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The Design of a Guide Device with Multi-Function to Aid Travel for Blind Person

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Abstract

A design method of a guide device with multi-function presented in this paper, the multi-function contents of obstacle avoidance, azimuth guidance, banknote recognition and time broadcast. The hardware system of the guide device based on single-chip system STC89C52 and peripheral added eight expansion units: power supply unit, key input unit, ultrasonic detection unit, azimuth guidance unit, banknote recognition unit, clock Unit, phonetic unit and display unit. The functions were tested and results show that the device is suitable for sunny conditions whose best setting distance range is between 700mm to 1600mm and direction function is good showing in open environment, while the function of currency recognition has some limitations because of color identification. Comprehensive consideration the device can meet the blind person's basic travel demand and has the characteristics of low-cost and stable performance.

Keywords*: guide device; ultrasonic sensors; multi-function; blind person*

1. Introduction

The material life and cultural quality improving along with the rapid economic development, more and more people around the world take care of blind people. Many studies are made to find a better way to assist the autonomous walking of blind people .Among them the great research made on the electronic travel aids (ETA). The common technologies used for this task are: Processing image, GPS and sensor detection. The devices based on processing image technology are used to support artificial vision by translating them into sounds vibrations or verbal messages [1-6]. The devices based on GPS technology are commonly used to conduct blind people to destination [7-10]. The devices based on sensor detection technology are used to intercept the obstacles by a variation of the distance between it and the user [11-15].

In this work we present a hybrid device based on GPS and sensor detection technologies. This approach has the goal of simplicity and is very cheap in comparison with those based on the image processing. Meanwhile some auxiliary functions have been added in the hybrid device such as banknote recognition and time service. All of the output signals have been translated into speech signals.

In this paper, the main work is to design for the hardware circuit. We use single chip microcomputer with an ultrasonic sensor, a color sensor, a clock chip and a GPS module, which has a higher control convenient, low cost, flexibility advantages. It is proved in the experiment that the design has the obvious effect for specific functions to aid blind travel.

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2. System Structure Design

The device has six buttons to control and convert different functions .Figure1 shows the diagram of the system structure. Obstacle avoidance function automatically runs when the start button is pressed .The distance parameter is adjusted through K2. Long press (2 seconds) K4 into banknote recognition and the color parameter is adjusted through K2. Press the K5 into azimuth guidance and the direction parameter is adjusted through K2. Short press K4 into time broadcast and the time parameter is adjusted through K3. The adjustment of parameters is displayed by LCD, and the specific functions are performed by phonetic unit. All above of them are based on single-chip system STC89C52.

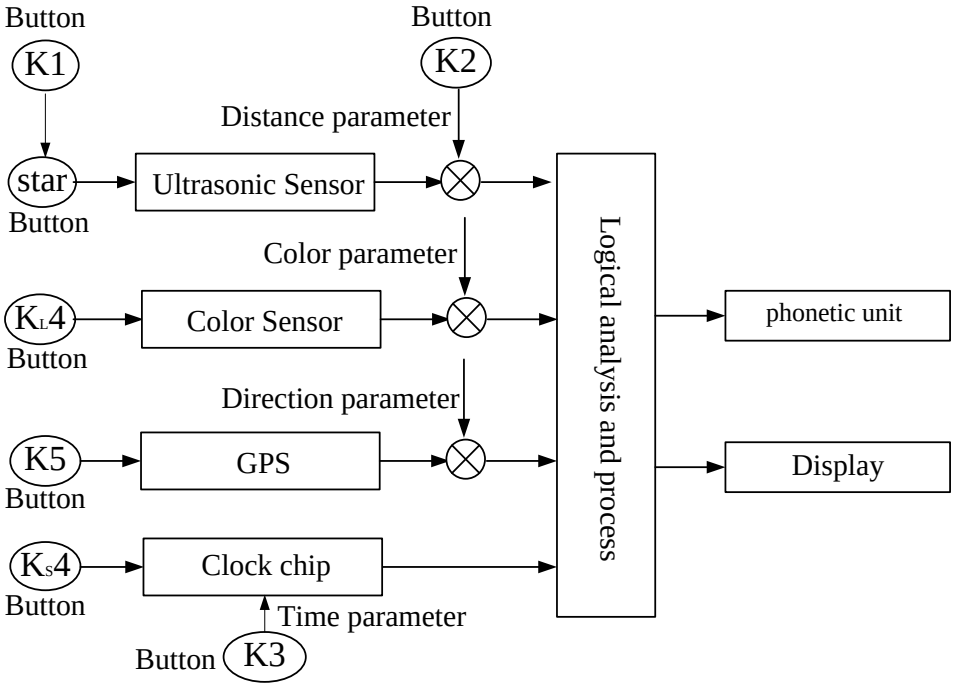

Figure 1. The System Structure Diagram

3. System Circuit Design

The system is composed of obstacle avoidance circuit, a azimuth guidance circuit, a banknote recognition circuit, a time circuit, a broadcast and display circuit, a power control circuit and SCM ATP89C52.

3.1. Obstacle Avoidance Circuit

In this part, we use digital ultrasonic sensor HC-SR04 to detect temperature. Figure 2 shows the package diagram of HC-SR04 and the connected relation with STC89C52. It is suitable for various harsh environments and it has from2 cm to 400 cm non-contact distance measurement function.

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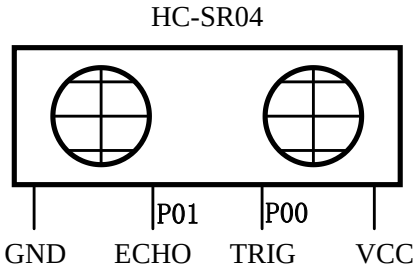

Figure 2. Package Diagram of HC-SR04 and The Connected Relation with STC89C52

3.2. Azimuth Guidance Circuit

Here we adopt programmable color to the light frequency conversion chip TCS3210.A new generation of TCS3210 is designed by TAOS Company that the digital quantity of output could direct drive the TTL or CMOS. Figure.3 shows the package diagram of TCS3200 and the connected relation with STC89C52.

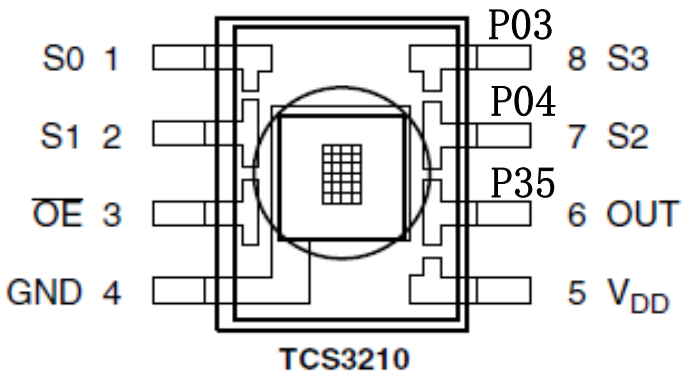

Figure 3. Package Diagram of TCS3210 and the Connected Relation with STC89C52

3.3. Banknote Recognition Circuit

According to the small volume of the aid device, we choose UBLOX-LEA-5s board as the processor, whose input and output use serial communication. Fig.4 shows the package diagram of UBLOX-LEA-5s and the connected relation with STC89C52. The UBLOX-LEA-5s receive signals from the antenna, and then a series of processing has been done such as frequency conversion, amplification and filter. On the basis of them, the latitude and longitude data have been calculated by satellite tracking and locking.

Figure 4. Shows the Package Diagram of UBLOX-LEA-5s and the Connected Relation with STC89C52

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3.4. Time Circuit

Because the two internal timers of STC89c52 single-chip have been occupied, we adopt the clock chip DS1302 to get the time, which is designed by DALLAS Company. Figure.5 shows the package diagram of DS1302 and the connected relation with STC89C52.

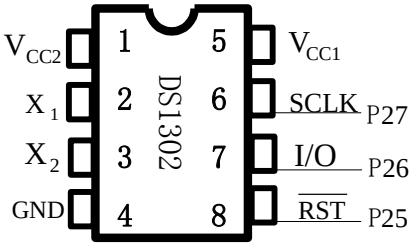
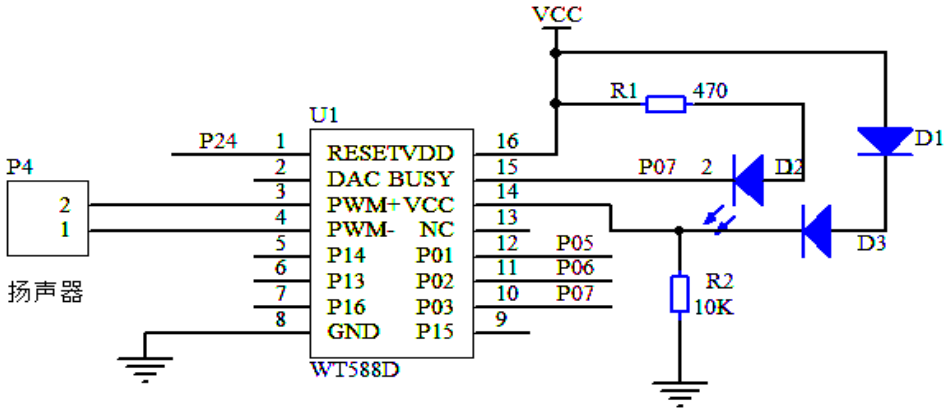


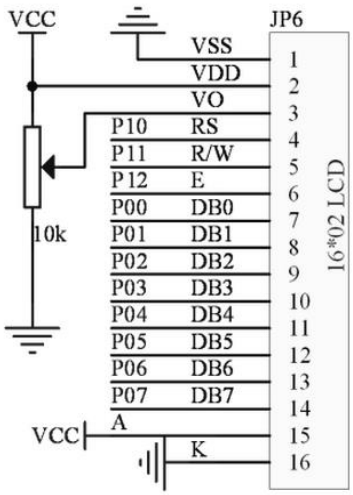
Figure 5. Shows the Package Diagram of DS1302 and the Connected Relation with STC89C52

3.5. Voice Broadcast and Display Circuit

The voice broadcast circuit shows in Figure 6. (a). We used voice chip WT588D whose built-in memory capacity is32M. The display circuit shows in Figure 6. (b). The LCD1602 is a dot-matrix display module, which is used to professional display the letters, numbers and symbols, *etc.*



(a)



(b)

Figure 6. The Voice Broadcast and Display Circuit

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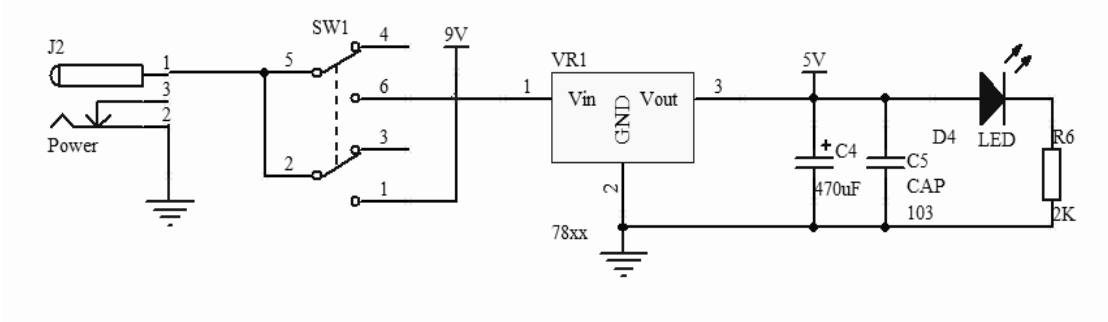
3.6. Power Control Circuit

We design the power control circuit according to the power supply voltage of all above chips. The chips working voltages show in Table 1.

Table 1. The Chips Working Voltages

Chip	working voltages（unit: volt）
STC89c52	DC3.3 V～5.5V
HC-SR04	DC5V
TCS3200	DC3V~5V
DS1302	DC2.5V～5.5V
WT588D	DC2.8V～5.5
LCD1602	DC3.3V或5V

According to the requirement of working voltage shown in Table 1, we determine power supply the voltage of 5V. On the premise of fully supply time, we design dual power supply system and power supply either 9V battery or electric storage device. The power control circuit is shown in Figure .7.



Figue 7. The Power Control Circuit

4. Test Results

4.1. Function Test

(1) Obstacle Avoidance Function

The man from of us blindfolded eyes, which run from a campus dormitory to another campus dormitory using the travel aid device. We changed the distance parameter after per 100 times test. The result is shown in Table 2.

Table 2. The Test Result of Obstacle Avoidance Function

Distance-warning（Unit :mm）	100	400	700	1000	1300	1600	1900	2100	2400	2700	3000
Pass Num	89	92	95	98	98	96	87	85	86	80	75
Pass rate	89%	92%	95%	98%	98%	96%	87%	85%	86%	80%	75%

(2) Banknote Recognition Function

We have prepared 100 per face value of RMB (100, 50,20,10,5,1 Yuan) and the test result of banknote recognition function is shown in Table 3.

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Table 3. The Test Result of Banknote Recognition Function

Par /RMB	1	5	10	20	50	100
Pass Num	99	98	97	100	100	100
Pass rate	99%	98%	97%	100%	100%	100%

(3) Azimuth Guidance Function

The weather is sunny or overcast; we test the azimuth guidance function in the Northeast Forest University. We had the different results in the different place that is shown in Table 4.

Table 4. The Test Result of Azimuth Guidance Function

Pass Rate / Place / Weather	Playground	Road	Market	Downtown Area
Sunshine	96%	89%	80%	75%
Overcast Sky	87%	83%	75%	70%

4.2. Parameter Test

The temperature is one of the important indexes for the working device .Here we use the thermocouple contact thermometer MK-301 to collect temperature value.

(1)Perform in obstacle avoidance function, we recorded device surface temperatures per 10 minutes, the result is shown in Figure 8.

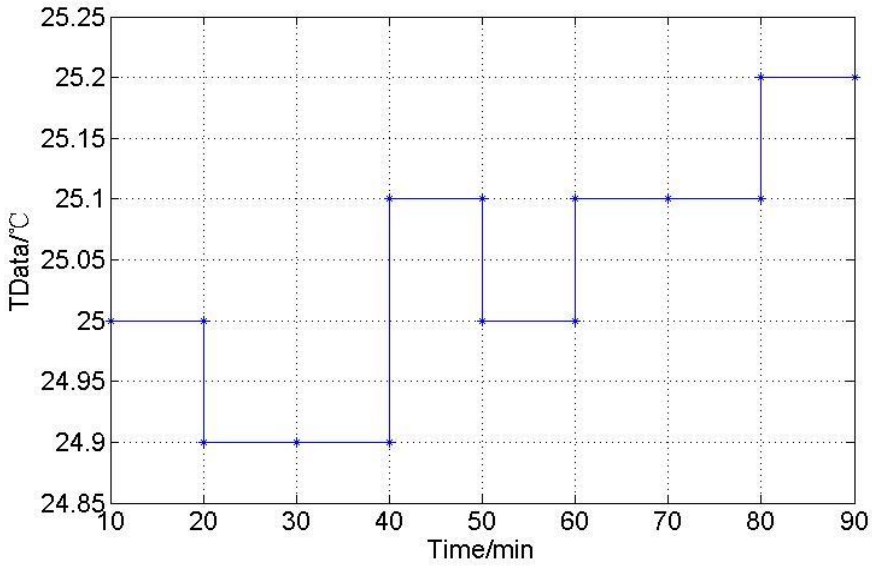

Figure 8. The Relation Curve of Temperature Change Along with Time in Obstacle Avoidance Function

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(2) Perform in banknote recognition function.During10 minutes, it recognized 579 banknotes, we recorded device surface temperatures per 1 minute, and the result is shown in Figure 9.

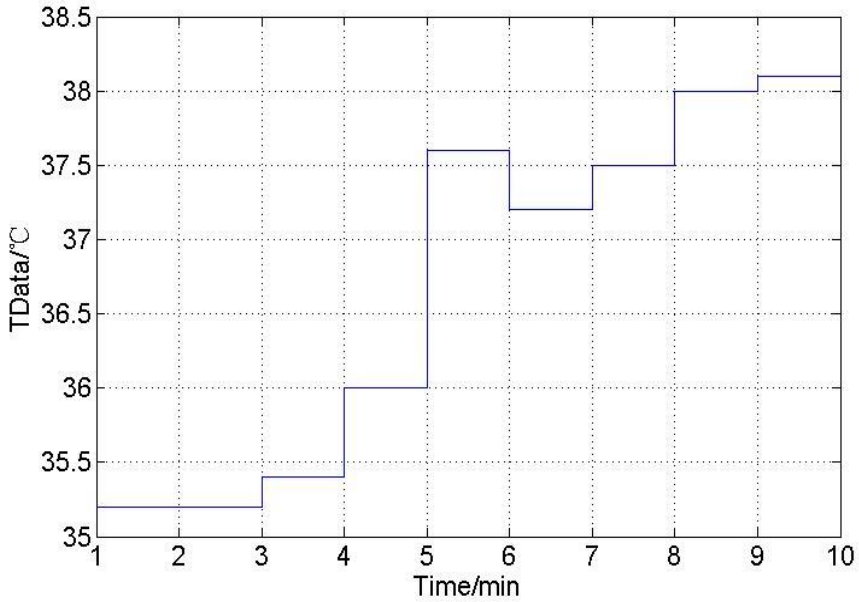

Figure 9. The Relation Curve of Temperature Change Along with Time in Banknote Recognition Function

(3) Perform in azimuth guidance function. Starting at the time of enters the GPS interface, it continues working 1hour and we recorded device surface temperatures per 10 minutes, the result is shown in Figure 10.

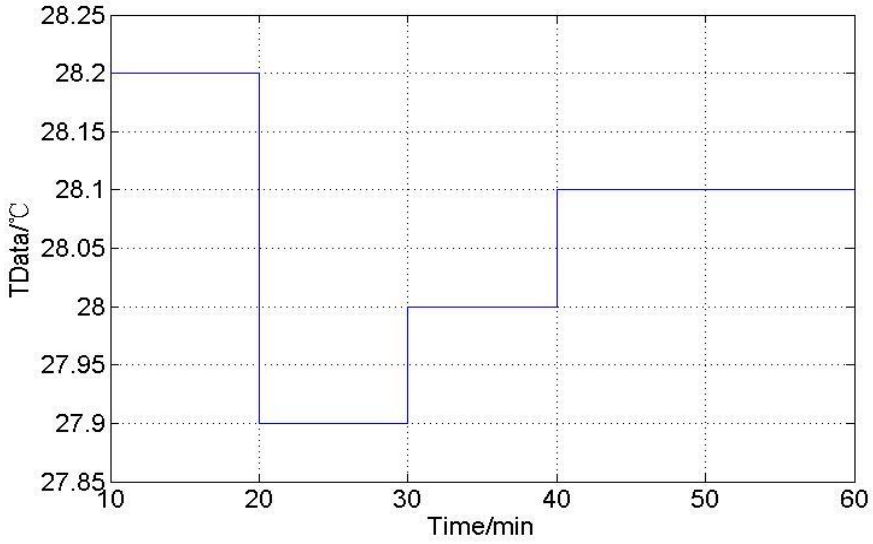

Figure 10. The Relation Curve of Temperature Change Along with Time in Azimuth Guidance Function

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5. Conclusions

Through the above test results, summary of the travel aid device performance is as follows:

(1)The travel aid device has not reached 100% success in the set range of obstacle avoidance, because the response speeds of the ultrasonic sensor in addition to the artificial factor. At the same time found in the testing process, the optimal range of distance parameter is 700 mm to1600 mm.

We use it as the effective distance of obstacle avoidance.

(2) The success rate of banknote recognition reached 100% for 20 Yuan, 50 Yuan and 100 Yuan, mainly because of the obvious color features, and then few of error exist that is caused by money old so color characteristic changes. It shows that the use color sensor to recognize the banknote has limitations. But consider that is the auxiliary function of aid device and inexpensive so we maintain the original design scheme.

(3)The azimuth guidance function is affected by the weather very seriously; therefore we suggest that the device could be used in sunshine. In the process of testing, we also found that the effect of azimuth guidance is better in the open environment. There is less demand in road or downtown area because of blind path. So we consider the azimuth guidance function can meet the practical requirements.

(4) When perform the banknote recognition function, the temperature increases obviously, which shows the speed of the energy dissipation is fast. When perform the obstacle avoidance function and direction function, the temperature of the device is similar as the environmental temperature, which shows the energy dissipation is less. We consider that there is the characteristic of intermittent short-term in performing banknote recognition function so the comprehensive energy consumption of the device is little.

In conclusion, the function of the device is able to meet people's basic needs, whose performances are satisfactory.

Acknowledgements

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