

# Artificial Eye and Sensory based an Intelligent Robot for Fire Extinguishment Task

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*Abstract – The safety measures due to fire accident of home, laboratory, office, factory and building is important to human life. Fire accidents may occur due to explosive or flammable materials. They can be prevented by taking safety measures. Robots are best and efficient way for taking these safety measures. So we are developing an autonomous ROBOT to detect fire and rescue from fire by using two methods. They are image signal processing and sensory methods. Usually image signal processing is proficient for detecting objects. Here the image signal processing is using to detect the fire from a long distance and priority manner, the sensor unit (flame, temperature sensors) is used to provide precision for extinguishing system.*

*Keywords – Autonomous Robot, Image processing, multisensory, Embedded systems, Fire extinguishment*

## I. INTRODUCTION

The main motivation of our project is to replace the human operating fire fighting system by an autonomous fire extinguishing system. We wish to build a Robotic system to extinguish the fire with more proficient than already existing systems such as manual operating fire engines, fixed extinguishers at wall or ceiling and etc., Large scale industries and factories having fire and safety system for create protection from fire accidents. But in homes, hospitals, laboratories, offices, small scale industries and factories this fire safety system is more expensive for installation process. An efficient fire extinguishing system is necessitating in these places with cost effective manner. Our intelligent Robotic system may offer a best solution to this problem. This Robot uses combination of two techniques to extinguish fire. They are image processing and electronic temperature sensors. It can take safety measures independently and alarming so it provides optimizing performance.

## II. TECHNOLOGY BACKGROUND

Some fire indicating systems are commercially available they are indicating fire by alarming [7]. This method does not endow with a correct safety appraise. This alarming indicator is replaced by automatic fire extinguisher [6]. An automatic extinguisher consists a temperature monitoring sensor is fitted with extinguisher tank if the fire is increase then the valve is open in the extinguisher bottle or tank. Such type of automatic system is not fit for detect and put out the fire properly.

The next technological era is robotics in most of the areas human is replaced by robots such as industrial automation, handling tools in factories and so on,. Robots are more optimal for fire extinguishment task because that operates more efficient than human and be protective. Generally wireless controlled robots are using in many places. Self decision making robotic systems are more power full in some places such as rescue operations, protective operations and etc., we are design a self decision making an intelligent autonomous robotic system for fire extinguishing task.

Autonomous fire fighting robots are also exist but they use a single technique in the following methods, one is multisensory interfacing [1],[4],[5],[8] and another one is image signal processing [9]. Multisensory interface means nothing but interfacing more than one sensor like smog sensor, flame sensor, temperature sensor these group of sensors provides a cumulative work in a shorter distance only. Here image processing technique means nothing but capturing image and digitizing that to detect the targeted object. Some autonomous robots use floor planning method but are only fit for a planned floor only.

We use image processing and multisensory techniques in our intelligent fire detecting and extinguishing robotic system. Because sensors are not capable for detection of fire in a longer distance.[8] Vision sensor mechanism is effective method but that not give a better performance in a closest distance. Our algorithm make this robot may work in whichever place i.e. no need for any floor planning. Artificial vision technology plays a major role in our system. So it has self decision making capability with itself. This technology would make it as a flexible in anywhere.

### III. PROPOSED SCHEME

This intelligent Robot is designed on the basis of artificial intelligence. It has six major blocks. They are providing improved solution to our Robotic arrangement. We use microcontroller is the control unit that tends to act as a brain to this robot. Multisensory block and image signal processing block is used for detecting and targeting the fire optimally. Obstacle detecting unit also employed with this robot for provide sensing task of some objects that would affect the locomotion of servo system and overcome from that obstruct. Extinguishing block assisted for making safety measures. Alarming and alerting unit is bringing into play indication about the fire to the surrounding as well as faraway. The top level block diagram of this intelligent robot is shown in figure 1.

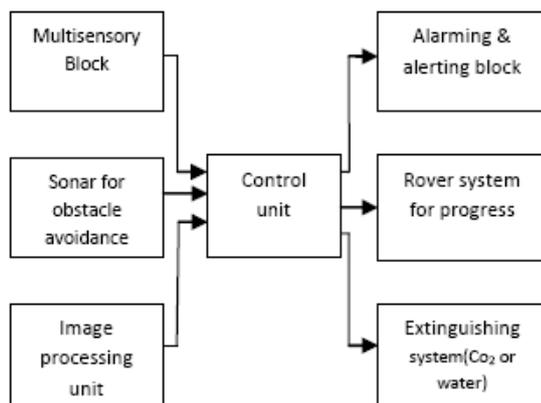


Fig.1: General Block diagram

The rover system provides the mobility to the system for the reason that this robot is moving towards the fire. Explanation about each unit is given as follows.

#### A. Sensory unit

Multisensory unit is nothing but it is the collection of sensors in order to detect the fire such as fame detecting sensor, smog detecting sensor, temperature sensor. These sensors acquire input from field and send out to the control unit.

#### B. Image processing

This unit has a camera with lens setup. The camera is directly connected to the small laptop for image processing. The image processing is carried out using *MATLAB*. The input signal is gathering from the captured image. Artificial intelligent process is used to making an advanced operation to find out the fire in visible environment and locating to nearby the detected fire for put out.

#### C. Alarming & Alerting Section

This part is employed to indicate the fire detection in nearby and far distance. It receives the indication signal from control block and an Alarm buzzer is used to indicate that a fire is there. GSM modem is used to bring up to date to the related ones to the area of accidental zone

#### D. Moving platform

It is an important unit for moving the whole unit towards the fire for extinguishment task. It is fully controlled by control under the supervision of multisensory unit, image processing unit and obstacle detecting unit. The moving platform of the motors is controlled using H-Bridge IC for which the control signals are given.

#### E. Control unit

It is the main part of entire system. This block is used to get the input signal from sensor units processing that for producing proper output to the appropriate unit. Here we use Arm-cortex3 as the control unit. This Robotic system is mainly bring into play in laboratories, homes, smart buildings, factories, industries and where ever need the fire extinguishment operation automatically. This robot finds out the fire and extinguishes it before that cause a severe problems and accidents. The intelligent robotic system doesn't operate on the basis of floor planning, sound navigation. It is working by the use of artificial vision i.e., Human can identify the fire by means of visualization (eyes) as well as sensation (skin) our robotic system also find out the fire same as to the human fire prediction.

Both image processing and sensor units are used as inputs. The image processing output is given to the laptop where the image processing is done. Based on the image processing the output is sent to the controller. The servo motor unit which is connected to extinguishing system of a water tank and motor pump is actually controlled by using. PWM (Pulse Width Modulation) signals. That would improve the performance of extinguishment task. A buzzer unit is also connected to the control unit which produces the sound when the fire is detected.

#### IV. SENSORS

The sensor unit that we use to detect the fire in addition to the image processing actually consists of four temperature sensors which are mounted on four sides of the Robot. The output of the temperature sensor is given to the ADC (Analog to Digital Converter) pin. The direction of the fire is found by measuring the output from the sensors. In general if there is no fire, then all the sensors will have almost the same value. If fire is present in a specific direction, then the output of the sensor increases. If one of the sensors output varies the other by a larger margin, then accordingly signals are sent to the controller to move the motors in that direction.

#### V. IMAGE PROCESSING

The threshold value for the fire has previously noted and a standard deviation has been set in the code. During the image processing the software compares the input image with the threshold values given already to detect the fire. The image resolution is 640X480. The centroid of the fire which consists of a x-coordinate and y-coordinate pixels. Only the x- coordinate is given as output to the controller unit. The x-coordinate is segmented into several units of 80 and based on the value different characters are sent to the controller which helps the Bot to move to the direction of the fire.

As the robot moves towards the fire the threshold level fixed image size increases and after it reaches a particular level a signal is given to the controller in order to stop. The maximum size of the threshold level fixed image after which the robot should stop moving is determined by experimenting with the image processing. We are not concerned about the y-coordinate since the Bot moves only in the x-z plane.

#### VI. MOTION PLATFORM

The servo unit is mounted in front of the robot. When the robot finds where the fire is and stops near the fire the servo motor starts rotating 180 degrees to left and right side. The sweep algorithm is fed into the program. The sweep algorithm makes the servo motor rotate 180 degrees in one direction and after it reaches 180 degrees again it rotates 180 degrees in the opposite direction. The water tank system is connected to the servo motor. After the fire is extinguished the operation of the servo motor acquire bring to an end.

The water tank is connected to the DC pump through a small pipe. The bottom of the pump is connected to the servo motor. The DC pump is connected and operated through a relay from the controller signal. The DC pumps when switched on pumps out water to extinguish the fire. Since the water

pump is connected to the servo the water is pumped through 180 degrees to and fro continuously. The Solenoid valve is an electromagnetically operated valve. The valve is controlled by giving signal from the microcontroller in order to control the flow of water. Moving frame is controlled by four DC motors. Two motors employed in left side and another two is employed for right side. In forward motion all the motors are rotating in clock wise direction. In backward motion all the motors running counter clock wise direction. Left and Right side movement is controlled by pairs of left side and right side motors.

#### VII. HARDWARE PROCESSING

This robot has several system hardware units. Some of the main hardware units are given below,

- Sensors
- Web camera with laptop
- Moving platform (4 stepper motors, 12V)
- Pump with PWM unit (servo motor 5V)

The output of the temperature sensor is an analog format. The moving platform is moved by DC motors .We use h-bridge module for motor driver. The proposed schemes of our project have the following schematic diagram shown in the diagram figure 3.(S,M-Sensors&Motors)

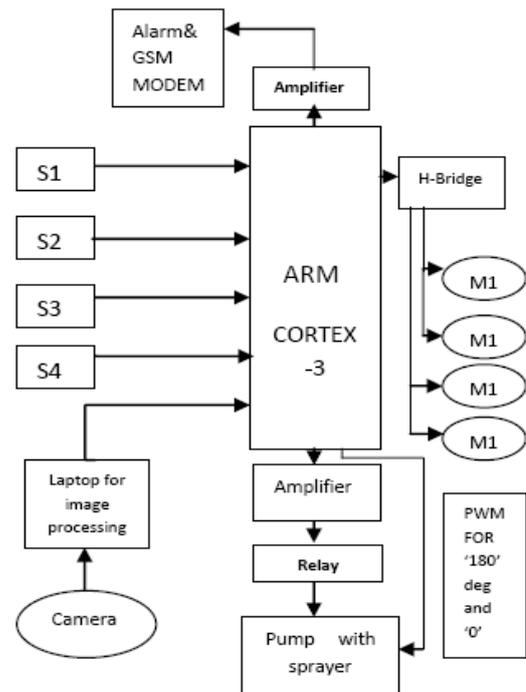


Fig. 2 : Schematic diagram

The power supply needed by each block is a common block so it isn't mentioned in the block diagram. 12V 20amp Lead Acid battery is used. Voltage regulator LM117 is used for microcontroller power supply.

Camera captures the image from the environment and processing this image on the laptop with MATLAB environment, Laptop transmitting control signal to the controller by serial com port. PWM is generated by the PWM pin from the ARM Cortex 3 Evaluation kit. The controller receives the signal from laptop as well as sensors. If the sensor block transmitting the signal then the image processing unit is deactivated that is in short distance from the target sensor block only give the signal to the controller. We were facing some constraints during mounting camera on the robotic platform. Because our plan is using wireless camera and assist the laptop or PC apart from the robotic platform. Wireless bit rate is not enough for real time image processing so we mount the mini laptop on the robot and using wired camera. 1GHz and 1GB Ram is enough for real time image processing.

VIII. SOFTWARE

The software implementation is done using Matlab, Keil Uvision4 etc. Matlab is used for the Image processing work. The Keil Uvision is the compiler that we use for writing the embedded code for the controller.

A. Matlab

Matlab is used for image processing work. The image processing operation consists of detecting the fire based on thresholding operation. The threshold value for the fire has previously noted and a standard deviation has been set in the code. During the image processing the software compares the input image with the threshold values given already to detect the fire. The image resolution is 640X480. The centroid of the fire which consists of a x-coordinate and y-coordinate.

Only the x- coordinate is given as input to the controller unit. The x-coordinate is segmented into several units of degrees and based on the value different characters are sent to the controller which helps the Bot to move to the direction of the fire. As the robot moves towards the fire the threshold image size increases and after it reaches a particular level a signal is given to the controller in order to stop.

This image processing unit acts as an artificial human eye. Infra Red signaling camera is more enough to detect the firing location optimally than normal camera. The algorithm is develop in order to perform efficiently to do this detection and targeting operation.

B. Keiluvision

The Keil Uvision is used for writing and uploading the program code in the controller. We get the temperature sensor input from the ADC pins. The servo motor is controlled by using the PWM pin. The sweep algorithm is used for the servo motor controlling operation. Flow chart of the temperature sensing process is shown in figure 3.

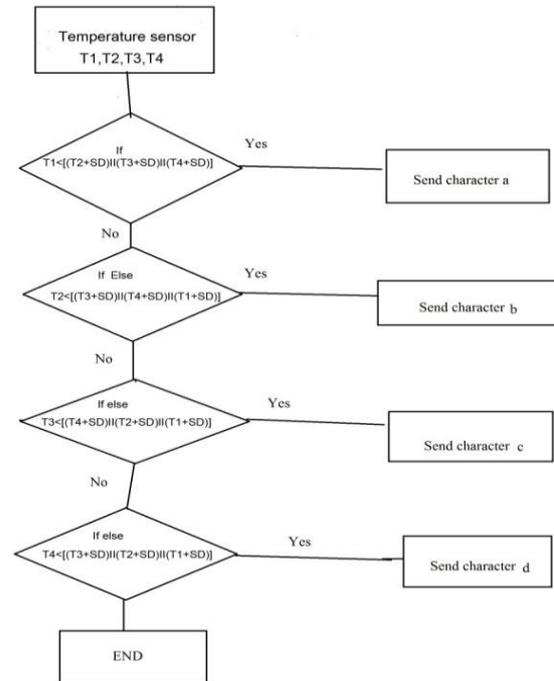


Fig.3: Flow chart of sensors

IX. RESULTS

As a part of this project the fire extinguishment robotic model is designed and its performance is observed for promoting this system in real time application. The trial field of this process evolved by making a simple fire and that is extinguished by the robot. The motion platform is working on the basis of the table 1.

Direction of motion	Motor pair 1 (Left side)	Motor pair 2 (right side)
Forward	Clock wise	Clock wise
Backward	Counter clock wise	Counter clock wise
Left	Counter clock wise	Clock wise
Right	Clock wise	Counter clock wise

Table 1 Motion control

The 3D simulation model of our robots is shown in the figure 11. That is the simulation output of animated robot.

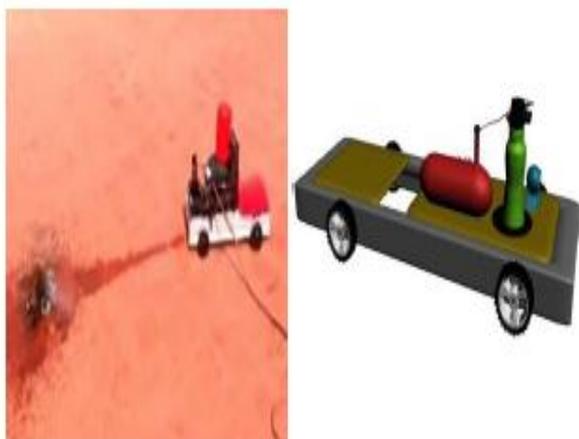


Fig. 4 : The real model and 3D model illustration of the robot.

#### X. CONCLUSIONS

Therefore this project illustrates a fire fighting robot that detects fire using multiple sensor units as well as through image processing. However this kind of robot only sprays water when fire is detected. There are situation where water spraying for extinguishing fire might not work.

Our future work will be of making a robot with embedding image algorithm to the entire monitoring camera with wireless communication to the robot. That provides more supple to our robot to put out the fire in an entire building. Such a kind of robot will detect the kind of fire and according use an appropriate extinguishing system. Adding multiple security schemes in this robot will make it as advanced security and surveillance robot. If we do this innovative project on large scale it will surely save many lives. As we go into the Future, we will be entering a Technological Era where humans and robots are going to co-exist.



#### XI. REFERENCES

- [1] Manish kumbhare, S.S Kumbhalkar, Ratneshmalik, "Fire fighting robot: an approach"-Indian Streams Research Journal Vol.2, Issue. 1/March; 2012 pp.1-4
- [2] William Dubel, Hector Gongora, Kevin Bechtold, Daisy Diaz "An Autonomous Firefighting Robot"-IEEE SOUTHEASTCON 2003 [http://dubel.org/robots/dubel\\_firefighter\\_FIU\\_fcrar2003.pdf](http://dubel.org/robots/dubel_firefighter_FIU_fcrar2003.pdf)
- [3] Lynette Miller ,Daniel Rodriguez ,Kristen Allen, Maksim Makeev "Firebot: Design of an Autonomous Fire Fighting Robot"<http://mil.ufl.edu/publications/fcrar03/Firebot.pdf>
- [4] Ren C. Luo and Kuo L. Su, Member "Autonomous Fire-Detection System Using Adaptive Sensory Fusion for Intelligent Security Robot"-IEEE/ASME TRANSACTIONS ON MECHATRONICS, VOL. 12, NO. 3, JUNE 2007
- [5] Chine, T.L.; Guo, H.; Su, K.L.; Shiau, S.V. "Develop a Multiple Interface Based Fire Fighting Robot" Mechatronics, ICM2007 4th IEEE International Conference on Topic(s): Components, Circuits, Devices & Systems ; Computing & Processing (Hardware/Software) ;Publication Year: 2007 Page(s): 1 -6
- [6] <http://www.afsi.us.com/>
- [7] <http://www.indiafireextinguisher.com/automatic-fire-extinguisher.html>
- [8] J. Reinhart, V. Khandwala, T. Shah, J. Young, L. Ross ,R. Delica, F. Angus, J. Burford, B. Lynch, R. Pollard"Design and Implementation of Fully Autonomous Fire-Fighting Robot for a Small House Model"-IEEE southcon-2003
- [9] Ching-Chih Tsai, Senior Member, IEEE, Hsu-Chih Huang, Member, IEEE, and Shui-Chun Lin- "FPGA- Based Parallel DNA Algorithm for Optimal Configurations of an Omni directional Mobile Service Robot Performing Fire Extinguishment" - IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 58, NO. 3, MARCH 2011