Intelligent Robotic System For Fire Fighting

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ABSTRACT

Fire-fighters faces several risks on jobs like burns, heat exhaustion and also they come in contact with high levels of carbon monoxide and other toxic hazards that put them at greater risks. This system is designed with the help of raspberry pi module which is integrated with ultrasonic sensor to avoid obstacles and pi camera which helps to detect fire or smoke using YOLOV2 Convolution neural network and also live video streaming is done that can be accessed by nearest fire fighting station through a web page. An aluminium sheet is used to make the body of the robotic system to protect it from high temperatures which can resist heat up to 700 centigrade. This intelligent robotic system performs many tasks and reduces damages caused by fire and also helps in saving lives of human fire-fighters.

1. Introduction

Robots are used for high risk tasks and one of them is fire fighting. Human firefighters faces many dangerous situations like high temperature ,dust ,low humidity ,smoke and life threatening situations like explosion and with all these dangerous exposures firefighters develops various diseases like heart disease, cancer, respiratory illness and stress. They have to extinguish fire in buildings ,climb heavy ladders ,carry injured person from one places to another and they work for long and irregular working hour to perform their jobs. so , this intelligent robotic system for firefighting is replacement for human fire fighters to save their lives which helps to stop fire immediately and rescue the people from dangerous fire and move to the safer place.

In the current time, fire fighting is risky for firefighters.Numerous creators are dealing with different strategies for fire fighting. a few misfortunes happen because of fire.Fire turns into the greatest catastrophe on the off chance that it happens close to any backwoods region, petroleum siphon, gas line and any instructive spot. On the off chance that the fire isn't doused initially, it can hurt enormous number of individuals. Dr. P. Ezhumalai proposed a system “Autonomous Fire Fighting Robot with Zigbee”.The robot goes in the direction of fire using a flame sensor and extinguishes it with the help of pump. It also avoids obstacles using ultrasonic sensor. Additionally, it has charging circuit [1]. Dr. Niranjan Bhattacharyya presents the plan and the execution of a putting out fires robot that moves towards the fire and siphon out water to douse the fire. The venture disclosed how to interface different parts to Arduino. The framework can possibly be valuable to go with firemen and forestall a flare-up. A framework equipped for exploring towards fire and afterward smothering it by siphoning water was made. Study on various part and their interfacing methods were accomplished [2]. Kirti Kadam proposed a system “Android controlled firefighting robot” that is used daily easily such as home, shops, laboratories etc .In this system arduino, relay, motor driver ,gas sensor ,Bluetooth module, pump interfaced with arduino module

to detect and extinguish the fire. In this patrolling was main function of the android controlled robot [3]. Sultan shamishev proposed a system "Development of network based autonomous robotic system" that was able to extinguish fire automatically .The main focus was on design, development and assembly of the robot which included electrical, mechatronics and mechanical system. For fire detection sensor network was used such as gas sensor network. The room was divided into three section to detect fire in range. To avoid obstacle Bayesian algorithm was used to reach the fire and extinguish fire with pump.[4]

Ratnesh malik proposed a system "fire fighting robot". This robot is fully autonomous which senses the flame and extinguishes the fire. This robotic concept implements environmental sensing and awareness of proportional motor control. Infrared, U.V and visible light are used to inspect elements present in atmosphere. It is designed for military applications that blow out fire which occurs in military war and also capable of extinguishing tunnel fire ,industrial fire. The alarm is attached to the robot is programmed in a way that if fire is detected ,the robot rings the alarm to alert others and simultaneously active the electronic circuit which releases sprinkles of water on the flame [5]. To plan and fabricate a little Fire Fighting robot, where a robot will be placed in a house model where a light candle is accessible and the robot ought to have the option to distinguish, and extinguish the flame in the briefest time while exploring through the house and keeping away from any impediments in the robot's way. Explores were done in the start of the task to get more data about mechanical technology by and large and to consider the plan, equipment parts, and the product procedure which will control the robot. This robot contains Light Sensor, 2 DC engines, and Buzzer is utilized in the robot's body.

Two DC arrangement engines are utilized to control the back tires and the single front wheel is free. The product some portion of the venture is the program code written in the miniature regulator to control the Fire Fighting Wireless Controlled robot Using 8051 [6]. Kristi Kokasih proposed a system" An Intelligent Fire Fighting Tank Robot". This system robot used material that are acrylic sheet, and iron. The components of robot are couple of servo motor, couple of DC motor, compass sensor, ultrasonic sensor, fire pointer, warm display sensor, sound inception and more limited size switch sensor. The aim is to glance through a specific region, find and extinguish the fire. DTMF transmitter and receiver starts the robot [7].

Swati Deshmukh proposed a system "Wireless Fire Fighting Robot" .This technique has a machine that could locate and blow off the fire. The movement of firefighting robot can be forward ,reverse, left and right direction. So ,fire can be operated over a distance so that there will be no need of humans to came near the fire. For detection of fire light dependant resistor is used which are very sensitive and can detect very small fire. This system gives security at buildings, laboratory , homes, offices [8]. H.P. Singh proposed a system" Autonomous Industrial Firefighting Mobile Robot". In this method ,the robot consists a couple of DC electric motor. Five infrared sensor are used by robot for conversion of analog to digital. Out of five two of them controls the movement and rest three are for fire revelation. The system consists of DC motor, water container, pump To get the detection of fire infrared is used and to follow the path PID controller is used. leaving the fire. Arduino microcontroller dominance the dousing framework [9].

Our paper is categorized into four sessions 1 which describes the introduction of project session 2 which consist of material and method session 3 comprise of result and discussion and session 4 consists of conclusion.

2. Material and Methods

2.1. Raspberry pi3 B+

It is a single, small board computer widely used in robotics, that has a 64-bit quad-core processor which is clocked at 1.4GHz and along with 2.4GHz dual-band wireless LAN, 4.2/BLE Bluetooth, and also has high Ethernet speed of up to 300Mbps. It is used for controlling movement of robot upwards,downwards, forward,backward.It is also used to host websites on a local server that can be used globally on internet.

Fig. 1 Raspberry pi3 B+ module

2.2. Raspberry pi camera

Raspberry pi camera is used to detect fire and smoke.Its Sensor resolution is of 3280 × 2464 pixels and Focal length of 3.60 mm +/- 0.01.It can be used for various exposure modes like auto, night, night preview, backlight, spotlight, fireworks.

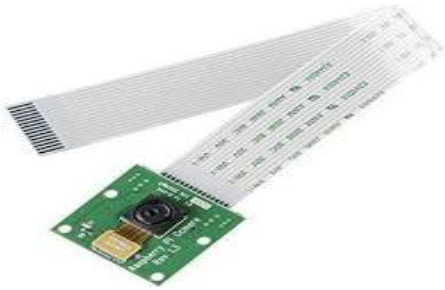

Fig. 2 Pi camera

2.3. L293D Motor Driver

It is a 16 pin of the motor driver which helps to drive a couple of DC motors at the same time independently in any direction.It provides maximum motor voltage from 4.5v to 36v and drives a maximum peak current of 1.2A.

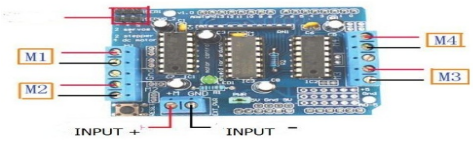

Fig. 3 L293D motor driver

2.4. Methodology

2.4.1. Working Concept

The working Concept is very simple. The block diagram in figure 4 of the intelligent firefighter robotic system which consists of pi camera through which fire and smoke is detected by using YOLOv2 convolution neural network which is useful in hazardous environment. Raspberry pi3 B+ controls the movement of motor driver. Then another sensor ultrasonic sensor that is used to detect any obstacle in path to avoid any interruptions in reaching destination place. The sensor, pump, motor driver are interfaced with raspberry pi 3 module.

When there is fire this intelligent firefighter robotic system will detect the fire using pi camera which has focal length of 50cm and it will move towards the direction of fire to extinguish it. This whole system will be connected to a web page through raspberry pi server and raspberry pi server sends the information to a web page which is operated by nearest fire station so that they can come to help injured people. The movement of system will be controlled by raspberry pi3 B+ module.

The system will be moving in a direction where fire mishaps is there and the video will be shown on web page and from that web page we can also control the robotic system movement remotely. The robotic system will be covered with aluminum sheet which can bear temperature of 700 degree Celsius so as to protect the electronic circuit of robotic system from high temperature. Once the robotic system reaches the place it will extinguish the fire by spraying water on it with the help of pump.

2.4.2. Block diagram

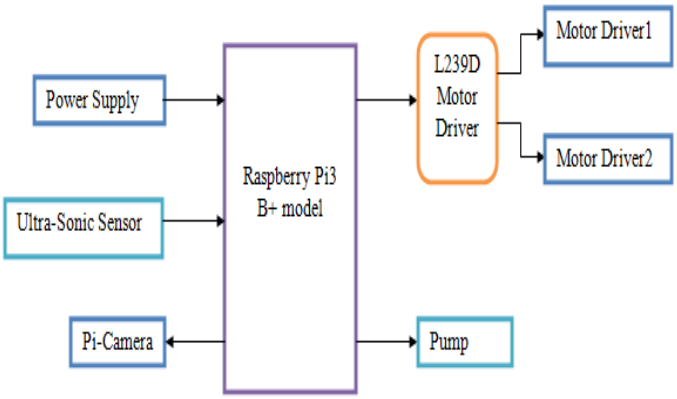

Fig. 4 Block diagram of intelligent fire fighter robotic system

2.4.3. Raspberry pi web server

Raspberry pi can perform as a web server and host a website which can be accessed from anywhere by installing Apache in it. Firstly, we have to find IP address of raspberry pi so that we can access it from anywhere. after configuration raspberry pi will able to host dynamic web page which can be created with scripting language. A mariadb mysql database is needed to store and retrieve data. Now, we have to enable FTP and SSH for remote access to our web server from other computer on our local network SSH provide data access, data transfer, data management and FTP is used to transfer file to another computer.

2.4.4. YOLOv2 convolution neural network for detection of Fire and Smoke

Generally, There are two methods of fire detection: Traditional and computer-vision. Traditional fire detection uses sensors like flame sensor, smoke sensor, thermal sensor. Smoke sensor sometimes is unable to distinct between smoke and fire on the other hand flame sensors to require sufficient amount of fire to detect efficiently, if it is not sufficient than it can result in huge damage and losses but it can be avoided with the help of vision based fire detection techniques.

Fig. 5 Fire and smoke detection

2.4.5. Flowchart

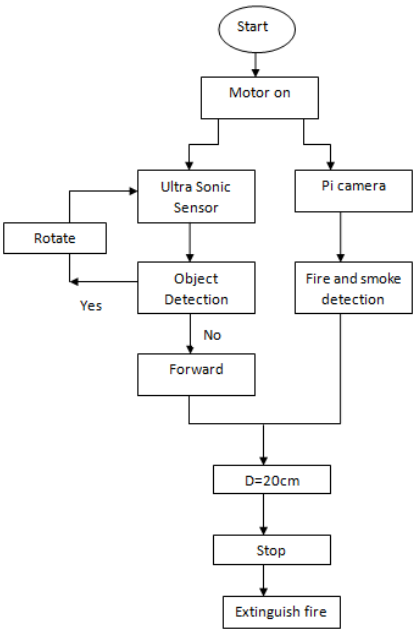

Fig. 6 Flowchart

3. Results and Discussion

This paper presents a robot which detects fire with the help of camera using YOLO V2 convolution neural network method from a focal range of 50cm.As soon as fire is detected it starts moving in that direction if obstacles is there in between it will detect with the help of ultrasonic sensor. Raspberry pi controls the movement of motor driver according to signals given by ultrasonic sensor and camera. While the process is going on, the camera will be streaming video live and with the help of raspberry pi server in which apache server is installed that sends the information and live

video to nearest firefighting station who has installed that robot and if any injured person is there the firefighters will come to save injured ones. The robot will move in a direction and extinguish fire from a distance of 20cm by sprinkling water on fire. Robot body is covered with Aluminum sheet which protects electronic circuit from fire and if there are people stucked then robot will make a way by sprinkling water on fire and extinguish fire around the people to reduce the injury and loss of life.

4. Conclusion

This paper describes the real time firefighting robot which is automated as well as controlled with the help of web applications. The detection of fire and smoke is done by using a pi camera with YOLO method and movement of the robot is done by raspberry pi 3 B+ module which controls the motor driver. After the fire detection, the live video streaming is send to the nearest fire station through a web page. The fire is extinguished by pumping mechanism, the pump is attached to system for spraying water on fire. This fire extinguishing process is safe and effective.

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