A Driverless Car Based on Openmv

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Abstract：In order to reduce the probability of a car accident, but also to create a safe traffic environment. In this paper, a driverless car based on OpenMV is developed. The device combines the vision sensor OpenMV with the underlying controller Arduino to achieve the following functions:（1）QR code recognition based on OpenMV;（2）The recognition result of the vision sensor OpenMV is transmitted to the underlying controller Arduino to realize the intelligent control of the driverless car. The test results of the device show that the device can fulfill the set basic functions and has potential popularization and application value.

Keyword：driverless car; Arduino; OpenMV

I. Introduction

In order to reduce the probability of a car accident, but also to create a safe traffic environment and improve people's travel level, cars are also evolving step by step with people's needs, so car intelligence has been put on the agenda. The original smart vehicles were used for military use, and now with the low cost of technology, smart cars [1] are also spreading in the civilian field.

The development of driverless cars has been at the forefront of the development of car companies in various countries. The development of driverless cars involves technologies in various emerging industries, such as sensors, chips, algorithms, etc., and has great potential for development. In the past, smart cars were only assisted driving, but in the future they may be fully autonomous driving [2]. It may become a fully integrated transportation network. And now it is in the struggle stage from assisted driving to autonomous driving. Now in order to allow the car to recognize the surrounding environment, vehicles, lanes, etc., it is generally necessary to install various sensors on the vehicle to identify the surrounding environment. Sensors such as ultrasound [3], lidar [4], computer vision systems [5]. Among them, the effective detection range of ultrasound is too close, and it is difficult to analyze the type of obstacles. The cost and required space of lidar are too large, and the computer vision system has good precision while ensuring the cost. It is now a major mainstream. In the OpenMV development board, the lightweight neural model FOMO [6] can also be used. Therefore, the application of vision systems in vehicles is meaningful and timely.

Vision sensors [8] are similar to the "eyes" of a

smart car. Cameras capture a raw image of the location required by the vision system, which is then analyzed by the vision processing system. Smart cars are now classified according to the number and capabilities of cameras.There are monocular cameras [9], binocular cameras [10], trinocular cameras, and infrared cameras with infrared vision. Different camera modules also focus on functions. For example, monocular cameras can see objects within a large range. Generally speaking, the wider the viewing angle, the shorter the distance that can be accurately detected. On the contrary, the narrower the viewing angle, the farther objects can be detected. However, in most cases, it is difficult for a monocular camera to obtain the distance information of the target. In most cases, a binocular camera can calculate the distance information between the target and the main body. In the accurate identification range, the smaller the distance between the two cameras of the binocular camera, the closer the distance can be accurately detected, and the greater the distance between the two cameras, the farther the detection distance. The triocular camera combines the cameras together and uses different field of view angles to detect different objects around it, such as lane lines, traffic lights, pedestrians, vehicles, etc. Infrared cameras use infrared light that is invisible to the human eye to capture the surrounding objects. At night, with infrared headlights, they can capture the desired original image without affecting the driver's perspective. They can also play a better role in foggy weather.

OpenMV has launched a large number of models after many years of development, and its performance is also increasing, which has also attracted many people to develop and research it. Vision systems have been applied in various industries. For example, Huangliangliang of Jiangxi Agricultural University has combined OpenMV with traditional pesticide sprayers. [11] Its research found that the research on pesticide spraying on low crops in our country is insufficient, resulting in the existing working machinery not being able to work effectively in an environment with uncertain working spacing. It designed an image sensor and recognizer using OpenMV MV4 as a whole machine, and then used Arduino UNO as a lower-level control board to link components such as relays and solenoid control valves that affect the outside world, enabling effective targeting of low-growth plants, plants with spacing that is too large or too small.

In this paper, a set of driverless car based on OpenMV is developed. The device combines the vision sensor OpenMV with the underlying controller Arduino, and intends to transmit the QR code recognition result of the vision sensor OpenMV to the underlying controller Arduino to realize the intelligent control of the driverless car.

II. bottom controller Arduino

Arduino is based on its easy-to-use hardware and software. At its core is the MCU board, also known as MCU, which offers a variety of options through the various Arduino boards available such as Arduino UNO, Mega, Nano, etc. Arduino's programming environment (IDE) allows developers to write code in simplified versions of C++ languages, which is beginner-friendly while remaining flexible enough to meet the needs of professional developers. The Arduino board is connected to various sensors, motors, LED lights, and other electronic components through a series of digital and analog I/O pins, allowing users to control their own physical products.

The main functions of Arduino include reading

data (sensors, remote signals, etc.), processing data (performing programming logic), and generating output (controlling motors, lighting LEDs, etc.). In addition, Arduino can communicate with computers, other Arduino boards, or various network connections, thus expanding its application range. This simple yet powerful feature makes Arduino an ideal platform for realizing various ideas and projects, whether it is a simple automation project or a complex experiment.

Arduino has a wide range of applications in various fields such as education, design and product development. In education, Arduino is used as a practical tool to teach MCU related courses such as programming, electronics and mechanical design. Its simplicity and convenience enables students to quickly learn the basic concepts of design and programming and apply these concepts to real projects to stimulate their creativity and strengthen their problem solving skills.

In the field of design, Arduino allows designers to integrate electronics and programming into their work to create their own unique ideas. Arduino provides a platform for ideas to combine creativity and finally realize a possibility.

Arduino allows developers to quickly develop and test their ideas. Whether it's smart home devices, environmental monitoring systems or wearable technology, Arduino offers a cost-effective and highly flexible solution that accelerates the process from concept to product.

In conclusion, Arduino, as an open source platform for electronic prototyping, has had a huge impact on the global technology, education and creative fields. With its simplicity, flexibility and strong community support, Arduino not only makes electronic production and programming easier to use, but also provides professional developers with powerful tools for rapid iteration and innovation. In the future, Arduino will continue to expand its influence, inspiring more creativity and invention as technology continues to advance.

III. Vision Sensor OpenMV

OpenMV smart camera is a high-end smart camera based on STM32 microcontroller. It adopts ARM Cortex-M4 core, which has the characteristics of high performance, low power consumption and easy expansion. It can easily realize applications such as image processing, computer vision and machine learning. OpenMV smart camera integrates functional modules such as image sensor, digital signal processor (DSP), SDRAM, flash memory, USB interface, I/O interface, etc., which can realize fast and accurate image processing and analysis. Thereby realizing security monitoring, intelligent transportation, smart home and other applications. The characteristics of OpenMV smart camera are as follows:(1) Powerful processor performance. OpenMV smart camera adopts ARM Cortex-M4 core, which runs fast, low power consumption, and has good scalability and customizability. Its maximum operating frequency can reach 168MHz, which can handle high-speed data streams and large-scale datasets; (2) High-definition image sensor. OpenMV smart camera is equipped with a new OV7725 image sensor, which can achieve a maximum resolution of 640x480. In addition, it also has good responsiveness in low light conditions, thus ensuring a good shooting effect in various scenes; (3) Support multiple programming languages. OpenMV smart camera supports multiple programming languages, including Python, C++, MicroPython, etc. By using these programming languages, users can easily develop and debug, and quickly build a variety of intelligent hardware projects.

OpenMV smart camera has a variety of interfaces, including USB interface, I/O interface, UART interface, SPI interface, etc. These interfaces can easily connect other devices to achieve data transmission and control functions.

IV. Driverless car real car test

Figure 1 is a top view of the driverless car. The driverless car platform is made of acrylic material, with a rectangular overall shape and a size of 25 * 16cm. It is a two-layer structure, each layer has specific functions and components, which together form the architecture of the entire system.

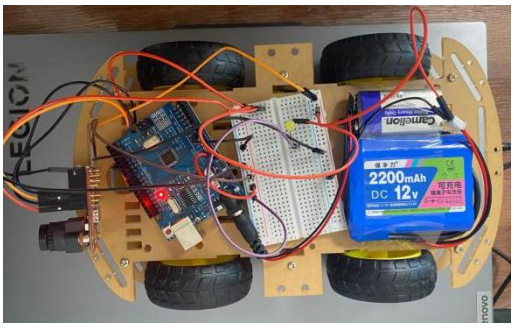

Fig.1 Top view of the driverless car

In the first layer (bottom layer), there are L298N drive modules with four DC motors.

In the second layer, there are breadboard, arduino development board, openMV development board (with camera), 12V lithium battery and 9V lithium battery.

4.1 overall structure

The architecture of the driverless car is shown in Figure 2. In terms of the main controller, In terms of actuators, the driverless car is equipped with four DC motors located on both sides of the driverless car. Each motor is connected by axle and wheel. The wheel has a diameter of 65mm and a width of 25mm. The wheel material is a plastic housing with black rubber tires. The placement of the motor enables the trolley to perform basic motion functions such as forward and backward motion. In terms of the drive module, the L298N drive module is used in this paper, which is used in conjunction with the motor.

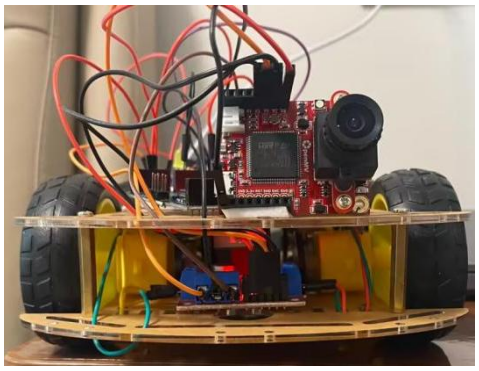

Fig.2 Driverless car architecture

4.2 Visual sensor OpenMV recognition function test

The main compilation method used by OpenMV is MicroPython. This compilation method is basically a Python that can be used on microcontrollers and MCUs. Although it is a language used for small computing devices such as MCUs, it is still compatible with many libraries and classes that Python can use. Having a large number of available libraries makes the writing process clear and simple, requires fewer lines, and is suitable for beginners to learn. At the same time, MicroPython's interpreter also has strong portability and can be used on different platforms, so no special compiler is required. It can be used on MUC by simply writing it in plain text and turning it into a py file.

First, use the import function to reference the required function library, so that you can directly call various functions starting with sensor and image after that. The first is to use the reset command to initialize the camera and set the color format and definition format. Figures 3 and 4 show the recognized QR code and serial end point feedback.

Fig.3 QR code with numbers identified

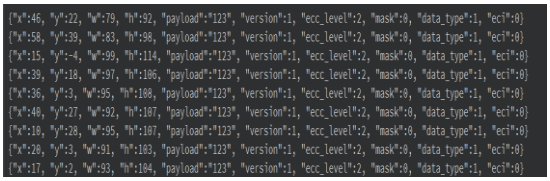

Fig. 4 Identifying the number of serial end point feedback

Fig.5 QR code with letters recognized

Fig.6 Serial end point feedback for letters recognized

4.3 Unmanned car vehicle measurement

After the visual sensor OpenMV recognition function was confirmed to be correct, the driverless car was then tested, as shown in Figures 7 and 8. In Figures 7 and 8, a small light was introduced to assist in the detection of the measured effect of the vehicle. The small light was on, indicating that the car was moving forward, the small light was off, and it was stopped.

The real vehicle test is an important indicator for the actual operation of the intelligent car to ensure that the system can maintain good performance under normal and high load environments. This real vehicle test mainly focuses on the corresponding time of the car, the battery life of the power supply and the processing capacity of the car intelligence system.

The response time of the real car test is one of the important indicators to measure the quality of the trolley. In this test, special attention was paid to the response speed of the trolley to the Arduino UNO command. By simulating different usage scenarios, the time from the Arduino UNO command to the actual response of the trolley was accurately measured and recorded, with the efficiency of the trolley system in real-time operation. After the Arduino UNO command is issued, the trolley will start the corresponding function of the trolley within 2 seconds, which is very fast. In actual use, this will not cause people to feel delayed.

The battery life of the driverless car is particularly critical, which affects the practicality and reliability of the car. Because four 1.5V batteries are used to power the L298N drive module, and two 3.3V batteries are used to power the Arduino module. This split power supply design not only optimizes the power distribution, but also facilitates the disassembly and replacement of the battery. During the test, the battery life of the car was measured under different operating conditions, such as continuous operation and intermittent use, to ensure that the long-lasting performance of the battery in actual use meets the design expectations. The conclusion is that under high-intensity use for up to 1 hour, the car can run normally and perform corresponding work, which means that the car does not need to worry too much about the battery life of the car during normal testing and use.

Considering that the car will receive and execute multiple instructions in a complex environment, the test also focused on evaluating the processing power

and stability of the system when receiving multiple complex instructions in a row. Issue a series of motion and navigation instructions in a short period of time, observe the reaction and execution of the car, and whether the system experiences a delayed or failed response.

The visual sensor OpenMV transmits the recognition result to the Arduino module. After the Arduino module issues a command, the car can accurately and quickly execute the motion command after 3 seconds. This means that the car can accurately follow the control command in a short time.

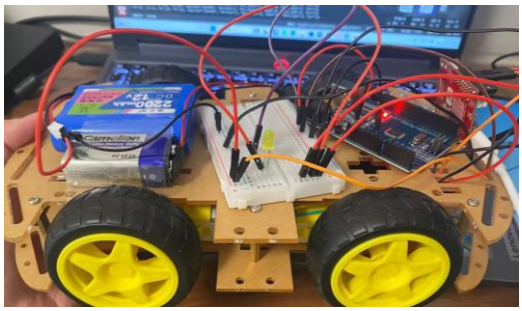

Fig.7 Stop the car by recognizing the letter QR code

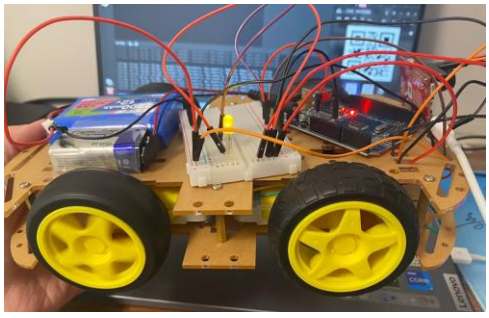

Fig. 8 Make the car move forward by recognizing the digital QR code

V. conclusion

This paper successfully designs and implements an intelligent car integrated with the visual sensor OpenMV and the underlying controller Arduino. Through the visual sensor OpenMV module, the car can receive and recognize QR code pictures in real time, and transmit the recognition results to the underlying controller Arduino in real time, providing technical support for the intelligent decision-making of the driverless car. The car in this paper is not only suitable for industrial fields such as warehousing and logistics and intelligent navigation, but also can become a part of smart home systems, providing services such as automatic delivery of goods and indoor navigation for the home environment.

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