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Design and Development of Fire Fighting Robot

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ABSTRACT: Fire occurrence is a catastrophe that can conceivably cause the death toll, property harm and lasting handicap to the influenced injured individual. Firemen are basically entrusted to handle fire occurrences, however they are frequently presented to higher dangers when smothering fire, particularly in risky situations for example, in atomic force plant, oil processing plants and gas tanks. They are additionally confronted with different challenges, especially if fire happens in thin and limited spots, as it is important to investigate the vestiges of structures and snags to smother the fire furthermore, spare the person in question. With high boundaries and dangers in fire extinguishment activities, mechanical advancements can be used to help firefighting. The advancement of a firefighting robot named QRob that can quench fire without the requirement for firemen to be presented to pointless risk. QRob is intended to be minimized in size than other regular putting out fires robot so as to ease little area passage for more profound reach. QRob is additionally furnished with an ultrasonic sensor to stay away from hitting any impediment and encompassing items, while a fire sensor is appended for fire discovery. This came about in QRob exhibiting capacities of recognizing fire areas naturally and capacity to douse fire remotely at specific separation. QRob is customized to discover the fire area and stop at most extreme separation of 40 cm from the fire. A human administrator can screen the robot by utilizing camera which associates with a cell phone or remote gadgets.

KEYWORDS*:* Fire Fighting Robot, QRob, fire extinguishment, Ultrasonic sensor, Safety measure.

I.INTRODUCTION

A robot is a computerized gadget which performs capacities normally ascribed to people or machines entrusted with monotonous or adaptable arrangement of activities. Various examinations have indicated that robot can be valuable in medication, recovery, salvage activity and industry. Throughout the years, apply autonomy has been presented in different enterprises. The mechanical robots are multi-work controllers [1] intended for increasingly specific materials, divisions, contraptions or gadgets through different automatic developments to perform different undertakings. In accordance with the Fourth Industrial Revolution (4IR) [2], there is interest for a one system that can control, impart and coordinate extraordinary robots paying little mind to their sorts and determinations. Machine learning has additionally heated up enthusiasm for mechanical autonomy, though as it were a bit of ongoing advancement in mechanical technology can be related with AI. Later automated advancement venture has installed AI calculations [3] to increment the knowledge in robots. This will build the profitability in industry while decreasing the expense and electronic waste in a since quite a while ago run. Concentrates on the utilization of humanoid robots are effectively conveyed out to limit firemen's wounds and passing's just as expanding profitability, security, effectiveness and nature of the task given. Robot can be partitioned into a few gatherings such as Tele-robots, Telepresence robots, Mobile robots, Self-governing robots and Androids robots. Telepresencerobot are like a tele-robot with the primary distinction of giving input from video, sound and other information. Henceforth, tele-nearness robots are broadly utilized in numerous fields requiring checking ability, for example, in kid nursery and instruction, also, on improving more established grown-up's social and day by day exercises. Portable robot is intended to explore and complete

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undertakings with the mediation of people. In the meantime, self-governing robots can play out the assignment freely and get the force from the earth, rather than android robots which are worked to impersonate people.

A "Fire Fighting Robot [4], [5]" is proposed. The primary capacity of this robot is to turn into an unmanned help vehicle, created to look and quench fire. There are a few existing kinds of vehicles for firefighting at home and stifle timberland fires. Our proposed robot is intended to have the option to chip away at its own or be controlled remotely. By utilizing such robots, fire distinguishing proof and salvage exercises can be finished with higher security without setting firemen at high threat and unsafe conditions. As such, robots can lessen the requirement for firemen to get into risky circumstances. Moreover, having a conservative size and programmed control likewise permits the robot to be utilized when fire happens in little and restricted spaces with unsafe situations, for example, burrows or atomic power plants.

Thermite and Fire Rob are two current accessible fireman robots that have been utilized broadly in industry. Thermite (created by Howe and Howe Technologies Inc.) is a firefighting robot that uses a remote control and can work as far as 400 m. It can convey up to 1200 gpm of water or 150 psi of froth. The size of this robot is 187.96 cm x 88.9 cm x 139.7 cm. This robot controls up to 25 bhp (18.64 kW) utilizing a diesel motor. The principle segment in the plan of this robot are multi-directional spout that is supported by a siphon that can convey 600 gpm (2271.25 l/min). This robot is intended for use in outrageous peril regions, for example, planes fires, preparing industrial facilities, concoction plants or atomic reactors. Fire Rob (Manufactured by Croatian producer DOKING) is a putting out fires vehicle constrained by a solitary administrator by means of remote control. It quenches fire without mediation of firemen with a high weight on a water powered arm that siphons water up to 55 m away. It additionally can convey 1800 litre of water and 600 litre of froth in its two on board tanks. The covering on Fire Rob permits it to withstand basic temperature of 250ºC and heat radiation of 23 kW/m for a time of 30 minutes.

A minimal and little fireman robot has been created. This robot is named QRob[6], which is short type of Rescue Robot [7]. This robot can sidestep deterrents, search furthermore, and douse fire. Besides, this robot can build the profitability, security, proficiency and nature of the undertaking given. QRob is increasingly conservative and progressively adaptable contrasted with Thermite and Fire Rob robot. Another bit of leeway of QRob is in its capacity to enter area with little passageway or limited space.

II.LITERATURE REVIEW

J. Reinhart V. Khandwala (2003) was all talked about structure and the usage of the putting out "Fire Fighting Robot". The key plan components of the robot to be talked about include: the get together and development of the robot equipment, the preparing calculation dependent on the sensors reaction, and the route calculation that will empower the robot to discover a productive way all through the house model.

Lynette Miller Daniel Rodriguez (2003) was all talked about the advancement of every segment of the robot that is intended to locate a little fire bar to by a light transmitting diode in a model home and stifle it. This paper will talk about every part of the robot from the beginning sign to the robot stage to the line following and room finding and completing with the fire discovery.

SahilS.Shah (2013) was all examined about plan a "Fire Fighting Robot" utilizing implanted system. A robot competent of battling a reproduced family unit fire will be structured and manufactured. It must have the option to self-sufficiently explore through a displayed floor plan while effectively examining for a fire. The robot can even go about as a way guider in ordinary case and as a fire douser in crisis. Robots intended to discover a fire, before it seethes crazy, can one day work with firemen extraordinarily diminishing the danger of damage to exploited people. The outcome shows that higher proficiency is in fact accomplished utilizing the implanted system.

U.JyostnaSaiPrasanna, M.V.D.Prasad (2013) structured the fire discovery system utilizing four fire sensors in the "Fire Fighting Robot", and program the fire recognition and battling technique utilizing sensor based strategy. The "Fire Fighting Robot" is furnished with four thermistors/fire sensors that constantly monitor the temperature. In the event that the temperature increments past the foreordained limit esteem, ringer sounds to suggest the event of fire mishap and a cautioning message will be sent to the separate work force in the business and to close by fire station with the GSM module [8] given to it.

Swati A. Deshmukh (2015) was all examined about the fire recognition system utilizing sensors in the system, and program the fire discovery and battling technique utilizing sensor based strategy.

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Saravanan P (2015) examined about the Design and Implementation of this undertaking is for the most part dependent on control of "Semi - Independent portable robot (SA-BOT)"[9]. The system controls four DC Geared engines which is fuelled by the Atmega2560 and controlled self-governing by Navigation system which includes coordinated ultrasonic and infra-red sensors. The bot is equipped with remote camera which catches the video and transmits it to the base station. The fire location system contains LDR and temperature sensor, if there is a fire, the sensors identifies it and the bot will be moved to the source also, begins stifling it. The Extinguishing System includes a BLDC engine with water holder. The SABOT can additionally be worked physically for outrageous conditions. They have given a GUI support through which the bot can controlled from the base station.

Swati A. Deshmukh (2015) was all talked about the fire recognition system utilizing sensors in the system, and program the fire identification and battling technique utilizing sensor based strategy.

AbhilashDhumatkar, SumitBhiogade (2015) was all Automatic Fire Fighting Robot" venture utilizes the electrical indoor regulator innovation for the controlling the fire 24 hrs. The system is financially savvy, has a wide applications which at the point when actualize can show great and powerful outcome. Synchronization of different hardware include in the system i.e. Indoor regulator Sensor, water fly, remote and remote android gadget Wi-Fi empowered Camera. This is mean to re-enact this present reality activity of Robot playing out a fire smothering capacity. Fluffy rationale gave a fitting answer for the generally intricate undertaking of numerically determining a precise model for the non-straight control system whereupon traditional control systems could then be applied.

By survey the different examinations show that "Fire Fighting Robot" using Arduino system isn't yet studied. So the point present work is "Fire Fighting Robot" using Arduino system has been performed, and the project is structured by following squares fire sensor, Arduino board, line following sensor, Motor with driver circuit, Robot model, and Driver circuit with hand-off and Fire extinguisher.

III.WORKING PRINCIPLE

The temperature of about 300°C from the heater, utilizing a Thermocouple [10]. The point by point particulars of the Thermocouple are yielded, has been utilized both as a Comparator and an Amplifier. The intensified DC voltage has been changed over into AC utilizing a DC to AC Convertor. The AC voltage subsequently created supplies capacity to the water siphon. By and large Water, or different substitutes like froth furthermore, carbon dioxide can likewise be utilized to smother the fire. Snag Avoider and Motion Sensor have been used to maintain a strategic distance from the impediments and move every which way as per the fire force. The Robot is protected with calcium silicate sheets to withstand extremely high temperatures.

The thermocouple appeared in figure 1 has been at first warmed to a cut-off temperature [11] at the intersection end to make it safe and touchy to all temperatures over the cut-off temperature. The distinction between the temperatures detected from the heater at the intersection end to that of the temperature produced at the last part measures a voltage distinction between the two thermo-components at the last part. The voltage from Thermocouple is being intensified and thought about utilizing IC 741and the yield DC voltage of the request 10~12V is changed over to 230V AC by utilizing DC to AC Convertor which is being provided to the water siphon. Water siphons generally utilized in water coolers are consolidated in the Robot whose particulars are given. The info supply to the IC is being given from an outer 5V battery associated with its pin.

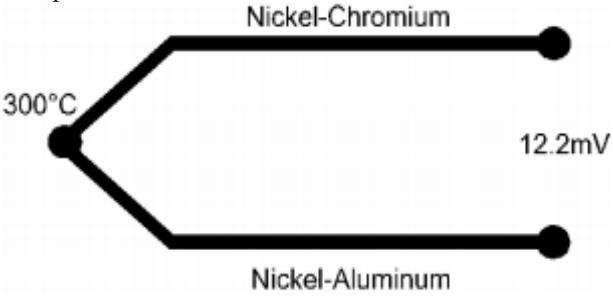

Fig. 1 Thermocouple (RTD)

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IV.WORKING

The working is separated into three sections. The initial segment is on the mechanicals schematics, trailed by equipment depiction and the at last on the programming structure. All parts were collected together and tests were at that point performed to decide the ideal distance of QRob to douse the fire were completed.

1. *Mechanical Design Structure*

Google Sketch Up programming and AutoCAD were utilized to produce 3D and 2D schematic outline. For the principle structure of the robot, to get the liked development and speed, QRob have two wheels at back side and two wheels at front side. The wheels can balance out the robot and make pivot until 360 degrees. The body of the robot is produced using acrylic plate to ensure the electronic circuit. The acrylic sheet is impervious to heat of up to 200 ^{0} C. This enables to utilize and work with (cut and drill). The collection of acrylic skeleton contains gaps that make it simpler to mounting of different sort of sensors and other mechanical parts.

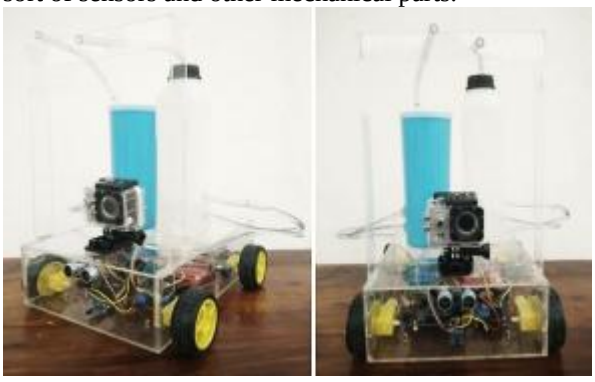

Fig. 2 Firefighting Robot (QRob)

The ultrasonic sensor and fire sensor were introduced at front of the robot to abstain from hitting any interruptions and to recognize the fire separately. What's more, smaller than expected camera was introduced in front side of the robot to screen the way and state of the area and is connected to the advanced cell. The structure of fire distinguisher robot is appeared in figure 2.

2. Hardware Implementation

The electronic part is one of the crucial parts in the advancement of QRob. It incorporates the few sorts of sensors, microcontroller, DC engine with wheel, Transmitter and Remote control and Water pump. The square outline of the QRob activity which comprises of fire sensor what's more, ultrasonic sensor as contribution of the system. Arduino Uno is utilized as a microcontroller that associated with other parts. Engine Driver (L298N) [12] is utilized to enact the moving of the apparatus engine while Transmitter Remote Control will give yield of the system. Stream of water and fire douser were pump in the wake of being constrained by the controller. Then again, the controller can screen the robot developments by utilizing camera (Go Pro) which *associates with a cell phone.*

2.1 Fire sensor:

In most “Fire Fighting Robots”, fire sensors play out a fundamental part in researches, which are consistently utilized as robot eyes to find wellsprings of fire. It tends to be used to recognize fire dependent on wavelength of the light at 760 nm to 1100 nm. The identification point and distance are generally 60 degrees and distance 20 cm (4.8V) to 100 cm (1V) individually. Fire sensor has two sign pins that are Digital Yield (DO) and Analog Output (AO). DO pins will give two sort of data that it's has fire or non-fire while AO pins will distinguish precise wavelength of various light.

2.2 Ultrasonic sensor:

One of the most vital perspective in concocting an independent objective location robot is a boundary and impediment evasion. A sensor must be reduced, minimal effort, easy to deliver and useful on a bigger scale. Besides, it ought to have the option to detect things with enough cut-off points to let robots to respond and travel appropriately. The existing sensors that suit every one of these necessities are ultrasonic sensors. The HCSR04 ultrasonic sensor[13] is used in this investigation to decide the distance inside the scope of 2 cm to 400 cm with an edge 15 degrees. This sensor transmits waves into the air and get reflected waves from the item. It has four yield pin for example, reference voltage (VCC) (work around 5V), ground pin (GND), advanced yield (DO) and simple yield (AO).

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2.3 DC engine with wheel:

DC outfitted engine with elastic wheel are appropriate material for this undertaking. This DC engine are appropriate to supplant 2 WD and 4 WD vehicle frame. The working voltage for DC engine is around 5V to 10 V DC. While the proportion of the apparatus is 48:1. Appropriate current for this engine is 73.2 Mama. DC engine is utilized to move the robot to the fire area.

2.4 Water pump:

The water pump is significant part in this robot as it will pump water or cleanser to smother the fire contingent upon the class of fire that happens. Little size and light-weight class of water pump has been chosen for use in this venture. Besides, it has low commotion, high viability and negligible power utilization. The ideal voltage for this water pump is 6V. Working voltage for this water pump is around 4V to 12V with the working current 0.8A.

2.5 Transmitter and remote control:

The remote control transmitter and collector with 4 control modes will be utilized. Model number of this collector or remote is S4C-AC110. This remote have four catches. The working voltage for this remote control is AC 100 – 120 V, while the working voltage scope of transfer are AC 110 – 240 V or DC 0 – 28 V. The model number of the transmitter is C-4. The distance of the remote control is 100 m or 300ft. Force supply for this transmitter are 12 V. The transmitting recurrence is 315 MHz/433 MHz by using the transmitter and remote control, QRob can be controlled from far off spots where the controller who controls it will be in a protected spot while the robot will go into a perilous fire territory.

3. *CONTROL PROGRAMMING*

Figure 3 shows the connection between QRob facilitate plane with fundamental surface plane. From the start, QRob is initially thought to be at the middle position with the facilitate point right now considered as (0, 0). At the point when the pivot happens on the z-hub, as appeared as the θ in figure 3.

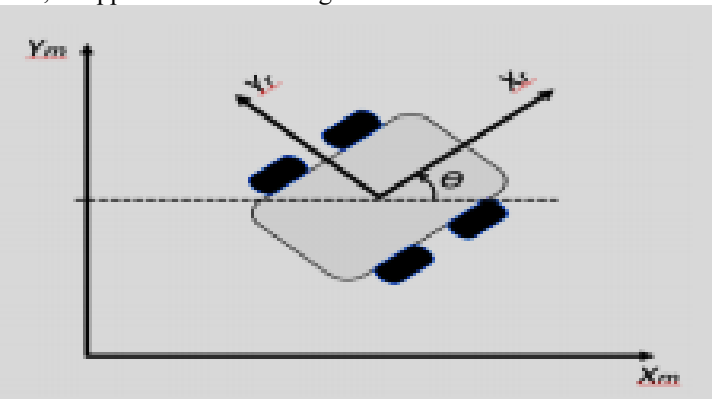

Fig. 3 Relationship between QRob Coordinate Plane with Main Surface Plane

The position change from the first to the last position gives another organize to QRob and is considered as (x, y) on the arrange plane. (Xm, Ym) is the fundamental surface organize plane and (Xr, Yr) is the QRob organize plane.

$$[x'\ y'\ \theta'] = [cos\theta\ sin\theta\ 0]v + [0\ 0\ 1]\omega \qquad (1)$$

Condition (1) is to decide the facilitate and rakish position for the QRob, where , what's more, are the directions concerning the fundamental surface plane (Xm, Ym) and are the driving and turning speed regarding the directions concerning the QRob facilitate plane (Xr , Yr). At that point, embracing differential drive vehicle as the kinematic model of QRob coming about,

$$v = \frac{r(\omega_R + \omega_L)}{2} \qquad (2)$$

$$\omega = \frac{r(\omega_R + \omega_L)}{d} \qquad (3)$$

Where r is sweep of the haggle is the distance of immediate focal point of turn. Every one of the information from sensor is checked and constrained by Arduino. The Arduino program which all the info and yield pin in Arduino should

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be pronounced. The forward and switch code development for QRob to discover the fire location. The flowchart of Fire Battling Robot (QRob) utilizing ultrasonic sensor and fire sensor. These codes will be utilized to program the development of QRob to discover the fire area.

V.CONCLUSION

Generally, a putting out "Fire Fighting Robot" that can be controlled from some separation has been effectively created. It has worthwhile highlights, for example, capacity to recognize area of fire consequently close to having a smaller body and lightweight structure. QRob likewise can abstain from hitting any snag or encompassing items because of its arrangement of an ultrasonic sensor. The QRob robot can be utilized at a spot that has a little passageway or in little spaces since it has a reduced structure. The controller can extinguish fire utilizing remote control from longer separation. Administrators can likewise screen the natural conditions during the procedure of firefighting by utilizing the camera that is associated with the cell phone. From the exploratory outcomes, the robot can sense smokes and fire precisely in a brief timeframe. As an end, the undertaking entitled "Advancement of Fire Fighting Robot (QRob)" has accomplished its point and goal effectively.

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