Intelligent Electronic Guide Dog

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Abstract

There are a large number of blind people in the world, and the scale is still increasing, so the scarcity of blind guide products has always been a difficult problem to be solved urgently. Although some intelligent blind guide products have flooded into the market in recent years, such as guide boxes, guide battles, etc., but most of their functions only stay in the obstacle avoidance stage, lack of path planning, intelligent recognition functions and are not easy to carry. Based on the above shortcomings, an intelligent mobile blind guide robot is designed in this paper. The blind guide robot is equipped with a variety of sensors and combined with the powerful computing power of the main control board to form a complete obstacle avoidance system to achieve autonomous navigation and obstacle avoidance in a complex environment. It controls GPS positioning through Jetson-Nano, plans the route, detects obstacles with the help of cameras and ultrasonic sensors, and gives users feedback through the alarm sound of the buzzer.

Keywords: *stm32, Jetson Nano, gps navigation, ultrasonic sensor, camera recognition*

1. Project Research Background

According to the data of the World Health Organization, there are currently about 285 million visually impaired people in the world, of whom 39 million are blind, and a survey in China has found that there are 21 million visually impaired people, of whom 23.8% are blind [1].

The continuous expansion of visual impairment groups has brought about an increase in the demand for blind guide facilities in the market. Not only that, with the continuous improvement of urban construction, people's living environment is also changing, the traditional blind guide equipment has been unable to meet this change. Therefore, the blind guide robot should be born and gradually be highly concerned by the industry and enterprises.

Guide dogs in China are free. As long as blind people can apply for guide dogs, guide dogs are donated free of charge to the visually impaired. However, it costs at least 130000 yuan to train a guide dog, and after training it, it is donated free of charge to the blind, and there is no capital recovery. China's first guide dog training public welfare organization, the Dalian training Base of China Guide Dog, is in trouble. Every year, only 20 guide dogs are provided to thousands of visually impaired people across the country. And the service life of the guide dog is 8 to 10 years, if the guide dog is too old, there may be errors in the work process. Therefore, for safety reasons, seeing eye dogs will retire when they work until they are 10 to 12 years old. Therefore, it is very important to design a practical guide robot to help the visually impaired.

At present, research work on guide assistance has been conducted in countries around the world, focusing on the research of walking AIDS, wearable marching AIDS, and mobile marching AIDS. As early as 2010, Japan developed an electronic guide stick, which uses ultrasonic sensors to make the visually impaired people feel the obstacles, and to effectively remind users through the vibration handles. The belt-like action accessory developed in the United States uses ultrasound to create a panoramic map of the region, allowing the visually impaired to "regain their eyes". In addition, the foreign research and development of smart trolleys and smart wheelchairs also provide the foundation and help for the research and development of mobile guide AIDS. China's research in this industry is relatively late, the current research focus is still on the guide rod, the research work on the blind guide robot is still in preparation, in the final analysis, the technology is not perfect. Whether it is sensor technology, tracking strategy and independent path planning capabilities, China needs to be further improved. On the whole, the blind guide robot belongs to the advanced products of the auxiliary blind guide tools. In order to achieve the progress of this industry, we still need to improve the core technology. Of course, the blind guide robot is a major trend in the future, and it must be the focus of our development. once the research and development of the blind guide robot in our country is on the right track, it will bring subversive changes to the existing blind guide facilities and the current situation.

2. Scheme Design

In this paper, we designed an intelligent mobile guide robot. The robot is equipped with a variety of sensors, combined with the powerful computing power of the main control board, to form a complete obstacle avoidance system, to realize autonomous navigation and obstacle avoidance in complex environments. It controls GPS positioning through the Jetson Nano, plans routes, detects obstacles with the help of cameras and ultrasonic sensors, and gives users feedback through the alarm sound of a buzzer.

2.1. Functional description

(1) Automatic obstacle avoidance of ultrasonic sensor.
(2) Bluetooth Module Motion Control.
(3) GPS positioning.
(4) Cameras identify vehicles, pedestrians, shoulders, etc, and the buzzer alarm when encountering pedestrians.

2.2. System composition

The system framework of the intelligent mobile guide robot system can be divided into the following parts: main control module, motion control module, obstacle avoidance module, positioning module, visual recognition module and power supply module.

2.3. Work principle introduction

The microcontroller stm32f103rct6 drive motor drive plate controls the speed of the rear two-wheel motor through PWM wave voltage regulation, and the stm32 microcontroller directly drives the steering machine through PWM pulse width modulation to control the steering of the first two wheels. SCM communicates with GPS module through serial port to obtain the position information. The ultrasonic module is directly controlled by the microcontroller to avoid the obstacles in front of it. The other main control board Jetson Nano controls the camera to obtain the wide-angle line-of-sight information in front of the camera, compare and analyze with other information collected from vehicles, road signs, pedestrians, and assist in obstacle avoidance.
The principle framework is shown in Fig. 1.

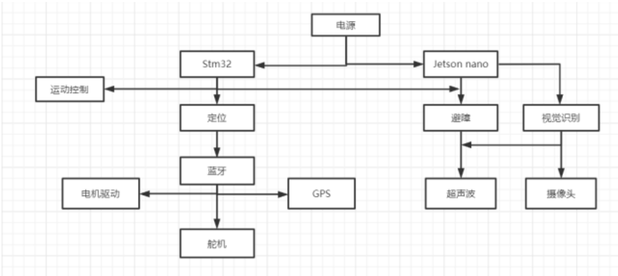

Fig 1 STM32F103ZET6 chip

2.4. Main control part design

With stm32 and Jetson Nano as the main control, stm32 is responsible for the underlying motion control, ultrasonic sensor and GPS module, Jetson Nano is responsible for visual information processing and analysis, and the two main control modules communicate through serial ports.
(1) Stm32f103rct6 Introduction
Using ArmCortex-M3 kernel, Harvard structure, with independent instruction bus and data bus.48KBSRAM, 256KBFLASH, 2 basic timers, 4 universal timers, 2 advanced timers, 2 DMA controllers (a total of 12 channels), 5 serial ports, 312-bit ADC, 112-bit DAC, 1 SDIO interface, and 51 universal IO ports. It has the advantages of powerful function, fast response, low power consumption, wide working temperature range, and is widely used in microcontroller motion control.
(2) Jetson Nano Introduction
Jetson Nano A02 is an open source hardware with good compatibility with the current commonly used Raspberry Pi motherboard. Its GPU is 128-coreMaxwell, 4GB of large capacity memory, strong image processing ability, low power consumption, high cost performance, so it is used as the main part of the visual recognition control.

2.5. Sport control design

The servo drive system is adopted, the first two wheels use the TBSK20 steering machine to directly receive the stm32 signal by PWM wave voltage regulation to control the steering, the second two wheels use the encoder motor, with TB6612 as the drive chip, and the PWM pulse width modulation technology is used to control the motor speed by changing the duty cycle, and then control the speed of the car. TB6612FNG is a DC motor drive device produced by Toshiba Semiconductor. It has a high-current MOSFET-H bridge structure, dual-channel circuit output, and can drive two motors at the same time. For PWM signal, the frequency of up to 100 kHz has a great advantage.

The motor drive schematic diagram is shown in Fig.2.

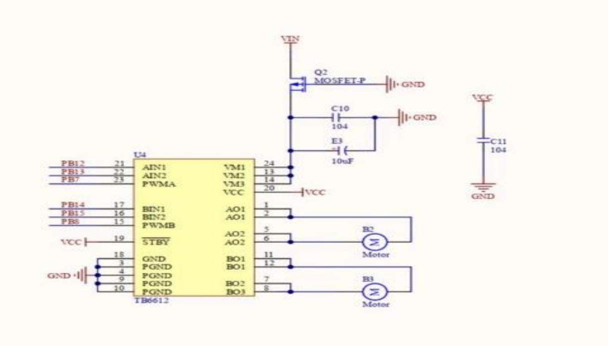

Fig 2 Motor drive module

2.6. Design of obstacle avoidance module

The principle of ultrasonic sensor ranging is to obtain the distance information of the obstacle by calculating the time interval between the time of sending the source sound wave and the time of receiving the echo signal. The calculation formula is as follows [2].

$$\text{Test distance} = (\text{High level time} \times \text{speed of sound}) / 2$$

(The speed of sound is 340m/s.)

The HC-SR04 ultrasonic module has 4 pins, namely Vcc, Trig (control end), Echo (receiving end) and GND; VCC and GND are connected with 5V power supply, Trig (control end) controls the ultrasonic signal, and Echo (receiving end) receives the reflected ultrasonic signal. With a high level above 10US issued through the Trig pin, the high level output can be waited at the Echo receiver; the timer can be opened. When the output becomes low level, the value of the timer can be read and the distance can be calculated. Such a constant periodic measurement, you can reach the value of the moving measurement.

The schematic diagram of ultrasonic module is shown in Fig.3.

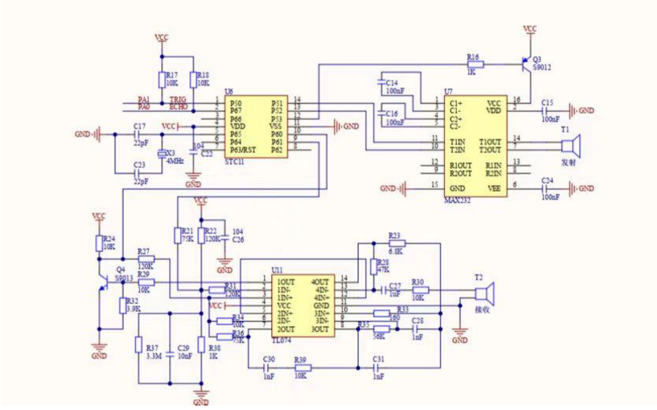

Fig 3 Ultrasonic module

2.7. Gps module design

The GPS positioning module uses the ATGM336H of Zhongke Microelectronics, which has high sensitivity, supports the single system positioning of the BDS / GPS / GLONASS satellite navigation system, and the receiver module with any combination of multi-system joint positioning. ATGM336H can directly replace U-blox's MAX series of multiple GPS modules, the main interface signal is Pin-Pin compatible, consistent installation hole, low power consumption, built-in antenna detection circuit, with antenna short circuit protection function.

The schematic diagram of the GPS module is shown in Fig.4.

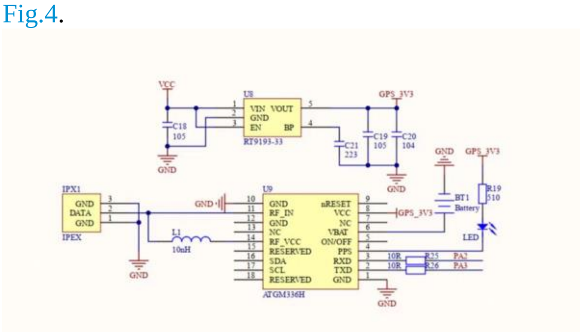

Fig 4 GPS module

2.8. Visual recognition module design

With a Jetson Nano NX AI HD camera and 160 focal field wide Angle, the optical sensor chip is SONY IMX219, which is suitable for image data acquisition and information processing. The program used in this project is the yolov3 algorithm under the AlexeyAB modified darknet framework, which has a strong performance in the field of real-time target detection and can fit the computing power of Jetson Nano. Real-time running time in Jetson Nano can reach a detection rate of 10 to 20 frames, and can cope with 90% of the scenes in daily life [3].

The Jetson Nano interface diagram is shown in Fig.5.

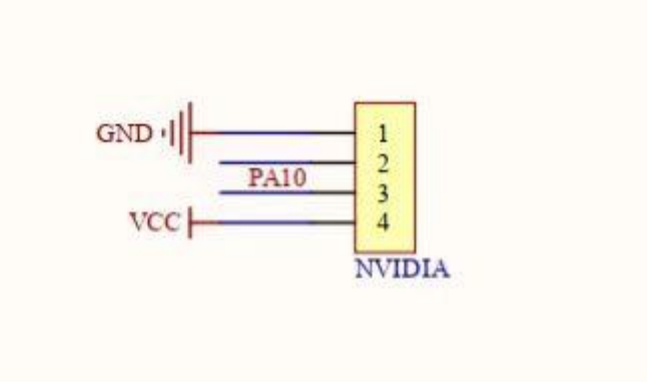

Fig 5 The Jetson Nano interface

2.9. *Power supply module*

Because there are many drive modules, the car adopts two parts to power supply stm32 and Jetson Nano respectively. First, 3 sections of 12V 1500mA power supply stm32, and another 3 sections of 12V 1500mA power supply, and AMS1117 5.0 is used to supply power to Jetson Nano with low voltage drop regulator.

The principle of antihypertensive is shown in Fig.6.

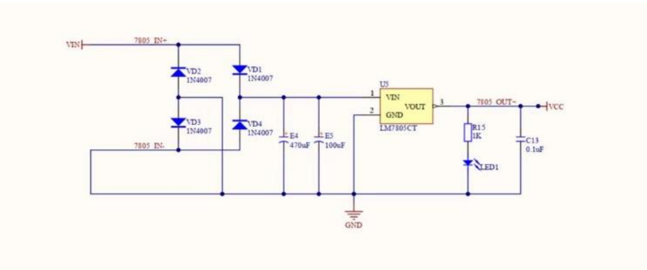

Fig 6.Anti-pressure module

3. Introduction of YOLO training algorithm

This project starts with devices with higher computing power than Jetson Nano, including the personal computer (windows platform) using the KIT T I data set published by the Karlsruhe Institute of Technology (KIT) and Toyota Technical University at Chicago (TTIC). It mainly includes data processing, training, use and deployment. Here is the first part. Download and use open source data sets or take a certain number of pictures in the field, and name the pictures in a certain order. The following example uses the KITTI-road dataset as an example. The dataset was manually annotated by using the labelIMG tool (The labelIMG tools: heartexlabs/label Img):

(1) Configure the preset value tag file in labelIMG: Open the predefined_classes.txt file in the data path and write the label name of the object to be detected to the file. The operation is shown in Fig.7.

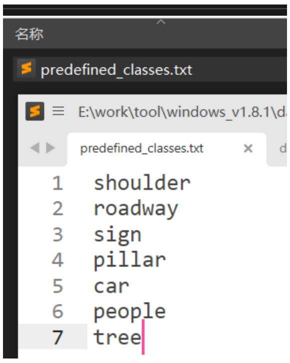

Fig 7 Enter the object label name

(2) Using the labelIMG software.

The operations are shown in Fig.8 and Fig.9.

Fig 8 Click on the Open Dir

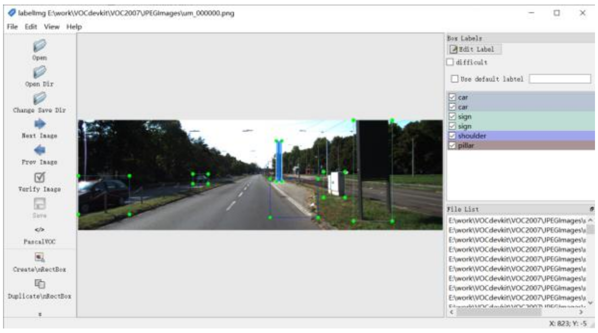

Fig 9 Select the path to the downloaded image dataset or the actual image file.

(3) To mark The operations are shown in Fig.10, Fig.11 and Fig.12.

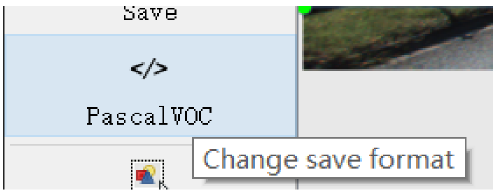

Fig 10.Select the PascalVOC format dimension on the left side of the window.

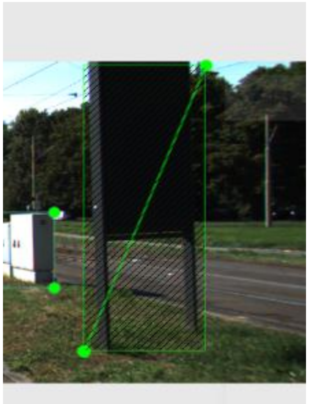

Fig 11 Press the shortcut key "w" to drag out the corresponding box on the image.

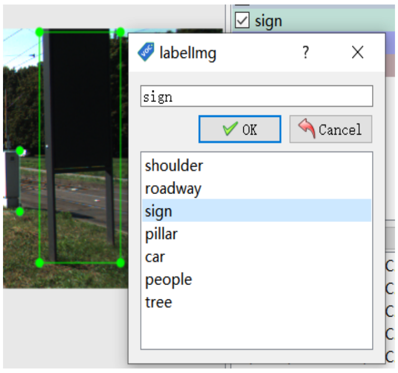

Fig 12 Then select the corresponding label in the pop-up window and click OK.

Right-key the box to modify the label or delete the box The annotation processing of the data set is completed after the annotation of all the picture files Then all the generated XML tag files are selected and cut to the scripts \ VOCdevkit \ VOC2007 \ Annotations folder, run the cut.py under scripts \ VOCdevkit \ VOC2007, and split the dataset, Then run the script under the project to further process the data, Open the voc_label.py script in the scripts directory, Edit the classes item in it, Keeping it consistent with the labels previously selected to make the dataset, The proportion of segmentation can be adjusted in the script, trainval_percent is the proportion of the datasets used for validation, The train_percent is the proportion of the data sets used for training: then run the voc_label.py in the scripts directory for format conversion, The modified classes item is consistent with the target category tag that you want to identify. To match the dataset format, the set item was modified as Fig.13.

```
sets=[('2007', 'train'), ('2007', 'val'),('2007', 'test')]
```

Fig 13 Modify the set code

This script generates both the 2007_train.txt and the 2007_val.txt files. Need to be used during the training sessions. These two files contain the path of the pictures contained in the training set randomly and the validation set.

4. Conclusion

The electronic guide dog introduced in this paper is a mobile robot, which is used to assist the blind people to travel safely. Compared with the current guide stick and guide box, it has obvious advantages and high cost performance. The main control module, motion control module, obstacle avoidance module, positioning module, visual recognition module and power supply module are introduced in detail, and the schematic diagram is given to complete the design of the whole guide dog.

References

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