



Article Title: An Efficient Technique for Fire Detection Using Deep Learning Algorithm

An Efficient Technique for Fire Detection Using Deep Learning Algorithm

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ABSTRACT

Fire detection using computer vision techniques and image processing mainly considered for rescuing operation. Indeed, good accuracy of computer vision techniques can outperform traditional models of fire detection. Computer vision techniques are being replaced by deep learning models such as Convolutional Neural Networks (CNN). Existing System has only been assessed on balanced datasets, which can lead to the unsatisfied results and mislead real-world performance as fire is a rare and abnormal real-life event. Also, the result of traditional CNN shows that its performance is very low, when evaluated on imbalanced datasets. Therefore, this proposed system use of transfer learning that is based on deep CNN approach to detect fire. It uses pre-trained deep CNN architecture namely VGG, and Mobile Net for development of fire detection system. These deep CNN models are tested on imbalanced datasets by considering real world scenarios. The results of deep CNNs models show that these models increase accuracy significantly and it is observed that deep CNNs models are completely outperforming traditional Convolutional Neural Networks model. The accuracy of Mobile Net is roughly the same as VGG Net, however, Mobile Net is smaller in size and faster than VGG

1 Introduction

1.1 Background

Fire is the big threat in human life like floods, and earthquakes. Situation like fire causes threat to public safety and health. It is the more commonly occurring abnormal event than other abnormal events such as earthquakes and floods. Fire detection system, which are made of hardware, are quite expensive. Hence, researchers proposed image processing and computer vision-based techniques for fire detection. Fire could have the most dynamic features such as area of the flame, randomness of the flame. Due to this reason, feature extraction using computer vision technique made this process very difficult. With the enhancement of the technologies, deep learning concept has been introduced. CNN based deep learning model is



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the most commonly used model in detection of fire. Performance of CNN has been found to be quite better as compared to computer vision techniques. Due to lack of large datasets, sometimes CNN does not give satisfactory results. After the introduction of Image Net dataset, which is trained on millions of images and over thousands of objects, Traditional CNN models have completely outperformed models of computer vision technique and is more accurate than computer vision-based model. The proposed system in this paper goes one step ahead by applying transfer learning to train the model using Image Net weights, model is called deep convolution neural networks model. These Deep CNN models are more accurate than CNN models.

1.2 Mobile Net

The core layers that Mobile Net is built on which are depth wise separable filters. Mobile Net network structure was described and also descriptions of the two model shrinking hyper parameters width multiplier and resolution multiplier was considered. The Mobile Net model is based on depth wise separable convolutions which is a form of factorized convolutions which factorize a standard convolution into a depth wise convolution and a 1×1 convolution called a point wise convolution. For Mobile Nets the depth wise convolution applies a single filter to each input channel. The point wise convolution then applies a 1×1 convolution to combine the outputs the depth wise convolution. A standard convolution both filters and combines inputs into a new set of outputs in one step. The depth wise separable convolution splits this into two layers, a separate layer for filtering and a separate layer for combining.

2 Methodology

2.1 CNN Classification and Optimization

A Convolutional Neural Network (CNN) is a feed-forward multilayer neural network, which differs from traditional fully connected neural networks by combining a number of locally connected layers aimed at automated feature recognition, followed by a number of fully connected layers aimed at classification. The CNN architecture, comprises several distinct layers including sets of locally connected convolution layers (with a specific number of different learnable kernels in each layer), subsampling layers named pooling layers, and one or more fully connected layers. The internal structure of the CNN combines three architectural concepts, which make the CNN successful in different fields, such as image processing and pattern recognition, speech recognition, and NLP. Optimization is to find the best weight values for all the network that will make a good classification of the data. To learn correct weight values, the optimization algorithm looks at the loss values and tries to minimize this loss to fit the data. A loss, or objective, can be thought as a multidimensional function with a global and the goal is to update the weights towards the minimum loss value. The loss derivative respect to each weight dimension is computed, and then the gradient is back propagate to the other layers of the convolution neural network using the chain rule of the derivatives.



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3 Existing System

In existing system, image processing-based forest fire detection using YCbCr colour model is presented. YCbCr colour space effectively separates luminance from chrominance. The proposed method separates high-temperature fire centre pixels by taking into account of statistical parameters of fire image. In this method four rules are formed to separate the true fire region. Two rules are used for segmenting the fire region and other two rules are used for segmenting the high temperature fire centre region. This systems is very complex with less accuracy and also gives false detection of output.it is also difficult to catch dynamic behaviour of fire

4 Proposed System

Proposed System use of transfer learning that is based on deep CNN approach to detect fire. It uses pre-trained deep CNN architecture namely VGG, and Mobile Net for development of fire detection system. The results of deep CNNs models show that these models increase accuracy significantly and it is observed that deep CNNs models are completely outperforming traditional Convolutional Neural Networks model. The accuracy of Mobile Net is roughly the same as VGG Net, however, Mobile Net is smaller in size and faster than VGG. Uses Deep CNN instead of traditional CNN. Deep CNN is based on the transfer learning that uses pre-trained model to train another model, which is being trained to detect different object. Two Deep CNNs, VGG 16 and Mobile Net have been used, which outperform traditional CNN model. The proposed work consists of images in jpg format. After processing, dataset is labelled into training and testing data. Both training and testing datasets are prepared by sampling frames into default and fire categories. Frames are kept in directories named after the class. The proposed approach uses Deep CNN instead of traditional CNN. Deep CNN is based on the transfer learning that uses pre-trained model to train another model, which is being trained to detect different object. Two Deep CNNs, VGG 16 and Mobile Net have been used, which outperform traditional CNN model. VGG16 uses sixteen dense layers of neural networks, while Mobile Net uses depth-wise separable convolution to create model and final result is tested whether image belongs to fire or non-fire category. Proposed method is more accurate, reliable and gives better performance by minimizing the false fire alarms.

4.1 System Architecture

The proposed method uses Deep CNN instead of traditional CNN. Deep CNN is based on the transfer learning that uses pre-trained model to train another model, which is being trained to detect different object. Two Deep CNNs, VGG 16 and Mobile Net have been used, which outperform traditional CNN model.



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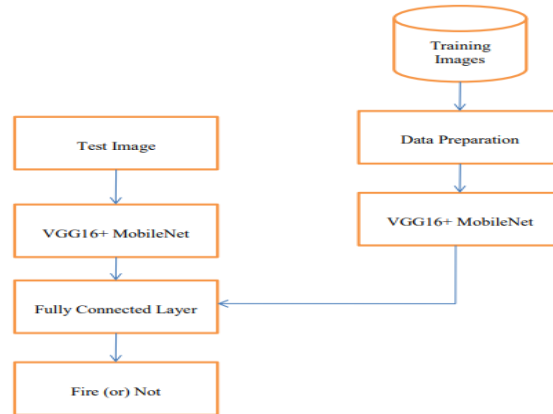


Figure 1: System Architecture

Data Preparation

The data consist for the proposed work consists of images in jpg format. After processing, dataset is labelled into training and testing data. Both training and testing datasets are prepared by sampling frames into default and fire categories. Frames are kept in directories named after the class. Training data and Testing data are used to train the model and validate the model. Data preparation phase can also be called as the input phase of Model Training phase.

Model Creation

The proposed work has been implemented by using two Deep convolution neural networks, i.e. VGG16 and Mobile Net. VGG16 uses sixteen dense layers of neural networks, while Mobile Net uses depth-wise separable convolution to create model. These models are created by using convolution layer of different channels with activation function and performing max pooling on these layers.

Model Training

To train model data augmentation is done in pre-processing input. The data for training and testing are read from directories using data generator function. After pre-processing training and testing data, these data send to model fitting for model training.

5 Result and Output

Result shows different graphs of accuracy and loss of training and testing data with epochs (go over training data epoch times and each time update results). Convolution Neural Network (CNN) model table is drawn as well as Deep Convolution Neural Networks tables. Final result is tested whether image belongs to fire or non-fire category.



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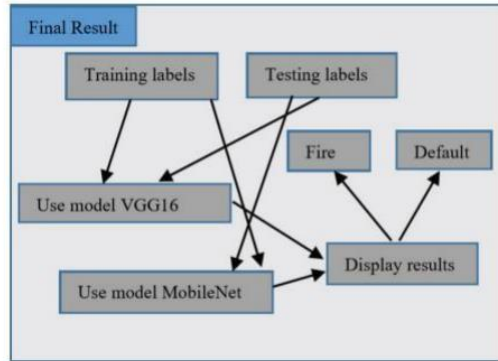


Figure 2: *Final Result*

5.1 Output



Figure 3: *Original Image*



Figure 4: *Grayscale Image*



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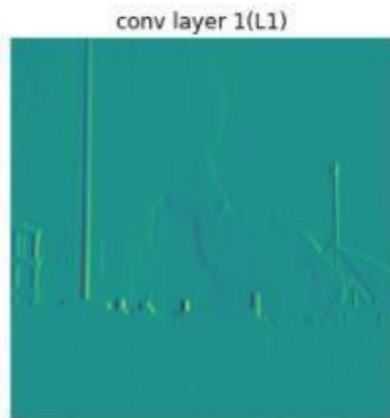


Figure 5: *Convolution Layer*



Figure 6: *RELU Layer*

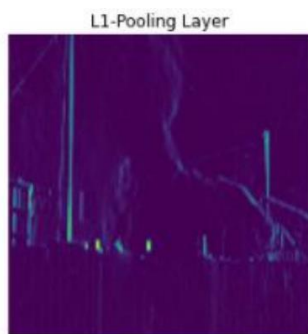


Figure 7: *L1-Pooling Layer*



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Fire : 85.4% | Not Fire: 14.5%
Fire detected
Fire detected



Figure 8: Fire Detected Image

5.2 Discussion

The performance of fire detection is tested against traditional CNN, and two deep learning models VGG16 and Mobile Net using transfer learning to increase accuracy. However, this may also increase training time.

Table 1 CNN Model Results

Table 1: Result CNN Model

Epoch	Accuracy
1	0.6922
16	0.9141
49	0.9053
50	0.9112

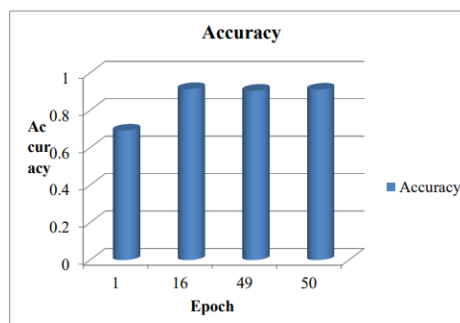


Figure 9: Accuracy Vs Epoch



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6 Conclusion and Future Work

The proposed work uses both Convolution Neural Networks and Deep CNN using transfer learning for the detection of fire in images. Convolution Neural Network (CNN) was tested set on dataset and accuracy of training and validation was observed and plotted graphs of loss and accuracy in accordance with epochs. After CNN model, Deep CNN models used for testing dataset and accuracy of Deep CNN models was observed and also plotted different graphs of loss and accuracy in accordance with the epochs. CNN models compared with VGG model and Mobile Net model. In future Work, YOLOv2 is designed with light-weight neural network architecture to account the requirements of embedded platforms. The training stage is processed off-line with indoor and outdoor fire and smoke image sets in different indoor and outdoor scenarios.

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