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Smart Fire Fighting Robot

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ABSTRACT

The paper describes a Smart Fire Fighting Robot which detects fire using Image Processing. The important feature of this project includes, that it can be controlled remotely from any work station. This is done with the help of the ESP 8266 Wi-Fi Module. The module along with the code compiled in Atmega328 creates a local IP Address displayed on a 16x2 LCD Screen. This address can be typed in any browser and by following the on-screen commands, the robot can be controlled. Unlike other robots, this robot will incorporate key technologies which are in existence, to create a fully equipped robust robot. This robot is also equipped with an Ultrasonic HC – SR04 Sensor, which is used to detect and avoid obstacles. The robot automatically changes it's head by 90 degrees or by 180 degrees; if it detects obstacle in any direction. To detect fire, the robot uses the concept of Image Processing which is known to have an accuracy of 100 percent. But still as backup, a Flame Sensor has been provided on the front side.

Keywords : Image Processing, Wi-Fi Module, Atmega328, IP Address, LCD, Ultrasonic Sensor, Flame Sensor.

I. INTRODUCTION

The purpose of the project is to solve the existing problem of human dependence on fighting fire which causes tremendous loss of human life. Our system uses various newer technologies such as Image Processing and Cloud Computing to minimize such loss. It involves little or no human effort. Even in today's world with full technological advancements and latest inventions, we still rely on human physical effort to fight fire. Not much has been done to change this taking into consideration the loss of human lives that occur. This led us to developing an algorithm so as to detect and extinguish fire from a live video feed by processing it in the background. It requires human effort only on the outside for monitoring the work done by the robot. The robot's movement is controlled manually by us. As already mentioned, our system aims at completely replacing the current human effort to fight fire by making the system completely automatic and robotic based. It will be employed by the Fire Fighting Departments to not just extinguish fire but also to protect or secure something valuable. It can be scaled further in future to make it bigger, better, robust and more fire efficient.

II. REVIEW OF LITERATURE

In recent times, owing to the rampant advancement in technology, there have been many projects and research done in the field of fire detection and extinguishment. A few of the prominent ones including the ones by MNCs and student research papers include:

1. There are many major Multi-National Companies (MNCs) that deal primarily in human life security, with fire safety being the most important objective. Various companies such as Apollo (A Halma Company) and Tyco (A Johnson Controls Company) are world leaders in providing safety against fire. They are the pioneers in Fire Detection Systems and provide world class Fire Solutions. But it has to be noted that almost all of their equipment works on smoke detection and not by actually detecting fire. They provide services such as Fire Alarm Control Panels, Fire Alarm Monitoring, Smoke and Heat Detectors and etc. These systems are the ones that have to be installed on the roofs of homes or offices. They are battery operated and since fixed to the ceiling are not mobile and thus cannot access remote corners of the place. Also these companies are not global

enough and thus their offices are limited to only a few major markets such as USA, Ireland and China.

2. Another study was done by a group of students (Kausik Sen, Jeet Sarkar, Sutapa Saha, Anukrishna Roy, Dipsetu Dey, and Sumit Baitalik) from the Burdwan University, W.B. India.

In their project/research they've used smoke and heat sensors for detecting and alarming about the fire. The project also includes an SMS based system which alerts the user of the place whenever a fire has occurred. They've also included a memory unit which holds the information of the exact place where fire has occurred and sends the appropriate location to the user. However, it is to be noted that the system does not respond if the fire generates very small smoke particles and very small amount of heat. The system does not display properly if two or more than two rooms or blocks are affected at a same time. This drawback has been highlighted by them in their research. Also, they've used smoke and heat sensors instead of image processing which is not very reliable as being electronic components, they are prone to errors in measurement and detection.

3. Yet another project was implemented by students (Toufiqul Islam, Syed Asif Abdullah, and Golam Sarowar) from the Islamic University of Technology (IUT), Gazipur, Bangladesh. They developed a similar project using image processing to detect and identify fire. The only difference was they collected and sent data using Radio Frequency (RF). This not only increases the overall cost of the project but also makes it more complex and delicate as interfacing RF module is a difficult process and takes time. Also the RF signals have to be strong enough to reach its destination and not get lost in transmission due to noise.

All the studies which have been reviewed show that there are a number of techniques for making a smart robot to detect fire and extinguish it. However, the study conclusion shows that image processing is the best method to detect fire as it has a near 100% accuracy as proved in various researches over the years. Our project includes the same and is also capable of reaching the remote places as it can be controlled and monitored wirelessly. Also, it has an ultrasonic sensor that can be used to avoid obstacles, in case it runs into any. With the help of a mobile camera it can monitor and scan the entire room at one go and can detect fire easily and quickly. Our project is not just easy to implement and efficient but also economical as it is made from easily available equipment.

III. SYSTEM DESIGN AND ANALYSIS

A. Block Diagram

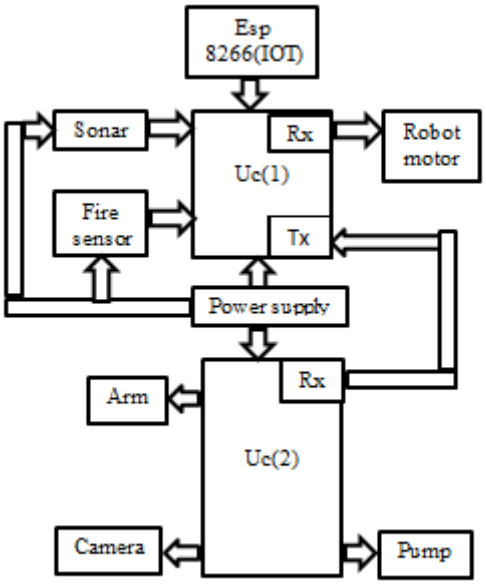

Fig. 1

B. Liquid crystal display

Fig. 2

A 16x2 Liquid Crystal Display (LCD) Screen is used in our project, mounted on top of the robot in front. This LCD receives data from the ESP 8266 Wi-Fi Module and displays the locally generated IP address. This IP address is typed in any browser and the robot can be controlled [6].

C. Ultrasonic sensor

Fig. 3

The modules (HC – SR04) includes ultrasonic transmitters, receiver and control circuit. The basic principle of work: (1) Using IO trigger for at least 10 uS high level signal, (2) The module automatically sends eight 40 KHz and detect whether there is a pulse signal back, (3) IF the signal back, through high level, time of high output IO duration is the time from sending ultrasonic to returning. In our project too, the sensor works to avoid obstacles that may arise in the path of the robot [8].

D. Camera

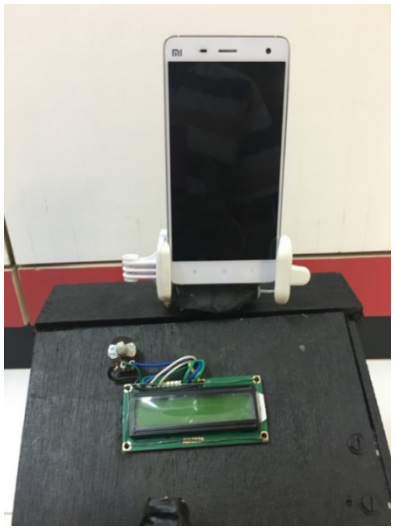

Fig. 4

A Camera is set up at the top of the robot. This is nothing but a regular phone camera that is used to monitor the entire area for presence of fire. It does so by recording a video and sending it to the server where the feed is processed and fire can be detected using Image Processing.

E. Image Processing using MATLAB

In imaging science, image is any form of signal processing for which the input is an image, such as a photograph or video frame: the output of image processing may be either an image or a set of characteristics or parameters related to the image.

In our project too, we use the concept of Image Processing to detect and identify Fire in our processing server. Various functions are used to give us the desired output which can be adjusted for different types of Fires.

MATLAB (MATrix LABoratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. We use MATLAB software to identify and detect Fire using two main detections :

- Colour Detection

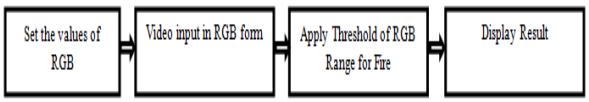

Fig. 5

- Motion Detection

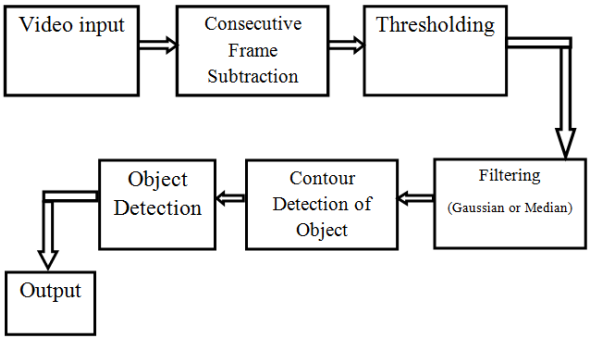

Fig. 6

IV. WORKING AND IMPLEMENTATION

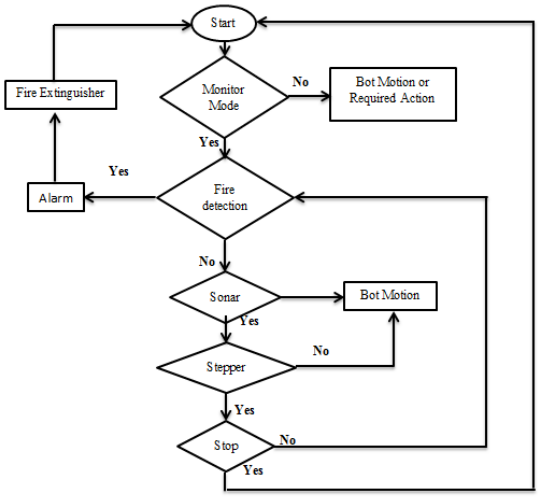

Fig. 7

When the power supply is switched on, the ESP creates the webpage through which the robot receives commands for its various operating modes. This is an example of Internet of Things (IoT). In Monitor Mode, the robot continuously monitors the area to detect fire in the area. This autonomous operation of the robot to detect fire is achieved by using various components like Fire Sensor and Ultrasonic Sensor. The second operating mode is the Manual Mode, in which the user can control the robot manually.

Once a fire is detected, the robot sounds an alarm through the buzzer and informs the user to extinguish the fire. The user can give the command to spray the water gun through the same Wi-Fi Module and webpage. As a backup for Image Processing, fire can also be detected and verified through the Flame Sensor [17].

Fig. 8

Fig. 9

V. CONCLUSION

The system is an innovative and effective replacement to conventional fire fighting system. It provides real time surveillance and fire fighting properties rolled into one product. The system is platform independent as the core system has cross-platform compatibility. Hence it can be used universally. Also, the hardware has already been in existent in the locations where the system can be put into place; thus saving capital cost and is available to the masses.

VI. FUTURE SCOPE

- To make the remote access secured with a 2-step verification and Login ID-Password system
- To enable regular scrutiny sessions using scripting in the internal dock system so that manual involvement can be completely removed.
- Adding layers of protection to make it more fire efficient and robust
- In future, the system can be added on a hovercraft to fight fires at sea due to oil spills, fire on ships etc. It will thus minimize human effort to actually go deep into the sea and extinguish fire.

VII. REFERENCES

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