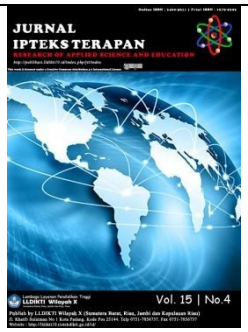

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FIRE DETECTION AND FIGHTING ROBOTS USING WALL FOLLOWING TECHNIQUES

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Abstract

Robot is defined as a mechanical device capable of performing dangerous human work. One of the human jobs that can be done by robots is fire fighting activities. In this study, a prototype fire extinguisher robot with a wall following technique will be designed by taking a simulated fire sample in a labyrinth and giving a candle flame as a fire to be extinguished. This fire fighting robot is designed with 4 (four) wheels, the robot uses ultrasonic sensors to adjust the distance between the robot and the walls so that the robot does not hit walls or objects that block it, the robot is also given a flame detector to detect the presence of fire and a DC motor to extinguish the fire. In addition, the robot can also move to find and extinguish hotspots through the control of the android application, by connecting the bluetooth on the smartphone to bluetooth, the system is connected to the smartphone so that it can move the robot according to orders through the application. From the test results obtained that the sensitivity is very influential on the performance of the movement of the fire fighting robot. The ideal limit for this fire fighting robot is below 80 cm.

Keywords: Fire Detector, Fire Fighting Robots, Wall Following Techniques, Microcontroller

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INTRODUCTION

Robotics is a testament to the progress of human civilization from time to time. The form of a robot is not just a shape that resembles a certain animal, but moves to resemble the shape it (Azis, 2020).

Robots are developed to be able to assist human work in carrying out various complex(Moniz & Krings, 2016), dangerous and demanding jobs that require accuracy and reduce the level of risk of work accidents, for example in extinguishing fires(Aliff et al., 2019). Fire fighting robots are tools that help humans to track, detect and extinguish fires or fires(Ramasubramanian et al., 2020). Fire fighting robots are tools that help humans to track, detect and extinguish fires or fires(Kanwar & Agilandeeswari, 2018). Fires often occur due to several problems such as electrical short circuits, human negligence and so on which result in loss of life and property loss(Jazebi et al., 2020).

The agency authorized to deal with fires that occur is the fire department. However, it is difficult to extinguish the fire to the interior of the room, tunnel or dangerous locations that cannot be entered by firefighters because it is a high risk for firefighters(Pluntke et al., 2019). These risks include explosions, burning room

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conditions, and sharp objects. Extinguishing that is done manually without a fire extinguisher robot for firefighters will experience accidents, disability and even death(Heydari et al., 2021).

Based on the description above, this research will design a robot "Designing a Fire Extinguishing Robot Using the Arduino Mega-based Wall Following Technique." The purpose of Wall Following is an automatic robot whose movement follows the dividing walls on the track. In addition, the robot can also move to find and extinguish hotspots through the control of the android application manually(Raju et al., 2018)(MS et al., 2016).

The purpose of the research is to reduce the level of accident risk in fire fighting work, to design a prototype fire fighting robot that can search for and extinguish fires, use a reliable navigation system so that it can support the robot's performance so that it can complete fire fighting(Kim et al., 2016).

RESEARCH METHODS

In this stage the researcher uses the prototype method, while the essence of this method is the work of a model development into a final system(Irawan, 2021).

The steps involved in making a fire fighting robot use the prototype method, namely:

1. Gathering Needs

At this stage the researcher analyzes the needs in the design of the fire fighting robot to be built(Rahmaddeni et al., 2022). Among them is the selection of the required hardware and software. In this case the researcher uses Arduino Mega as the main hardware and Arduino software(Irawan et al., 2022).

2. Build Prototyping

In this case, the researcher describes the input and output formats that will be produced(Perkasa et al., 2021).

3. Prototyping Evaluation

Next, after the prototyping development stage, the researcher defines the format and overall requirements of the robot, identifies all requirements, and outlines the robot to be built(Irawan, 2021)(Wahyuni et al., 2023).

4. Coding Robot

In this stage the agreed prototyping is translated into the appropriate programming language as a process for inputting commands to be received on Arduino(Purwanti et al., 2021).

5. Robot Testing

In this stage, the modules that have been made using the wall following technique are combined and tested to find out whether the robot that has been built is in accordance with the design and whether there are still errors or not(Prasojo et al., 2020).

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RESULTS AND DISCUSSION

Implementation is one of the stages in system development, where this stage is the stage of putting control of the fire fighting robot control system using the Arduino Mega-based wall following technique. so that it is ready for operation and can be seen as an effort to realize the tool that has been designed(Priyanka et al., 2017).

The picture below is a series of Arduino Mega machines with Bluetooth.

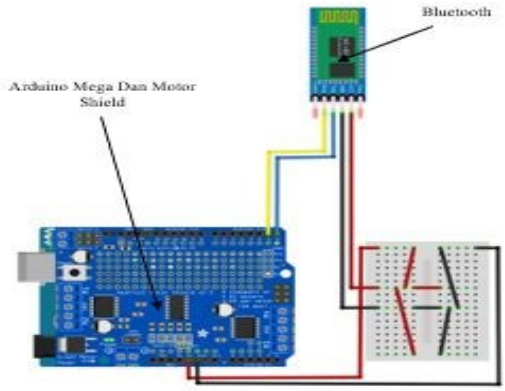

Figure 1. Arduino mega, Motor Sield and Bluetooth

The picture below is an Arduino Mega machine circuit with a Flame sensor.

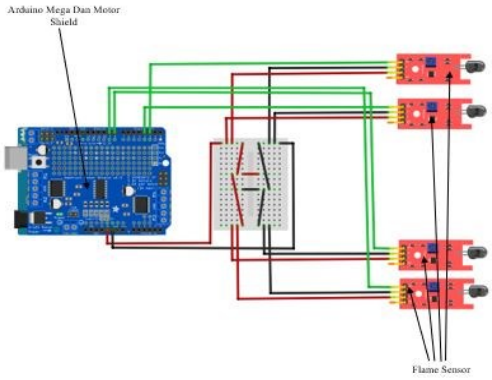

Figure 2. Arduino Mega, Motor Sield and Flame Detector

The picture below is a series of Arduino Mega machines with dc motors

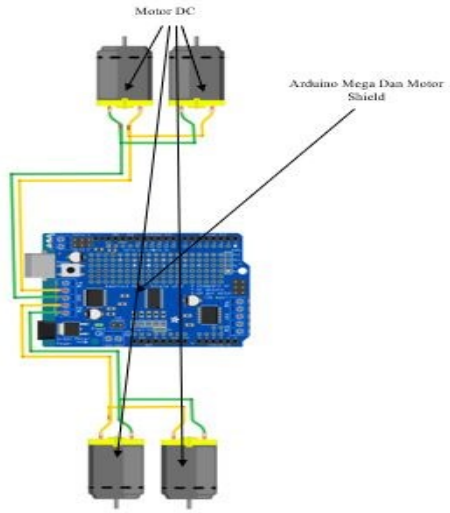

Figure 3. Arduino Mega, Sield Motor and DC Motor

The picture below is a series of Arduino Mega machines with Ultrasonic Sensors

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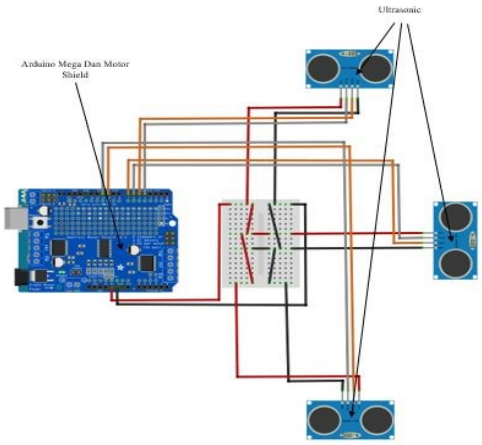

Figure 4. Arduino Mega, Sield and Ultrasonic Motors

The picture below is a series of Arduino Mega machines, Relays with Pumps.

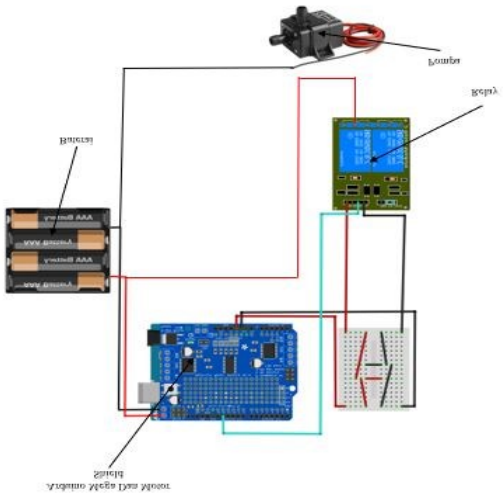

Figure 5. Arduino Mega, Relay with Pump

The picture below is a series of the entire fire fighting robot control system using the Arduino Mega-based wall following technique

Figure 6. Overall view

The picture below is an android application display design for a fire fighting robot control system using the Arduino Mega-based wall following technique.

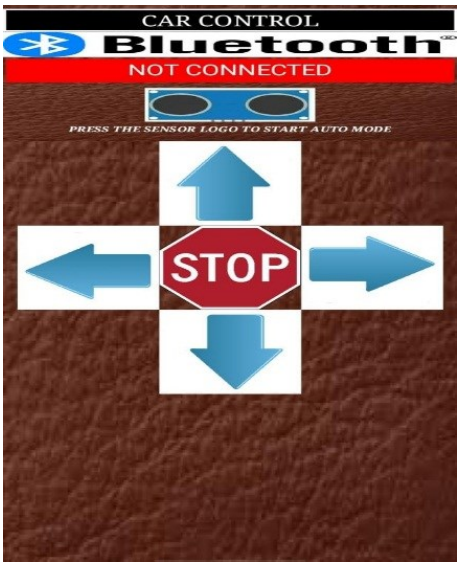

Figure 7. Display of the android application

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Testing the Arduino Mega system on a wall following fire fighting robot can be done with the following steps:

1. Connect the battery to the hardware circuit of the wall following fire fighting robot
2. After that the wall following fire fighting robot will light up like its supporting devices, namely Arduino Mega, Flame Sensor, Relay, and DC Motor.
3. After the fire fighting robot turns on the robot is ready to run the command.
4. When the hotspots are in the room/labyrinth, the robot will search for the hotspots by following the existing side of the wall automatically.
5. And if the robot is outside the room where the fire occurred / outside the labyrinth, the fire fighting robot is run manually controlled from the android and directed to the point of fire to be extinguished.

Flame Sensor Test

Testing with candles. When the flame sensor detects a fire around, the robot will spit water and the buzzer will sound, and when the flame sensor no longer detects a fire, the robot will continue to run and look for hotspots. The flame sensor will send data to the Arduino Mega microcontroller.

Table 1. Flame Detector Test

Condition	Pump	*Buzzer*
No Fire	Not active	Not active
Fire Detected	Active	Active

Left Ultrasonic Test

Testing with candles. When the distance read by the ultrasonic sensor in the prototype is above 5 cm then Forward and when the distance read by the ultrasonic in the prototype is below 5 cm then Right. Ultrasonic will send data to the Arduino Mega microcontroller.

Table 2. Left Ultrasonic Testing

Distance	Condition
<5 cm	Right
>5 cm	Forward

Right Ultrasonic Test

Testing with candles. When the distance read by the ultrasonic sensor in the prototype is above 5 cm then forward and when the distance read by ultrasonic in the prototype is below 5 cm then left. Ultrasonic will send data to the Arduino Mega microcontroller.

Table 3. Right Ultrasonic Testing

Distance	Condition
<5 cm	Left
>5 cm	Forward

Wall Following System Testing

The test is carried out by following the left wall and right side walls carried out in a labyrinth. By following the left wall and the right wall, the wall following robot

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managed to follow the wall with a duration of 20-30 seconds to the point where a fire was detected.

Table 4. Wall Following System Testing

Test Number	Time (seconds)	Results
1	25	Successfully extinguished the fire
2	20	Successfully extinguished the fire
3	30	Successfully extinguished the fire
4	28	Successfully extinguished the fire
5	23	Successfully extinguished the fire

CONCLUSION

Based on the results of the research that has been carried out, it is concluded that the presence of a fire fighting robot using the Arduino Mega-based wall following technique can reduce the risk of firefighters' accidents. In addition, this fire fighting robot control system uses wall following and bluetooth techniques. By connecting the bluetooth on the smartphone to bluetooth, the system is connected to the smartphone so that it can move the robot according to commands through the application. Fire Extinguishing Robot Using Wall Following Technique based on Arduino Mega based on Android has not been able to run on uneven floors, in the future the Fire Extinguishing Robot Using Wall Following Technique based on Arduino Mega based on Android can already run on uneven floors. The sensitivity of the flame detector greatly affects the performance of the movement of the fire fighting robot. The ideal limit for a fire fighting robot is below 80 cm. And for the spray of water that is released, you should use a nozzle sprayer so that the water released is more water efficient and more effective in extinguishing the fire.

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