IoT Enabled Water Sprinkler Trigger using Visual Recognition

Shantha S, Rajath V, Srimithrra Kuttappa, Mohammed Atifulla, Mohammed Sufiyan
Maharaja Institute of Technology Mysore, Karnataka, India

Abstract- Fire disasters are man-made disasters, which cause ecological, social, and economic damage. To minimize these losses, early detection of fire and an autonomous response are important and helpful to disaster management systems. Therefore, in this article, we propose an early fire detection framework using fine-tuned convolutional neural networks for CCTV surveillance cameras, which can detect fire in varying indoor and outdoor environments. To ensure the autonomous response, we propose an adaptive prioritization mechanism for cameras in the surveillance system. Our goal is to enhance the disaster control scenario by triggering the IoT enabled sprinklers and sending alert messages. The existing IP enabled CCTV cameras can be employed with this feature and fire based disaster can be detected and prevented in early stages.

Keywords- Neural Networks, Computer Vision, IoT, CCTV, fire, disaster management, fire extinguishing, cloud computing

I. INTRODUCTION

The increase in fire accidents and traditional prevention mechanisms are harder to implement. CCTV surveillance can be used to detect disasters in the scene like flood or fire. According to a report, the fire safety equipment market in India will cross USD 4.26 Billion (approx. INR 23,000 crore) by the end of 2017. The National Crime Records Bureau Data indicates that a total of 113961 people lost their lives due to Fire Accidents from 2010 to 2014. This is an average of 62 deaths a day. Disaster management is the prime concern in any infrastructure on how to handle the damage and save lives this can be achieved with proper disaster management. Fire is essential in human life but fire can be uncontrollable and may cause destruction. Among the fire deaths, 78% occurred only due to home fires. One of the main reasons is the delayed escape for disabled people as the traditional fire alarming systems need strong fires or close proximity, failing to generate an alarm on time for such people. This necessitates the existence of effective fire alarming systems for surveillance. To date, most of the fire alarm systems are developed based on sensors, considering its affordable cost and installation. As a result, the majority of the research is conducted for fire detection using cameras. With this motivation, there is a need to develop fire detection algorithms with less computational cost and false warnings, and higher accuracy. Considering the above motivation, we extensively studied convolutional neural networks (CNN) for flame detection at early stages in CCTV surveillance videos[1]. The main contributions of this article are summarized as follows:

1. Considering the limitations of traditional hand engineering methods, we extensively studied deep learning (DL) architectures for this problem and propose a cost-effective CNN framework for flame detection in CCTV surveillance videos. Our framework avoids the tedious and time-consuming process of feature engineering and automatically learns rich features from raw fire data.
2. Triggering IoT enabled water sprinkler using the MQTT protocol.
3. Sending alert messages to the concerned person with all the details regarding the event.

II. PROPOSED SYSTEM

Traditional system was always inefficient due to its nature of triggering false alarms. The proposed system is an intelligent way of detecting fire and proper disaster management. In our system, we first detect fire in the surveillance footage of CCTV if a fire is detected it will trigger the IoT enabled water sprinkler and send alert messages to the concerned people. The response time is increased and many disasters can be prevented. This system overcomes the detection of false fire and enhances the response time. In Figure .1 fire detection using visual recognition is proposed which will send an alert message and trigger a IoT enabled water sprinkler and also send alert messages to the concerned person.

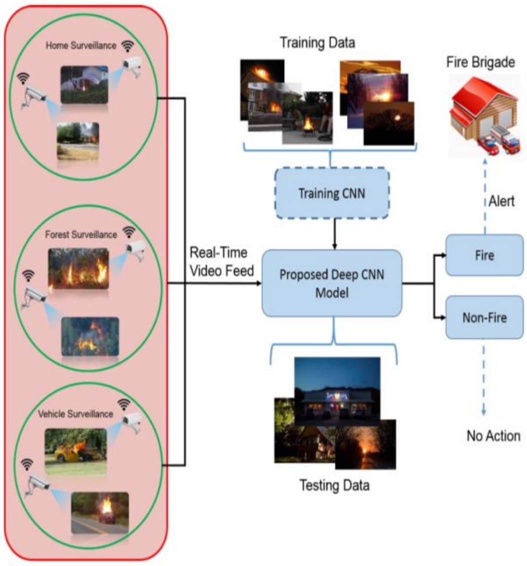
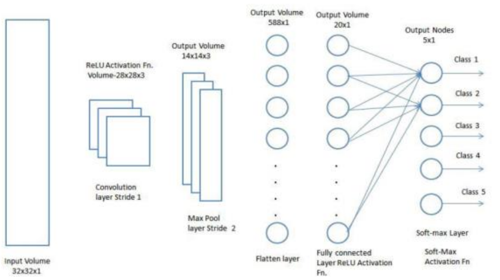


Fig.1: Fire detection using visual recognition

A. Convolutional Neural Network Architecture

CNN is a deep learning framework which is inspired by the mechanism of visual perception of living creatures. Since the first well-known DL architecture LeNet for handwritten digits classification, it has shown promising results for combating different problems including action recognition pose estimation, image classification visual saliency detection, object tracking, image segmentation, scene labeling, object localization, indexing and retrieval, and speech processing. Among these application domains, CNN's have extensively been used in image classification, achieving encouraging classification accuracy over large-scale datasets compared to hand-engineered features based methods[2]. CNN is widely preferred for image classification the CNN architecture has several layers as seen in Figure 2.



. Fig.2: Fully Connected CNN architecture

In convolution operation, several kernels of different sizes are applied to the input data to generate feature maps[3]. These features maps are input to the next operation known as subsampling or pooling where maximum activations are selected from them within a small neighborhood.

In the proposed CNN model we have taken dataset consisting of 1048 images with fire and 1048 images without fire. This dataset is preprocessed and converted into 64X64 input images to feed into the input layer of the neural network.The size of the input image is 224×224×3 pixels on which 64 kernels of size 7×7 are applied with stride 2, resulting in 64 feature maps of size 112×112. Then, a max pooling with kernel size 3×3 and stride 2 is used to filter out maximum activations from previous 64 feature maps. Next, another convolution with filter size 3×3 and stride 1 is applied, resulting in 192 feature maps of size 56×56. This is followed by another max pooling layer with kernel size 3×3 and stride 2, filtering discriminative rich features from less. Next, the pipeline contains two inception layers.

B. Deployment of CNN model on cloud

After the model is built the model is tuned using different parameter to increase efficiency, performance and response time, The model is deployed on IBM Cloud and the API endpoint are used to send inputs for the model and received proper output. The deployed model will be running without any downtime (except planned maintenance downtime by the cloud service provider). The model can detect fire in the surveillance video and trigger the IoT enabled water sprinklers and even send alert message regarding the fire detected in the visual. For triggering the IoT[4] sprinkler we are using Blynk cloud this can accept API request and send turn on devices connected to the blynk cloud in our case the IoT water sprinklers are connected to the blynk cloud which will be triggered on if fire is detected in the visual. Email is sent using SMTP protocol from the cloud server when the event occurs.

C. Hardware used in the proposed system.

1. Raspberry Pi 3 Model B+

Raspberry Pi is a 1.4Ghz 64bit quad-core ARM CPU Broadcom processor[5], which consists of WiFI and Bluetooth for wireless connectivity and a wide selection of IO ports for interfacing with other hardware. We have used Raspberry Pi 3B+ in place of CCTV camera which will stream captured video to cloud for processing and detecting fire.

2. Nodemuc

Nodemcu is a ESP8266 development board which can be connected to internet and then can be used to trigger motors using the internet connection.

3. Water Sprinklers

We are using a DC submersible 9V pump water sprinkler which will be triggered by the nodemcu which is connected to network.

III. OUTCOME

In this section, all experimental details and comparisons are Illustrated. We conducted experiments from different perspectives using images and videos from different sources. All experiments are performed using NVidia GeForce 940MX with 2GB onboard memory and deep learning framework and Windows OS installed on Intel Core i5 8th Gen CPU with 8GB RAM. The experiments and comparisons are mainly focused on benchmark fire datasets: . However, we also used data from other two sources for training purposes. The total number of images used in experiments is 1048.The CNN model is trained using tensorflow framework which gives an accuracy of 84.44% after training for 10 ephocs the structure is shown in Figure 6.

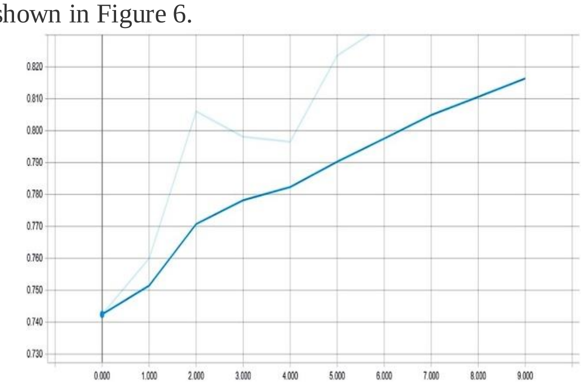


Fig.3: Tensorflow graph of accuracy for 10 ephocs,

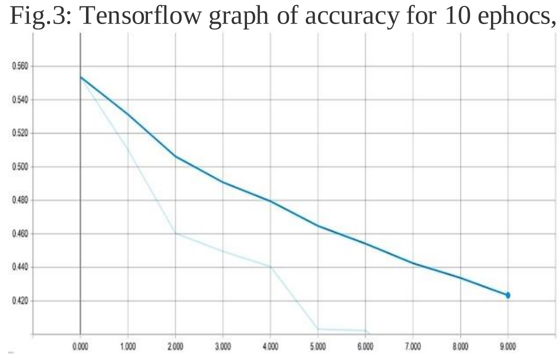


Fig.4: Tensorflow graph of loss for 10 ephocs

The model gave a consistent accuracy then we used the model to detect fire from images which had fake fire and the model was able to predict real fire and trigger a email Figure 5 and water sprinkler. The accuracy rate increased and the loss decreased for every ephoc and at the 10th ephoc the accuracy was 84.44% Figure 3 and the loss decreased Figure 4.

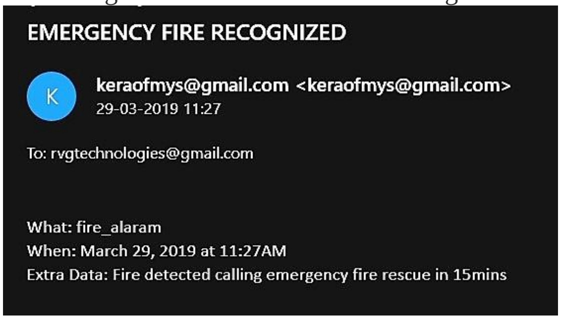


Fig.5: Email received when fire is detected.

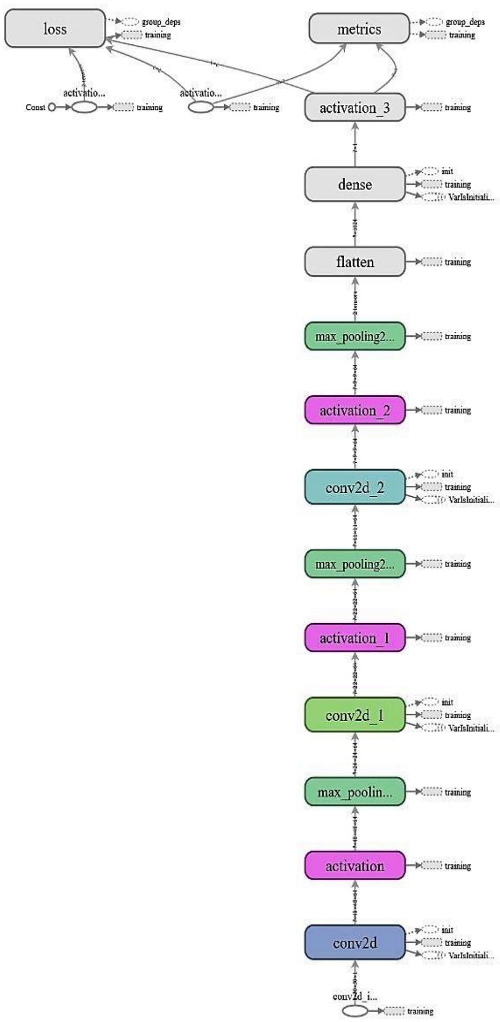


Fig.6: Structure of CNN model used in proposed system.

IV. CONCLUSION

The recent improved processing capabilities of smart devices have shown promising results in surveillance systems for identification of different abnormal events i.e., fire, accidents, and other emergencies. Fire is one of the dangerous events which can result in great losses if it is not controlled on time. This necessitates the importance of developing early fire detection systems. Therefore, in this research article, we propose a cost-effective fire detection CNN architecture for surveillance videos. This project will enhance the traditional disaster management techniques and reduces the rate of false fire alarms. The project also uses different technology stack and implements in a beneficial way which is very modular for implementing in all situations..

V. FUTURE WORK

In the proposed system we are using the cloud to detect fire and trigger the IoT enabled devices.due to the compute intense CNN model. The project can be further enhanced to make the model lightweight and embedded in the CCTV cameras and give them power to perform actions in the event of diaster. Also the project can be enhanced by using fire traacking mechanism and pointing a water jet towards the fire to have efficient fire extinguishing technique.

VI. REFERENCES

[1]. Md. Mahamudul Hasan, M. Abdur Razzak, “An Automatic Fire Detection and Warning System Under Home Video Surveillance”, Department of Electrical and Electronic Engineering, Independent University, Bangladesh, March 6,2016

[2]. Khan Muhammadi, Jamil Ahmadi, Irfan Mehmood, Seungmin, sung Wook Baiki, “Convolutional Neural Networks based Fire Detection in Surveillance Videos”, Sejong University, Seoul 143-747, Republic of Korea, June 2017.

[3]. Meiyin Wu, Li Chen ”Image Recognition Based on Deep Learning”, College of Computer Science and Technology, Wuhan University of Science and Technology Key Laboratory of Intelligent Information Processing and Real-time Industrial System Wuhan, China, 2015.

[4]. Shivangi Vashi, Jyotsnamayee Ram, Janit Modi, Saurav Verma, Dr.Chethana Prakash, “Internet Of Things(IoT) A vision, architecture elements and security issues”, Mumbai, India, 2017.

[5]. Wilson Feipeng Abaya, Jimmy Basa, Michael Sy, “Low Cost Smart Security Camera with Night Vision Capability Using Raspberry Pi and OpenCV”, Electronics and Communications Engineering Department, Gokongwei College of Engineering, De La Salle University Manila, Philippines, November 2014.