International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

Design and Development of Multi-Purpose Fire Extinguisher Robot

Vyomkesh J. Sangewar[1], Abhishek S. Thorat[2], Mrunal M. Kholamkar[3], Vishal V. Shinde[4]

Mechanical Engineering, M.V.P.S.'s K.B.T. College of Engineering, Nashik-422013, Maharashtra, India
[1]*vyomkesh2311[at]gmail.com*
[2]*abhi24699[at]gmail.com*
[3]*mrunal2kholamkar[at]gmail.com*
[4]*shinde.vishal[at]kbtcoe.org*

Abstract: ***Fire disasters can cause loss of life, damage property and the environment. Primary task of fire-fighters is to handle fire incidents but while doing so they are at a higher risk especially when extinguishing fire in hazardous environments like nuclear power plants, gas stations, oil rigs. They are faced with other challenges like fires in narrow places where a human being cannot reach. With so many risks involved in fire fighting operations, technological advancements can be used to assist in fire fighting. Therefore, in this paper development of multi-purpose fire extinguishing robot is proposed which can assist in carrying out fire extinguishing operations as well as reconnaissance missions.***

Keywords: Fire Extinguisher Robot, Fire fighting robot, Multi-purpose fire fighting robot. Fire safety Robot, Fire Safety Vehicle

1. Introduction

Firefighting is the act of extinguishing destructive fires. A firefighter must be ready to stop fire quickly and safely extinguish the hearth, preventing further damage and rescue victims to a safer location from the hazard. Technology has finally bridged the gap between firefighting and machines allowing a more efficient and effective method of fireside fighting. Robots are designed to seek out a fireplace , before it rages out of control. The robots are designed hoping they could one day work with fire fighters in reducing the risk of injury to victims and fire fighters.

2. Literature Review

Many researches have contributed to the development of line follower robot, some of the application are summarized below:
Makhare Sonal, Sapkal Saraswati, Mane Bharat, Professor V.V. Bansude, the Project is based on the implementation of the fire Fighting robot; the design and details are explained in this paper. The robot is operated on the basis of the web server. When the rate of fire is increased the temperature, sensor senses the rate of increased fire temperature according to that the robot is operated. Three different sensors are used in the robot. Smoke detector detects the amount of smoke that is caused due to fire, whereas obstacles in the pathway of robot is detected by IR. Water is pump by the use of the DC water pump by the robot. All the data is sent via Bluetooth to the android device and then it is sent to web server from that android device. It Sprays water over the fire from the tank which is placed on the robot.

M.S.M. Hasimi, W.H.W. Zuha, Suhaidi Shafia, M. Hamiruce Marhaban Department of the Electrical and Electronic, University Putra of Malaysia; as known to all of us that fire Fighting is the dangerous occupation, design of the robot is done such that they are used to find fire areas and then it goes to that place by highly reducing the risk of the injury to the fire fighters. The fire extinguisher robot consists of the three parts that is Hardware part, the electronic part and the programming part. The robot design is based on MUROC's rules. In the mechanical part the design of the robot and the stimulation of design is done by CAD drawing using the design software. In the electronic part several sensors are used and finally in the programming part the use of start Point counters or strategy switch for the operation of the robot.

Rahul Ray, Sunny Singh, Vinay Kr Gupta, Sandeep Maurya Mechanical Engineering department UCEM, Allahabad, India; as robotics has developed a lot from recent years it has become one of the interesting field, in this project the fire fighting robot is made for the small floor area. It is also called as the small autonomous fire fighting robot. The size of this robot is very small so that it can do its specific task quickly and at the faster level. The robot is made by using the material that is galvanized steel or iron. Then the water pump is used for lifting of water. DC motor is used so that it will convert electrical energy into a mechanical energy. Adapter converter is used as the external power source for the robot. This robot can be used at small floor areas by reducing the risk to the human beings.

Ya-Zhou Jia, Ji-Shun Li, Nan Guo, Qi-Su Jia, Bo-Feng Du, Chang- Ye Chen, School of the Mechatronics Engineering, Henan University of the Science And Technology, Luoyang, China; in this project the robot is made by the waterproof shell. It realizes the accurate change in the temperature and also detects the presence of the dangerous objects by its side in fire places. It has the high intelligence of the detection and its structural reliability is excellent. This two are main significance of this robot. It uses the virtual prototype technology. It is a small crawler robot. It detects the presence of the toxic gases, smoke, dust, high chemical into the atmosphere.

Komal N. Ambadkar, Vaishnavee A. Gorte, Shravasti M. Rekhate, Renuka D. Nichit, Pratik A. Gaupal, P.K. Khedkar,

department of electrical Engineering and Technology, Amravati, India; this project is based on the design of the fire Fighting robot using Arduino. It is electrical based project. It uses the XBEE module for the remote operation of the robot. Robot vehicle is loaded with the water tank and is operated wirelessly. The used of Arduino is for same desired operations. The remote controller uses the RF transmitter with the camera which is wireless, and robot is operated or control by a person using remote controller.

Li Cai, Rong Zhang, Advanced materials Research (volume 823); the project is based on the firefighting robot which uses photoelectric sensors for the detection of the obstacles in its path. It extinguishes fire from the flame detected with used of the far infrared sensors. In the software design it introduces the optimize algorithm of the swarm particle for the improvement in the sensitivity of the firefighting robot. The robot has the advantage of easy control and simple structure. It uses intelligent technology with microelectronics and microprocessor technologies.

Bhargavi Gharat, Priti Kaudgaonkar, Bhagyashri Korche, Tejaswini Lokare; this firefighting robot which is design has a capability to move in the all 360 degrees that is in all directions. There is no need of humans to go in the fireplace and this robot can be operated with the help of the remote controller from over a longer distance. The proposed system has a main control block which is the 89S52 microcontroller. The L293D which is the motor driver acts as a push-pull type of amplifier which gets logic with the help of the microcontroller. It supplies the rate of power to the motor and the pump. This robot has ability to detect fire and also it has a capability to extinguish it. It makes human life more comfortable and easier. It uses computer and the nano technologies.

3. Experimental Technique

3.1 Basic operation

The basic operation of fire extinguishing robot is to assist fire fighters in extinguishing fire. The robot is designed such as to carry the water hose from the hydrant on the road side or from the hose points. These robots are so agile that they can be even deployed from fire brigade truck and assist the fighters. In case of emergency or necessity these robots are capable to carry a human on itself and away from the blaze of fire. [1]Also, this multi-purpose robot can be used in reconnaissance operations by replacing the surface mounted water hose assembly with necessary equipment or weapons.

3.2 Methodology

The methodology is divided into two parts. The first part is on the mechanical schematics, and the second part is hardware description. All parts were assembled together and then test runs were performed to determine the optimal distance to extinguish the fire.[1]

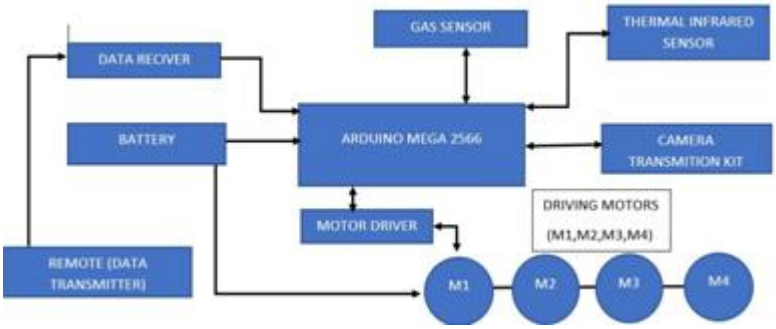

Figure 1: Working Methodology

a) Mechanical Design

Solidworks was used to produce 3D and 2D schematic diagram. For the main structure of the robot, to get the preferred movement and speed, it has caterpillar tracks on both side. The tracks have the ability to stabilize the robot and make rotate the robot 360 degrees.[2] The body of the robot is made from mild steel to protect the electronic circuit. The mild steel plate is resistant to heat of up to 400-500 ºC. This gives the ability to use and work in close proximity of fire. [3]The body of mild steel chassis contains holes that make it easier to mounting of various type of sensors and other mechanical components. The gas sensor and thermal infrared sensor were installed at front of the robot to avoid hitting any obstacles and to detect gas and fire respectively. In addition, mini camera was installed in front side of the robot to monitor the way and condition of the location and is connected to the smart phone.

b) Hardware implementation:

The electronic part is one of the vital parts in the development of the robot. The fire extinguisher robot is designed such that it captures the data from the incident and transmit it back to the controller. On board sensors such as gas sensor, thermal camera, dc motor, transmitter and remote control are used. [4]Arduino Mega 2566 is used as a microcontroller that is connected with other components. Motor Driver (DMC60) is used to activate the movement of gear drive system when Transmitter Remote Control will give output of the system. Flow of water and fire extinguisher were being controlled by the operator. The operator can monitor where the robot is moving with the help of camera (GOPRO) which is connected to the smartphone

c) Gas Sensor

The gas sensor acts as an essential part in the investigation of the site. Gas Sensor(MQ2) module is useful for fuel line

leakage detecting(in domestic as well as industry). [5]It can sense gases like LPG, i-butane, methane, alcohol, hydrogen, smoke and many more. Based on its speedy reaction time, measurements may be taken as quickly as possible. Also, the sensitivity may be adjusted through the variations in potentiometer.

Figure 2: MQ2 Gas sensor

d) Thermal sensor

Adafruit MLX90640 Thermal Camera sensor contains a 24x32 array of IR thermal sensors placed in them. When connected to your microcontroller (here arduino) it will send an array of 768 individual infrared temperature readings over I2C to processor. [6]It's similar to expensive fancy thermal cameras, but compact and simple enough for easy integration with the system. The sensor will measure temperatures ranging from -40°C to 300°C with an accurate measurement of +- 2°C (in the 0-100°C range). With a maximum frame per seconds of 16 Hz the theoretical limit provided is 32Hz but we were not able to practically attain it on small displays, [7]It's perfect for detection of human and mini thermal camera. The code for using this sensor on an Arduino or compatible (the sensor communicates over I2C) or on a Raspberry Pi with Python language. To using an Arduino-compatible, we will need a processor with at least 20KB RAM - a SAMD21 (M0) or SAMD51 (M4) chipset will do adequate job. On the raspberry pi , you can even perform interpolation processing with help from the SciPy python library and attain pretty amazing results.

Figure 2: MLX90640 Thermal Camera sensor

Transmitter (FrSky 2.4GHz Taranis Q X7)

The version X7 ACCESS capabilities 24 channels with a quicker baud charge and decrease latency way to its high-pace module virtual interface. As with the relaxation of the ACCESS transmitters, [8]it presents a steady and dependable link, in conjunction with wi-fi firmware updating making it completely well suited with our most recent line of OTA receivers. The battery compartment now makes use of 2 18650 Li-Ion batteries and may be stability charged through the Mini USB interface. The Taranis merges the strength of the "OPEN TX" open-supply software program with an ergonomically designed case with 6 programmable switches (four x 3-position, 1 x 2-position, 1 x momentary) and twist knobs. [9]Set up your switches and controls the way you need them. Alerts may be provided within side the shape of audio speech outputs, sound or vibration signals making this extraordinarily user-friendly.[10]The MicroSD card slot gives limitless version reminiscence options, it additionally has a USB port for improvements and to hook up with a PC for adjusting settings. As nicely as this there's the capacity to apply all of your version documents from the older TARANIS X9D/X9D Plus/X9E making it clean to get the brand-new device up and working.

Figure 3: FrSky 2.4GHz Taranis Q X7(transmitter-reciever)

Battery

Amaron ABR-PR-12APBTX50 using this battery serves very important purpose in the entire system. As battery is the main part of the entire assembly, every component of the robot work with this on board supply. This rechargeable Lead Acid Battery, Which forms a single source of power with the capacity of 5000mAh and a voltage of 12V. [1]These batteries supply power to Control Board, Sensors and Motor Driver. This Batteries are used because robot can easily work for an entire operation, considering the task it has to carry out over a period of time.

Figure 4: Amron battery (on board)

Arduino

[11]It's the main control unit of the robot. It processes all data and provides required command to the parts because it is ordered. This microcontroller board based on ATMega2566. It has 14 digital input and output pins among them 6 can be used as PWM outputs, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and also a push button. It consists of both a physical programmable circuit board and IDE that runs on your computer, used to write and upload computer code to the physical board. The Arduino interface uses a basic version

of C++, which makes it easier to learn to program. Programs are easily uploaded from computer with the help of USB cable. It are often powered by both USB connection or external power supply.

Figure 5: ATMega2566 (main computing device)

Motor driver

Motor drivers are circuit which permit control of motors. One need them because we can't power a motor with just a microcontroller supply. Motor Drivers are available in IC form, implemented within the sort of an H-Bridge . They allow us to modify on and off a motor using an output from a microcontroller, and therefore the best feature is that they allow one to run the motor in both forward and reverse. This means each motor has 2 dedicated inputs from a microcontroller, one for direction control and one as an toggle switch. If using PWM one need a pin capable of manufacturing a PWM output to regulate the toggle switch.

Figure 6: TALON DMC60 (motor driver)

4. Conclusion

Overall, a fire-extinguisher robot that can be controlled from long range is successfully developed. It has advantageous features such as ability to reach location of fire rapidly besides having a compact body and rigid structure. Robot also has the ability to drive over any obstacle or surrounding objects due to its provision of a caterpillar tracks. The robot has compact structure hence it can be used at a place that has a small entrance or in small spaces . [12]The operator has the ability to extinguish fire using remote control from longer distance. Controller can also monitor the environmental conditions during the process of firefighting by using the camera that is connected to the smartphone. The robot can defuse smokes and fire accurately in a short time. As a conclusion, the project entitled "Development of multipurpose fire extinguisher robot" has achieved its aim and objective successfully

5. Future Scope

- An ultrasonic sensor can be attached to detect objects around the robot to avoid collision.
- A fire extinguisher ball throwing mechanism can be added to make it more powerful extinguisher.
- A GPS module can be installed so that robot can return to its original position if there is loss of signal
- The water hose assembly can be swapped with military equipment to assist soldiers in their missions.

References

[1] Mohd Aliff, MI Yusof, Nor Samsiah Sani, Azavitra Zainal, "Development of Fire Fighting Robot (QRob)", (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 10, No. 1, 2019
[2] J. Suresh, "Fire-fighting robot" , 2017 International Conference on Computational Intelligence in Data Science(ICCIDS), Chennai, 2017, pp. 1-4. doi: 10.1109/ICCIDS.2017.8272649
[3] K. L. Su, "Automatic Fire Detection System Using Adaptive Fusion Algorithm for Fire Fighting Robot", 2006 IEEE International Conference on Systems, pp. 966-971, 2006.
[4] H. Amano, "Present status and problems of firefighting robots", Proceedings of the 41st SICE Annual Conference. SICE 2002, vol. 2, pp. 880-885, 2002.
[5] A. Bradshaw, "The UK Security and Fire Fighting Advanced Robot project" in IEEE Colloquium on Advanced Robotic Initiatives in the, UK, London, pp. 1/1-1/4, 1991.
[6] T. L. Chien, H. Guo, K. L. Su and S. V. Shiau, "Develop a Multiple Interface Based Fire Fighting Robot", 2007 IEEE International Conference on Mechatronics, pp. 1-6, 2007.
[7] T. Rakib and M. A. R. Sarkar, "Design and fabrication of an autonomous firefighting robot with multisensor fire detection using PID controller", 2016 5th International Conference on Informatics Electronics and Vision (ICIEV), pp. 909-914, 2016.
[8] J. H. Hwang, S. Jun, S. H. Kim, D. Cha, K. Jeon and J. Lee, "Novel fire detection device for robotic fire fighting", ICCAS 2010 Gyeonggi-do, pp. 96-100, 2010.

[9] L. Celentano, B. Siciliano and L. Villani, "A robotic system for firefighting in tunnels", IEEE International Safety Security and Rescue Rototics Workshop 2005. Kobe, pp. 253-258, 2005.
[10] D. J. Pack, R. Avanzato, D. J. Ahlgren and I. M. Verner, "Fire-fighting mobile robotics and interdisciplinary design-comparative perspectives", IEEE Transactions on Education, vol. 47, no. 3, pp. 369-376, Aug. 2004.
[11] M. Sato, H. Torikai and Y. Iwatani, "Flame extinguishment by a prototype of an aerial extinguisher with an inert gas capsule", The SICE Annual Conference 2013, pp. 2051-2056, 2013.
[12] Tong Feng, Xu Lufeng and Tong Daoling, "An ultrasonic obstacle avoidance system for firefighting robot", Proceedings of the 4th World Congress on Intelligent Control and Automation (Cat. No.02EX527), vol. 2, pp. 1219-1222, 2002.
[13] M. Li-Xin, S. Dao-Nian, C. Min-Xuan and W. Xiao-Qin, "Application of Intelligent PID Control for Robot", IEEE Conference on Cybernetics and Intelligent Systems, pp. 455-458, 21–24 Sept. 2008.
[14] E. Krasnov and D. Bagaev, "Conceptual analysis of firefighting robots' control systems", 2012 IV International Conference “Problems of Cybernetics and Informatics” (PCI), pp. 1-3, 2012.