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MACHINE LEARNING-BASED SURVEILLANCE FOR FIRE ACCIDENT MONITORING

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ABSTRACT: In the face of diverse environments ranging from sprawling urban landscapes to dense jungles, the threat posed by fire accidents remains a significant concern worldwide. Despite the potential for mitigating such risks through the deployment of fire detection systems, existing solutions are hindered by several challenges. These include prohibitive costs, high rates of false alarms, the necessity for dedicated infrastructure, and the overall lack of robustness in both hardware and software-based detection systems. To address these obstacles, our research endeavors to advance fire detection capabilities harnessing the power of deep learning techniques, particularly within the domain of video analysis. Deep learning, rooted in artificial neural networks, has demonstrated remarkable across various disciplines, notably in computer vision tasks. Our proposed system is designed to detect fires in videos swiftly and reliably, with the capability to operate effectively across diverse environments and sends messages to the owner.

INTRODUCTION

In today's rapidly evolving technological landscape, the integration of machine learning techniques into surveillance systems has become indispensable for addressing safety concerns, particularly regarding fire accidents. The timely detection and response to fire incidents are crucial for minimizing their destructive impact on lives and property. Therefore, leveraging machine learning algorithms in surveillance systems presents a promising solution for early detection and effective monitoring of fire accidents. The "Machine Learning-Based Surveillance for Fire Accident Monitoring" project aims to utilize advanced machine learning algorithms to enhance fire detection capabilities in surveillance systems. By employing sophisticated image processing techniques and predictive modeling, the system can autonomously identify and classify potential fire incidents in real-time, enabling swift response measures to mitigate risks. Traditional fire detection methods often rely on human intervention or simple rule-based algorithms, which may lead to delayed response times and high false alarm rates. In contrast, the proposed machine learning-based approach offers several advantages. By analyzing patterns specific to fire events, the system can distinguish between genuine threats and false alarms more accurately, reducing unnecessary disruptions and ensuring efficient resource allocation for emergency response teams. The project involves the development of a comprehensive surveillance framework integrating various components such as image acquisition, preprocessing, feature extraction, and classification. Through continuous

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learning and adaptation, the system can enhance its accuracy and reliability over time, thereby improving its effectiveness in fire accident monitoring across diverse environments. Furthermore, the scalability and versatility of the proposed solution make it suitable for deployment in various settings, including commercial buildings, industrial facilities, and public spaces. By providing stakeholders with real-time insights and alerts, the system empowers them to take proactive measures to prevent fire incidents and safeguard lives and assets effectively. In summary, the "Machine Learning-Based Surveillance for Fire Accident Monitoring" project represents a significant advancement in the field of fire safety and surveillance technology. By harnessing the power of machine learning, it offers a proactive and intelligent approach to fire detection, ultimately contributing to public safety and disaster management efforts.

METHODOLOGY

The existing smoke and fire detection systems, relying on photometry, thermal, or chemical detection, exhibit significant limitations. These systems typically react after several minutes, necessitating a substantial amount of fire or smoke to trigger an alarm. Furthermore, they fail to provide precise information regarding fire location and size, rendering them ineffective for outdoor environments. Moreover, traditional opto-electronic fire detection systems come with several disadvantages including the need for separate and often redundant systems, fault-prone hardware, frequent maintenance, and susceptibility to false alarms. Additionally, deploying sensors in harsh industrial conditions proves challenging. As a viable alternative, leveraging surveillance video streams for fire detection emerges as a promising solution. This approach eliminates the need for extensive infrastructure installation or investment. However, existing video-based machine learning models require refinement to address new threats and adapt to evolving scenarios, often relying heavily on domain knowledge and engineering expertise for effective detection.

Proposed System

We aim to develop a classification model using Deep learning and Transfer Learning to recognize fires in images/video frames, thus ensuring early detection and save manual work. Traditional Machine learning using feature extraction yielded high accuracy and low false positive rate, yet it requires immense domain knowledge i.e., about colour model, colour, space, patterns and motion vectors of flames. when the object changes, the models need to be rebuilt for the new objects.

Development Done To The Existing Model

- Installation of CCTV Camera's in place of smoke sensors
- Installation Of Alarm System
- Development Of ML Model

Benefits

Here we can detect fire through surveillance videos and owner get notified by a message

MODELING AND ANALYSIS

Now a days, computer vision and digital camera technologies are developing rapidly. Therefore, innovative fire detecting methods are proposed. The main use of deep learning is it can extract features automatically which

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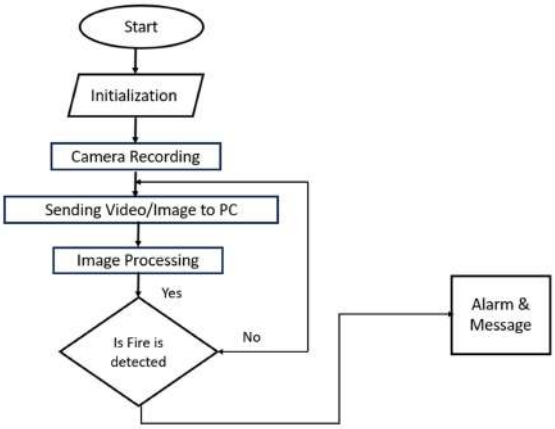
improves the state-of-art in classifying image detection and object detection methods.



Algorithm

We use standard InceptionV3 model and customize it. A complex model is capable of learning the complex features from the images. Inception v3 is an image recognition model that has been shown to attain greater than 78.1% accuracy on the ImageNet dataset. The model itself is made up of symmetric and asymmetric building blocks, including convolutions, average pooling, max pooling, concatenations, dropouts, and fully connected layers. Batch normalization is used extensively throughout the model and applied to activation inputs. Loss is computed using SoftMax.

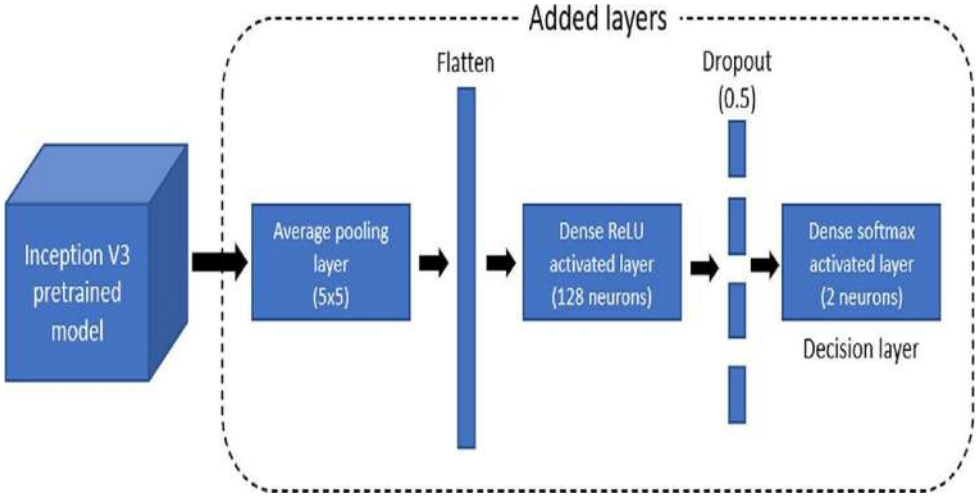


Figure 2: Model Flow chart

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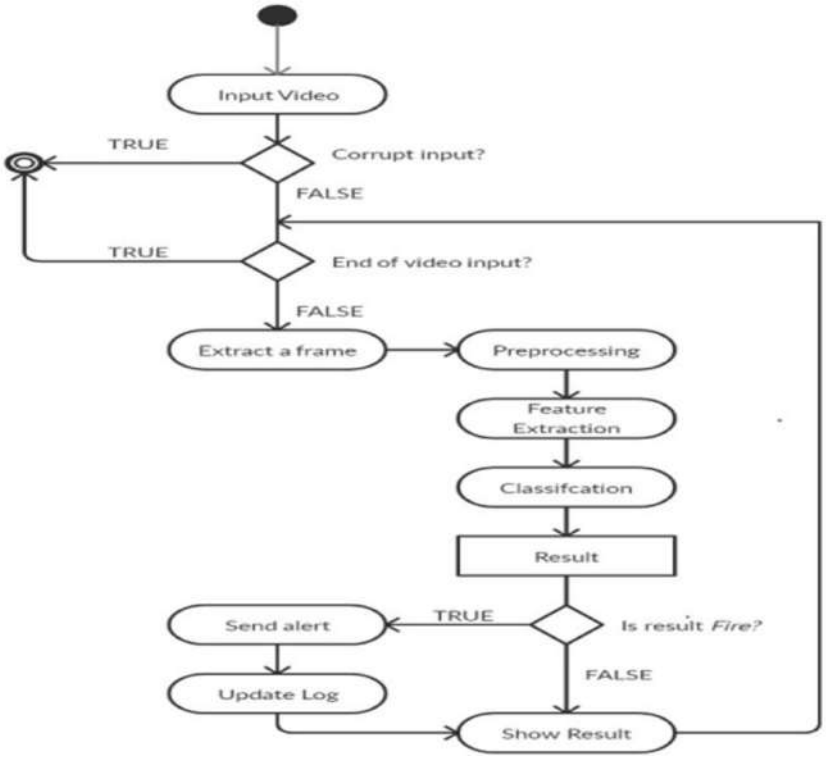
In this paper, Inceptionv3 model was used which is from Keras API. At the top of InceptionV3 model two layers are added. Then a global spatial average pooling layer was added and next 2 dense layers and 2 dropout layers was added. Dropout layer was added to reduce overfitting. At the end, SoftMax dense layer was added

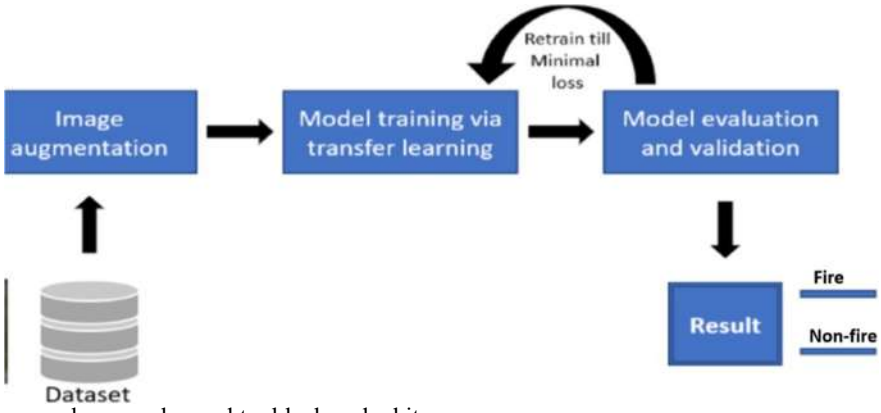


for 2 classes.

Figure 3: Activity Diagram

3.2. Real-Time prediction

OpenCV was used to access webcam and to predict whether each frame contains fire or not. If a frame contains



fire in it, frame color was changed to black and white.

RESULTS AND DISCUSSION

Convolution Neural Networks can be used to detect fire in surveillance videos. Here pre-trained model InceptionV3 was used for training the data.

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Sample images from dataset

The link for dataset is https://github.com/DeepQuestAI/Fire-Smoke-Dataset/releases/download/v1/FIRE-SMOKE-DATASET.zip

Fire

Non-Fire

- The ImageDataGenerator function was used for our model. In this paper, the dataset contains images

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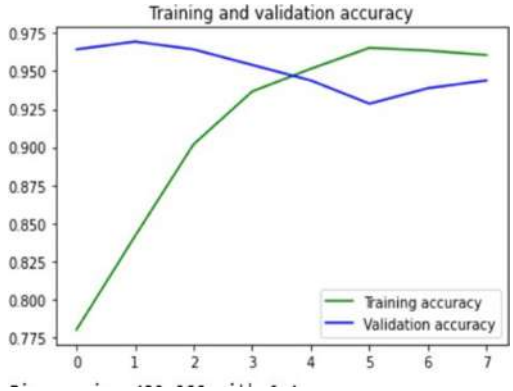
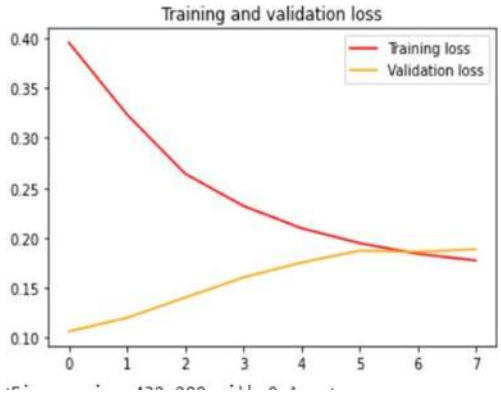
belonging to 2 classes. This model was trained in google colab.

- To generate more images for training, data augmentation techniques used are horizontal flipping and zooming.

- InceptionV3 model was imported from Keras API. The new layers are added on the top of the Inceptionv3.
  - In this step, the layers which are added are only trained. These layers are randomly initialized. Here RMSpropoptimizer was used.
  - The top layers are trained for 20 epochs by freezing the first 249 layers of the model and trained theremaining layers. In this model, SGD optimizer was used and learning rate was 0.0001.
  - Here, model was trained for another 10 epochs, and reached a training accuracy of 98.04% and training lossof 0.053.

The validation accuracy was 96% and validation loss was 0.108.





Output:

Now, our model is ready for real time testing. OpenCV module was used for predicting whether each frame contains fire or not. If a frame contains fire in it, frame color will be changed to black and white and

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sends msgs

CONCLUSION

Smart cameras have emerged as effective tools for identifying various critical incidents, including medical emergencies, accidents, and fires. Among these, fires present an exceptionally severe threat due to their potential for widespread destruction and loss of life if not promptly controlled. Deep learning techniques, particularly convolutional neural networks (CNNs), offer a promising solution for addressing this pressing issue by enabling sophisticated fire detection solutions. By harnessing deep learning, tailored models can be developed to detect fires in both images and videos, facilitating early intervention and mitigation efforts. This paper proposes a model specifically designed for fire detection in surveillance videos. Deep learning algorithms provide the means to create highly accurate and efficient fire detection systems. Achieving high accuracy in fire detection is crucial, particularly for disaster management teams tasked with minimizing the impact of fire disasters. The proposed model has significant potential for enhancing the capabilities of disaster management teams in responding to fire-related emergencies. By swiftly and accurately detecting fires in surveillance videos, the model offers decision-makers valuable insights and actionable information to aid in formulating effective response strategies. Overall, the adoption of deep learning-based fire detection systems marks a substantial advancement in disaster management practices. By leveraging artificial intelligence, these systems offer a proactive approach to fire prevention and response, ultimately saving lives and mitigating the destructive consequences of fire disasters on communities and infrastructure.

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