Mini Project Report on

Real-time Fire Detection System

Submitted in partial fulfilment of the requirement for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE & ENGINEERING

Submitted by:

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CANDIDATE’S DECLARATION

I hereby certify that the work which is being presented in the project report entitled **“Real-time Fire Detection System”** in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Computer Science and Engineering of the Graphic Era (Deemed to be University), Dehradun shall be carried out by the under the mentorship of **Mr. Arnav Kotiyal**, Department of Computer Science and Engineering, Graphic Era (Deemed to be University), Dehradun.

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Chapter I

Introduction

1.1 Introduction

Fires are one of the main causes of death amongst the worlds. Although there are various fire detection systems most of them did not proof its effectiveness in detecting fires due to inefficiency or restrictions. The presented the project I worked on with the aim of implementing a more efficient and trustworthy Realtime fire detecting system. The project was done by using various image processing techniques to detect fire flames and turn on the fire alarm if the fire is detected.

To put out fire, traditionally use of Fire Extinguishers is done. The user goes to the area affected, and manually uses the fire extinguisher there. The time required for the user to reach the place may result in an increase in the intensity of fire or spreading of fire around the place.

The project aims at creating an advanced device based on Image Processing to cease the fire as soon as it starts. The system would be fully automated and hence no need for any human interference is required.

Some of the reasons for fire breakout are as follows:

Low ceiling heights.

No short circuit protection in household wiring.

No safety equipment remained available for emergencies.

Excess number of flammable objects like wood, paper, plastic stored in one place.

No Fire prevention measures are taken.

In this concept, we will create a fire detecting device using a camera and a ML model and apply the concepts of IoT and Image Processing to get real time fire detection results. When the Model is started, it continuously monitors the area in front of the camera for fires. This is done by using HAAR Cascade Classifier Algorithm. Once detected the system could just set an alarm.

The Algorithm we use in this project is Haar Cascade Classifier, which is a method for detecting objects in an image easily. The Haar Cascade Classifier is an object detection method developed by Viola & Jones. This method is based on Haar-like features, combined with the classifier which results in the cascade becoming strengthened. Haar-like features are features that are widely used in detection of objects, offering rapid extraction process and can represent a lower resolution image. This method has been successfully applied in many object detection applications.

The classifier is made with training a cascade file from several positive & negative images, which have the same size. After assessment of the image is done, the areas which are like the object are marked as 1 whereas its marked as 0 for the areas that do not match. After the training, the cascade is now ready to examine further input images.

The classifier goes on to look across the entire image to find similar features as the cascade of the object to be detected. To detect the target area more accurately and to reduce the time taken to scan every image, the scanning window size is changed adaptively by the classifier. During the process of classification, the model features the optimal rectangles in accordance with the objects and the scanning window.

Chapter II

Literature Survey

Visual fire detection systems have the following advantages: (1) low cost relying on more and more existing surveillance cameras, (2) large monitoring regions, (3) comparatively fast response time without waiting for fire diffusion, (4) fire confirmation without visiting the fire site, and (5) the availability of fire details. Thus, visual fire detection methods have attracted particular attention during the last decade. Traditional visual fire detection methods use hand-crafted features, such as color, texture, shape, edge, and motion. Color information is a key factor in fire detection, and existing mature color models include RGB, HIS, and YCbCr. Chen et al. (2004) proposed a method using the red channel threshold. binti Zaidi et al. (2015) performed fire detection based on RGB and YCbCr features. Li et al. (2018) proposed a fire detection framework based on the color, dynamics, and flickering properties of flames. Schultze et al. (2006) proposed to obtain flame features using spectrograms and sonograms based on the characteristic that flames flicker and move upwards for detection. Töreyin et al. (2006) and Toreyin and Cetin (2007) represented the boundary of flames in the wavelet domain and used the high-frequency natures of the boundaries of fire regions to model flame flicker. Foggia et al. (2015) used an expert system to build a rule set based on fire color, shape, and motion features. Dimitropoulos et al. (2015) built an SVM classifier for fire detection based on motion, texture, flicker, and color probability features. Wang et al. (2019) extracted multiple features for forest fire recognition, including color, texture, area, and shape features. The above researchers built their extractors to improve the accuracy of fire detection. Such hand-crafted features have promoted the development of visual fire detection. However, because of the high complexity of fire scenes in videos, artificially designed features are highly redundant.

Recently, to achieve higher efficiency and better generalization ability, some convolutional neural network (CNN) based visual fire classification and detection methods have been proposed. Muhammad et al. used the pre-trained CNNs like AlexNet (Muhammad et al., 2018a), GoogleNet (Muhammad et al., 2018b), and MobileNetV2 (Muhammad et al., 2019b) as baseline architectures and fine-tuned the fully-connected layers on a small fire dataset, achieving a performance boost. Frizzi et al. (2016) proposed a nine-layer CNN for identifying whether there is a fire or not. With the rise of object detection approaches, fire detection is no longer satisfied with determining fire, but rather locating and extracting exact areas. Several variations of generic object detection methods have been proposed for fire detection tasks. Sharma et al. (2017) combined the pre-trained VGG16 and ResNet50 to develop a fire detection system. Wu and Zhang (2018) tested Faster R-CNN, YOLO, and SSD for fire detection, and adjusted the YOLO's tiny-YOLO-VOC structure to improve accuracy. Yang et al. (2019) proposed a CNN inspired by MobileNet for fire detection. Wang et al. (2017) replaced the fully connected layer in a lightweight CNN with SVM to get better performance in fire identifying. Muhammad et al. (2019a) fine-tuned SqueezeNet for fire detection and localization. Zhang et al. (2021) proposed the ATT Squeeze U-Net which incorporates SqueezeNet structure into Attention U-Net architecture for fire detection.

Chapter III

Methodology

3.1 SYSTEM DESIGN

The ML model is used for image processing.

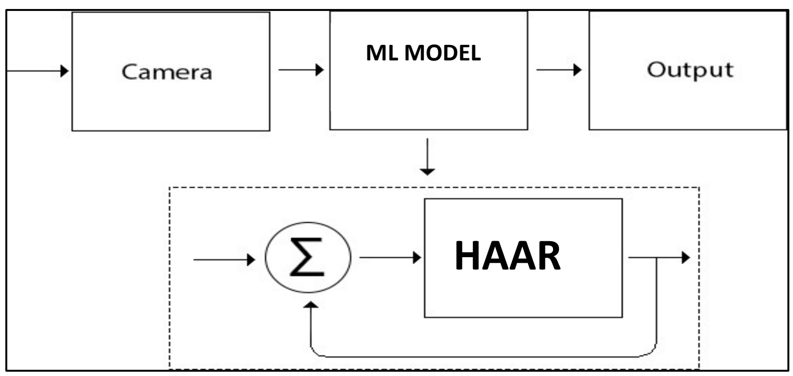

FIG 3.1SYSTEM DESIG OF MODEL

We are using ML model, device camera for the input, as it is a bit faster than the regular USB camera because the USB cameras require the CPU to work with the USB interface which takes more time rather than just the on-board camera. The image data would then be supplied to the python script that we are running with OpenCV to detect fire by using Haar Cascade.

3.2 FLOWCHART

The flowchart of the system working is shown in the figure below. First the camera is set up with ML model using OpenCV. Image from the camera would be processed with the HAAR Cascade, and if the image contains fire, the system will recognize the fire and will give the output as fire detected.

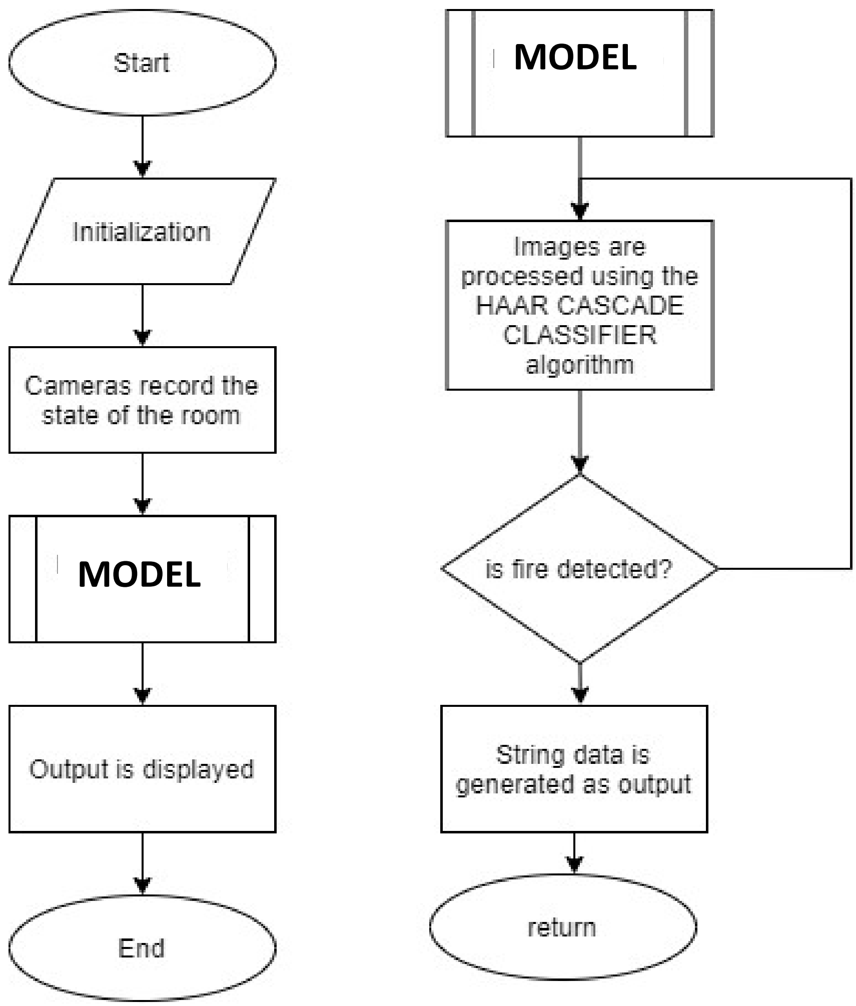

FIG3.2 FLOWCHART OF MODEL

3.3 PREPARING THE HAAR CASCADE

To start the detection, we need to make the cascade file for detection of fire. To train a boosted cascade of weak classifiers, we need to use a bunch of positive and negative images. Positive images are the ones in which the images check the object that we are trying to detect, while negative images are the ones which strictly do not contain the object that we are trying to detect. We are using the software Cascade Trainer GUI.

There are around 300 positive images and 600 negative images in our Classifier and the efficiency of the classifier was more than 85%. After the training process, the trained cascade was saved in xml format and was ready to use.

Chapter IV

Result and Discussion

4.1 Results of tests at distance 50 centimeters.

For the very first test, we decided to keep the distance short. We varied the intensity of fire by using various sources of fire at different angles and the accuracy of the system was as follows:

Distance	Test no.	Real fire	Other light sources	Accuracy
50 cms	1	Detected	Not Detected	100%
	2	Detected	Not Detected	
	3	Detected	Not Detected	
	4	Detected	Not Detected	
	5	Detected	Not Detected	

TABLE 4.1 RESULT FOR DISTANCE 50CMS

4.2 Results of tests at distance more than 100 centimeters.

Then we changed the distance to more than 1 meter for detecting fires at long distances. The distances and angles of the fire were different this time. The accuracy of the system was as follows:

Distance	Test no.	Real fire	Other light sources	Accuracy
>100 cms	1	Detected	Not Detected	80%
	2	Detected	Detected	
	3	Detected	Not Detected	
	4	Detected	Detected	
	5	Detected	Not Detected	

TABLE 4.2 RESULT FOR DISTANCE GREATER THAN 100CMS

Chapter V

Conclusion and Future Work

In this project, a fire detecting system has been proposed which is a more accurate and reliable way of detecting fires in small houses or office places, rather than conventional methods such as smoke detectors.
With the accuracy of 85%, The system can be used in various areas like in parking lots to check the vehicle has paid the parking fee. Counting the number of cars passing through the junction, which helps to store data for the improvements in road traffic congestions, agriculture, farming, there are many uses of object detection.
Our approach was limited due to the devices used and it can be improvised to be even more accurate than the system already is.

The system can be made more accurate and precise by using other machine learning algorithms like YOLO (You Only Look Once), TensorFlow, Keras algorithm, neural network like CNN, RCNN, which are more advanced than the current algorithm used for this project.

Future scopes also include following aspects:
using this system along with fire extinguishers to make them automated.
Notify the person using mail, SMS, or any other communication.
Alert government bodies to act accordingly.

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