Design and Implementation of Autonomous Fire Sensing and Extinguishing Robot along with Buzzer Alarm

Dr. Kavitha P [a], Rohini.[b] PrincyVeni.S[c] Ganeshmoorthy G [d]

[a] Associate Professor, Department of EEE, R.M.K. Engineering College, RSM Nagar, Kavaraipettai 601206

[b,c] Third Year Student, Department of EEE, R.M.K. Engineering College, RSM Nagar, Kavaraipettai 601206

[d] Manager, Samsung India electronics Pvt Ltd, SH120, Sriperumbudur, Kanchipuram, Tamil Nadu 602106

[a] pkt.eee@rmkec.ac.in, [b] rohi18235.ee@rmkec.ac.in [c] prin18222.ee@rmkec.ac.in
[d] ganeshg_be@yahoo.com

Abstract

There are voluminous likelihoods for fire accident in amanufacturing industry or in any inaccessiblezone. For instance, intextile industry, garment factories, fuel tanks, etc., electric discharges can lead to massive loss. As well, it's a most awful case, causing huge damages not only economically but also destroying the zonesadjacent it. It is recurrently that fire serviceswere not able to reach the source of fire because of the devastation of structure and extreme temperature, ordue to the existence of volatileelements. With such restrictions and extraordinary threat in handling of fire, a scientific innovation that can help hostile the fire is indispensable.Robotics is the evolvingelucidation to guard human lives and their wealth and environments. In this paperwe presented the design of a robot accomplishedwith firefighting a simulated household fire or industry fire. It is capable of autonomously steer over a sculpted floor design while dynamically look over for a fire.The firefighting robot is furnished with four firesensors that uninterruptedly senses the temperature. If the temperature rises further than the pre-set threshold value, buzzerjingles to notify the occurrence of fire calamity.If fire is sensed, user instruct the robot in that definite route for validation. After confirmation, robot sprinkling water on affected fieldand extinguishes the fire.After quenching the fire robot move towardto its original location. During fire quenching process if any barrier comes in between the model and the affected area the sensor notices the obstacle, and the arm of the robot moves to another location for clearing the path.A cautionary message can also be sent to the corresponding people in the production industry and tonearest fire station with the GSM module provided to it.The development will help to create enhancements in the field of robotics and to obtain anelucidation to protect lives and diminish the risk of assets loss.

Keywords: Microcontroller, Flame sensors, Sensing of flame, Fire Extinguisher, DC drive, WaterPump Motor, Water Sprinkler

1.   Introduction

In the recentage of technology, the whole world is moving in the direction of the automation and unmanned vehicles. Fire fighters are always at a risk of losing their life during fire extinguishing processhave to work in some unfavourable surroundings like high temperature, flare-ups and buckled buildings also.Nowadays robot are utilised to diminish the personage efforts. Necessity of fire quenching robot that can sense and quench a

flameby itself. Robotics is the fastest developing engineering fields[1-5]. Robots are manufacturedin order to eliminate the personage factor from manual labour exhaustive or treacherous work and also to work in an unapproachable environment.Because of the development of fire quenching robots, lives and assets can be protected with negligible harminstigateddue to fire.IoT based fire quenching robot that identifies fire. [6-8].

The artificial intelligence is integrated over programming that is embedded in Arduino UNO microcontroller and gives as platform to develop several instructions. These instructions are used to control the displacement, route of the robot and takes appropriateaccomplishment in response to the information givenby the flame sensors. In the conventionalelectromechanical robotic structure no autonomous control was present on the movement of the robot or no control on risk management which may causeunsuccessful impact in grave fire caught condition. In the IoT based cellular controlled fireextinguisher which has the nosegay to control the fire i.e. the fire controllingchemicals. A cellular android app is developed to converse with the distantly positioned robot vehicle. The cellular androidapp professionally control the actions of the robot which is positionedfar away fromdangerous place [9-16]. Asmart home systempractically contains the smoke detection framework in it.Theprevious literatures shows large numbers of robots are used for administration robot. Moreover, preciselyinspectinclined to in the robot essentially to have the capability about flame quenching.

The regular fire extinguishing frameworks have impediment like they work with confined recurrence and has deficient work range. When coordinated with old framework the novel and imaginative framework has bewildered the current limitations, for example, it can perform at wide work range and advanced control framework. In regular frameworks Radio Frequency is liked to administer the robot where there is requirement with transferable reach which can be overpowered with DTMF tone.

A Self-governing fire sensing and quenching robot has been developed to quench the fire by traversing the ground and eluding obstacles.This robot can change over a classical structure, and discover fire and then stub out with the assistance of water jet. This is to mimic the actual domain of robot carrying outfire extinguishing functions in oil industry. The robot is also accomplished of being controlled physically and spontaneously. In this paper, section II is circuit design, section III hardware components used, section IV software flow chart section V results and discussion and Section VI is the conclusion.

2.   Block Diagram and Methodology

The square chart of microcontroller based fire smothering robot is displayed in fig.1. It comprises of different practical units to play out the primary part in detecting fire at adjoining put and extinguish the fire with proper directions. The vital components in the figure are fire sensor, Arduino UNO microcontroller, driver circuit for the engine, DC engine and water siphon. The primary point of the proposed framework is to identify the spot of fire and to extinguish the fire by showering the sea-going fluid by utilizing the siphon. The fire sensor is used to recognize the fire by detecting it and guides its yield to regulator which empowers the cycles in the total framework. A siphon is associated with the microcontroller and constrained by it to splash the water on terminated region. The driver circuit of the engine is additionally constrained by microcontroller to control the DC engine. The DC engine is a device which changes electrical energy into mechanical energy. This engine will make the robot to move in front and back ways.
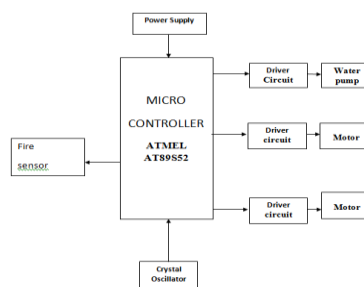

Fig.1 Functional Block Diagram of fire quenching robot

Robot contains microcontroller in order to drive flame sensors, andto communicate distance range to the controller of the fire fightingrobot through series interface. 5V and 12VDC supply isneeded to drive all modulesavailable in the robot system. DC supply is obtainedfrom mains of 230VACwhich is reducedto 12VAC using a step down transformer. The output is then fed to thebridge rectifier whose output is thepulsating DC. By usingcapacitor filter the continuous DC is obtained which is the 12V DC. Micro controller functions on 5V DC,a fixed voltage regulator (7805) is used togive aconstant output voltage regardless ofthe input voltage. Micro controller also needs the pre-setlogic circuit for the safety of interior program andtimerdue to failure of power. Onecapacitor and a resistor is are present in the reset circuit. The driver circuit consists of single

transistor and a relay and isgenerally operated by the micro controller.The regulator changes the condition of the yield pin from the low to significant level. The semiconductor go about as a switch comparing to the contribution to the base terminal. On the off chance that the base current is high the semiconductor is in ON state else it is in OFF state. These settings will be utilized to work the transfer. The fire sensors sense the warmth inside the room. The sensors will offer data to the miniature regulator when it detects heat. The miniature regulator pin touch will goes high when the fire is available. The miniature regulator ceaselessly check the information signal from sensors. When the sensor gives the information about fire to the miniature regulator, it then, at that point, finds the development to arrive at the fire by working out the info information. A pre-set admonition message is shipped off comparing personals to hint the event of fire mishap. The ringer gave to the circuit sounds. The miniature regulator drives two engines. One engine is utilized to give development to the Robot to move forward way to arrive at the objective point and the other is utilized to sprinkle the water ablaze. In the wake of quenching fire the robot will return to the first position.
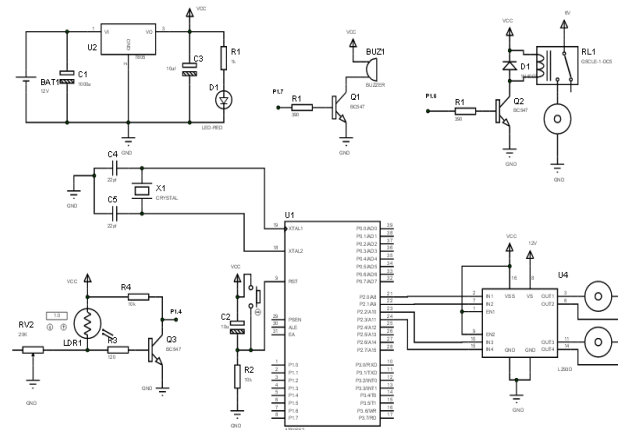

Fig. 2. Circuit diagram of the robot

Working:

Arduino board is the core of the unlimited authority activity of the robot. Robot involve the fire sensors that are associated in the control circuit. Fire sensors are set to recognize fire got region and gives the information to the regulator. Delivering to the gathered data the regulator will make the vital move to move the robot and when the robot will reach in the fire area then a siphon or douser which is joined with the robot comes into achievement to extinguish the fire. This model that freely sense the fire and quench something similar. The robot contains fire sensors associated with the control board which detects the event just as strength of fire and to take the responsive achievement subsequently. The robot is conscious to work first where the measure of fire is immense. Being a modified robot it doesn't need any controller activity. The human is to introduce the robot in a fire inclined region and it will unexpectedly look working once it detects a fire breakout. This robot gets its sales in life saving activities in fire adversities where the probability for fireguards to enter the fire inclined regions is uncommon. The robot is constrained by utilizing Arduino UNO. A water compartment alongside the siphon is kept on the robot to extinguish the fire. Rather than water siphon a fire quencher can likewise be put.

3.   Hardware Components

In this segment, the several hardware components used in the fire extinguisher robot is discussed.

Arduino UNO board:

Arduino UNO is utmostextensively held boards which is normallyused in robotic applications because of it is lesser size and amusing characteristics. The panel emanates with integrated boot loader. The Atmega 328 microcontroller is interfaced on Arduino consists of fourteenpins for GPIO, sixpins for PWM pulse generation, six pins for analog inputs and an UART also.In order to connect the six fire sensors the available threeanalog input pins of the board are exploited and the rest three pins are used to interface motor driver ICs L293D.

Fig.3. Arduino board

Fire Sensors:

Fire acknowledgment sensor is unpretentious to the fire anyway it can likewise detect the typical light sign. It is regularly utilized as an alarm. It detects a blast or a splendid wellspring of a frequency of 760 nm to 1100 nm. The distance covered by the sensor is about 1m to 2m. Infra-Red indicators are liked as fire acknowledgment sensors. The simple information pins of the board are associated with the sensors that are in voltage segment plan. The yield of the voltage divider is associated with pins A0, A1 and A2 of the microcontroller.
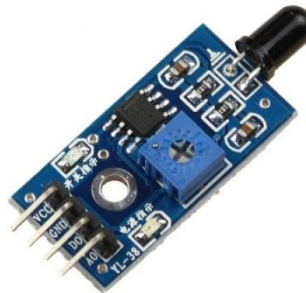

Fig.4 Fire sensor

Driver IC (L293D):

A double H-connect engine driver IC is utilized to drive the DC engine. The Motor drivers proceeds as flow enhancers since momentum control signal is little in size and convey a high momentum signal. This intensified current sign is utilized to drive the DC engines. This driver circuit comprises of sixteen pins. For the development of robot two servo engines are utilized. The driver circuit comprises of one force semiconductor and one electromagnetic transfer which is actuated by the regulator. The regulator alters the state of the yield pin from the low level to significant level which utilizes the request to inclination the foundation of the semiconductor. The semiconductor will turn on dependent on the sign given to the base pin. In the event that the foundation of the semiconductor is high, it will be turned on else it will be off.

Fig 5. Motor driver IC (L293D)

Chassis:

It is the foundation of the robot. Whole constituents of the robot are fixed to the case; henceforth a hearty however less weight frame will be awesome. Case can be made of various sorts of materials in particular aluminum, steel, acrylic, plastic, and high thickness polymer.

Geared DC motor:

In this fire extinguishing robot, equipped DC engines of are associated with the wheels. These engines are possible with broad scope of speed and force, which makes the robot to travel dependent on the sign given by the driver IC of the engine.

Fig 6. Geared DC motor

4. **Flow Chart**

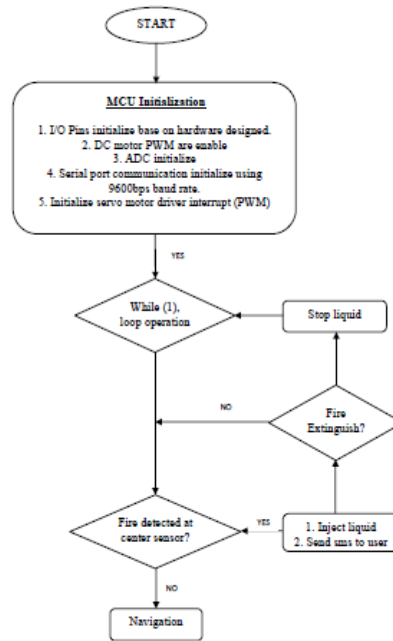Figure 6 explains the functionality of this fire extinguisher robot in the flow chart.

Fig 7. Flow chart for the robot

The micro controller initialisation is done as given below.

1. I/O Pins are initialised based on the hardware designed.

2. PWM signal needed for DC motor drive are enabled

3. Analog to Digital Converter (A/D) is also initialised

4. Serial port communication is also initialised using 9600bps baud rate.

5. DC servo motor driver interrupt is also initialised using PWM signal.

If the flame or blaze is sensed by the sensor it gives the input to the controller and necessary commands are generated for the robot to move and to peppering the water. After quenching the fire the robot has to restore to its initial position.

5. Experimental Design and Result

The prototype of the robot designed is given in Fig. 8(a) and (b). it consists of two DC motors, fire sensor and water pump with spraying unit. The power supply arrangement is also shown.

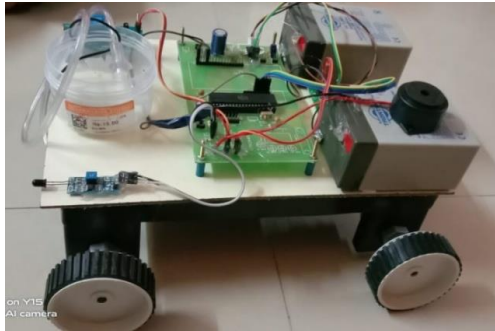**Fig. 8**(a) Prototype of the robot (Top view)

Fig.8(b) Prototype of the robot (Side view)

The plan and improvement of independent firefighting robot is examined. In this segment, the robot control grouping were investigated. From the results, this project is successfully achieved which are:

1) Flame Sensor Connection:

a) The robot will not react when the sensor not activated and the robot will react when the sensor is activated.

b) It is also connected with geared DC motor.

c) It is OFF when fire was not detected

d) ItON when fire is detected.

When Flame Sensor is on i.e. 1 then DC Motor is off i.e. 0,

When Flame Sensor is off i.e. 0 then DC Motor is on i.e.1.

2) DC Motor

a) Motor is connected with driver motor and Arduino Uno Microcontroller.

b) Motor ON, Flame Sensor OFF.

c) Motor OFF when Flame Sensor ON.

6. Conclusion

A model of independent fire detecting and smothering robot with signal alert is effectively evolved in the current work. It worked all the more precisely in spotting fire and sprinkling the water. The shaft points were estimated suitably and in like manner the wheels are advanced right way. Microcontroller produces individual orders to control the bearing of the robot. This douser robot can be easily and fittingly utilized and enacted precipitously when any fire mishap emerges in instructive, modern, private and emergency clinic regions to ensure human existence. Fire extinguishing Robot comprise of a few sensors and engines, little in measurement, less mass, which brings about less space possessing. This douser robot excellently extinguishes fire before it end up being exceptional and offers danger to life. Fire extinguishing robot additionally viably eliminates obstacle from the way to make room. By presenting this fire quencher robot in enterprises and different plants, fire hardship rates can be decreased.

References

[1] Kristi Kosasis e al., 2010,"The Intelligent Fire Fighting Tank Robot", Electrical Engineering Journal Vol.No. 1, pp. 73-80.

[2] Mangayarkarasi V, 2018 "Remote Controlled Fire Fighting Robot", International Journal of Trend in Scientific Research and Development, Vol 2, No 5, pp 820.

[3] C. Shaohua, B. Hong, Z. Xianyun, and Y. Yimin,2003 "A fire detecting method based on multi sensor data fusion", IEEE International ConferenceSystems, Man and Cybernetics, vol.4 pp. 3775-3780.

[4] Young-Duk K, Jeon-Ho, Duk-Han S, M. Jeon-I R. Young-Sun, and A. Jinung, 2010 "Design and implementation of user friendly remote controllers for rescue robots in fire sites," Proceedings of SICE Annual Conference ed, 2010, pp. 875-880.

[5] K. L. Su, "Automatic Fire Detection System Using Adaptive Fusion Algorithm for Fire Fighting Robot," in Systems, Man and Cybernetics, 2006. SMC '06. IEEE International Conference on, 2006, pp. 966-971.

[6] N. Suresh Kumar et. al. / International Journal of Engineering Science and Technology. "Virtual Software to Design and Interface peripherals with different Microprocessors" Vol. 2(5), 2010, 1143-1146.

[7] Samantha Cardoso et al.,2017 "Literature Survey on Fire Fighter Robot", International Journal for Scientific Research and Development, Vol. 5, Issue 01,

[8] N. Suresh Kumar et al.,2019 "Multi-dimensional parametric assessment with IoT in acquaintance of digital pipeline", International Journal of Electrical and Computer Engineering Vol. 9, No. 6, Dec, pp. 4649~4656.

[9] Sale A H, 2019, "Fire Fighting Robotic Vehicle", International Research Journal of Engineering and Technology, Vol. 06 No: 04.

[10] Kuchi N S Utpala.,2019 "Authenticated IoT Based Online Smart Parking System with Cloud", Pramana Research Journal, Vol. 9 No 4,

[11] Swetha Sampath B, 2011 "Automatic fire extinguisher robot", 8th international conference on ubiquitous robots and ambient intelligent, songdoconventia, Incheon, Korea pp 23-26,

[12] Suresh Kumar N, 2010, "Digital frequency meter using DMA Terminal Count Stop method", International Journal of Engineering and Technology vol. 2, No. 2, pp 34-37.

[13] Tushar NandkishorSatbhai,2010, "Fire Fighting Robot", International Journal on Recent and Innovation Trends in Computing and Communication, Vol: 4 No: 4. pp 34-37

[14] Saravanan,P 2015, "Design and Development of Integrated Semi-Autonomous Fire Fighting Mobile Robot", International Journal of Engineering Science and Innovative Technology Vol. 4, No. 2.

[15] Jyostna PrasannaU,.PrasadM V D, 2013 "Automatic Fire Sensing and Extinguishing Robot Embedded With GSM Modem", International Journal of Engineering and Advanced Technology, Vol 2 No.4

[16] Swati A. Deshmukh , Karishma A. Matte and Rashmi A. Pandhare2015, "Wireless Fire Fighting Robot", International Journal for Research in Emerging Science And Technology vol-2, Special Issue-1.

[17] Ratnesh Malik, S. S. Kumbhalkar, 2021, "Fire Fighting Robot: An Approach", Indian Streams Research Journal, Vol.2, No.2 pp.1-4.

[18] Kumbhare M., Kumbhalkar S. S. and Malik R. (2012), Firefighting robot: an approach, Indian Streams Research Journal, pp. 1-4.

[19] Taiser T. T. Barros, Walter Fetter Lages, „Development of a Firefighting Robot for Educational Competitions", RiE 2012, Prague.

[20] Et. Dr. Raju N.Pamnchal, "Fire Fighting Vehicle," International Journal of Engineering Science and Research (IJETSR)," Volume 4, (Issue 9, September 2017), ISSN 2394-3386.

[21] Lakshay Arora, Prof. Amol Joglekar. Cell Phone Controlled Robot with Fire Detection Sensors. (IJCSIT) International Journal of Computer Science and Information Technologies. 2015.6(3):pp: 2954-2958.

[22] E.V.Sivakumar, P.Manoj, S.Punithadevi, S.Sherlin Sylvia, M.Thangaraj (2016). Voice Controlled Intelligent Fire Extinguisher Robot. IJSART - 2016.2(2).

[23] Vipul Agrawal, Anoop Kini. Design & Development of an IoT based Firefighting Robot using Arduino. International Journal for Research in Applied Science & Engineering Technology 2019.

[24] Joga D. Setiawan, MochamadSubchan, and AgusBudiyono "Virtual Reality Simulation of Fire Fighting Robot. Dynamic and Motion." ICIUS, October 24-26 2007.

[25] Et. S.O. Lee, "A stable target-tracking control for unicycle mobile robots," Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems(IROS 2000)," Vol.3, 2000, pp. 1822-1827.

[26] L. E. Parker and B. A. Emmons, "Cooperative multi-robot observation of multiple moving targets," Proceedings of the IEEE/RSJ International Conference on Robotics and Automation," Vol.3, 1997, pp. 2082-2089