Development of Fire Fighting Robot (QRob)

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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 extinguishing fire, especially in hazardous environments such as in nuclear power plant, petroleum refineries and gas tanks. They are also faced with other difficulties, particularly if fire occurs in narrow and restricted places, as it is necessary to explore the ruins of buildings and obstacles to extinguish the fire and save the victim. With high barriers and risks in fire extinguishment operations, technological innovations can be utilized to assist firefighting. Therefore, this paper presents the development of a firefighting robot dubbed QRob that can extinguish fire without the need for fire fighters to be exposed to unnecessary danger. QRob is designed to be compact in size than other conventional fire-fighting robot in order to ease small location entry for deeper reach of extinguishing fire in narrow space. QRob is also equipped with an ultrasonic sensor to avoid it from hitting any obstacle and surrounding objects, while a flame sensor is attached for fire detection. This resulted in QRob demonstrating capabilities of identifying fire locations automatically and ability to extinguish fire remotely at particular distance. QRob is programmed to find the fire location and stop at maximum distance of 40 cm from the fire. A human operator can monitor the robot by using camera which connects to a smartphone or remote devices.**

Keywords—*Firefighting robot; compact size robot; ultrasonic sensor; flame sensor; remote control*

I. INTRODUCTION

A robot is an automated device which performs functions usually attributed to humans or machines tasked with repetitive or flexible set of actions. Numerous studies have shown that robot can be beneficial in medicine [1], rehabilitation [2-6], rescue operation [7, 8] and industry [9]. Over the years, robotics has been introduced in various industries. The industrial robots are multi-function manipulators designed for more specialized materials, divisions, 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 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.

Studies on the use of humanoid robots are actively carried out to minimize firefighters' injuries and deaths as well as increasing productivity, safety, efficiency and quality of the task given [16]. Robot can be divided into several groups such as Tele-robots, Telepresence robots, Mobile robots, Autonomous robots and Androids robots. Telepresence robot are similar to a tele-robot with the main difference of providing feedback from video, sound and other data. Hence, tele-presence robots are widely used in many fields requiring monitoring capability, such as in child nursery and education, and on improving older adult's social and daily activities [17, 18]. Mobile robot is designed to navigate and carry out tasks with the intervention of human beings [19, 20]. Meanwhile, autonomous robots can perform the task independently and receive the power from the environment, as opposed to android robots which are built to mimic humans [21].

In this paper, a firefighting robot is proposed. The main function of this robot is to become an unmanned support vehicle, developed to search and extinguish fire. There are several existing types of vehicles for firefighting at home and extinguish forest fires [22]. Our proposed robot is designed to be able to work on its own or be controlled remotely. By using such robots, fire identification and rescue activities can be done with higher security without placing fire fighters at high risk and dangerous conditions. In other words, robots can reduce the need for fire fighters to get into dangerous situations. Additionally, having a compact size and automatic control also allows the robot to be used when fire occurs in small and narrow spaces with hazardous environments such as tunnels or nuclear power plants [23, 24].

Thermite and FireRob are two current available fire fighter robots that have been used widely in industry. Thermite (produced by Howe and Howe Technologies Inc) is a firefighting robot that uses a remote control and can operate as far as 400 m. It can deliver up to 1200 gpm of water or 150 psi of foam. The size of this robot is 187.96 cm x 88.9 cm x 139.7 cm. This robot powers up to 25 bhp (18.64 kW) using a diesel engine. The main component in the design of this robot are multi-directional nozzle that is backed by a pump that can deliver 600 gpm (2271.25 l/min). This robot is designed for use in extreme danger areas, such as planes fires, processing factories, chemical plants or nuclear reactors [25].

FireRob (Manufactured by Croatian manufacturer DOK-ING) is a fire-fighting vehicle controlled by a single operator