

Solar Powered Automatic Fire Fighting Robot using Image Processing

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ABSTRACT

Image processing based fire detection and extirpation robot which is solar power driven. The agent is primarily based on Image processing (HAAR Cascade algorithm) and is mounted with 4 sensors and 2 motors and both has a capability of detecting the fire prone areas with the help of sensors . It creates a buzzer alert and sprays water or CO2 by pumping it from the tank or cylinder mounted on the chasis of the robot. Robots are the machine developed by humans to guard human live, because the accidents happening during the fire extinguishing process is uncountable. This robot main function is to detect fire and move towards the fire automatically to extinguish it from a safe distance using water. By designing and implementing an autonomous robot capable of detecting and extinguishing flames, disasters can be avoided with minimal risk to human life.

Keywords: Camera, Micro-Controller, Smoke Sensor, Temperature Sensor, Solar Power Driven

INTRODUCTION:

As commonly know in a company or industrial plants are very prone to fires, whose name occurs whether caused by man or machine error in production and even not rarely also caused by short-circuit or shorted power. Typically, these fires occur in an area that is less oversight such as warehouse storage. Originally probably only happen a small spark of fire on the room, but due to the lack of supervision and the slowness anticipation that is done then the sparks that burn the entire contents of the room so that the fire is widespread. Growing Technology, came the tools like camera surveillance. Camera is used to monitor or oversee the rooms there is less supervision, so if there are such incidents spark can be rapidly anticipation before the spark of the fire spread and cause a fire. However, even though it has Camera surveillance with no fixed rarely happen that the name fire. It will be based in the background by the lack supervision off. Even though we've been keeping an eye on a room with Camera but if the officer's supervisors off guard and not immediate do anticipation when the api recorded by Camera and thus are not denied the fire keptcoming.

Because the Camera can only supervise, then to add a function or applied a method on Camera feature named image processing or image processing. So, this image processing is any form of signal processing where the input is an image like a photo or video, while its output can be either a picture or a number of characteristics or parameters related to the image. By combining image processing in camera surveillance, then when the camera surveillance to detect or record the presence of sparks packed image processing or image processing will continue to cultivate the image that sparks and displayed on the monitor supervision.

In our project along with this feature we are adding up Co2 sensor for the prior detection for occurrence of fire and also integrating a pick and place arm for picking up an obstacle blocking the way or any other useful purpose. After detection of the fire at place it would send a message to the local fire substation alerting of fire at that particular location. We are also integrating IR camera for the model.

RELATED WORK:

[1] The work is based on the sensors and the main problem with the sensors that it will take time to detect the fire

or smoke which is being generated by the fire incident. The sensors are used in Robot for sensing the fire and send the information about fire to the microcontroller, after that microcontroller pass the signal to the control circuitry for moving the robot in that particular fire zone for extinguishing the fire by using water pump or extinguisher.

[2] It aims to design a robot capable of detecting and suppressing fires. By designing and implementing an autonomous robot capable of detecting and extinguishing flames, disasters can be avoided with minimal risk to human life. In this research, we illustrate an autonomous robot capable of detecting flames indoors and manoeuvring towards the flame to extinguish it with the help of carbon dioxide.

[3] Project aims to design a fire fighter robot that can be operated and controlled by remote user and has the ability to extinguish fire after locating the source of fire. It is equipped with a monitoring system and operates through a wireless communication system. The fire detection system is designed using the sensors mounted on the fire fighter robot. The robot is controlled autonomously using Android application.

METHODOLOGY:

A. Design Considerations:

- Locomotion, the robot must have a flexible drive system
- Communication, Control and Power
- GSM technology would be used in the prototype
- GPS to show the position and orientation of the robot
- Additional features to assist in search and rescue applications, including cameras, audio systems and sensors

B. Description of the Proposed Algorithm:

Aim of the proposed algorithm is Haar Cascade Classifier using Open CV, which is a method for detecting objects in an image, and the method of Haar Cascade Classifier is an object detection method. This method is based on Haar-like features, combined with the classifier cascade are strengthened. Haar-like features are features that are widely used in detection of objects, offering rapid extraction process and are able to represent a lower resolution image. This method has been successfully applied in many object detection.

➤ HAAR CASCADE:

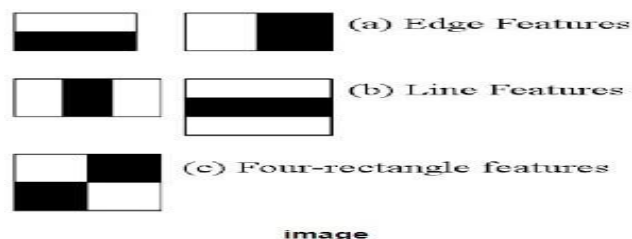


Figure 1: Feature Based classifier

During the process of Object Detection using Haar feature-based cascade classifiers is an effective object detection method. It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images. Here we will work with face detection. Initially, the algorithm needs a lot of positive images (images of faces) and negative images (images without faces) to train the classifier. Then we need to extract features from it. For this, Haar features shown in the below image are used. They are just like our convolution kernel. Each feature is a single value obtained by subtracting sum of pixels under the white rectangle from sum of pixels under the black rectangle.

Now, all possible sizes and locations of each kernel are used to calculate lots of features. (Just imagine how much computation it needs? Even a 24x24 window results over 160000 features). For each feature calculation, we need to find the sum of the pixels under white and black rectangles. To solve this, they introduced the integral image. However large your image, it reduces the calculations for a given pixel to an operation involving just four pixels. Nice, isn't it? It makes things super-fast.

But among all these features we calculated, most of them are irrelevant. For example, consider the image below. The top row shows two good features. The first feature selected seems to focus on the property that the region of the eyes is often darker than the region of the nose and cheeks. The second feature selected relies on the property

that the eyes are darker than the bridge of the nose. But the same windows applied to cheeks or any other place is irrelevant. So how do we select the best features out of 160000+ features? It is achieved by **Adaboost**.



Figure 2: Face Feature extraction classifier

For this, we apply each and every feature on all the training images. For each feature, it finds the best threshold which will classify the faces to positive and negative. Obviously, there will be errors or misclassifications. We select the features with minimum error rate, which means they are the features that most accurately classify the face and non-face images. Before use the Haar Cascade Classifier, we need to prepare all of the needed to create the good Haar Cascade Classifier. This preparation steps are used for prepare all of the training data. For training a boosted cascade of weak classifiers we need a bunch set of positive samples (containing actual objects you want to detect) and a bunch set of negative images (containing everything you do not want to detect). The set of negative samples must be prepared manually, whereas set of positive samples is created using the opencv create samples application.

1. **Negative Samples** First we need to prepare the negative samples. The negative samples are taken from any images that not contain the objects that you want to detect. These images are generated with some method and called the background samples or background images. The image that used in the negative samples should be equal or larger than the size of the object image that you want to detect, because these negative samples are used to subsample a negative image into several image samples which has the same training window size.
2. **Positive Samples** After we done prepare the negative samples, now we need to prepare the positive samples. Positivesamples are created by the open CV create samples command on the Processor. The command are used the boosting process to define what the model should actually look for when trying to find the objects that you want to detect. And before that we need prepare more than a single positive samples to make the positive samples with these command. Thebunch of images on positive samples are created to a text file that similar to the background description file.
3. **Cascade Training** The last step we need to do after we finish prepare negative and positive samples, is the training of the cascade classifiers step. This step is processed the positive and negative samples that was prepared beforehand. The process of cascade training is using the command `opencv_traincascade` to make the file cascade.

We are using a Microcontroller. It has many input and output ports.

- Camera is mounted on the agent and is connected to a web server to monitor.
- The frames are being compared with HAAR classifier, based on it – fire is being detected.
- Smoke sensor is given to any one of the Input ports and output is set to high when it detects flammable gasesand smoke.
- DHT11 is used as temperature sensors and is given as input to the microcontroller and output is interfaced with input of DC motor pump.
- Ultrasonic sensors are used to detect obstacles on the path and is given as input to microcontroller and outputto servo wheels, motor to change direction of the path.
- PIR sensor detects the motion of the human body and any objects, it is given as input and output is interfaced to buzzer to create alert.

- Buzzer is connected to relay and microcontroller which acts as a switch to turn on and off.
- Water is pumped by the Dc motor once fire is detected to extinguish it. Stepper motor is used for the servowheels to move towards the direction of the fire.
- Here we are using HAAR cascade algorithm which basically works as an image processing algorithm.
- Here the Over view of the systems is shown and explained briefly.

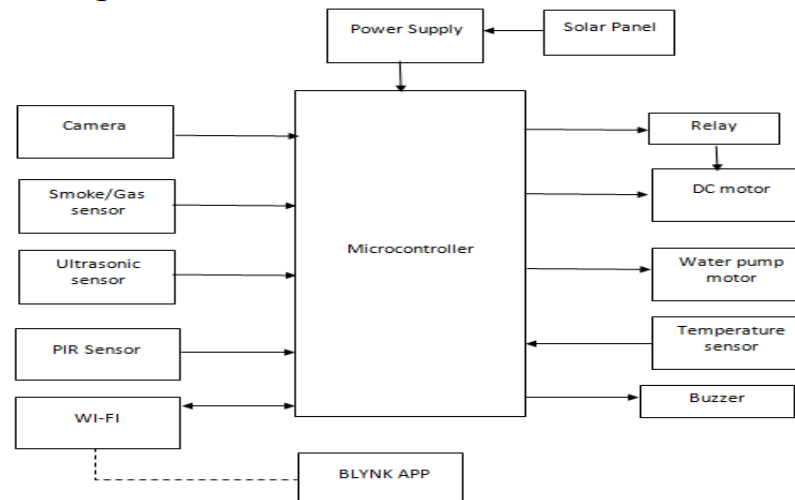


Figure 3 : Block diagram of overview of the system

The main goal is to integrate a medium-size, robot type unmanned ground vehicle (UGV), for searching for fire hazards. UGV is built with camera for detecting the person using image processing and video processing techniques for fire extinguishing purpose:

- Temperature sensor and IR sensor is used for detecting the condition of the fire. Once the fire is detected as ignited thenextinguishing the fire actions would take place . The robot will get the fire location through GPS Navigation system via GSM/Zig-Bee.
- All this sensors and protocols are interfaced in the LPC2148 microcontroller which has 32 bit and have 64 pins high performance ARM-7 in which only 48 pins are used by the user which are multi-function pins operating at 3.3V power supply and has an oscillation frequency of 60Mhz.
- Two motor drivers are used which are connected to a motor, these motor drivers are nothing but jus like a relay which act as a switch used to turn on the motor which indirectly help the vehicle to move.

PSEUDO CODE:

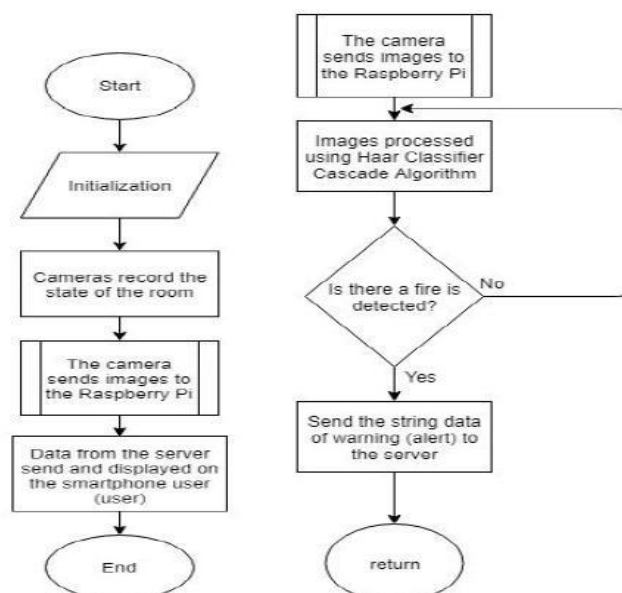


Figure 4: Flow of Execution

Algorithm for temperature sensor:

- Step 1: The sensor sends the analog signal to the microcontroller.
- Step 2: ADC 0,1 converts the analog signal into digital.
- Step 3: The digital value will be converted into degrees using the formulae $\text{Temperature} = (\text{ADC_value})/19.37$
- Step 4: Depending on the temperature w.r.t. the threshold.
- Step 5: Send a message to the number provided with the exact location of site of accident.

Algorithm for image processing:

- Step 1: Clear all
- Step 2: Activate the camera and start a video.
- Step 3: Take the images from the video and store the image in x.
- Step 4: Subplot the image in rows and columns and display it on the screen.
- Step 5: Crop this image into 40*40 pixel and check for a fire .
- Step 6: Face is detected using the protocol Cascade object detection and displayed it on screen.
- Step 7: Once the fire is detected control is send to the controller.
- Step 8: End.

EXPERIMENTAL RESULTS:

The resultant output identifies the presence of fire in the surrounding and Extinguishing the fire with the means of water or by a fire extinguisher, this would be the primary measure taken whenever there would be an accidental fire. Along with this feature we are adding up Co2 sensor for the prior detection for occurrence of fire and also integrating a pick and place arm for picking up an obstacle blocking the way or any other useful purpose. After detection of the fire at place it would send a message to the local fire substation alerting of fire at that particular location. We are also integrating IR camera for the model.

Further improvements would involve adding more sensors. The primary candidate for addition would be a thermal imaging camera, allowing the robot to see surface heat on obstacles to precisely locate any survivor. To allow more utility in hazardous materials situations, the robot would have additional sensors for air purity, temperature, pH, radiation, etc.

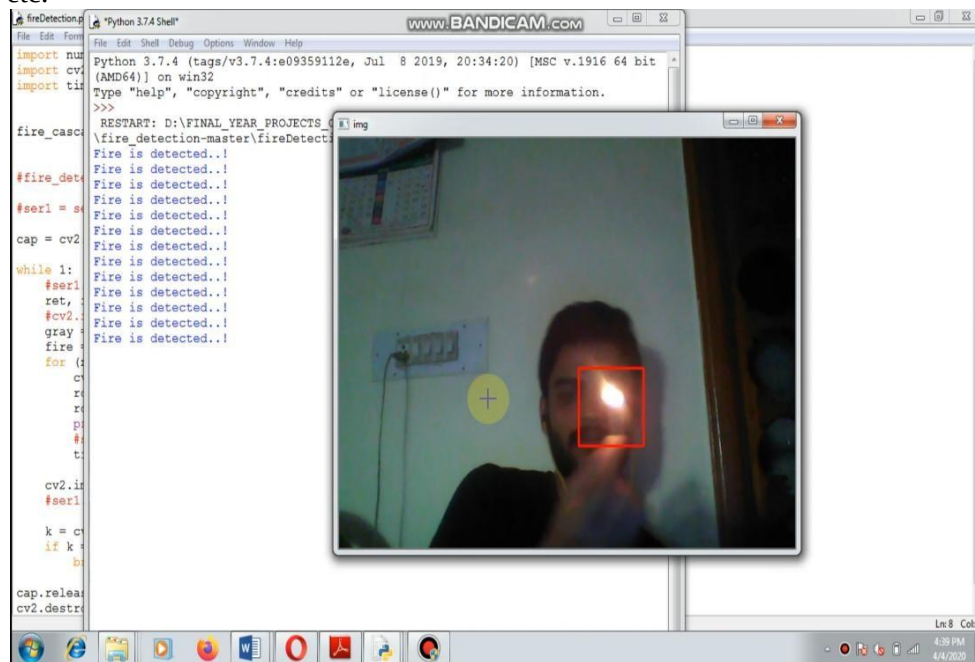


Figure 5: The camera starts searching for fire and displays detection around it as seen below.

CONCLUSION:

A prototype of the project has been developed and tested which works according to the designed algorithm with satisfactory results. The sensors work efficiently as coded and provide accurate outputs. The base station can easily monitor and track the fire as the front-end is designed such a way so that it makes everything clear. Further improvements the microcontroller could also be modified to monitor the voltage across each arm rotation motor

to determine when the motor has stalled (and by extension, when the arm has made contact with the ground or an obstacle). These contacts would be communicated to the laptop via the Wi-Fi router on the robot. The arms would flash a different color when they confirm contact with an obstacle. In addition, the two processors used by the team would be replaced by a single, more powerful processor with more input and output pins, which would eliminate the communication delays experienced by the prototype.

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BIOGRAPHY

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