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DEVELOPMENT AND IMPLEMENTATION OF SMART FIRE FIGHTING ROBOT

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ABSTRACT- Fire incident is a disaster that can potentially cause the loss of life, property damage and permanent disability to the affected victim. They can also suffer from prolonged psychological and trauma.
Fire fighters are primarily tasked to handle fire incidents, but they are often exposed to higher risks when, they are robot in case of difeerance in extinguishing fire Particularly in hazardous environments such as nuclear power plants, refineries, and gas tanks. They face additional chal lenges, particularly if the fire occurs in a narrow and restricted area, as it is necessary to explore the ruins of buildings and obstacles in order to extinguish the fire and save the victim. With high barriers and risks in firefig hting operations, technological innovations can be used to aid firefighting. As a result, this paper describes the development of QRob, a firefighting robot that can extinguish fires without exposing firefighters to unneces sary danger. QRob is designed to be smaller in size than other conventional firefighting robots in order to facil itate smalspace entry for a de-eper reach of extinguishing fire in a narrow space.
QRob also has an ultrasonic sensor to avoid colliding with obstacles and surrounding objects, as well as a flame sensor for fire detection. As a result, QRob demonstrated the ability to automatically identify fire locations and extinguish fires at specific distances. QRob is programmed to locate the fire and stop at a maximum distance of 40 cm from it. A human operator can keep an eye on the robot by using a camera that connects to a smartphone or other remote devices.
Index Terms- Firefighting robot; compact size robot; ultrasonic sensor; flame sensor; remote control

I. INTRODUCTION

A robot is an automated device that performs functions normally assigned to humans or machines is taske d set of repetitive or flexible actions. Numerous studies have demonstrated that robot can be useful in medicine [1, 2,6], rehabilitation [7, 8], rescue operations [7, 8], and industry [9]. Robotics has been introduced in a variety of industries over the years. Industrial robots are multifunction manipulators that are designed for more specia lised materials, divisions, and applications gadgets or devices through various programmatic movements to perform various tasks [10]. In line with the Fourth Industrial Revolution (4IR), there is demand for a one system that can control, communicate and integrate different robots regardless of their types and specifications. Machine learning has also heated up interest in robotics, although only a portion of recent development in robotics can be associated with machine learning. Recent robotic development project has embedded machine

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learning algorithms [11-15] to increase the intelligence in robots. This will increase the productivity in industry while reducing the cost and electronic waste in a long run.

Humanoid robot research is being actively pursued in order to reduce firefighter injuries and deaths while also increasing productivity, safety, efficiency, and task quality. Telerobots, Telepresence robots, Mobile robots, Autonomous robots, and Android robots are some of the different types of robots. Telepresence robots are similar to telerobots, with the main difference being that they provide feedback via vide,sound, and other data. As a result, telepresence robots are widely used in many fields that require monitoring capability, such as child nursery and education, as well as improving the social and daily activities of older aduls. A mobile robot is designed to navigate and perform tasks without the assistance of humans.Meanwhile, autonomous robots can complete the task on their own and receive power.

II. METHODOLOGY

The methodology is broken down into three sections. The first section focuses on mechanical schematics, follo wed by hardware descriptions, finally on programming design. All parts were assembled together, experiments were carried out to determine the optimal distance for QRob to extinguish the fire.

A. Mechanical Design Structure

The 3D and 2D schematic diagrams were created using Google SketchUp and AutoCad software.

QRob's main structure has two wheels on the back side and two wheels on the front side to achieve the desired movement and speed. The wheels have the ability to stabilise the robot as well as rotate 360 degrees.

To protect the electronic circuit, the body of the robot is made of acrylic plate. The acrylic sheet can withstand temperatures of up to 200 degrees Celsius. This allows you to use and work with it (cut and drill). The acrylic chassis's body contains holes that facilitate the mounting of various types of sensors and other mechanical components.

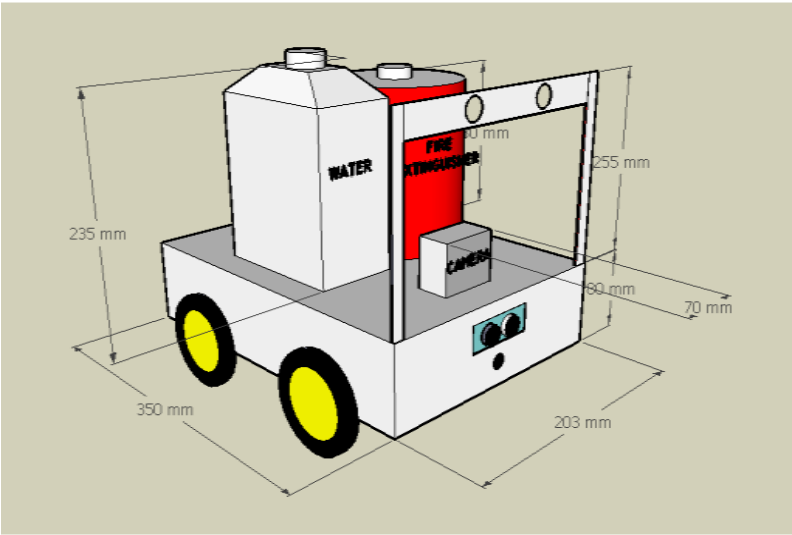

Fig. 1. 3D Structure of QRob with Dimension.

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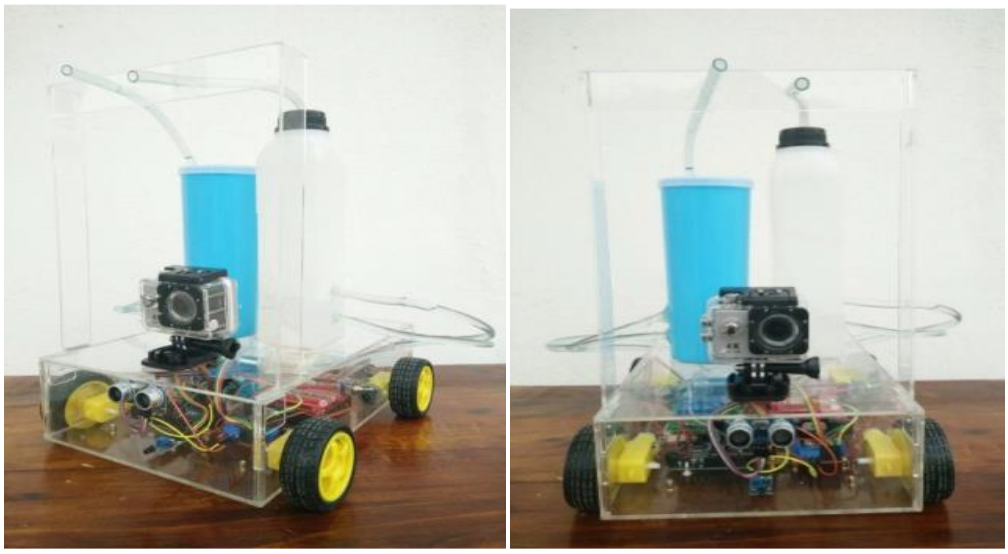

Fig. 2. Firefighting Robot (QRob).

B. Hardware Implementation

The electronic part is one of the vital parts in the development of QRob. It includes the several types of sensors, microcontroller, DC motor with wheel, Transmitter and Remote control and Water pump. Fig. 3 shows the block diagram of the QRob operation which consists of flame sensor and ultrasonic sensor as input of the system. Arduino Uno is used as a microcontroller that connected with other components. Motor Driver (L298N) is used to activate the moving of the gear motor while Transmitter Remote Control will give output of the system. Flow of water and fire extinguisher were pump after being controlled by the operator.

1) Flame sensor: In most firefighting robots, fire sensors perform an essential part in investigations, which are always used as robot eyes to discover sources of fire [1]. It can be utilized to identify fire based on wavelength of the light at 760 nm to 1100 nm. The detection angle and distance are roughly 60 degrees and distance 20 cm (4.8V) to 100 cm (1V) respectively. Flame sensor has two signal pins that are Digital Output (DO) and Analog Output (AO). DO pins will give two kind of information that it's has flame or non-flame while AO pins will detect exact wavelength of different light.

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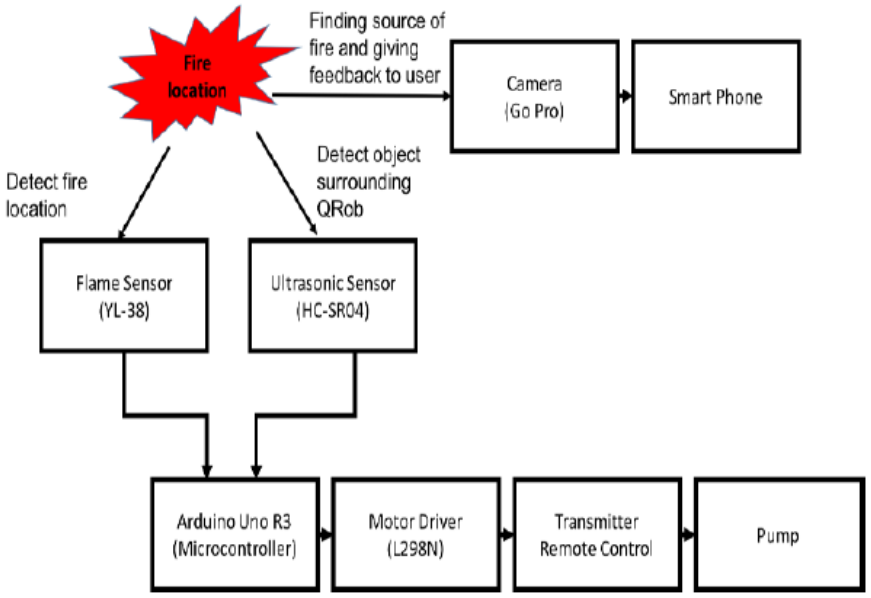

Fig. 3. Block Diagram of QRob.

2) Ultrasonic sensor: One of the most crucial aspect in inventing an autonomous target detection robot is obstacle avoidance. A sensor must be small, low-cost, easy to manufacture, and functional on a large scale. Furthermore, it should be capable of sensing things with sufficient limits to allow robots to react and travel appr opriately. Ultrasonic sensors are the only existing sensors that meet all of these criteria. In this study, the HC-SR04 ultrasonic sensor is used to determine distances ranging from 2 cm to 400 cm at an angle of 15 degrees. This sensor transmits waves into the air and receive reflected waves from the object. It has four output pin such as reference voltage (VCC) (operate around 5V), ground pin (GND), digital output (DO) and analog output (AO).

3) DC motor with wheel: DC geared motor with rubber wheel are suitable material for this project. This DC motor are suitable to replace 2 WD and 4 WD car chassis. The working voltage for DC motor is around 5V to 10 V DC. While the ratio of the gear is 48:1. Suitable current for this motor is 73.2 mA. DC motor is used to move the robot to the fire location.

4) Water pump: The water pump is important part in this robot as it will pump water or soap to extinguish the fire depending on the class of fire that occurs. Small-size and light-weight category of water pump has been selected for use in this project.

Moreover, it has low noise, high effectiveness and minimal power consumption. The optimal voltage for this water pump is 6V. Working voltage for this water pump is around 4V to 12V with the working current 0.8A.

5) Transmitter and remote control: In this study, the wireless remote control transmitter and receiver with 4 control modes will be used. Model number of this receiver or remote is S4C-AC110. This remote have four buttons.

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III. CONTROLLING

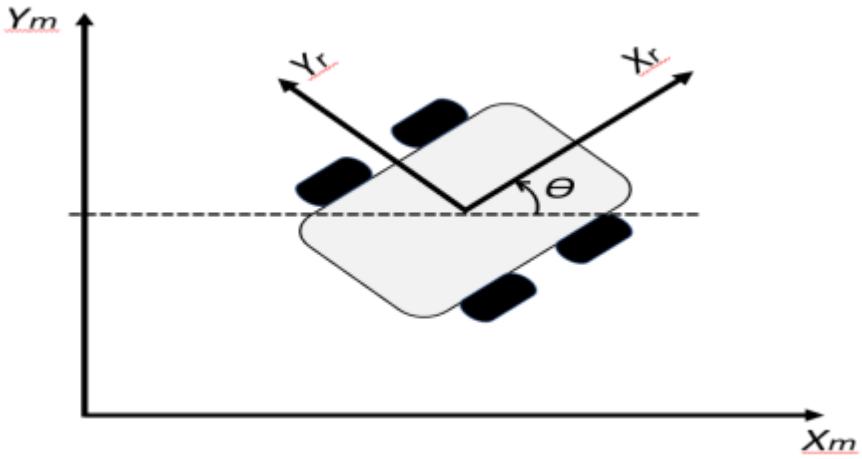

Fig. 4. Relationship between QRob Coordinate Plane with Main Surface Plane.

IV. RESULT

A firefighting robot (QRob) has been developed to locate and extinguish fires. QRob can locate itself using a flame sensor and an ultrasonic sensor. The flame sensor detects the presence of fire, while the ultrasonic sensor detects the presence of objects around the QRob. Both sensors are linked to an Arduino Uno, which controls the DC motor.When the flame sensor detects a fire, the DC motor will stop 40 cm away from the fire. The operator will use a remote control to extinguish the fire from a safe distance. The operator can also monitor the QRob using a smartphone-connected camera.

V. CONCLUSIONS

Overall, a remote-controllable firefighting robot has been successfully developed.It has advantageous features such as the ability to automatically detect fire location, as well as a compact body and lightweight structure. Thanks to the inclusion of an ultrasonic sensor, QRob can also avoid colliding with any obstacles or objects. Because of its compact structure, the QRob robot can be used in places with small entrances or in small space. The operator can extinguish fires from a greater distance by using a control. Operators can also monitor the environmental conditions during the firefighting process smartphone's camera. According to the results of the experiments, the robot can detect smoke.

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