

# CNN Based Fire Detection System

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**Abstract:** Fire is one of the dangerous events which can result in great losses if not controlled on time. It spreads quickly, hence detection of fire events in early phases and alerting the same is very essential. In this research paper we propose a cost-effective fire detection system which will detect fire using surveillance images and videos captured by a CCTV in industrial sites or places in general. Our fire detection system is based on convolutional neural networks (CNN's). The model uses images and videos that contain both fire and non-fire elements as a dataset for training.

**Keywords:** CNN's, Fire Detection, Surveillance, Alerting, CCTV.

## I. INTRODUCTION

Today, fire is mainly detected using smoke and flame detectors which are placed across the locations. These detectors monitor for smoke / fire in initial phase and raise an alarm and also take few measures like sprinkling of water to control the spread of fire at large scale. In the same way as technology is improving there are many solutions coming up from domain of artificial intelligence and machine learning. Similarly, we are using fire dataset to train our model to detect fire content in surveillance videos captured by the CCTV's. As the system uses already installed CCTV for monitoring, we can say that it is cost effective compared to smoke and flame detectors.

Our model is based on CNNs, where we have trained it using fire dataset which involve wide variety of fire incidents and captured photographs as well as videos. Our model took these as input, learned the features of these datasets and classified them accordingly. We also alert the nearest fire station located in the surveillance area through different modes of communication like a phone call, SMS and a telegram channel.

## II. STEPS FOLLOWED IN MODEL TRAINING & PREDICTION

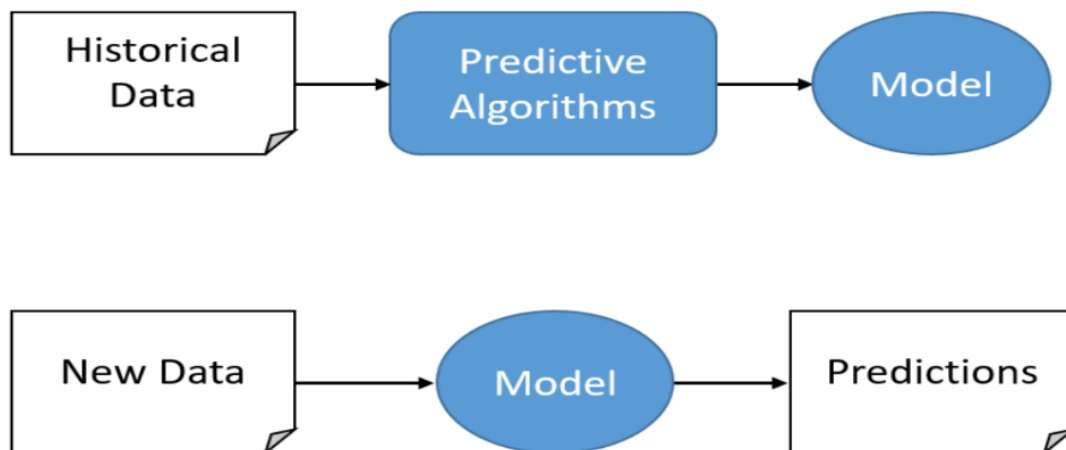


Fig.1 Steps Followed Diagram

## III. EXISTING SOLUTIONS

### SMOKE DETECTORS

Smoke detectors are devices which can sense smoke. These detectors use either photoelectric or ionization methods to detect the smoke and they are usually made up of plastic. Few detectors use both photoelectric and ionization method to which help them to detect smoke more accurately. Batteries are used as power source. Installation and placement of these detectors cost high.

A. Photoelectric based smoke detectors, these detectors sense sudden scattering of light when smoke enters the detector chamber, triggering the alarm. they respond in an average of 15 to 50 minutes faster to fire in its early, smouldering stage, before it breaks into fire.

Smoke generated by a fire affects the intensity of a light beam that passes through air. The smoke can obscure the beam, or block it. It can also cause the light to scatter because the smoke particles are reflected off. By using these effects of smoke on light photoelectric smoke detectors are designed to sense smoke.

B. Ionization based smoke detectors, Ionization smoke alarms are highly sensitive to small smoke particles and usually respond about 30 to 90 seconds faster to fast flaming fires than photoelectric smoke alarms, but not to smouldering fires. A typical ionization chamber is composed of two electrically charged plates and a radioactive source (usually Americium 241) to ionize the air between the plates. The radioactive source emits particles that collide and dislodge their electrons with the air molecules. As the molecules lose electrons, they become ions which are charged positively.

#### **IV. RELATED SURVEY**

The paper [1] provides a design and implementation of a smart fire detection system using a Wireless Sensor Network (WSN) and Global System for Mobile (GSM) communication to detect fires effectively and reduce false positives. The proposed system uses smoke and temperature sensors. SMS capability via GSM was implemented so that occupants can interact with the fire detection system and aid in the detection of false positives. The aim of this work was to design and implement a fire detection system that detects fires effectively and reduces false positives. The results show that the system meets the specifications.

The paper [2] points out that, fire detection has been an important phenomenon to save human life. In their paper, they proposed a hybrid model that incorporates computer vision and smoke sensor-based fire detection into a single system to devise a more accurate and smart fire detection system. Their vision-based fire detection model utilizes colour and motion attributes of fire combustion. Rule-based colour segmentation is performed for classifying fire colour regions and a modified image difference technique is used for detecting the motion of fire regions in consecutive frames. The proposed dynamic threshold technique is used for mitigating the false positive rate of the vision-based model. After performing a vision-based analysis, the proposed algorithm uses the MQ-2 smoke sensor to detect environment smoke and gas caused by fire combustion. Our implemented system raises a fire alarm in the form of remote notification after analysing vision and smoke sensor-based model data. Real life experimental data shows that our system can detect fire with 86.67% of accuracy. In addition, the system can be incorporated in existing surveillance systems at an adequately low extra expense.

The recent developments in embedded computing have made it possible to detect vision based systems to detect fire using Convolutional neural networks (CNNs) shoot during surveillance. Such methods, however, generally Need more computational time and memory, limiting its use in surveillance networks, says paper [3].

According to paper [4], One of the most popular deep neural networks is the Convolutional Neural Network (CNN). It takes this name from mathematical linear operation between matrixes called convolution. CNN have multiple layers; including convolutional layer, non-linearity layer, pooling layer and fully connected layer. The convolutional and fully connected layers have parameters, but pooling and non-linearity layers don't have parameters. The CNN has an excellent performance in machine learning problems. Specially the applications that deal with image data, such as largest image classification data set (Image Net), computer vision, and in natural language processing (NLP) and the results achieved were very amazing.

The paper [5] proposed a deep convolutional neural network architecture codenamed Inception that achieves the new state of the art for classification and detection in the ImageNet Large-Scale Visual Recognition Challenge 2014 (ILSVRC14). The main hallmark of this architecture is the improved utilization of the computing resources inside the network. By a carefully crafted design, they increased the depth and width of the network while keeping the computational budget constant. To optimize quality, the architectural decisions were based on the Hebbian principle and the intuition of multi-scale processing. One particular incarnation used in our submission for ILSVRC14 is called Google Net, a 22 layers deep network, the quality of which is assessed in the context of classification and detection.

V. PROPOSED METHOD

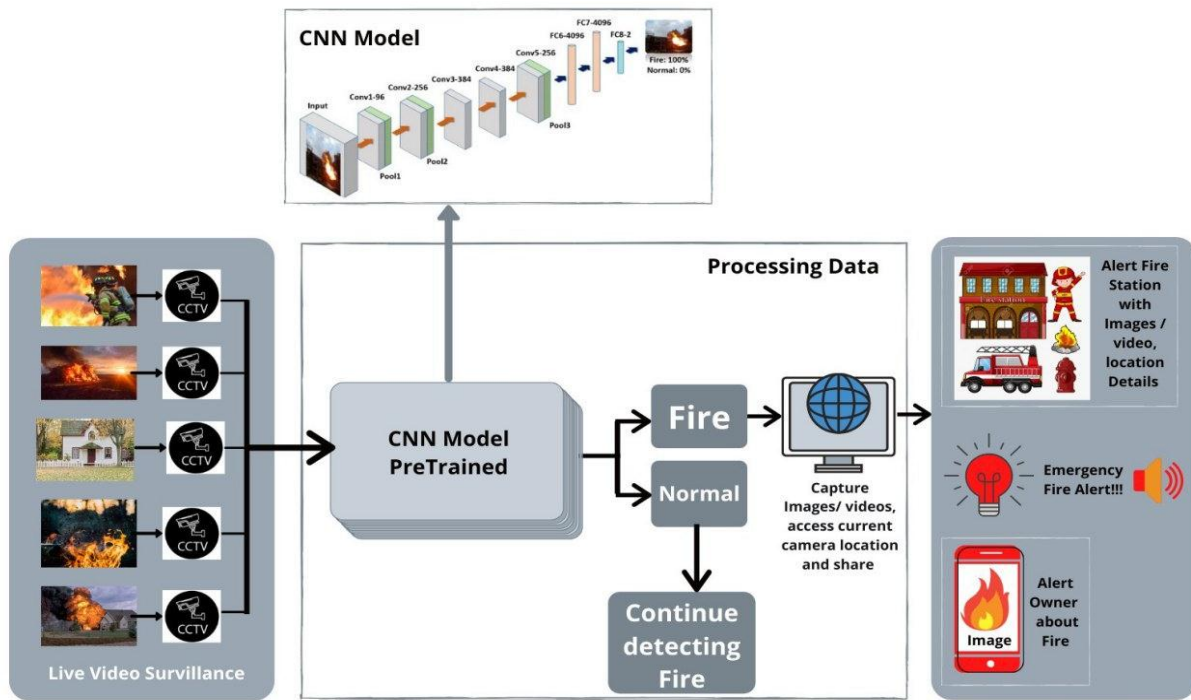


Fig.2 Architecture Diagram

The above architecture gives a picture of architecture and how the model is trained to detect the fire. We first train our model using convolutional neural network. The CNN model takes fire dataset which consists of both images and videos as input for training. Once the model takes the input, it classifies them under certain categories. As we know computers sees an input image as array of pixels and it depends on the image resolution. Based on resolution of the image, it will extract the height, width, dimension.

Technically, CNN models to train and test, each input image goes through a series of convolution layers with filters, pooling, fully connected layers and then apply softmax function to classify an object with probabilistic values between 0 and 1. So convolution is a first layer to extract features of a particular image. Which is part of feature learning along with pooling involved. Post this the classification is done by model once softmax is applied. In the same way as the architecture of convolutional neural network, it also classifies our fire dataset based on the features of the image which helps in training the model to detect fire and non-fire images as well as videos.

The same can be seen in the architecture diagram shown above , the live video surveillance data is processed by the CNN pre trained model which classifies them as fire or normal and if the classification turns out to be normal , then it continues to detect fire else if it obtains a classification as fire anytime during processing the data obtained from live surveillance video it captures those images and sends them along with an alert to respected person in charge through a telegram channel using a bot. we also alert the respective person in charge by calling him immediately with a pre recorded voice note which informs him about the fire detection alert and also drops a SMS to his phone number. Here the person may belong to the nearest fire station located in that surveillance area or fire and safety team of a site where the fire was detected.

Thus, alerting the respective person in time will be very useful to control and avoid big disaster which would result if the fire was not detected on time and alerted.

VI. CONCLUSION

Thus, our fire detection model, which is based on convolutional neural network, detects fire from the live videos and at the same time if any fire is detected during this process our system also alerts regarding the same to respective person or team in charge. Which helps in detection of fire in early stages and as we are also alerting at right time that results in controlling of dangerous fire events which would cause great losses.



## ACKNOWLEDGMENT

We would like to take this opportunity to thank our guide, **Mr. Omprakash B**, for giving us all the help and guidance needed. We are very grateful to him for his kind support and valuable suggestions.

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