A Customized Dispensing Robot Based on OpenMV Visual Recognition

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Abstract

Dispensing medicine in hospital wards is a mechanized process, but it is difficult to develop on a large scale due to the uncertainty of the environment. In this study, a customized dispenser robot was designed to automatically deliver drugs to the designated ward according to the given instructions. The Visual identity module (OpenMV) is designed to collect images from the progress and then compare them with pre-stored images to achieve automatic pathfinding. Among them, the tracking part uses PID open-loop operation to increase the accuracy of movement. The ward number enables the camera to recognize the number in different scenes for many times, which increases the accuracy of recognition. The unique structure of this study provides an innovative and effective way to customize ward dispensing.

Keywords: OpenMV, STM32; image recognition; multi-template matching

1. Introduction

Modern society cannot do without medicine and the intelligence of hospitals and other health institutions has become a current trend in development. The development of intelligence has taken the management, services and research of healthcare to a new level, helping hospitals to provide better services and offer higher quality healthcare to society.[1] With the expanding needs of the medical industry in recent years and the emergence of innovative technologies and systems for medical robotics, medical automation is emerging as an emerging industry with great promise.[2] But health institutions around the world are all different, and this requires robots that can have the ability to customise recognition to handle it.

Next we will discuss the Custom Delivery Robot (CDR). This is a robot based on OpenMV visual recognition, which can recognise external room numbers based on visual input and can automatically plan routes. In addition, it can perform automatic localisation and recognition to ensure effective obstacle avoidance of objects in front of it.

2. Digital recognition solutions

OpenMV forms the main vision recognition module (VPU) for CDR, an open source vision recognition system that can be used to develop and deploy custom CDR[3]. The system consists of an ov7725 camera and a 51 microprocessor that can be used to detect objects and identify their position in the environment. With its ability to recognise objects and their positions, OpenMV can be used to create bespoke CDR that are tailored to the exact needs of a given application. The design of OpenMV is shown in Fig.1.

The OpenMV system has been successfully tested in many different scenarios, including object recognition and navigation[4]. In addition, the system has proven to be reliable and robust in a wide range of environments. This makes the OpenMV system ideal for the development and deployment of CDR. In addition, the system provides a cost-effective solution for those wishing to create efficient and reliable robotic recognition systems.

Fig. 1 The design of OpenMV

3. Tracing and junction identification solutions

Grey sensors are analogue sensors. The grey scale sensor uses the principle that different colours reflect light differently on the detection surface and that the photoresistor has a different resistance to the light returned from the different detection surfaces to detect the shade of colour. The design of the infrared homing module is shown in Fig.2.

Fig. 2 The design of the infrared homing module

It is used to distinguish between black and other colours when the ambient light interference is not very serious. It also has a relatively wide operating voltage range and can work normally in the event of large fluctuations in the supply voltage. The output is a continuous analogue signal, which makes it easy to determine the reflectance of an object by means of an A/D converter or a simple comparator, making it a practical sensor for robotic line inspection. The grey scale sensor is equipped with an analogue size adjuster for the return of the detected colour. To detect a given colour, the transmitter/receiver head can be placed at the given colour and the appropriate return analogue can be adjusted with the regulator. Turn the regulator counterclockwise to increase the return analogue amount; turn the regulator clockwise to decrease the return analogue amount; and continue adjusting until the desired value is reached. If the exact analogue quantity is required, it can be programmed to be displayed on the LCD screen and the exact analogue quantity can be adjusted in conjunction with the regulator. Because different areas require different colours and thresholds to be recognised, the CDR can automatically distinguish and save the corresponding colour selection according to the size of the set threshold.

4. Microcontroller unit selection options

The STM32F1 microprocessor is a powerful and efficient alternative to the CDR. This microprocessor offers a high level of computing power with a wide range of features such as a 32-bit ARM Cortex-M3 core, DMA controller and multiple on-chip peripherals. In addition, it offers a wide range of on-chip memory options, including up to 512 KB of Flash memory and up to 64 KB of SRAM. These features make the STM32F1 ideal for a variety of applications, such as robots that need to process data quickly and accurately.

Secondly, the STM32F1 microprocessor is low power, with multiple low-power modes that can be used to reduce power consumption while maintaining performance. In addition, the processor is able to run from a low-voltage power supply, allowing the robot to be powered by a battery or other low-voltage power source. This feature is particularly beneficial in applications with limited or unreliable power supplies. The design of the MCU is shown in Fig.3.

Fig. 3 The design of the MCU

Finally, the STM32F1 microprocessor is highly flexible and scalable. The processor can be used in combination with a wide range of peripherals and external memory.[5] This allows the robot to be customised to meet the specific needs of its application. In addition, the processor is able to run multiple tasks in parallel, allowing the robot to perform complex tasks more efficiently.

5. Software design and theoretical analysis

This summary will consider the functionality, architecture and performance of the system in order to determine the best solution. In order to achieve this goal, this paper will use computer vision techniques to build the CDR.

Firstly, a systematic analysis of the OpenMV framework will be carried out to identify its possible application scenarios and functional characteristics.[6] A live image is acquired by the camera and then the numbers are matched to the stored template and returned by a model recognition algorithm. The microcontroller processes the numbers and then controls the DC motor to drive in the corresponding direction, during the driving process the camera then matches the numbers captured during the driving with the stored template through the model recognition algorithm and returns the numbers. The microcontroller processes the numbers and makes the correct direction of travel, stops after identifying the corresponding ward, waits for the medicine to be taken away and then reverses and returns in the same direction according to the route recorded by the CDR on its way, and prompts after returning to the pharmacy.

6. Openmv model recognition algorithm

The basis for number recognition is the need to configure the use of NCC template matching.[7] The NCC template matching allows the template image of the numbers to be recognised to be saved to an SD card, which can then be used for the next step of recognition. During the programming process it is realised that pictures of different numbers are stored for model entry and then during the CDR run the models are compared with the signage ward number plates of the nearby walls and the corresponding numbers are recognised for the correct route selection.

Based on this algorithm, multiple sets of images are then entered, making it possible for the identified images to be found in the image library for comparison under different lighting and other external conditions. The comparison is shown in Fig.4.

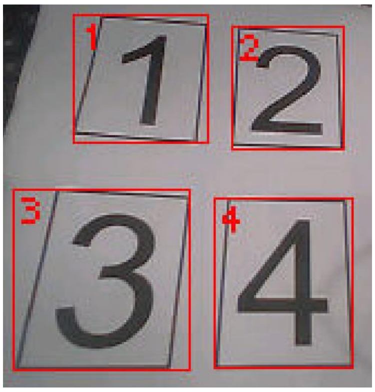

Fig. 4 Vision modules recognise numbers in different lighting conditions

7. PID algorithms

In process control, the PID controller (also known as PID regulator) is the most widely used automatic controller according to the proportional (P), integral (I) and differential (D) control of deviations. It has the advantages of simple principle, easy implementation, wide application, independent control parameters and simple selection of parameters; and in theory it can be proved that for the typical objects of process control - "first order hysteresis + pure hysteresis" and "second order hysteresis + pure hysteresis "The PID regulation law is an effective method for dynamic quality correction of continuous systems, with simple parameterisation and flexible structure changes. The use of the PID algorithm during the CDR travel can make the CDR travel more stable.[8]

8. Hardware circuit design

The hardware circuitry should be designed in such a way that all components of the CDR work together to achieve the required functionality. The hardware circuit consists of an STM32f103rct6 microcontroller, a power supply module, an image recognition module, a motor drive module, an optoelectronic module and a greyscale sensor module.

The STM32f103rct6 microcontroller is the core part of this hardware circuit, the power supply module provides sufficient power for the entire circuit, the image recognition module recognises images, the motor drive module translates commands into motor movements, the optoelectronic module detects light intensity and the greyscale sensor module detects the colour and shape of objects. Openmv is connected to the main control through the serial port, and the openmv serial port is connected to the serial port of the microcontroller. The block diagram of the scheme structure is shown in Fig.5. And the circuit schematic for the specific design is shown in Fig.6.

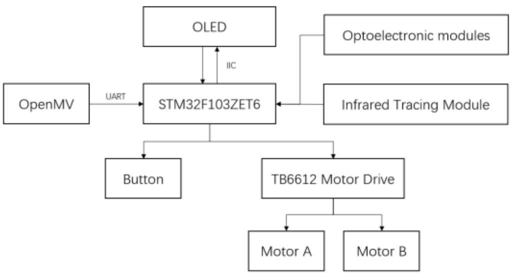

Fig. 5 The block diagram of the scheme structure

The DC regulated power supply is a device that converts AC power to DC power and can be connected directly to the motor drive module, which is then connected to the motor drive module to enable the motor to be driven.[9],[10] The greyscale sensor and the optoelectronic module are also each connected to the gpio of the microcontroller to enable data transfer. The operation of the entire system relies on the interplay between these devices and the functions they provide.

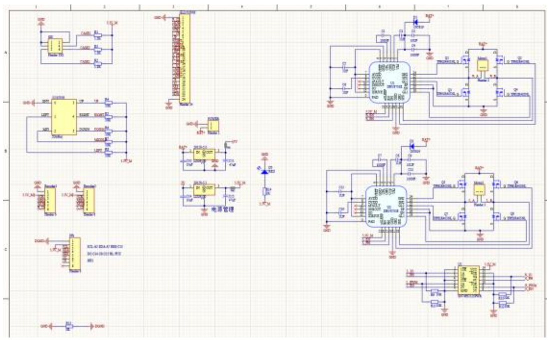

Fig. 6 Circuit schematic

9. Conclusion

This thesis presents an OpenMV vision recognition-based custom drug dispensing robot that enables fast and accurate drug dispensing, an intelligent drug transport process and reliable drug dispensing services. This novel custom drug dispensing robot greatly improves the efficiency of drug dispensing and provides a reliable drug dispensing service for clinical purposes.

References

1. Tan, M. & Wang, SH. (2013). Advances in robotics research. *Journal of Automation* (07), 963-972.
2. Zhao Xinguang, Duan Xingguang, Wang Qining & Xia Zeyang. (2021). Research perspectives on medical robotics. *Robotics* (04), 385.
3. Wang Congzheng & Li Qiguang. (2018). Opencv-based multi-target template matching algorithm for images. *Electronics Technology and Software Engineering* (05), 57-59.
4. Ding, Heng-Wang, Zheng, Jin-He & Yan, Shao-Min. 2011 A new species of the genus Phyllostachys (Coleoptera, Staphylinidae) from China. (2022). Research on drug delivery system based on neural network combined with template matching algorithm. *Automation Instrumentation* (09), 52-55.
5. Chen, Yan, Hu, Guang, Luo, Houcheng, Wan, Shuhan, Chen, Chuang & Zou, Min. (2022). Design of an STM32 chip-based intelligent guide cane for the blind. *Electronic Technology*(10),10-11.
6. Zhang Lei. (2016). Design of intelligent trolley control system (Master's thesis, Jilin University).
7. Yue Youjun, Huo Xiaodong, Wang Hongjun & Zhao Hui. (2023). Research on dynamic identification and tracking algorithm of apple. *Agricultural Mechanization Research* (06), 41-46.
8. Zhang Bo. (2021).Application of PID algorithms in control systems. *Information Record Materials* (07), 197-199.
9. Zhou, Jian & Xu, Zhiguo. (2020). Design of an STM32-based intelligent tracer robot. *Integrated Circuit Applications* (02), 45-47.
10. Jiang Linglong, Hu Jian & Liu Qingyun. (2021). Non-contact object recognition device based on OPENMV. *Science & Technology Innovation* (09), 160-161.

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