Research of Intelligent Temperature Measuring Robot System

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Abstract. With the outbreak of novel coronavirus pneumonia worldwide, a kind of epidemic prevention robot is urgently needed in society. The intelligent temperature measurement robot system mainly includes the robot's high stability multi-attitude omnidirectional movement module, robot path planning and autonomous navigation module, robot environment information acquisition and recognition module, robot remote control module, and robot system integration. According to the design principle of the wheeled robot, high stability and multi attitude omni-directional mobile platform of temperature measuring robot are constructed; path planning and autonomous navigation of robot are realized based on sensor data fusion; temperature detection and remote care function are realized by thermal imaging sensor system by capturing the thermal radiation emitted by the human body, and based on open modular control system architecture. Based on the existing research foundation, the intelligent temperature measurement robot system is established by integrating the robot multi attitude omni-directional mobile system, robot path planning, and autonomous navigation system, robot environment information acquisition and recognition system, and robot remote control system.

Keywords: Omnidirectional mobile, path planning, and autonomous navigation, thermal imaging, environmental information acquisition and identification, system integration

1. Introduction

At present, most of the research on medical robots is mainly on some surgical auxiliary robots, while the research on the anti-epidemic robots dedicated to the temperature measurement in the ward is still relatively small, so the research on multi-functional medical anti-epidemic robots has become a development trend. From the perspective of improving medical service experience, the design practice of epidemic prevention robots inward is discussed to alleviate the problems such as backward hardware and poor air environment inward, so as to improve the medical service experience of users[1].

The anti-epidemic robot based on wheel structure can realize a more flexible and fast omni-directional movement, which is more suitable for ward epidemic prevention robot and has broad application prospects. Therefore, it is of great significance to construct an omni-directional mobile platform with high stability and high operation accuracy for the development of an epidemic prevention robot.
Medical temperature measurement robot usually needs to have the ability to accurately perceive the surrounding environment and move autonomously. Its core technology is instant positioning and map building (SLAM) and autonomous navigation. Slam includes robot pose estimation and map building, both of which are carried out at the same time. Accurate pose estimation is used to collect environmental information. Autonomous navigation mainly includes global positioning, path planning, and motion control. The robot path planning algorithm has achieved remarkable results in theoretical research and practical application. Path planning algorithm includes global path planning and local path planning[2].

The research on the environmental information collection and identification processing of the epidemic prevention robot is mainly about the collection and recognition of body temperature. The infrared thermometer is used to monitor body temperature. The temperature measurement results are accurate and reliable, which can reduce the manual workload of related applications.

2. High stability multi attitude omnidirectional mobile platform system

For the mechanical structure design of high stability multi attitude omni-directional mobile platform, the new single wheel damping floating suspension mechanism can overcome the turbulence, improve the running stability and obstacle crossing ability, and the self-locking mechanism of driving wheel can reduce the sliding distance of omni-directional mobile platform when braking, and realize the fixed-point parking on the ramp. Complete the operation modeling of omni-directional mobile platform, analyze its posture and motion characteristics; use ADAMS software to simulate the mobile platform when it passes through obstacles, gullies, concave-convex surfaces, S-shaped lines, and other complex external environments, identify and optimize the factors that affect the motion characteristics such as body vibration, obstacle crossing ability, turning smoothness, braking and sliding distance. ANSYS software is used to analyze the key parts of the mobile platform, especially the driving mechanism and suspension mechanism, so as to realize the lightweight design of the platform under the condition of meeting the carrying strength. This paper analyzes the factors affecting the moving accuracy of the platform, identifies the error parameters through additional sensor experiments, establishes the dynamic error model and static error model of the mobile platform, and PID controller based on artificial intelligence algorithm, so as to realize more accurate platform trajectory tracking control[3]. The functional block diagram of multi attitude omnidirectional mobile platform system is shown in the following figure:

![Functional block diagram of multi attitude omnidirectional mobile platform system](image)

**Fig. 1** Functional block diagram of multi attitude omnidirectional mobile platform system

3. Robot path planning and autonomous navigation system
For the research of robot path planning and autonomous navigation system, an ant colony algorithm is used to solve the problem. The evaluation function of the ant colony algorithm is introduced to improve the heuristic function and pheromone update mode of the ant colony algorithm. The directivity of the algorithm is increased, the probability of falling into "self-locking" is reduced, and the speed and precision of its search are improved, in order to find the optimal path quickly when the amount of data is large. When an ant colony algorithm is used to solve the problem of path planning, the grid method is mostly used to model the environment map of path planning. The basic idea is to use the path set of ants to represent the set of feasible solutions to solve the problem. Under the effect of positive feedback, the ant optimization process gradually converges to the optimal path, that is, the best solution to realize the path planning and autonomous navigation of the robot[4]. The logical framework of the robot path planning and autonomous navigation system is shown in the following figure:

![Logical framework of path planning and autonomous navigation system](image)

**Fig. 2** Logical framework of path planning and autonomous navigation system

### 4. Environmental information identification and collection system

The robot environment information recognition and acquisition system mainly includes an image acquisition system, radar detection system, and sensor system. The image acquisition system includes a zed camera, a wide-angle camera, and a long-focus camera. In actual use, it is responsible for the identification of human images and captures and collects people in motion. The radar detection system includes lidar, anti-drop radar, and ultrasonic radar to solve the problem of perception error caused by interference factors such as light and noise, and ensure the accuracy and accuracy of robot environment identification. The sensor system includes a raindrop detector and a thermal imager. The raindrop detector can protect the robot by sensing the humidity of the environment; the thermal imager can detect the body temperature and remote care of the robot by capturing the thermal radiation emitted by the human body[5]. The functional block diagram of environmental information identification and acquisition system is shown in the following figure:
5. **Robot remote control system**
The main purpose of the robot control system is to realize the remote control of the robot. The walking function and position adjustment function of the robot can be controlled remotely through the network. Remote detection and monitoring of human body temperature can reflect the body temperature information of the detected personnel at any time[6]. It can deal with the network delay problem reasonably, and the system is required to be stable and reliable. In order to complete the functions required by the remote control system of the robot, the key modules mainly configured in hardware are composed of central controller, network controller module, remote monitoring control terminal module, motor drive module, sensor communication module, and so on. The hardware framework of the control system is shown in the following figure:

![Fig. 4 Hardware frame structure of the control system](image)

6. **Robot system integration**
According to the market demand for an epidemic prevention robot and based on the existing research foundation, the robot multi attitude omnidirectional mobile module, robot autonomous navigation and path planning system, environmental information acquisition and recognition system, and robot remote control system are integrated[7]. The prototype of the epidemic prevention and temperature measurement robot system is developed and optimized, and the operation specification of the robot system is established. Aiming at the ward of the infectious disease ward, the robot is tested to verify
the effectiveness and safety of the robot. On this basis, according to the medical needs of indoor and outdoor, the actual application test of the robot was carried out.

![Fig. 5 Robot and its working diagram](image)

7. Conclusion
The intelligent temperature measuring robot system realizes the functions of robot autonomous navigation, path planning, remote control, body temperature detection, etc, which greatly promotes the development of medicine and becomes one of the hot research directions in the field of the robot[8]. The intelligent temperature measuring robot has greatly improved the medical service level, produced the huge medical market demand, liberated the hands of nursing staff to a certain extent, and improved work efficiency.

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