ISSN No:-2456-2165

Automated Fire Fighting Robot

Nandakumar S, Sanjay Sagar I, Subash R, Vishal Vaitheeshwaran R.K
Dr. S. Uma Maheswari
M.E, Ph.D. (Professor)
Electronics and Communication
Panimalar engineering college
Chennai, Tamilnadu

Abstract:- With the development in the field of robotics, human intrusion has become less and robots are being widely used for safety purpose. In our day-to-day lives, fire accidents have become common and sometimes may lead to hazards that make it hard for the firemen to protect human life. In such cases, a fire fighting robot is used to guard human lives, wealthand surroundings from the fire accidents. Here we implement two modes of robotic operations- Manual mode & Automatic mode.In the Manual mode, PHP webpage is used to control the robotic vehicle. In Automatic mode, the robot takes controls by itself based on the user predefined command. To detect fire we use OpenCV for image processing. Standard colors of fire are defined by upper and lower boundaries of HSV color spaces of red, orange and yellow. The water spraying mechanism is completely automatic to both the modes. In the PHP webpage we have a control to switch between manualand automatic modes based on our choice.

Keywords:- *Embedded systems, Image Processing, OpenCV, Python, Raspberry Pi.*

I. INTRODUCTION

As robotic Technologies have improved and has been an integral part of our lives lots of people have made attempts to find an alternate for human work and efforts with new improvement in technology of embedded design particularly when people risk the lives during fire hazards. This allows robots to act to their full potential and understand complex and difficult scenarios aftermath of a disaster however it would be effort full if the robots fight against fire hazards rather than responding after the occurrence of the hazard. The need for production systems in cities and major towns has been mandatory and this robot has been built to match the difficult environment of such topographical areas. The basic idea is to implement fire sensors positioned by estimation of the range of fire radiation. There are smoke detectors and gas detectors which are normally cheap and easy solution for fire detection. What recent developments that includes distributed fire optic temperature sensors which are used to extinguish fire. This module uses wireless sensor structures ultrasonic sensors that senses obstacles and moves according to the detected obstacles. Digital image processing technique has been used with color video pictures and it could sense the flames.

II. LITERATURE SURVEY

A. Existing System

The present-day systems only rely on the output from the analog sensor whose values are not precise and tend to fluctuate easily. Hence depending on these sensor for emergency situations won't be effective. Autonomous robots that are developed in this field of firefighting can't be controlled manually when needed. Manually controlled robot need a human operator in the vicinity of fire which can be harmful.

B. Drawbacks Of The Existing System

Analog sensor values are not dependable enough and fluctuates based on the environment.

Sometimes the autonomous robot may get lost from the field of fire.

Operation of the manually controlled is limited in the existing system.

C. Proposed System

In this project we have implanted both automatic and manual controls to overcome the drawback on the existing system. Manual mode acts as a pair of eyes for the firemen outside thereby helps to evaluated the situation inside the building. In case of automatic mode, the firemen don't need to worry about the low priority situation which can be handled by the robot itself.

The major advantage of this project is that we can switch between modes with PHP webpage whenever we want and the water spraying mechanism after the detection of fire is completely similar to both modes.

D. Proposed System Modules

- Manual mode controls on the PHP webpage consists of forward, backward, left, right and stop.
- There is also an option to switch between automatic and manual modes in the PHP webpage.
- Ultrasonic sensor to detect obstacles
- Fire is detected with the help of the Image processing (python and open CV) and the water is sprayed over the fire.
- Water spraying mechanism consists of a wiper motor and solenoid valve.

E. Abbreviations and Acronyms

OpenCV (Open Source Computer Vision)

PHP	(Personal Home Page)
GPIO	(General Purpose Input Output)
HDMI	(High-Definition Multimedia Interface)

ISSN No:-2456-2165

III. HARDWARE REQUIREMENT

The movement of the robot is achieved by using a four-wheeledmotor driver. L293D controller is used to control 100RPM motor on the robot. Raspberry pi is used to read the values from the ultrasonic sensor and sends signal to control the motor controller board based on obstacles. In order to spray the water a separate DC motor is used in the upward and downward movement of the spraying arm and to control the flow of the water we use wiper motors along with the solenoid valve to control the discharge of water. Front view of the robot can be seen in the fig a.

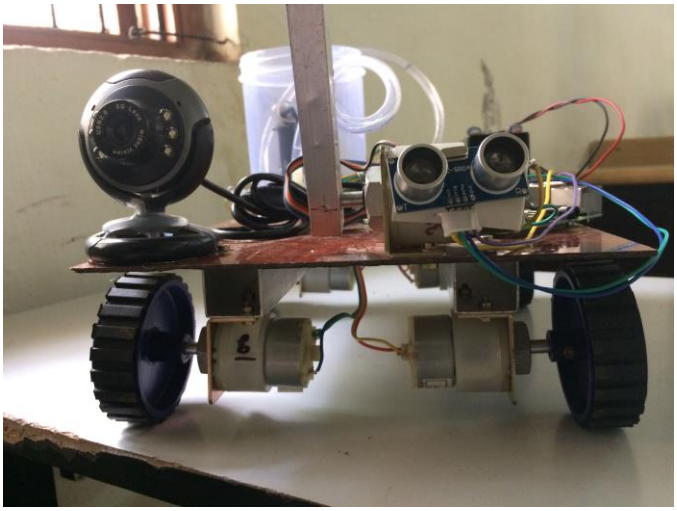


Fig 1:- Front view

Ultrasonic sensor is used to determine the distance between the robot and the obstacle by interfacing it with the Raspberry pi. This also provides us with sufficient data to not only avoid obstacles but also to maintain a safe distance between the fire source and the robot. There is a USB camera in the setup to detect the fire with the help of image processing. Once the fire is detected, by turning on the DC motor we can spray the water from the container. Prototype can seen in Fig b.

Every movement of the robot is achieved by the help of various DCmotor used in the design. To spray water from the container we use a separate car wiper motor and a solenoid valve to control the pressure of the water sprayed.

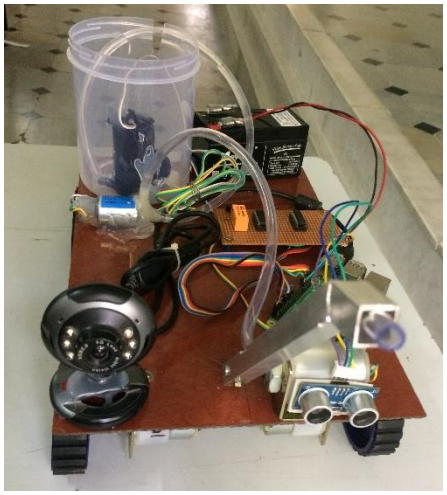


Fig 2:- Prototype

IV. SOFTWARE IMPLEMENTATION

The raspberry pi is programmed using python. Once it is powered ON, the raspberry will initialize GPIO pins as output in order to send the control signal to the ultrasonic sensor, in return the sensor sends back a pulse as time taken for the ultrasonic wave to travel from the sensor to any object and back.

To detect fire we use OpenCV for image processing and through upper and lower boundaries of HSV color spaces of red, orange and yellow, we define the standard colors of fire.Once the fire is detected we send a signal to the wiper motor and DC motor (on the front side) in order to extinguish the detected fire, until the fire is extinguished this loop will be repeated. This mechanism, of detecting the fire is similar to both the modes.

In manual mode we use PHP webpage to control the robot's movement. This was designed in a vision of controlling the robot from a different location.

V. WORKING

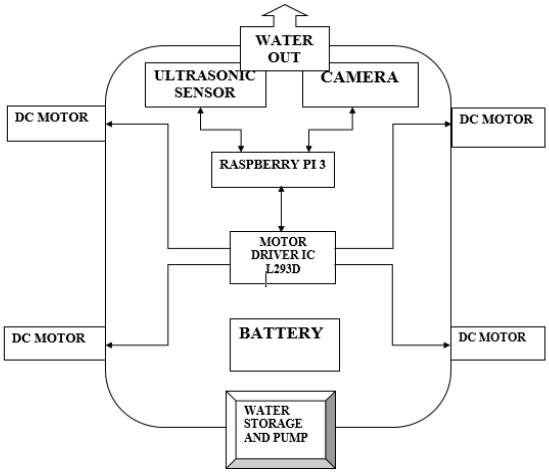
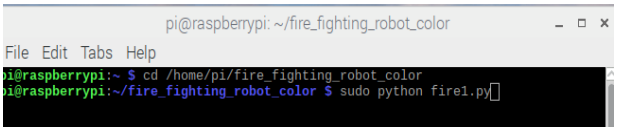


Fig 3:- Block diagram

Initially a local adhoc network is created with a single device generating the Wi-Fi hotspot and Raspberry pi connects to it. Once it is successfully connected there is an option to start the robot either in auto or manual mode. In auto mode the robot is switched ON by simultaneously running two python scripts one for color detection and another for running motors. There is also a separate program for ultrasonic sensing which is called from the main GPIO program. The command for running a python script in Raspberry Pi terminal is

cd<space>file location directory
sudo<space>python<space>filename.py



ISSN No:-2456-2165

Fig 4:- Running the fire program and argument results

Once the python program is run and the camera or ultrasonic sensor detects anything, the corresponding arguments are displayed in the terminal.

The arguments we have used are

- "FIRE detected" in case any colour constituent is detected
- "Obstacle detected" if any obstacle detected by Ultrasonic sensor
- "MANUAL MODE" for manual mode operation
- "AUTO MODE" for auto mode operation

VI. MANUAL MODE

In Manual mode, the robot is completely controlled through a PHP webpage where we can send commands to motor driver via GPIO pins of Raspberry Pi to move in the required direction. The robot has four wheels connected to four 12V 100 rpm DC Motors. The PHP webpage is designed with the following controls,

- Forward
- Backward
- Right
- Left
- Stop

There is also a control to switch between automatic and manual mode. The following figure gives a clear view of it,

Fig 5:- PHP webpage

VII. AUTOMATIC MODE

In automatic mode the first process is capturing images by the USB camera. When an image is captured, the raspberry pi looks for the color constituents we have provided in the OpenCv coding (Red, Yellow and orange).The color is detected by calculating its color range in HSV color space .We have added lower and upper boundary values of the colors and when the detected color matches the range in between the thresholds Raspberry pi gives command to the motordriver to run the motors towards the fire for a short time, then the pump and solenoid valve starts to eject water from the water storage tank. As long as the fire is detected the water spraying mechanism will work and once the fire is completely quenched the camera will not pick up any given colors so the robot starts rotating 360 degrees to detect fire. Once the camera picks up fire the robot again starts the water spraying mechanism.

The amount of time in water spraying can be altered in the software level and also the radius of detection can be varied to detect any range of fire.

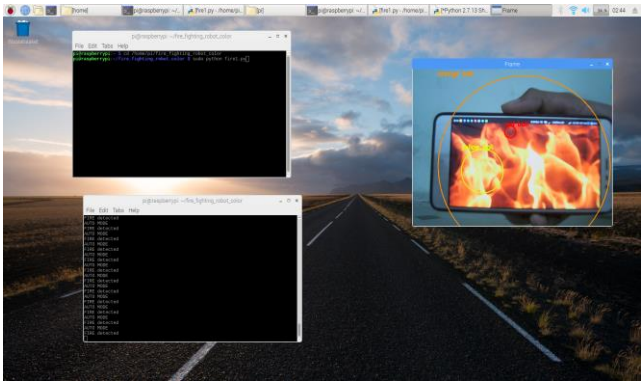


Fig 6:- Fire detection

VIII. SPRAYING MECHANISM

The water spraying mechanism consists if a storage tank, a wiper motor, a solenoid valve and hoses connecting all. There is a mechanical arm in front to facilitate the movement of hose up and down so as to spray over a wider area rather than focusing on a single point of fire.

IX. RESULTS

The automated fire-fighting robot is capable of detecting fire and extinguishing the fire source successfully. The raspberry pi controls the DCmotor and ultrasonic sensor for movement of robot. It can detect fire under normal and dark lighting conditions and better suited for extinguishing fire inside a building.

X. CONCLUSION

The Fire Fighting Robot is fabricated with locally available materials and some tests are done to observe its effectiveness at different situations. As the Fire Fighter Robot has to endure different situation, this effectiveness test will help us to make a better model. The Fire Fighting Robot is effective enough to fight against fire on a small scale. It can sense fire flame better at darker places. It is made as a preventer robot. Because it can detect fire instantly and can extinguish it before spreading. This multisensory based robot may be a solution to

all fire hazards. With enough funding and scope, this design of robot can also fight against large fire with larger reserving capacity and an improved sensing unit can provide even an earlier detection of fire at all circumstances.

XI. FUTURE WORK

IOT can be implemented onto the robot to control it from another location in manual mode. More sensors can be mounted to achieve a better performance and we can also reduce the reaction time detecting the fire source. With the addition of a 360º camera we can achieve a great field of view. The storage can be replaced with a water pipeline for extinguishing larger fire source. Colour detection of fire is not very reliable. Hence a thermal camera can be installed rather than the USB camera to achieve better detection of fire source based on intensity.

REFERENCES

[1] Che-Bin Liu and Narendra Ahuja, “Vision BasedFire Detection,” International Conference on PatternRecognition, pp.134 – 137, 2004.

[2] I.Doshay, "Robotic fire protection system," U.S. PatentNo.6,364,026,April 2002.

[3] J. H. Hwang, S. Jun, S. H. Kim, D. Cha, K. Jeon and J. Lee, "Novelfire detection device for robotic fire-fighting,"ICCAS 2010, Gyeonggido,2010, pp. 96-100.

[4] K. L. Su, "Automatic Fire Detection System Using Adaptive FusionAlgorithm for Fire Fighting Robot," 2006 IEEE International Conference on Systems, Man and Cybernetics, Taipei, 2006, pp. 966-971.

[5] M. Hefeeda, and M. Bagheri, "Wireless sensor networks for earlydetection of forest fires." Mobile Adhoc and Sensor Systems, 2007.MASS 2007. IEEE International Conference on, pp. 1-6, October 2007.M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.

[6] P.H. Chang, K.B. Park, G.R. Cho, J.K. Kim, W.J.Lee, "A Vision Enhancement Technique for RemoteControl of Fire Fighting Robots", Korean Institute ofFire Science & Engineering, 2007.

[7] S. L. Rose-Pehrsson, S. J. Hart, T. T. Street, F. W. Williams, M. H.Hammond,D. T. Gottuk, M. T. Wright and J. T. Wong, ”Early warningfire detection system using a probabilistic neural network”,Firetechnology, vol. 39, pp. 147-171, April 2003.

[8] T. Rakib and M. A. R. Sarkar, "Design and fabrication of anautonomous firefighting robot with multisensor fire detection usingPID controller," 2016 5th International Conference on Informatics,Electronics and Vision (ICIEV), Dhaka, Bangladesh, 2016, pp. 909-914.