

The Design of Community Multifunctional Automatic Patrol Monitoring System

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Abstract

The monitoring of emergencies such as fire and thermal pipeline burst is very important for the safe operation of large communities. The traditional way based on manual patrol is difficult to realize uninterrupted patrol inspection, and wastes human resources. Therefore, this paper designs a community multifunctional automatic patrol monitoring system to realize the intelligence of patrol monitoring and the alarm function of emergencies. The community multifunctional automatic patrol monitoring system adopts Raspberry Pi 4B controller to process, forward and control the data obtained by the sensor. It also realizes the automatic tracking and patrol of the community, monitors various safety parameters of the community, gives an alarm, and returns the community image in the process of patrol.

Keywords

Raspberry Pi, Sensors, Automatic tracking.

1. Introduction

Community automatic patrol monitoring system is an intelligent system developed for community needs. Due to technical constraints, community automatic patrol monitoring is not very common in daily life, though the development of security robot technology related to community automatic patrol monitoring has basically met the requirements of the market^[1,2]. Many scientific research institutions and high-tech companies at home and abroad have also carried out the research and development of a large number of security robots. Nowadays, various types of security robots have appeared in the market^[3,4].

However, the traditional security personnel and fixed monitoring security technology cannot meet the needs of community monitoring. People need to find a security task with twenty-four-hour omni-directional mobile monitoring and abnormal alarm function. The community automatic patrol monitoring system is an intelligent system that can meet this demand. It can replace the security personnel and traditional surveillance cameras to automatically patrol and monitor the community, which saves human resources. It has also strengthened the monitoring of sudden accidents such as community fire and thermal pipeline burst.

The development of community automatic patrol detection system is based on the research of robot technology^[5]. In the late 20th century, the research of mobile robots began to rise^[6], and more and more widely used in high-tech industries^[7]. As a popular service-oriented mobile robot, community automatic patrol and monitoring has the characteristics of intelligent patrol, flexibility, portability, and realizes the functions of automatic patrol and mobile monitoring. Therefore, the technical research on motion control, route planning, non-destructive detection of fire and heat pipeline leakage is of great significance^[8,9].

2. Overall System Design

The community multifunctional automatic patrol monitoring system is divided into two parts. First, it achieves automatic patrol monitoring vehicle. Second, the client monitoring software of the community monitoring room is designed. In details, the automatic patrol vehicle realizes the automatic tracking patrol of the community and monitors various safety parameters of the community. When an abnormal condition occurs, it gives an alarm, returning the community image in the process of patrol. The community monitoring software displays the main parameter images and alarm information collected by the automatic patrol vehicle.

The project is based on the development of Raspberry Pi. The design contents of the project are as follows:

(1) Design of automatic tracking and obstacle avoidance function of automatic patrol monitoring vehicle.

The automatic patrol monitoring vehicle drives the car through the DC motor chip to achieve the purpose of remote mobile environmental monitoring. The system has automatic tracking and manual control functions. Automatic tracking can collect line patrol data on the set route. Real time video image data can be obtained based on Raspberry Pi core board and HD camera.

(2) Analysis model of community environmental safety parameters and design of alarm function

The infrared thermal imager is used to complete the night image of the community and transmit it back, detect the temperature of the thermal well in the patrol fixed line, establish a mathematical model, judge whether the hot water leaks according to the optimization algorithm, and report the failure of the thermal well cover in the community monitoring software. Smoke detection is used to detect whether there are abnormal smoke phenomena such as fire in the patrol route It uses noise meter and infrared thermal imager according to the abnormal (noise) crowd aggregation around the algorithm. Eventually, community personnel get the alarm, viewing the returned image for processing, and report to the community monitoring software.

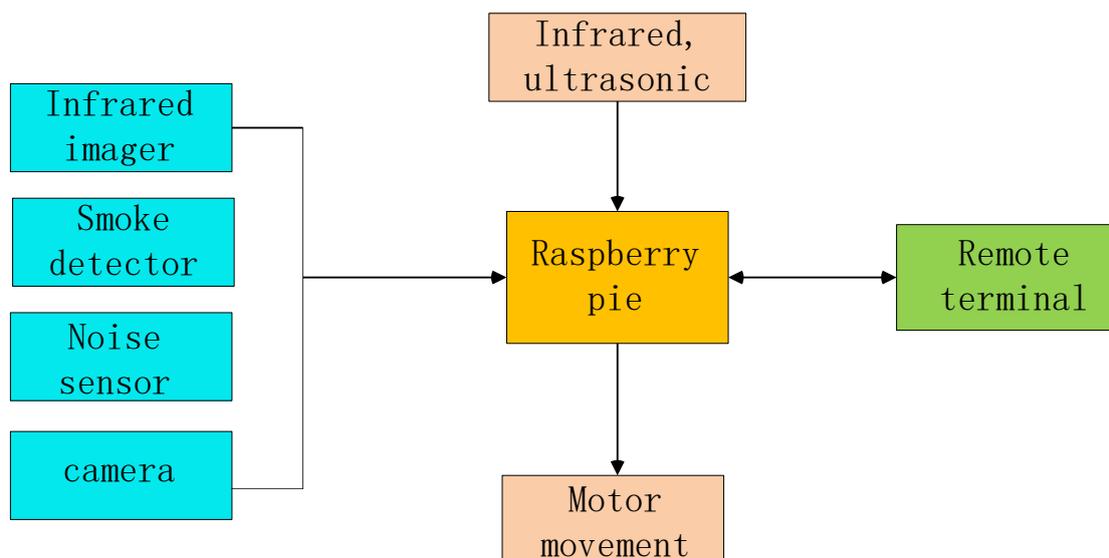


Figure 1: Structure of community multifunctional automatic patrol monitoring system

(3) Client software and wireless data transmission design

Based on clarifying the functional requirements and processing flow of the client software, the overall architecture of the software is designed to meet all the functions of the client software. Use python programming tools to realize the interface and various functional modules of the software system, and conduct joint test of software and hardware. For wireless data

transmission, small data such as temperature and noise will be transmitted back through the wireless WIFI software module on the patrol monitoring vehicle, whereas big data such as video and picture data are embedded into the third-party live video software for transmission, to achieve the purpose of economy, stability, and efficiency. Figure 1 shows the structure of the system:

3. System Hardware Design

The community multifunctional automatic patrol monitoring system adopts Raspberry Pi 4B controller to process, forward and control the data obtained by the sensor. It realizes the automatic tracking and patrol of the community, monitors various safety parameters of the community, gives an alarm, and returns the community image in the process of patrol.

The automatic patrol monitoring vehicle drives the car through the DC motor chip to achieve the purpose of remote mobile environmental monitoring. The system has automatic tracking and manual control functions. Automatic tracking can collect line patrol data on the set route. Real time video image data can be obtained based on Raspberry Pi core board and HD camera. The hardware composition of the system mainly includes Raspberry Pi 4B and HD camera, which together constitute the device sensing layer of the system by cooperating with the sensor. The speed and direction of the smart car are controlled by the motor and steering gear. The speed detection module uses the photoelectric encoder to feed back the speed of the car to the core controller to realize the closed-loop control of speed.

Analysis of community environmental safety parameter model and design and implementation of detection alarm should also be considered. It uses infrared thermal imager, complete the image of the community at night and send it back. It detects the temperature of the thermal well in the patrol fixed line and then establishes a mathematical model, judging whether the hot water leaks according to the optimization algorithm. Smoke detection is used to detect whether there are abnormal smoke phenomena such as fire in the patrol route, and noise instrument and infrared thermal imager are used to detect the abnormal (noise) crowd aggregation around the algorithm. When the community personnel get the alarm, check the returned image, process it, and report it to the community monitoring software at the same time. In the hardware circuit of the main controller of the system, Raspberry Pi 4B model is selected as the main controller to realize central control. Human-computer interactive display and control, temperature and camera signal acquisition, alarm control are all based on mini program. The hardware configuration of the whole system is shown in Figure 2:

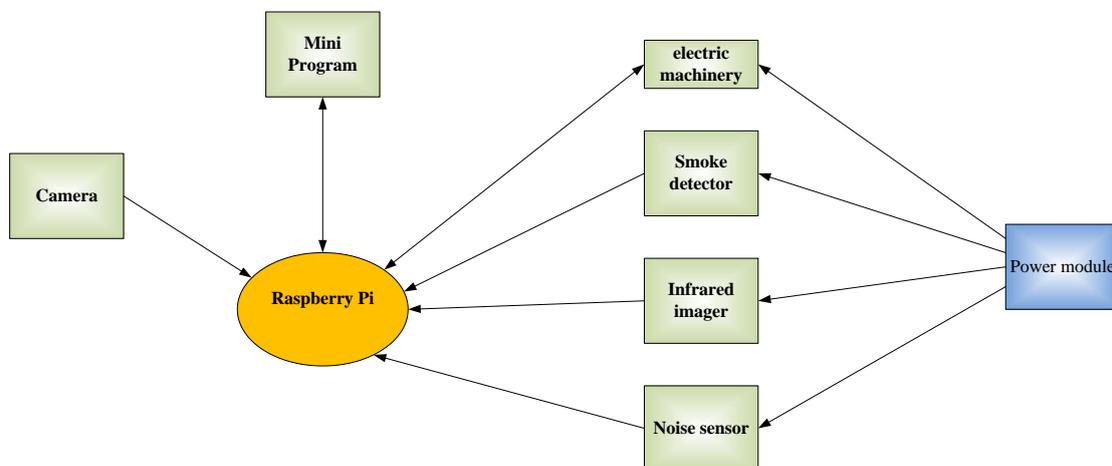


Figure 2: The hardware configuration

4. System Software Design

4.1. Patrol vehicle automatic tracking and obstacle avoidance function software

The control algorithm of automatic tracking and obstacle avoidance function is designed and implemented by Python language. For the road image information extracted by the camera, the threshold method and robust linear regression algorithm are used to extract the road guide line, and the multi-template matching method is used to extract the obstacle information. Combined with the traditional PID control technology and fuzzy control technology, the automatic tracking and obstacle avoidance functions of the guide line of the intelligent car system are realized.

4.2. Parameter detection alarm analysis and client software

The nonlinear and unpredictable parameters of the system are analyzed. Based on the temperature measurement model of thermal imager, the steam leakage detection model of thermal well cover is established. Taking the radiation temperature as the research object, a lattice subtraction method of radiation temperature is established to eliminate the detection interference caused by different emissivity and strengthen the infrared characteristics of leakage, verifying the feasibility of applying infrared thermal imaging technology to leakage detection. It establishes the model of crowd gathering events through the noise and infrared imager, and completes the early warning of community emergencies. With the help of MATLAB modeling, simulation analysis, and experimental comparison, it can be accurately judged.

According to the modeling and simulation analysis, the alarm triggering algorithms such as steam leakage of thermal well cover and community crowd gathering emergencies are designed and implemented by Python language. Because the system parameters are nonlinear, irregular, and greatly disturbed by the external environment, it is necessary to collect data, establish an expert database and adopt expert control strategy to reduce the false alarm rate of alarm.

The client software receives the images and test data returned by the patrol monitoring vehicle in real time, and can display important parameters and community real-time images on the monitoring software interface according to user customization requirements. In case of an emergency, the interface will automatically switch the parameters of the accident scene screen and accident location, and give audible and visual alarm at the same time. At the same time, the running route of the trolley can also be set in the software.

4.3. WeChat Program

WeChat Program, as a function for remote user, achieves the control of community multi-functional automatic patrol monitoring system. The design of the Mini Program is based on Raspberry Pi. OneNET Cloud Platform, served as the hub for connectivity and data, is the bridge between the Mini Program and Raspberry Pi. Figure3 shows the flow chart between RPi and WeChat Mini Program.

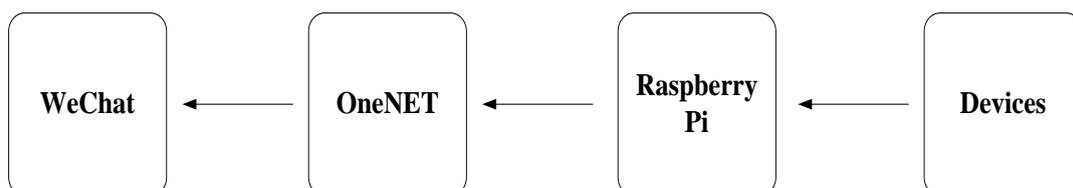


Figure 3: WeChat Program flow chart

5. Conclusion

The system makes comprehensive use of sensor technology, automatic detection technology, communication technology and embedded control technology to develop a set of multi-functional automatic patrol monitoring and automatic control system for the community. The software and hardware design of the system is reasonable. The operation verification shows that the intelligent control function of the system basically meets the design requirements. In addition, the control effect is stable and reliable, and has strong practicability.

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