# An Intelligent Guide Hat Based on The Internet of Things

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**Abstract**

With STM32 as the control core, the new guide cap has ranging obstacle avoidance, ranging obstacle avoidance, intelligent recognition, voice interaction, GPS positioning and other functions. The system uses OpenMV4 Cam H7 Plus intelligent camera for continuous real-time monitoring and effective feedback of traffic lights, zebra crossings and other important road information; Assisted by ultrasonic sensor, the electrical signal is converted into ultrasonic output through the transmitter to effectively measure the distance of obstacles; At the same time, the user's location information is sent to the surrounding vehicles and passers-by in real time through the Wi-Fi module and GPS positioning, ensuring the user's safety to the greatest extent.

*Keywords:* microcontroller, intelligent guid, Internet of things, voice control, target detection

## 1. Introduction

The number of blind people in the world is very large. Ac cording to the World Health Organization, by 2022, there will be between 40 and 45 million blind people and appr oximately 140 million people with low vision worldwide.

We see that the number of blind people is still on the rise every year: "mobility for the blind" has become a pre ssing issue. In recent years, with the rapid development o f computer software and hardware technology, wearable e lectronic products have come into our lives, allowing the blind to enjoy the benefits of technological advances. Thi s product is based on solving the problem of blind people' s travel, in order to help blind people solve such difficulti es, realize voice accessibility control, integrate multi-func tional integration, assist blind people to build a mental ma p, and hope to facilitate the life of blind people.[1]

The rest of this paper is organized as follows. Section II c arries out the structural design of the smart guide cap, wh ich contains the overall system scheme design and the int roduction of auxiliary sensors. The third section introduce s the intelligent guide cap software design and algorithm, including various core technologies such as image proces sing algorithm, obstacle distance detection algorithm, co mmunication program, positioning algorithm, and voice i nteraction program. The fourth part summarizes the main contents of this paper.

## 2. Intelligent Guide Cap Structure Design

### *2.1. Overall system design*

This design uses STM32 as the control core of the new g uide cap, which has the functions of distance and obstacle avoidance, intelligent recognition, voice interaction and GPS positioning. The system is continuously monitored i n real time by OpenMV4 Cam H7 Plus intelligent camera , which effectively feeds back important road information such as traffic lights and crosswalks, and is supplemente d by ultrasonic sensors that convert ultrasonic waves into electrical signals through transmitters to effectively meas ure the distance of obstacles; at the same time, through W i-Fi module and GPS positioning, the user's location infor mation is sent to surrounding vehicles and passers-by in r eal time to ensure maximum safety for the user. To ensur e the safety of users to the greatest extent. The design of the 3D model of the product is shown in Fig.1. The design of the physical picture of the product is shown in Fig.2.

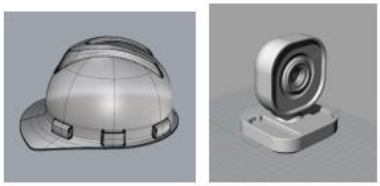

Fig.1 3D model of the product

Fig.2 Physical picture of the product

### *2.2. Auxiliary sensors*

(1) OpenMV4 Cam H7 Plus

This product uses a low-cost, scalable, low-power, pytho n-driven machine vision module, OpenMV-H7, based on the 32-bit ARM Cortex-M7 core, equipped with a MicroP ython interpreter, which makes programming machine vis ion algorithms on the embedded easy.[2] At the same tim e, OpenMV provides communication interfaces such as s ynchronous asynchronous transceiver, serial peripheral in terface and integrated circuit bus, which are capable of pr ocessing and programming complex algorithms, providin g OpenMV with strong performance that is well capable of shape recognition, line recognition, color recognition, etc. The design of the OpenMV4 Cam H7 Plus picture is shown in Fig.3.

Fig.3 OpenMV4 Cam H7 Plus picture

(2) Ultrasonic Sensor

Ultrasonic distance measurement module uses low power consumption, low price, easy to connect HC-SR04 ultras onic distance sensor, the core of which is two ultrasonic t ransducers, one used as a transmitter, the duration of each pulse group emitted is about 0.5ms, the signal is amplifie d through the transistor, and then after the impedance mat ching circuit that is transformer, the two ends of the trans mitting transducer is coupled with a high voltage, the inte rnal piezoelectric chip began to vibrate and send out 40k Hz pulse ultrasonic. When the output ultrasonic wave me ets the obstacle return, the TL074 chip to return the sound wave filtering, amplification, demodulation and other pr ocessing, and then through the STC11 chip for ultrasonic waveform and level conversion, return ECHO a certain ti me of high level signal. Then the port enters the low pow er state, the module stops timing and reads the timer wort h to the time required for the sound wave round trip, and t hen calculates the distance to the obstacle by calculating t his time. The control program will make processing of th e measured data, if the distance is less than 3 meters voic e system will immediately issue an alarm.[3] The design of the ultrasonic sensor is shown in Fig.4.

Fig.4 Ultrasonic sensor

(3) Wi-Fi communication module

This module integrates a 32-bit Tensilica processor, stand ard digital peripheral interface, antenna switch, RF balun, power amplifier, low-noise amplifier, filter and power m anagement module, etc. It only requires few peripheral cir cuits and takes up significantly less PCB space. It support s low power consumption mode, the current required to k eep Wi-Fi connection in general scenario is only about 50 mA, and the power consumption is even reduced to 10uA during deep sleep. The design of the Wi-Fi communication module is shown in Fig.5.

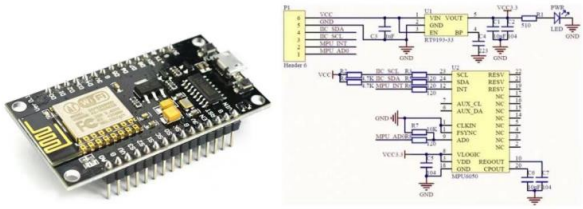

Fig.5 Wi-Fi communication module

(4) GPS Module

The GPS module uses the STM32 microcontroller as the processor, and the data signal output from the GPS signal receiving module is passed to the serial interface of the S TM32 microcontroller. The signal receiving module main ly consists of inverter, signal channel, memory, central pr ocessor and input/output interface, using the RXD1 and T XD1 pins of the UM220 module, which are connected to the STM32 microcontroller through the serial chip, and th e reset circuit realizes low-level reset by jumping from hi gh to low BDRST potential when S11 is pressed; and the peripheral circuit is composed of GPS receiver devices an d auxiliary circuits. The design of the GPS module is shown in Fig.6.

Fig.6 GPS module

(5) Voice interaction module

The hardware of voice interaction is mainly composed of AIUI speech recognition module, audio amplifier module and speaker, AIUI is the core component of the voice module, whose CPU uses R16 a cortex-A7 intelligent hardware processor; the running memory uses K4B4G16 with memory size of 1GB; Flas uses NCEMASD9-08GEMMC with storage space.[4] The ADC audio acquisition chip is Cosmos CX20819-11Z, a 4-channel far-field voice capture high performance HD video ADC, and the two are directly connected for data interaction through serial port, and the baud rate of 115200bps is used for serial communication parameters.[5] The design of the voice interaction module is shown in Fig.7.

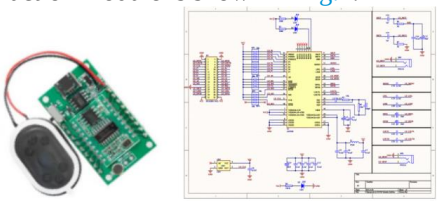

Fig.7 Voice interaction module

(6) Angle sensor module

This product uses the integrated six-axis angle sensor MPU6050 from InvenSense, which integrates a three-axis MEMS gyroscope, a three-axis MEMS accelerometer and an expandable digital motion processor DMP inside, so that it can be combined with a motion processing library to achieve attitude solving. With the self-contained DMP, the data of the nine-axis fusion algorithm can be output through the IIC interface to reduce the load of the motion processing operation on the operating system. The design of the angle sensor module is shown in Fig.8.

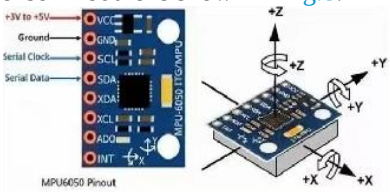


Fig.8 Angle sensor module

## 3. Intelligent Guide Cap Software And Algorithm

### *3.1. Overall algorithm*

This product uses STM32 for C language programming, mainly to achieve real-time control and real-time monitoring software two parts, including intelligent image recognition, ultrasonic distance measurement, voice interaction and other functions. In the main program, two interrupts are set, one for the network communication interrupt, which is used to receive instructions and data from the monitoring computer; the other for the timer with a frequency of 1 kHz. When the interrupt is queried, it enters the control interrupt subroutine, which collects and processes the data collected by each module, then judges the current control mode and the type of response, and then further solves and sends the The control signal can be sent according to the set control algorithm, which can complete the work of the guide efficiently and accurately. For example, the OpenMV4 Cam H7 Plus distance measurement module can perform effective and accurate distance measurement work. The design of the overall algorithm communication picture is shown in Fig.9.

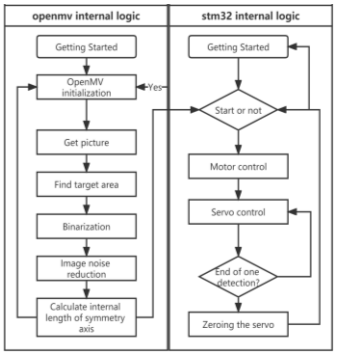


Fig.9 Overall algorithm communication picture

### *3.2. Communication protocol development*

(1) OpenMV uses python to drive machine vision modules, equipped with MicroPython interpreter, which makes it easy to program machine vision algorithms on embedded; meanwhile, OpenMV provides communication interfaces such as synchronous asynchronous transceiver, serial peripheral interface and integrated circuit bus, which can process and program complex algorithms and can be well capable of shape recognition, It is capable of shape recognition, straight line recognition, color recognition and other functions. The design of the OpenMV identification results is shown in Fig.10.

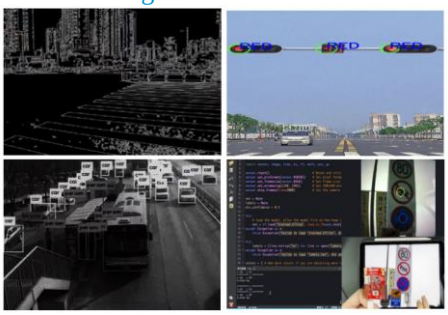

Fig.10 OpenMV identification results

(2) Ultrasonic module first uses DS18B20 digital tempera

ture sensor to measure the ambient temperature, by looki ng up the pre-established speed of sound - temperature co ntrol table to get the current speed of sound; turn on the c ounter timing, while through the STC16F40K128 PWM module to generate ultrasonic echo, to be echo into the re ceiving circuit, after shaping and amplification and other hardware processing into the microcontroller. The microc ontroller captures the trigger signal of the echo and recor ds the moment of the falling edge; after software filtering and peak time detection algorithm to get the peak momen t as the moment of the echo arrival, and finally calculate t he distance. The design of the Ultrasonic module test results is shown in Fig.11.

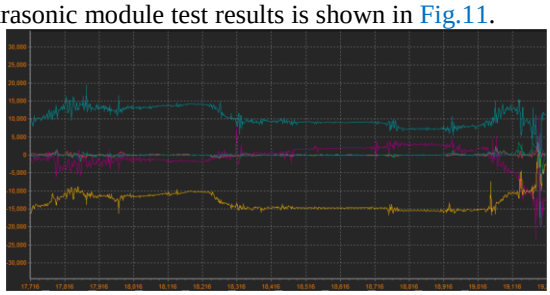

Fig.11 Ultrasonic module test results

(3) The GPS module consists of four parts: data loading, data pre-processing, calculation and result return, and the GPS receiver interface connects the corresponding positio ning module to receive the feedback data in real time. Thr ough the fusion of single-point real-time positioning and post-facto precision single-point positioning settlement so lution, the positioning accuracy of the system is greatly i mproved. In order to enhance the security of the system, RXM/RAW decoding technology is added in the data tra nsmission process to ensure the safety and reliability of th e program to the greatest extent.[6] The ability to accurat ely transmit the location to surrounding vehicles and pede strians in a timely manner also reduces the security threat to the blind from unexpected situations to a certain extent. The design of the GPS module positioning results is shown in Fig.12.

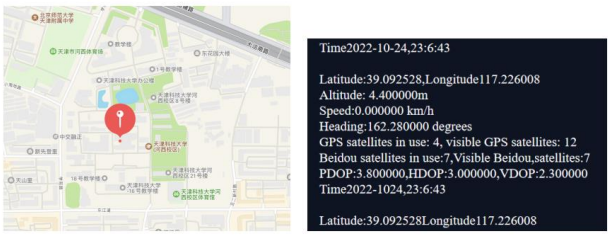


Fig.12 GPS module positioning results

(4) The voice control part is written in C language, the ke ywords are set during development, and the voice chip ex tracts the features of the voice and compares them with th e keywords. The code is written to send the correspondin g data from the serial port to the main control board when the corresponding command is recognized, thus realizing voice control. The voice recognition chip is connected to the MCU and transmits the data in JSON format. After re ceiving the data, the serial port analyzes it to get the ident ification code corresponding to the current command and executes the corresponding operation accordingly. The design of the Voice module communication code initialization and ope ration resultsis shown in Fig.13.

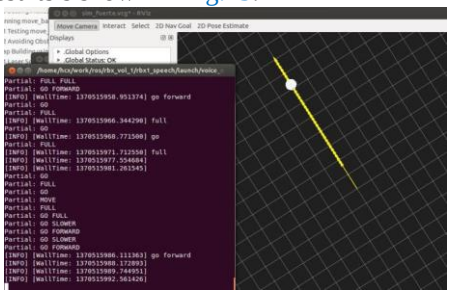

Fig.13 Voice module communication code initialization and ope ration results

(5) The gyroscope MPU6050 is used for attitude resolutio n, it integrates a 3-axis MEMS gyroscope, a 3-axis MEM S accelerometer, and an expandable digital motion proces sor DMP, which can be connected to a third-party digital sensor, such as a magnetometer, via an I2C interface. Aft er expansion, a 9-axis signal can be output via its I2C or SPI interface.[7] The design of the Gyroscope MPU6050 communication code running result s is shown in Fig.14.

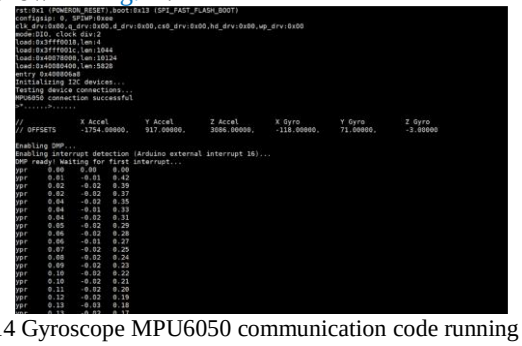

Fig.14 Gyroscope MPU6050 communication code running resul ts

(6) For the WIFI module, the main processor communicat es with the guide cap via the ESP8266, which will print t

he name of the connected wifi and the 8266's own IP addr ess when it starts up, and will always print connected if it is not connected to the server. The design of the WIFI module communication results is shown in Fig.15.


Fig.15 WIFI module communication results

## 4. Conclusion

The intelligent guide cap with integrated multi-senso rs and external devices analyzes the demand and experim ental conditions and theoretical technology research. This product includes the practical operation through microco ntroller, machine vision, Internet of Things, embedded sy stem, voice control, etc. It effectively realizes the informa tion such as the distance status of discerning obstacles an d reminding blind people to avoid them in time; promptin g blind people the status information of traffic lights at int ersections; recognizing crosswalks and guiding blind peo ple along The product is designed to be used in a wide ra nge of applications, such as the identification of zebra cro ssings and guiding the blind to cross the road safely in the correct direction, voice prompting and other prompting f unctions, informing the blind of the current status results, and simple human-machine interaction. With the continu ous promotion and popularization of this product, more a nd more blind people are able to go out alone, and the mi sunderstanding and prejudice of the society towards blind people will be reduced, which makes a contribution to th e development of the society.

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