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Development of an Intelligent Medicine Delivery Robot based on OpenMV and STM32

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Abstract

With the aging of the population and the growing demand for healthcare, hospitals and other medical places are in urgent need of improving the efficiency and quality of services. Medical robots have been gradually applied to real life, but they still have problems such as low recognition accuracy and slow signal transmission efficiency. Based on OpenMV digital image recognition technology and A* algorithm, the target image is accurately recognized using OpenMV technology, and the A* algorithm is introduced to optimize the route planning and obstacle avoidance, so as to realize a more efficient and fast drug delivery using sensor modules and Bluetooth communication modules, and algorithmic optimization of route planning and obstacle avoidance, so as to realize the multi-device operation of the smart drug delivery robot and a more efficient and fast Drug Delivery.

Keywords

OpenMV; A* Algorithm; STM32; Path Planning; Intelligent Robot.

1. Introduction

At present, the per capita number of medical and nursing personnel in China is still at a low level, especially during special periods when the situation of manpower extraction occurs from time to time, further aggravating the phenomenon of insufficient human resources in the medical system [1-2]. With the aging of the population and the growing demand for medical care, hospitals and other medical venues urgently need to improve the efficiency and quality of service.

In the delivery of medicines, the traditional way of drug delivery mainly relies on manual operation, low efficiency, error-prone and in special environments there is a risk of infection; with the development of science and tehnology, drug delivery robots have brought some improvement, but the existing drug delivery robots in the recognition of the accuracy and efficiency of the path-finding is still insufficient. In order to facilitate patients to receive treatment and improve the efficiency of medical staff and hospital intelligent service level, intelligent and efficient distribution of drugs between the pharmacy and wards has always been a matter of concern [3]. Intelligent drug delivery robot is a medical device based on logistics robot hardware facilities, intelligent control system and automated mechanical devices, combining new generation of information technology such as big data, artificial intelligence and medical diagnosis and treatment means. It can automatically complete the task of picking up and delivering medication, improve the efficiency of drug delivery, reduce the waste of human resources and inter-personnel contact, and have the advantages of high efficiency, convenience and safety [4].

The current drug delivery robots are not intelligent and efficient enough in finding their way, and often fail to make rapid and dynamic adjustments according to the complex actual environment, resulting in the possibility of detours and jams in the drug delivery process, which greatly affects the efficiency of drug delivery. In recent years, researchers in China have carried out a lot of research work in this field, such as PLC-controlled track drug delivery trolley [5], which has the characteristics

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of touch-screen control, human-computer interaction, diverse ports, and a high level of automation; Literature [6] takes the home-based maternity ward as a working scenario, and completes the structural design of the drug delivery robot and the development of the intelligent function, which achieves a good effect; Literature [7] takes the SLAM technology as the basis, constructed the visiting medicine delivery robot system composed of vision module, trajectory module and drive module, etc., and realized the robot's race function; Literature [8] used the combination of infrared sensors and ultrasonic sensors to complete the design of the robot trajectory and obstacle avoidance module, which greatly improved the accuracy of the robot's trajectory. It can be summarized from these studies that at present, with the continuous improvement of the level of intelligence, the functional objectives of the intelligent drug delivery trolley are gradually improved, but there is a gap between the accuracy and efficiency of the machine recognition of objects and engineering applications, which needs to be improved [9-11].OpenMV is a kind of open-source machine vision module with huge functions, on the one hand, OpenMV is small in size, easy to carry, and it can be selected through the On the one hand, OpenMV is small in size, easy to carry, and can choose to communicate with hardware through UART, I2C, SPI and GPIO, which is especially suitable for embedded development; on the other hand, OpenMV module carries Python interpreter, which makes it possible to develop using MicroPython language, and it can be more convenient to use the library functions related to machine vision, which greatly reduces the difficulty of the development of the machine vision aspect [12].

In response to the above needs, the design of this paper proposes the design and study of an intelligent medicine delivery robot based on OpenMV and heuristic algorithm (A*), which utilizes a microcontroller master STM32F103C8T6 belonging to the ARMCortex-M3 architecture as the main device control chip. The chip has 256KB FLASH flash memory on board, which is used to store program codes such as map data, A* algorithm code program and some fixed parameters. At the same time, it has a CPU clock frequency of 72MHz, which is able to handle various control tasks quickly. It also has CAN bus function, which can be used to communicate with other CAN bus-enabled devices, enhancing the system's expandability and communication capability. In addition, there are five USART serial ports and two I2C buses that can be used to connect to various external devices. This design seeks to add a new research basis in the field of intelligent drug delivery robots, to open up innovative paths, and also to provide some reference for scholars researching in this field.

2. Vehicle Schematic Design

2.1 Overall Program Design

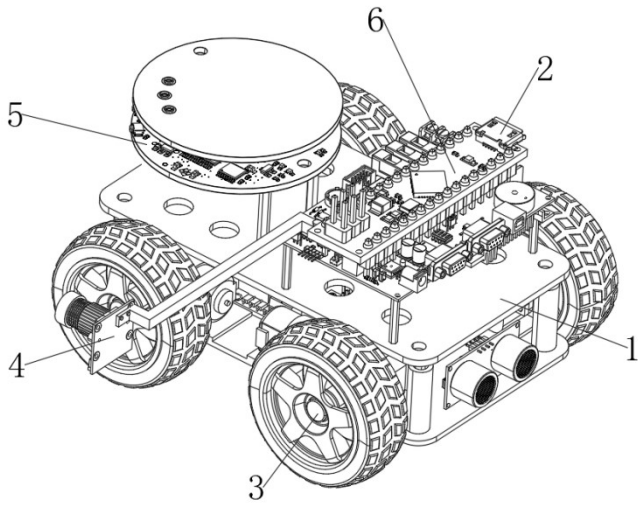

Fig. 1 Hardware design of intelligent drug delivery robot

The robot consists of a body 1, a communication module 2, a drive module 3, a vision recognition module 4, a gravity detection module 5 and a core control module 6.

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Among them, the body module is made of a metal material, and the body has preset mounting positions for each module. The drive module 3 can be mounted at the bottom of the body 1, and the drive module 3 can include:

2.2 Segmented Modules

I. The drive module includes:

(1) Motors:DC brushed coded motors are used to drive the four wheels of the robot so that the robot can move on the ground, and the rotational speed of the motors and the rotation angle of the wheels are measured and fed back to the core control module 6, thus realizing the precise control of the robot's motion state.

(2) Wheels: ordinary rubber wheels are used.

II. Communication module Including:

(1) Wireless communication chip: this robot is loaded with BT08 Bluetooth chip, then it is suitable for short-range and low-power connection, and it is more convenient to pair with nearby handheld devices.

(2) Communication interface: including UART (Universal Asynchronous Transceiver Transmitter), SPI (Serial Peripheral Interface), etc., which is used for data transmission with the core control module.

The communication module is placed at a higher position inside the robot to avoid signal interference by other metal parts or electronic devices inside the robot.

III. Visual Recognition Module (using OpenMV image recognition technology) includes:

(1) Camera: an OV7725 camera is used, which has a suitable resolution to capture images of the front of the robot. For example, this OpenMV module is equipped with a camera with a resolution of 640 x 480 pixels to meet basic needs such as recognizing guide lines.

(2) Image Sensor: Converts optical images into digital signals to provide data for subsequent image recognition.

(3) Microcontroller: Runs the OpenMV firmware, processes the image data, and performs the operations of the image recognition algorithm. The microcontroller usually has a certain amount of memory and processing power for storing image data and executing recognition programs.

The visual recognition module is mounted higher up on the front of the robot so that a good field of view can be obtained to facilitate the recognition of guide lines on the road in front of the robot. The camera lens needs to be facing the direction of travel of the robot.

IV. Gravity Detection Module Included:

(1) Pressure sensor: this robot uses a strain-gauge pressure sensor to detect pressure changes by measuring the strain of the material under pressure; a capacitive pressure sensor uses capacitance changes to sense pressure. When the medicine is placed on the robot, the pressure sensor detects the pressure change.

(2) Signal Conditioning Circuit: The weak signal output from the pressure sensor is amplified, filtered and processed so that it can be accurately recognized by the core control module.

V. The core control module adopts STM32F103C8T6 chip, which is equipped with CAN bus function and can be used to communicate with other devices supporting CAN bus, which enhances the expandability and communication capability of the system.

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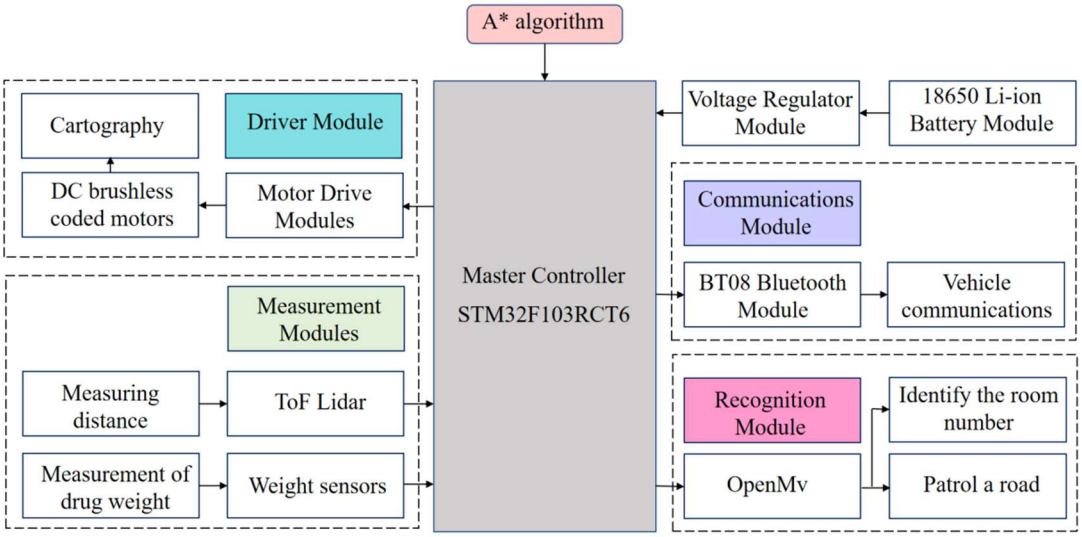

Fig. 2 Robot part modules

3. Transportation Process

During the traveling process of the robot, based on the OpenMV image recognition technology, it recognizes the guide line preset on said road surface and adjusts said traveling instruction based on said guide line to make said robot arrive at said target room along said guide line.OpenMV is a programmable microcontroller camera with image processing function. It mainly contains an STM32 chip and a camera, and is characterized by simple structure, stable performance and low cost.OpenMV has some built-in image processing algorithms, which are easier to use, and its STM32 reference materials are abundant, which is convenient for secondary development.

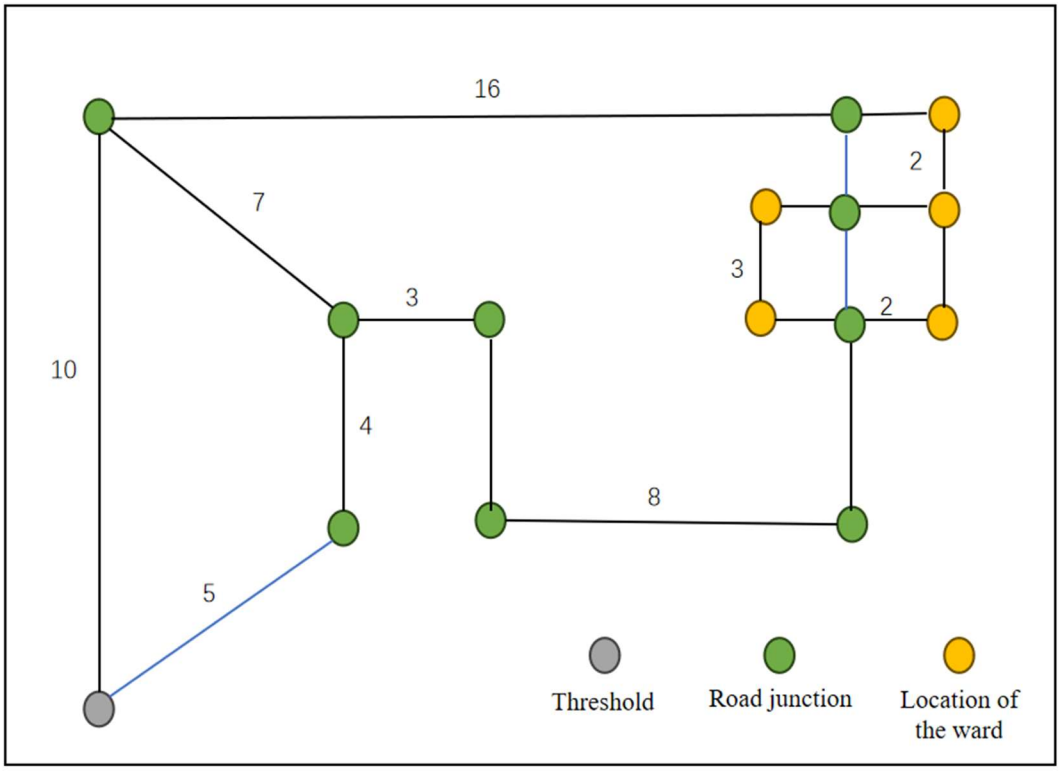

Fig. 3 Robotic drug delivery path

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Firstly, obtaining a drug delivery map and a number of a target room; wherein said drug delivery map comprises nodes and road sections connecting said nodes, said nodes comprising a starting point, various road section forks and various room spots, each said road section connecting only two of said nodes, and each of said room spots corresponding to an independent number, said independent number corresponding to the number of a room corresponding to said room spot in reality. Secondly determining said room point location corresponding to the number of said target room as the end point, and based on said medication delivery map and said end point, utilizing a path planning algorithm, path planning is performed to obtain a target path; said target path denotes a path to move from said point of departure to said end point in said medication delivery map. Finally, when the medicine is in said robot, a traveling instruction is generated based on said target path, said traveling instruction being used to instruct said robot to travel on a corresponding road surface in reality in accordance with said target path.

4. Conclusion

To address the problem of drug delivery, this paper designs and develops an intelligent drug delivery robot based on STM32. The actual test shows that the robot realizes the drug delivery better. At the same time, there is still much room for improvement in this project, such as improving the algorithm to shorten the path of drug delivery, optimizing the sensitivity of obstacle avoidance to make the robot travel more smoothly in the process of drug delivery. These issues will be the next improvement direction of the project.

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