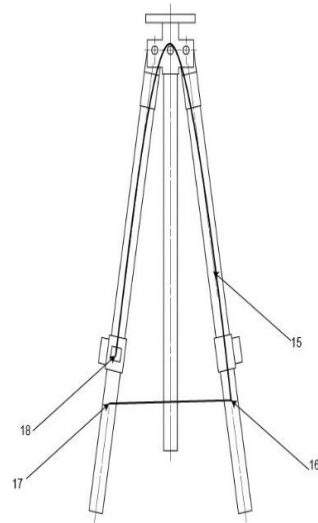


Figure.11

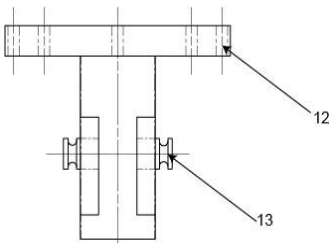


Figure.10

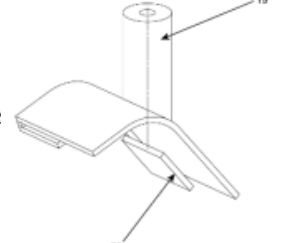


Figure.12

The supporting member of the canopy is a round canopy (Fig.4), with 8 through-holes on the top (12 in Fig.9). 8 umbrella bones on the top of the canopy are installed for fixation. The hinge base (2 in Fig.9) is located below the support member of the canopy with a through hole(14 in Fig.4), the guide groove (7 in Fig.9) is located at its front and rear ends, a total of two, for guiding the nylon cord (15 in Fig.11).

The umbrella opening mechanism consists of a supporting member (Fig.11), two connecting rods (3 in Fig. 9), two expansion rods (4 in Fig.9), two sliders (5 in Fig. 9) and two nylon ropes (15 in Fig.11). The connecting rod is installed on the hinge base, the connecting rod is connected with the expansion rod, and the sliding block is installed on the expansion rod. The external boss of the slider (10 in Fig. 9) is mounted with 4 supporting umbrella bones on the side of the umbrella, which can be used to open the umbrella surface. One end of the nylon cord (17 in Fig.11) is attached to the extendable pole on one side and leads to the other

A guide slot on a telescopic rod (16 in Fig.11) is then bypassed on the support member (7 in Fig.9) and finally fixed on the slider (5 in Fig.9) on the same side as the beginning end of the nylon cord (17 in Fig.11). Another nylon cord is installed on the other side of the main bar. When the two expansion bars are spread to both sides, pull the nylon cord, use the guide slot on the expansion bar and the support member of the umbrella top, pull the slide block to slide up along the expansion bar, so that it will be inclined to hold up.

Root umbrella bone, achieve open umbrella purpose.

The shoulder fixing mechanism consists of a telescopic rod connecting shaft sleeve (19 in Fig.12) and a strap groove (20 in Fig.12).

#### IV. CONCLUSION

This paper Innovative improves the existing problems of traditional umbrellas from two aspects. NodeMCU is adopted to enable the umbrella to acquire current weather information intelligently, intuitively use color to prompt the user, and avoid the embarrassment of the user forgetting the umbrella. The lighting circuit of photosensitive resistance is designed, so that the intelligent umbrella can automatically light the road in the bad light environment, and ensure the safety of pedestrians. A "A" glyph could be used to form the shoulder and back umbrella bone in the form of labor-saving lever to increase the strength of the umbrella and reduce the burden on the user while freeing the user's hands.

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