DESIGN OF ROBOT FIRE EXTINGUISHING FIRE EXTINGUISHERS USING TECHNOLOGY OF NAVIGATION WALL FOLLOWER WITH ARDUINO MEGA, PING PARALAX, AND TPA81 DISTANCE SENSORS

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Abstract— The purpose of this study is to develop a legged Fire Extinguisher Robot that is able to detect fire and extinguish it. This robot is controlled by Arduino meda which has been given an algorithm so that it can automatically perform its function / The mechanical component of this robot includes 5 paralax ping distance sensors as navigator, TPA81 as a fire detector, 18 servo as a drive, and a water fire extinguisher to extinguish the fire. The robot will automatically activate after the sound activation is turned on. The robot will move through the room by searching the wall. The robot is equipped with 3 sets of line detectors to distinguish rooms and roads, homes, and candle flame areas. The test results show that the robot can detect the presence of hotspots in each room. The robot can also find hotspots in a particular room and extinguish it. The time needed to find and extinguish the fire from start to return to home is 3 minutes.

Keywords : Arduino, Robot, Sensor, Fire Fighting

I. INTRODUCTION

The discovery of robots is very helpful for humans in doing work that requires high accuracy, requires large power, repetitive and dirty work, and high-risk or dangerous jobs. One of the high-risk human jobs that can be carried out by robots is the fire department. Fire fighting work requires a quick reaction because the fire problem can be reduced if the source of the fire can be found and extinguished in a short time.

Actually this dangerous work can be replaced by a robot. This type of work requires a quick reaction because a fire can be avoided if a fire can be extinguished before spreading. Fire problems can be minimized if a fire source can be found and turned off in a short time.

In Indonesia alone, there are competitions that compete with fire fighting robots. Since the Indonesian Fire Extinguisher Robot Contest (KRPAI) was first held in 2004 under the name of the Indonesian Smart Robot Contest (KRCI) until 2017, there have been many significant developments both in terms of technological mastery among student participants and on the achievements of international achievements. at Trinity College International Robot Contest (TCIRC), formerly Trinity College Fire Fighting Home Robot Contest (TCFFHRC) in Hartford, Connecticut, United States.

The firefight robot needed to meet the requirements and rules as outlined by the 2016 Trinity College Fire Fighting Robot Competition Rulebook [1]. The robot had be fullyautonomous and could not receive outside changes during a trial. The robot could touch wallsduring normal movement, but could not "crash" into walls at high speed. The robot was required to fit into a bounding box 31cm x 31cm x 27cm. The only exemption to the bounding box was the optional use of an extendable arm for level 3. The robot had to include a momentary start button with a green background. This had to be the only start button. The microphone had to be placed on the top of the robot. It had to have a blue background with the words MIC on thebackground. An LED was required on top of the robot to indicate when the robot sees the flame.A kill switch had to be included on the top of the robot to kill power to the sensors, motors, and and logic. The robot had to have an obvious handle for the judges to use in putting the robot in the arena. The rules changed significantly in comparison to the 2015 rules. The competition had three levels within each division. The only way to compete in levels two and three was to complete the level before it. For the first level, the robot needed to start the competition when a fire alarm buzzer sounds. The robot then autonomously navigated through a course as outlined in the rules to find a candle. When the candle was found, the robot used a versa valve controlled CO2 canister to extinguish the candle. After extinguishing the candle, the robot navigated back to its starting position. The robot earned points for completing each requirement and for how quickly the robot is able to complete the course. The course had to be completed in under three minutes. Figure 1 shows the basic layout and dimensions of the arena. There are 4 rooms connected together by hallways.

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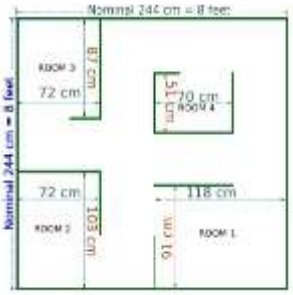

Figure 1. Basic Track

Level two had the same requirements as level one, but added the complexity of rugs and wall decorations as well as a dog obstacle and furniture. Level two also added a level of complexity with four possible course layouts that were chosen at random when the robot was turned over to the judges for a run. Level two had to be completed in under four minutes. Figures 2, 3, 4, and 5 show the different layouts possible for the level 2 arenas. The differences between these arenas were the entrances to rooms 1 and 4 are varied either separately or together.

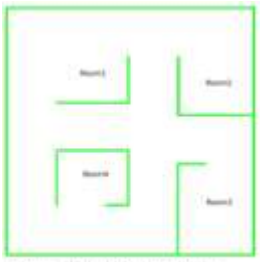

Figure 2. Level 2 layout A [1]

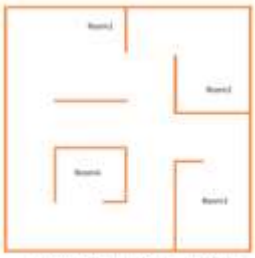

Figure 3. Level 2 layout B [1]

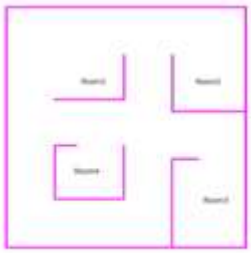

Figure 4. Level 2 layout C [1]

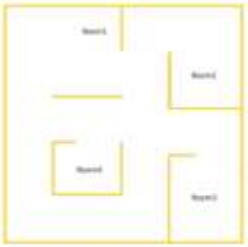

Figure 5. Level 2 layout D [1]

Requirements for this project included:

1. Produce a fully autonomous robot

2. Meet all size requirements

3. Include handle for easy transportation to arena

4. Include start button, Mic, “Fire Found” LED, and kill switch

5. Be competitive at the first and second levels and attempt the second level

From this background, the researchers are interested in design of robot fire extinguishing fire extinguishers using technology of navigation wall follower with arduino mega, ping paralax, and tpa81 distance sensors

II. METHOD

A. Algorithm for Entering The Room

When the robot enters the room, the line detection sensor will live as a warning if the robot has entered the room. After that it will proceed to the fire detection algorithm in the room. The line detection system image can be seen as follows, figure 6. (image line detection system)

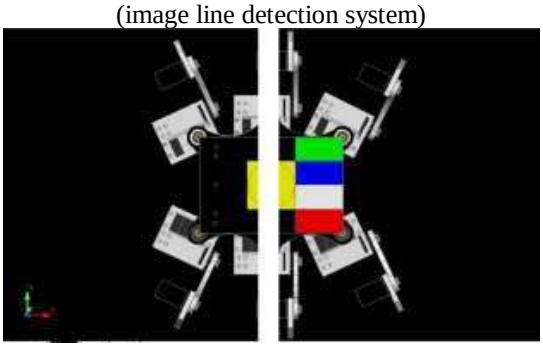

Figure 6. Robot Entering Room

B. Fire Detection

After the robot receives a warning from the line sensor that the robot has entered the room, the robot will stop. When the robot stops, continue with the search for fire using TPA81. The purple area of the Figure is a fire sensor detection area. If a full fire search has been carried out in the room, the robot will continue to search in another room.

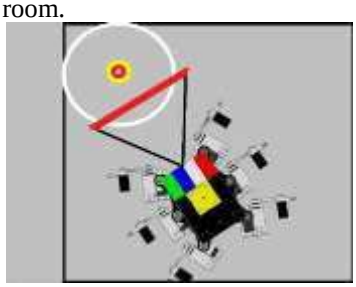

Figure 7. Robot Looking For Fire

C. Entering Home

The robot enters or is on the home marked by the three line sensors in the on .

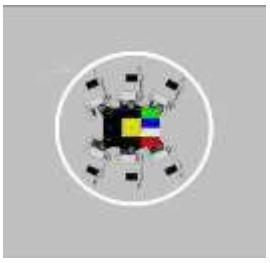

Figure 8. Robot Entering Home

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D. Flowcart

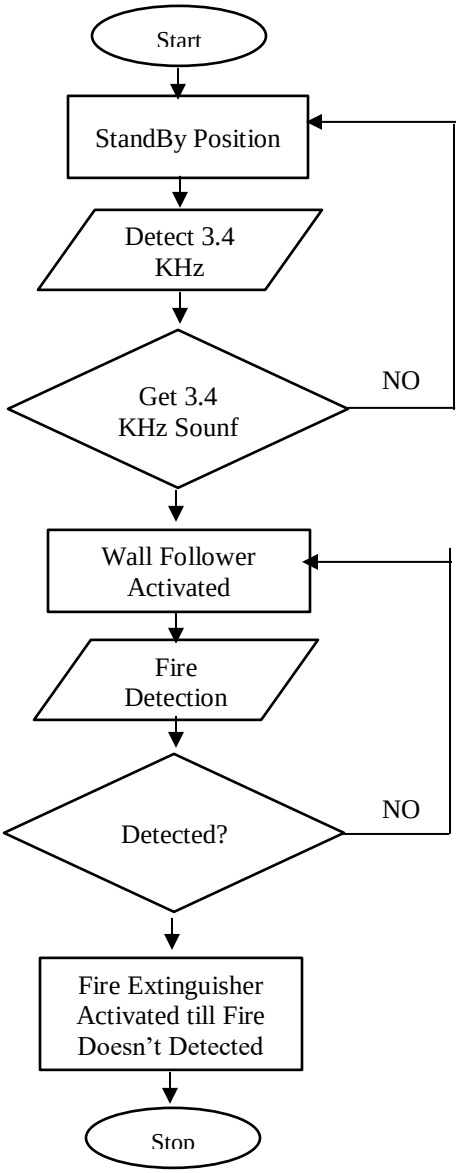


Figure 9. Flowcart

E. Mechanical Design

The following are some robot sketches that can be seen from several points of view.

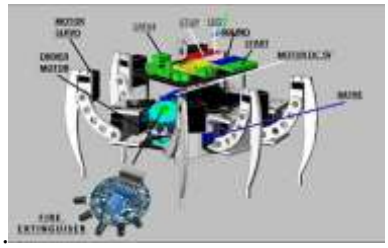
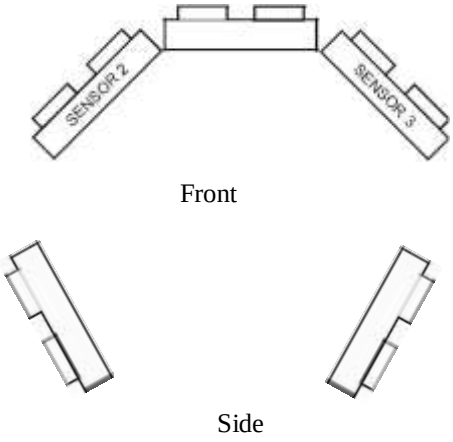


Figure 10. Overall View Of Robot

For Ultrasonic sensor layout (SRF04) as a labyrinth lane reader system can be seen as follows.



Front

Side

III. RESULT AND DISCUSSION

A. Device

- Robot Drive System

The SFR_Reborn robot uses 18 Dynamixel AX-12A servo motors, this servo motor has a maximum torque of 15 Kg. Here is the Dynamixel AX-12A servo motor Figure.

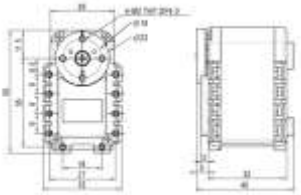


Figure 11. Motor Servo Dynamixel AX-12A

- Microcontroller Arduino Mega

Arduino Mega 2560 is an Arduino-based microcontroller development board using ATmega2560 chip. This board has a lot of I / O pins, some 54 digital I / O pins (15 pins of which are PWM), 16 pin analog input, 4 pin UART (serial port hardware). The Arduino Mega 2560 is equipped with a 16 Mhz oscillator, a USB port, DC power jack, ICSP header, and reset button. This board is very complete, already has everything needed for a microcontroller. With a fairly simple usage, by connecting power from USB to computer or through AC / DC adapter to DC jack.

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Figure 12. Microcontroller Arduino Mega

- Fire Extinguishing System

The fire extinguishing system on the robot uses an extinguisher with a 12V DC motor. The following is a Figure of the robot fire fighting system.

Figure 13. Fire Extinguishing System

- White Line Detection

The Working Principle of the Proximity Sensor (Photodioda) is that the sensor will receive more light when the obstacle approaches the white color. If the line is bright or white, the LED signal can be reflected. Photodiode becomes active so the output has a low voltage (close to 0 Volts). Instead the output becomes high (close to 5 V). The circuit image of the detector line can be seen as follows.

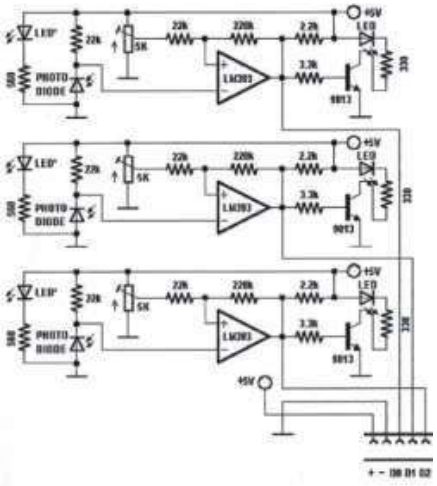

Figure 14. White Line Detection

- Distance Detection

Detect objects in front by capturing reflections from the transmitted signal, similar to bats, radar.The working principle of Devantech SRF04 is as follows: The controller sends a start signal, Devantech SRF04 emits a short burst signal, Devantech SRF04 sends an echo pulse, the Controller measures the echo pulse width of Devantech SRF04. The Ultrasound System Figure for wall followers can be seen as follows.

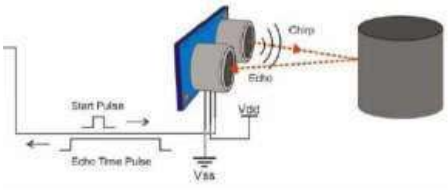

Figure 15. Sensor Ultrasonic SRF04

- Fire Detection

The heat sensor that we use to detect the presence of hotspots, TP81. The interface that we use in accessing the TPA81 sensor is using I2C communication. On this sensor, there are 8 pixels of data generated. Besides being able to detect temperature, this sensor also has a channel that can be used to drive servo. The physical figure of the TPA81 sensor can be seen as follows.

Figure 16. Sensor TPA81

B. Result

The experimental results are stated in the following table

Start Room	Fire Room	Time
1	2	00:30
1	3	01:10
1	4	02:30
2	3	00:45
2	4	01:58
3	1	02:10
3	2	02:58
4	1	00:38
4	3	03:00
4	2	02:03

IV. CONCLUSION

The robot was able to meet all project requirements. The robot was able to autonomously navigate through level 1 and all layouts of level 2. The robot was able to identify a fire using the TPA81, and was also able to navigate to the rrom using wallfollowers technique.. The robotwas able to start at 3.8 kHz and not at ambient noise. The robot also met all rulebookrequirements for size and labeling. The robot was very reliable in its operation, being able to find and extinguish candles on seventy percent of runs.

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