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Mobile Robot for Fires Detection Development

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Abstract:

In the article, the authors propose the development of a mobile robot. The base is Arduino Mega 2560 R3. The wheelbase chosen is a single-deck robot platform. Breadboard without ration MB-102 with 400 points was selected next. The robot is equipped with the following sensors: ultrasonic sensor HC-SR04, KY-033 Line sensor, flame sensor KY-026, IR thermomodule, Wi-Fi module ESP8266 version ESP-01. The rest of the article suggests programming the fire sensor.

Key words: Mobile robot, Microcontroller, ESP8266, Remote system, Emergency control.

Introduction

In today's world, automation is made possible largely by robots, and they now do most of the work in various areas of human life. Initially, robots were programmed to perform monotonously repetitive tasks. But at present, especially in our conditions of war, it is advisable to use them in various situations caused by man-made disasters. In such conditions, they can also be controlled manually, including implementing remote control to perform complex tasks. Many articles now address the design and control of robots [1]-[11].

Mobile robots application in various spheres of life, such as industry, domestic spheres of life, ecology and military affairs, is becoming more and more common [12]-[20]. This stimulates the need to develop new technologies that allow robots to perform a variety of tasks, ensuring safety and optimizing work processes.

In this paper, we propose a robot prototype development with an interactive control system for a mobile robot based on an Arduino board and the use of sensors that will enable the mobile robot to perform the assigned tasks. The idea is to create a robot that is able to move independently and recognize dangerous situations, in particular, the start of a fire and an increase in temperature.

It is expected that the developed prototype of a mobile robot will reduce the risk of fires and the need for human intervention, providing an immediate response to

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danger. In addition, a mobile robot with the ability to independently navigate and recognize danger will ensure the optimization of work processes at various enterprises, or to check dangerous areas, improve the safety of workers or people around and reduce material costs.

Related works

Currently, a huge number of researchers are engaged in robots development. Every robot developed must be controlled in one way or another. Consequently, a variety of control systems are being developed for robots. Many scientific works are devoted to solving these problems. These problems are so multivariate that even books are devoted to solving them [21].

Let us consider several recent works devoted to robot control. Varlamov, O. in his paper [22] proposes to create a dynamic algorithm of robot actions that can be used in the decision module has been considered. There are used Mivar expert systems of a new generation for high-level control.

Researches [2] and [23] consider soft robotics and its features such as control systems, material and construction, modeling, and sensors.

In [24] authors note that conventional feedback control methods can solve various types of robot control problems very efficiently. They study how difficult control problems can be solved in the real world by decomposing them into a part that is solved efficiently by conventional feedback control methods, and the residual which is solved with reinforcement learning.

Scientists [25 present a review of human–robot collaboration, presenting the related standards and modes of operation. This work concludes with an analysis of the future trends in human–robot collaboration as determined by the authors.

Attar, H. and co-authors in their paper [26] describe zoomorphic robot development.

In [27] a reliable intelligent path following control method for a robotic airship subject to sensor faults is presented. There is developed detection and isolation mechanism. And due to it the airship control system still work well in the presence of sensor fault.

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In paper [28] the typical products and prototypes of lower limb exoskeleton rehabilitation robots are introduced and state-of-the-art techniques are analyzed and summarized.

Authors [29] studied the singularity-free adaptive fuzzy fixed-time control problem for an uncertain n-link robotic system with the position tracking error constraint.

Researchers present their own control scheme for the robot manipulator's trajectory tracking task considering output error constraints and control input saturation [30]-[33].

Thus, we see that robot control tasks are extremely diverse and differ from each other. We should note that to solve the problem of robot control, scientists use various approaches and methods. Therefore, first of all, it is necessary to narrow the scope of problems to the specific problem being solved, and then choose a method for solving it. Further in the article we will present the development of a mobile robot that is capable of finding fires, as well as areas of high temperature, and a control system for it.

Mobile robot development

Let's start with the board, which is the central component of the system. Choosing the right board, such as the Arduino Mega 2560 R3, provides sufficient computing power and the ability to control various aspects of the robot.

An example of the board is shown in Figure 1.

Figure 1: Arduino Mega 2560 R3

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It is equipped with a powerful Atmega2560 microcontroller, which provides enough computing resources to implement complex algorithms and control various devices. The board also has a large number of digital and analog inputs and outputs, which allows you to connect various sensors, actuators and other peripheral devices. The Arduino Mega 2560 supports a variety of software libraries and the Arduino IDE development environment, which simplifies the process of programming and development. It is also compatible with a large number of extensions and modules, which allows you to expand the functionality and capabilities of the system. The combination of low cost, availability, multifunctionality and support makes the board an attractive choice for projects including the development of mobile robots with interactive control.

The next important component for a mobile robot is a platform on which all elements will be located. In our case, it is a mobile 3-wheeled transparent robot platform for robotics. It offers a number of advantages and functionalities that make it suitable for the development of a mobile robot with interactive control. A robot platform appearance is shown in Figure 2.

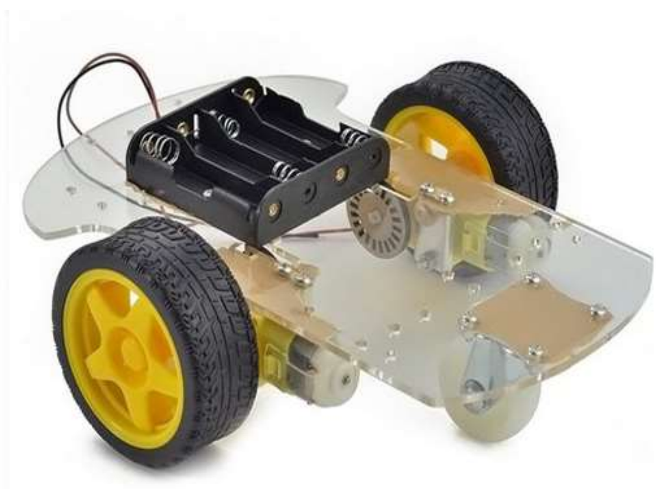

Figure 2: A single-deck robot platform

The platform is equipped with two motors with a deceleration ratio of 48:1. These motors provide enough power and torque to move the robot. They work from voltage

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3-6 and have a low current consumption, which is an energy-efficient solution. Three wheels, two of which are leading and moving motors, ensure the stability and maneuverability of the robot. This allows it to efficiently move in different directions and make turns. This platform also has a compartment for batteries, which simplifies the integration of the power system into the structure of the robot itself. This provides convenience and compact placement of batteries, which is especially important for mobile robots.

The next item will be a breadboard without ration MB-102 with 400 points. The selected L293D collector motor bridge driver is designed to control two collector motors. To connect all the components to the board, we also need to have a set of mother-to-mother, father-to-mother jumpers.

The first sensor that we will consider will be an ultrasonic sensor. This is a component that allows you to measure the distance to objects based on the principle of reflecting ultrasonic waves. Our chosen HC-SR04 is one of the most popular distance sensors and is widely used in various robotics projects. HC-SR04 can measure the distance to objects in the range from a few centimeters to several meters. This makes it versatile and applicable in various scenarios. Also, the sensor has a simple interface for connection and communication with the microcontroller. It works based on the echolocation protocol, which simplifies programming and integration into projects.

Wi-Fi module ESP8266 version ESP-01 was chosen for communication and connection to wireless networks in the mobile robot project.

The KY-033 Line sensor is a device specially designed to detect and follow lines on a surface.

Flame sensor KY-026 is a module designed to detect the presence of a flame, based on a photo-sensitive element that responds to changes in the intensity of light created by the flame.

The last module to be installed on our mobile robot will be an IR thermomodule. An infrared thermometer is designed to measure the temperature of objects using the infrared radiation they emit.

The connection to the board is shown in Figure 3 and Figure 4.

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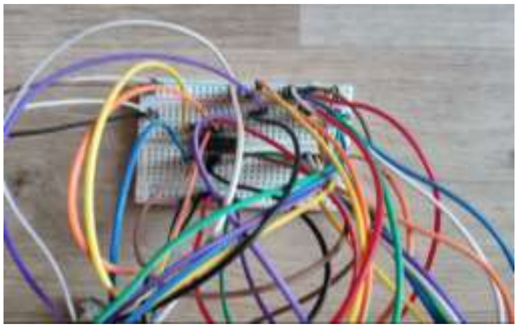

Figure 3: Connection to the board

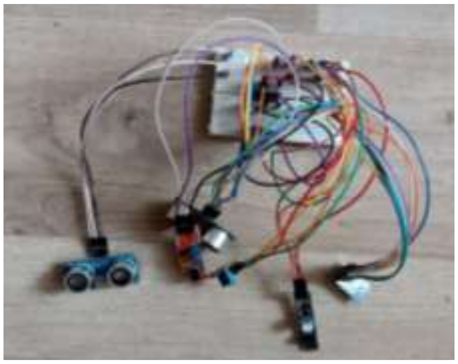

Figure 4: Connection with sensors

Thanks to the Wi-Fi module ESP8266, we can implement the control of the mobile robot through the browser. The user, being in a local Wi-Fi network, opens a browser on his device. A mobile robot equipped with an ESP8266 module creates a web server on the module that listens for incoming HTTP requests. A web page with a robot control interface is displayed in the user's browser. The user clicks buttons on a web page to control the robot. The browser sends a corresponding HTTP request to the IP address and port of the robot. The ESP8266 module receives the request and interprets it as a command to control the robot's motors. The module transmits signals to the L293D bridge driver, which controls the robot's motors. The robot moves according to the commands received from the user through the browser. Thus, the user can control the mobile robot by pressing buttons on the web page in the browser, and the ESP8266 module transmits commands to the robot's motors through the bridge driver.

Programming the flame sensor KY-026

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Here is an example code to test the operation of the KY-026 flame sensor. The code will output a message to the serial port monitor when a flame is detected:

```
// Connection of the KY-026 flame sensor pin
const int flamePin = 2;  // A pin for reading the flame sensor signal
void setup() {
  Serial.begin(9600);  //
  pinMode(flamePin, INPUT);
}
void loop() {
  // Reading the state of the flame sensor
  int flameState = digitalRead(flamePin);
  if (flameState == HIGH) {
    // Flame detected
    Serial.println("Flame detected!");
  } else {
    // Flame not detected
    Serial.println("Flame not detected ");
  }
  delay(1000);  // Pause for 1 second before retesting
}
```

In this code, the flamePin pin (the pin for reading the flame sensor signal) is set to input. Then, in an infinite loop, the state of the pin is read using the digitalRead() function. If the state of the flamePin pin is HIGH, then the message "Flame detected!" monitor the serial port using the Serial.println() function. If the state of the flamePin is LOW, the message "Flame not detected" is displayed. It then pauses for 1 second before retesting.

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Our mobile robot has a 1:48 DC3V-6V Motor that is responsible for its movement. We have developed and implemented the appropriate code for efficient robot control. It includes motor control functions such as turn left, turn right, forward, reverse and stop. Each function sets certain values on the pins connected to the motors to achieve the desired direction of movement. This code will allow us to easily control the motors and implement the necessary movements of the robot. Next, we can integrate motor control with information from ultrasonic sensors, fire sensors, or a line sensor so that our mobile robot can move reliably and flexibly in the environment. Continuing, we can create a basic program loop, in which we will combine the functions of controlling motors and processing data from sensors. This will allow us to create intelligent behavior for the robot, including obstacle avoidance, line following, etc.

Conclusion

The article presents the development of a mobile two-wheeled robot. A single-deck robot platform was chosen as the wheelbase. In this case, two wheels are driving, and the third is stabilizing.

The sensors that are advisable to choose to solve two problems are considered: firstly, it is necessary to ensure the movement of the robot taking into account avoidance of obstacles, and secondly, a group of sensors is needed to ensure the detection of fire hazardous situations. The second group of sensors should include a fire source detection sensor and a high, that is, fire hazardous, temperature sensor. The appropriate sensors have been selected.

The article also describes the development of a program for responding to signals from a fire detection sensor.

In the future, it is planned to test the developed robot in real conditions, and also to correct the software based on the results of this testing.

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