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Fire-Extinguishing Robot Design by Using Arduino

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Abstract: *The aim of this thesis is to contribute to the development of automation systems and to design an unmanned fire extinguisher robot. By this purpose, an attempt was made to develop a mobile robot in order to detect fires (simulated with fire, candle) that could occur In a closed environment. Designing robot able to motion by using the (rotor motor), beyond the barriers by(sensor MZ80), find the flame by (flame sensor), and extinguish the fire by(fan), and it progresses in conjunction with the search for the fire to control it and send message to the mobile or tablet by using (blutooth HC-05) when it founded the fire and all of this is controlled by the microcontroller (Arduino uno). The robot can move on the specified route without being caught in the obstacles, and conducts a fire scan as it moves. By using the microcontroller module on it evaluates the data in the direction of the software and performs obstacle detection, flame detection, actuation, informing and extinguishing processes. Robot design and application process; The design and development of the mechanıcal system, the design and development of the electronic system, and the preparation of the necessary software. During the design and development of the mechanical system; Draft drawings, measurements, computer aided design and solid modeling programs. The robot designed in the study was able to detect fire sources randomly placed in random obstacle areas and extinguished with determined fire extinguishing systems.*
Keywords : *Fire-Extinguishing, Robot Design, Arduino.*

I. Introduction

With the ever-increasing technology, the developments are increasing in the face of the situations that cause human life. Every day, the robot industry emerges as a model that is produced as an alternative to human element in a new branch. Flying, robots, wheeled robots legged robots, humandroid robots, underwater robots are just some of them. The growing world population is bringing involuntary problems together.

Fires are among the most important of these problems. Robot industry has a lot of work in this area. Some of these are fixed mobile robots with different features, which are equipped with different sensors that detect before the fire is out, mobile rescue robots as fire search and rescue equipment, mobile locating robots used for fire detection, fire extinguishing robots in many different models designed to assist firefighters in the fire. There are many studies on robotics both in the sector and academically. Kızılhan, Bingül and Verity (2010) designed a 3D (3D) underground imaging robot for underground studies. The robots obtained by this study, infrastructure works, geophysical surveys, etc., which are difficult to view, were able to get underground images which were applied to many areas [1]. In the Mert (2016) study, the robot produced using the Kinect ToF camera was transferred to the Stäubli Rx160 industrial robot arm, which has six degrees of freedom simultaneously with the operation of the operator's arm by teleoperation. With this system, human limbs are perceived and their movements are followed [2]. In Eroğlu's (2006) study, fundamental behaviors have been developed which should be done by the robot such as wall finding, wall mounting, avoidance of front and side obstacles, concave and convex corner turns, control of tampons, control of wheel jam [3]. Qui, Qian and Xiang (2006) have designed a dynamic robot that will overcome barriers using ultrasonic sensors in their work. They used fuzzy logic for direction finding. With the help of robot infrared sensors produced in work, the barriers can cross different barriers without a fixed route [4]. Çavuşoğlu and Kırmızı (2007) have realized a project of a remote control camera with a serial port [5]. In Parlaktuna and Eroğlu (2007) study, a map of the circulating circles of the robot was created by using Bayes update occupancy grids by using the ultrasonic sensors on the robot and the data obtained from the encoder [6]. Sır and Umar (2007) have designed a forklift robot that can be controlled by computer via RF in their work. The robot is controlled by an operator outside the workshop by computer and remote control [7]. Xu et al. (2009) have designed a fire fighting robot consisting of 4 main modules in their work. Each module was assembled with appropriate components to design a mobile robot capable of detecting fire at 360 degrees with 6 sensors [8]. Chien et al. (2010) have designed and manufactured a fire robot with 3600 control areas using 5 IR sensors and 5 ultrasonic sensors. This robot based on the determination of fire in simple sense and extinguishing with fan help has the advantage of fire control and detection with its 3600 control area [9]. Darwish (2010), the difference developed by Lot Zadeh is based on

fuzzy logic algorithms which vary according to the situation. The extinguishing system was implemented with a fan connected to a motor coupled to the micro-controller using an engine controller. The microcontroller software of the project was created with a logic that can be learned by using fuzzy logic [10].

II. Material and Method

The main goal of the mobile fire fighting robot application in this study is to search the fire with the flow chart determined in the labyrinth created in any way and to extinguish the fire with the help of the fan when the fire is found. A variety of mechanical and electronic components were provided for this purpose and then the mobile robot was assembled. Finally, the designed robot has been programmed to perform the intended functions.

2.1. Mechanical and Hardware Units Used in Navigational Fire Fighting Robot

The two wheels that make the movement of the traveling robot are connected to two reducer motor. It can work independently from each other within the flow chart determined on both wheels. Both wheels can operate independently of each other Within the specified flow chart. Rear wheels are fitted with ball bearings that do not interfere with rotation so that the wheels can not keep the system standing. The Plexiglas body is used for the body where all the components belonging to Robota are placed and assembled. The Arduino Uno R3 central control unit, just above the torpedo was installed and the other components of the sistem were built on the Plexiglas above the ardunio uno R3 (Fig. 1).

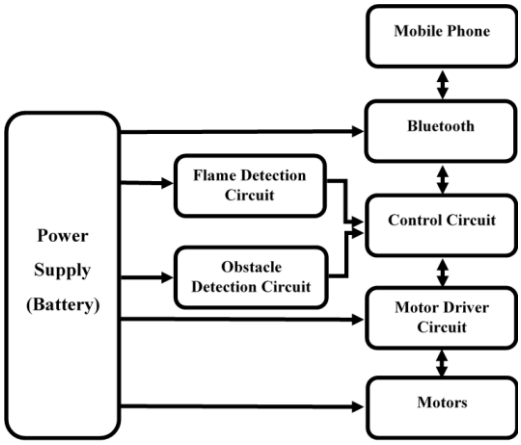

Fig. 1. Simplified diagram of the designed robot

The circuit used in the study is as in fig. 2.

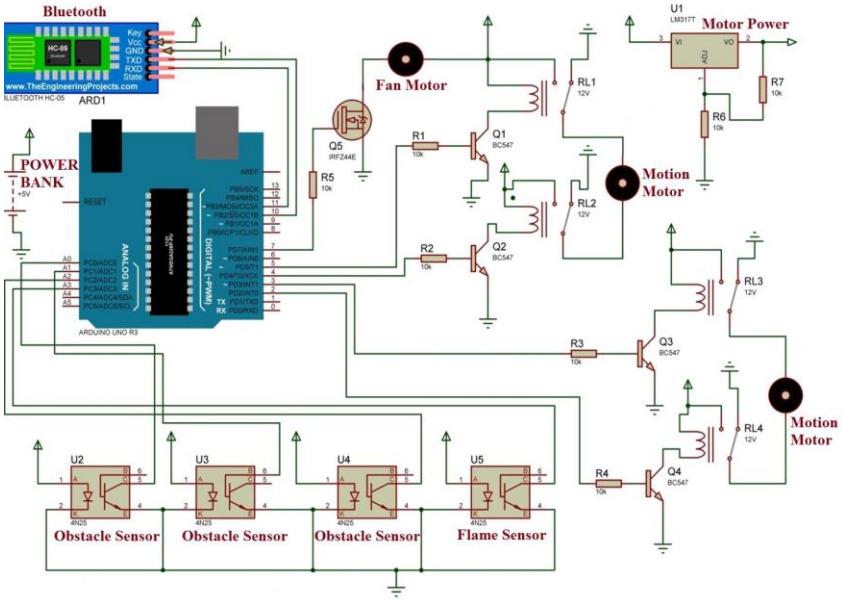

Fig. 2. Circuit used in robot control

The first floor of the Navigator firefighting robot has a Plexiglas, at the top of the chassis: Arduino Uno R3, mounting plastic platforms which holding the sensors (3 pieces), 3 obstacle sensors connected to sensor's platforms, Plastic platform which holds the fire extinguisher fan and is made by ourselves, beside the sensor which is in front of this platforma fire extinguisher fan, there is the platform holding the fire sensor we made and the fire sensor connected to this platform. On the lower part of the chassis, there are mounted gearmotors (2 pieces), and the wheels connected to the gearmotors are mounted. All of the complementary parts of the robot are mounted on these platforms. These complementary components consist of cables, relay circuit, lipo battery, flame sensor (Fig. 3).

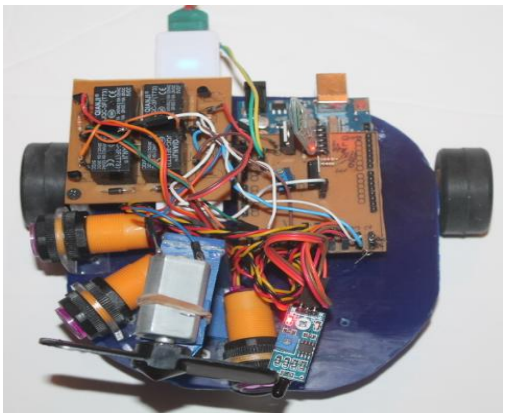

Fig. 3. Installation of the navigating fire-fighting robot

2.2. Navigator Fire Fighting Robot Obstacle and Object Sensors

The intent of the navigational firefighting robot to function in a large area and the presence of the flame, which is expected to be found by the robot, in different locations give rise to considerable difficulties in design. There are different perceptions developed for the perception and discovery of fires [11]. Ultrasonic sensors can give erroneous results in terms of detecting reflected signals from the environment. In addition, when video communication is used (such as a camera, etc.), processing of acquired images will result in more energy and more cost as well as a more complex structure [12]. This will cause significant difficulties for a real-time robot to work in this measure [13]. The MZ80 Sensor, which is used in operation, is a powerful sensor with minimum response time, manufactured in industry standards. It has 80 centimeter range. The range is made with a trimpot located behind the setting. The distance can be reduced to 3 cm by narrowing the circumference (Fig. 4) [14].

Fig. 4. MZ80 used for Obstacle Identification

Transmitting rays are emitted in this body, which helps to detect objects. The rays coming from the object are reflected and detected by the receiver. Thus, objects in the environment are perceived by the rays they reflect. Because of the economical and fast results of these sensors, these types of obstacle detectors are widely used today [12].

2.3. Software for Navigational Fire Fighting Robot System

2.3.1. About Arduino Uno R3 Programming

To programing Arduino Uno, you need the open source Arduino IDE software that the card manufacturer company wrote. The Arduino IDE Program is a software program written in Java language, used to program Arduino cards and to download Arduino cards to Arduino cards. I downloaded the program that I downloaded from the firm's site (https://www.arduino.cc/) with this program. It has an editor that uses the Processing / Wiring language, the commands that resemble the C language in some places, and the supporting utilities for the projects (Library - library). Along with this, another company's editor (IDE) has been developed since Arduino includes open source software. A bootloader (boot loader) has already been installed on ATmega328 on Arduino Uno. With this bootloader we can develop software without the need for an external programmer to program Arduino. The programming work can easily be performed by making the necessary settings and definitions in the IDE program (Fig. 5).

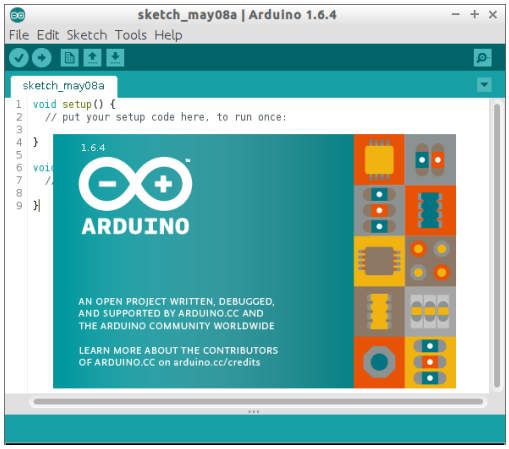

Fig. 5. Arduino IDE program's image

2.3.2. About Communication Structure

Bluetooth-based HC05 Bluetooth-Serial Module Card is used for communication. The HC05 Bluetooth-Serial Module Card is designed for use with Bluetooth SPS (Serial Port Standard) and wireless serial communication applications. The possibility of rapid prototyping, breadboard, arduino and pins needed to be used comfortably in various circuits have been taken out thanks to the circuit board. Unlike most bluetooth modems, it also supports master mode [15].

When the Bluetooth module is connected to the Arduino circuit, the first module name, baud rate and password are set. In order to pass the HC-05 bluetooth module to the configuration mode, the 5V connection was made while holding down the button on the module. When entering the configuration mode, the frequency of the LED lit on the module is set as standard. The flashing of the LED indicates to us that the module is in communication mode. The module is set to be listed in the scans made by other bluetooth devices while in the communication mode. When connected to a device mode in communication mode, the LED flashes briefly once every 3 seconds to indicate that communication is on [16].

After the installation, the software and the devices were introduced to each other by making the configuration [17].

The mobile robot is designed to complete the cycle by controlling the right side so that the route will travel in a certain environment. This robots flowchart shows Fig. 6.

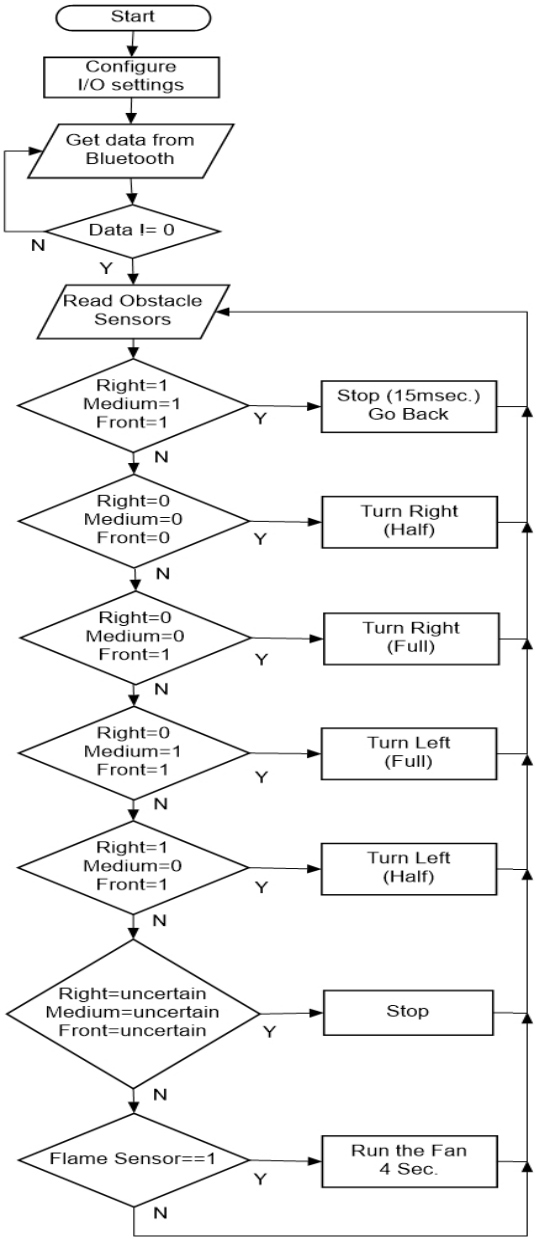

Fig. 6. Flow chart diagram of a fire-extinguishing robot

When the right, middle and front sensors are obstructed, the left engine goes backward for 15 ms and returns to the right. When the right, middle and front sensors do not detect obstacle, And the obstacle is not detected in the middle sensor but the obstacle is detected in the front sensor, the vehicle stops for 15 ms, goes back 100 ms, the left engine goes back 500 ms, the right engine goes back 400 ms, the right sensor does not obstruct the center and the front sensor detects the obstacle, When the obstacle is detected in the middle sensor, the vehicle turns 15 ms, 100 ms back, left motor 150 ms forward and right motor 50 ms backward. If anything else happens, if the flame is detected by the sensor, the fan will not start or the vehicle will stop.

III. Results

The initial stage of the project is the part of Finding fire, fire sensor LM393 The fire sensor detects fire at a certain distance. It does not receive data from areas outside of the determined area. It was decided to use two Reducing motors in order to realize the motion system. Both of these Reducing engines can move forward and backward. According to the obstacle state, if the motor is to be turned, one of the motors is given a reverse current by the processor and the axial rotation is provided and the obstacle less driving is provided. Thus, every obstacle was easily overcome in the environment where the system is located. When it detects obstacles, it intercepts 3 MZ80 sensors and sends the necessary data to the robot so that the robot can move without hitting the obstacles. In order to provide this communication in the project, communication is made with the android

interface created using HC-05 bluetooth module. If the robot system is navigating through the obstacle and fire is detected by the flame sensor, microcontroller data is being sent. After the scan is finished, the microcontroller fan motor is activated according to the incoming signal and the fire extinguishes with the help of wind (Fig. 7).

Fig. 7. Extinguishing the fire detected by the robot

IV. Conclusion and Discussion

In the fire-extinguishing robot project, the aim was to develop a system that detects and extinguishes the fire before the fire starts and informs the electronic environment. In this project, targets are microcontroller and motor control with reductive motor, obstacle detection with MZ80 sensor, flame detection with flame sensor, bluetooth communication.

The mobile robot which is designed as a result of this study communicates with the mobile phone through the serial port via the serial port and processes the analog and digital data received from the sensors in the microcontroller control so as to determine the fire in the environment while determining the fire in the environment. In this work, a system that works successfully both hardware and software has been realized. This system "fire detection and extinguishing robot" is capable of being used in everyday life if more professionals are selected instead of the elements used in the project. This can be easily used in closed parking lots, supermarkets, stores, shops. By the fire extinguishers which can be added to the robot, the fire can be firstly intervened and most of the fire can be extinguished without any growth. Among the changes that can be made are the provision of safety of the robot by using non-combustible materials, the increase of the number of sensors for obstacle detection and the increase of the quality of the batteries used for the longer life of the robot's energy. In our work, fire extinguishing was done with the help of fans only. However, there are many alternatives in this regard. There are many applications such as water spraying, fire extinguisher gel tightening with the help of servo motors. However, we chose not to extinguish it with the wind which is most suitable for both time and material work. This method may not be effective for every oil intervention, but may even be dangerous for some oils. In this sense, it is possible to think of many alternatives for this part of robotics.

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