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Video Surveillance Fire Detection System using CNN Algorithm

Prof. U. L. Tupe[1], Lakhan Jadhav[2], Shivanand Koli[3], Prasad Kulkarni[4] and Mayur Gaikwad[5]
[1-5]JSPM's Rajarshi Shahu College of Engineering/Information Technology, Pune,India
Email: ultupe_it@jspmrscoe.edu.in

***Abstract*— Fires in public places such as shopping malls, hospitals, train stations, and others can endanger both people and resources. This has been a big concern for the past few decades. Stopping these accidents should be a priority. So to achieve these, there are various techniques, but there are some loopholes in those techniques. So to overcome those loopholes, we have developed a model that detects fire in images and video frames, and as soon as it detects fire, it sends an alert message to the nearest fire station and related authorities. The main purpose of these models is to prevent accidents due to fire and minimize human work load. This paper uses the CNN algorithm to build these projects.**

I. Introduction

Fire accidents are one of the biggest threats to industries, social gathering places, hospitals, malls, and various densely populated areas across the world. These kinds of incidents may cause damage to property and the environment and pose a threat to human and animal life. According to the recent National Risk Survey Report [1], fire was ranked third in terms of its impact on various fields related to problems, among many others. There were some fire accidents in different countries that resulted in the impending ecological disaster, claiming millions of lives and resulting in billions of dollars in damage. Early detection of fire can save many lives, as well as various resources, and prevent damage caused by fire. This is one of the advantages of detecting fire at an early stage. In order to achieve high accuracy and robustness in dense urban areas, detection through local surveillance is It is both necessary and effective. There were numerous issues with traditional fire systems, such as false alarms, detecting fire when there was none, and ringing alarms when there was no fire. Maintenance was difficult. The use of sensors in hot, dusty industrial conditions is also not possible. Thus, detecting fires through surveillance video One of the most feasible and cost-effective solutions is streaming, which is suitable for the replacement of existing systems without the need for large infrastructure installations or investments. The existing domain knowledge is heavily used in video-based machine learning models.

As a result, they must be updated to meet new threats. So our model can detect fire in a video or image frame and send an alert message as soon as it detects fire. It can be used to detect fires in surveillance videos. Unlike existing systems, this neither requires special infrastructure for setup, like hardware-based solutions, nor does it need domain knowledge and prohibitive computation for development.

II. Proposed framework

We investigate deep neural networks for potential fire detection in the early stages of the suggested system's surveillance. For the objective problem, we investigate various deep CNNs while accounting for accuracy, the embedded processing power of CCTV systems, and the frequency of false alarms. The computer vision problems

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and applications where CNNs have shown promise include object detection and localization, image segmentation, super-resolution, classification, and indexing and retrieval. Their hierarchical method, which automatically learns very potent qualities from raw data, might be credited for this widespread success.
A typical CNN design is made up of three well-known processing layers. 1) Numerous feature maps are created as a convolution layer when various kernels are applied to the input data. 2) A pooling layer that, in order to achieve some translation invariance and dimensionality reduction, chooses the maximal activation from a small neighbourhood of feature maps acquired from the previous convolution layer. 3) A fully interconnected layer that builds a global representation of high-level data from input information. The high-level characteristics of the input data are produced by this layer after a sequence of convolutional and pooling layers. These layers are arranged in a hierarchy, with the output of one layer serving as the input for the following one.
In convolutional kernels and fully connected layers, the weights of every neuron are adjusted and learned throughout the training period. By simulating the characteristic features of the input training data, these weights can carry out the objective classification. Pre-processing refers to all the adjustments made to the raw data in our project before it is provided to the deep learning or machine learning algorithm. A CNN model, for instance, would almost likely produce subpar classification results if trained on raw images. A neural network called CNN extracts the features of the input images. The input image is used by a network for feature extraction. The feature extraction signals are used by the neural network for categorization.

III. RELATED WORK

THE SDLC MODEL TO BE USED each software development life cycle model begins with an analysis, in which the technologies employed in the project and the team load are specified. Software Development Life Cycle models, or SDLC models, are one of the fundamental ideas in the software development process. The SDLC is a continuous process that begins when the choice to start the project is made and ends when it is completely removed from exploitation. No single SDLC model exists. Here, the waterfall model is used in the suggested system. The steps of the waterfall model that are necessary for creating the suggested system project are shown in Figure 3.1.
The phases of the proposed system's waterfall model are listed below. Requirement Analysis

A. Waterfall Model:

Figure 3.1 the most crucial and essential stage of the SDLC is the requirement analysis. With input from all Department of Computer Engineering, ACEM, 2021–22 18 Video Surveillance Fire Detection System stakeholders and subject matter experts (SMEs) in the sector, the senior members of the team carry it out. At this point, planning is also done for the requirements for quality assurance and for the identification of project-related risks. A meeting is scheduled with the client by the business analyst and project manager to obtain all the necessary information, such as what the customer wants to construct, who will be the end user, and what the product's goal is.

B. System Design:

System Design is the following phase that will compile all of the information on requirements, analysis, and software project design. This phase is the result of the previous two, such as requirement collection and client input.

C. Implementation:

The actual development process starts here, and the programming is created. Coding represents the start of design implementation. Programming tools including compilers, interpreters, debuggers, and other similar tools are used to generate and implement the code, and developers must adhere to the coding standards outlined by their management.

D. Testing:

After the code is created, it is tested in comparison to the requirements to ensure that the solutions are addressing and accumulating the demands throughout the requirements stage. Unit testing, integration testing, system testing, and acceptability testing are carried out at this level.

E. Deployment:

After the software has been certified and no problems or errors have been reported, it is deployed. The software may then be delivered as is or with proposed improvements in the object portion depending on the assessment. The maintenance of the software starts once it has been deployed.

F. Maintenance:

Once the client begins utilising the built systems, the real problems surface and periodic problem-solving is required. Maintenance is the process when the developed product is given attention.

IV. PROPOSED WORK

When classifying images, convolutional neural networks have produced results with extremely high accuracy. Convolutional neural networks are the most widely used deep learning architecture and are quite powerful.

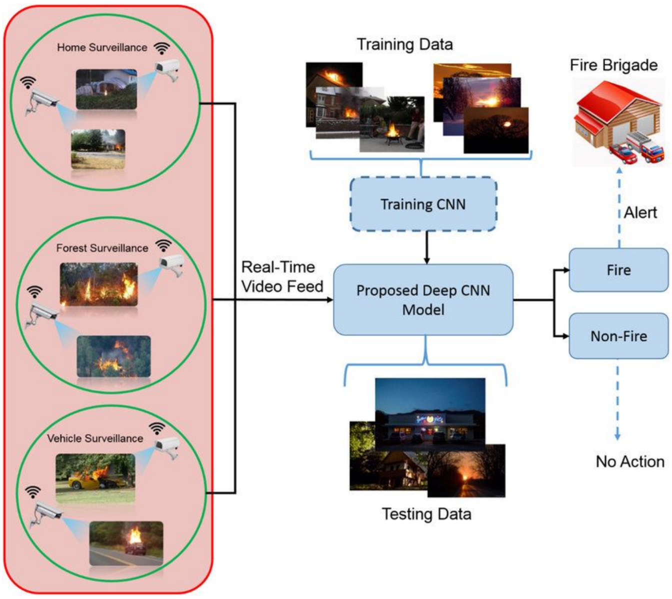


Figure 1. Using deep CNN Early flame detection in surveillance videos.

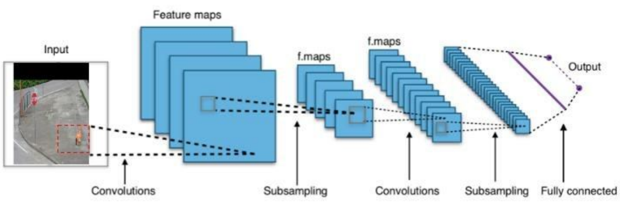


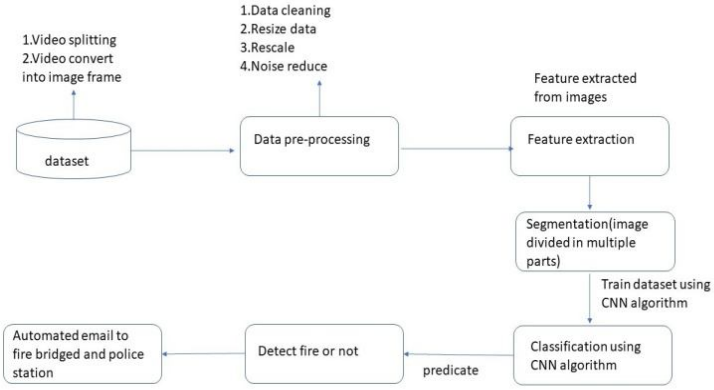
Figure 2: Operation of CNN architecture

This built model will collect data from CCTV or surveillance footage and process it gradually in real time. Frame by frame, the video is processed, and then the processed frames are fed into the pretrained CNN model. This pre-trained CNN model will categorise frames into two groups in real time: one with fire and the other without fire. This pre-trained CNN model may be set up to operate on a distant server using data from various video surveillance systems. After processing these inputs, the pre-trained CNN model outputs a real-time prediction on the real-time streaming data. To ensure that no frames are lost, streaming frames will be kept in data storage. As the knowledge grows, the model will shortly

By doing this, a rich dataset is produced, and the model is trained using a large number of frames from the dataset. As a result, the model's frame prediction accuracy will grow. Since the architecture of the monitoring system won't need to be changed, this fire detection will be affordable. The model uses information from current CCTVs or surveillance systems to forecast the presence of fire. This architecture is shown in Fig. 1.

V. CNN

An example of an eager learner algorithm is CNN. One of the Deep Learning models is CNN. The classification performance of CNN is excellent. The most effective algorithm for classifying images at the moment is CNN. Since LeNet, a Deep Learning algorithm, CNN has gained enormous popularity for classifying images. Huatan Watan Jishu Wutan AUG/2020, Volume XVI, Issue VIII, ISSN 1001-1749 Pages: 99 There were five concepts utilised, all of which had very good accuracy, to classify handwritten digits. The convolution layer, the Relu layer, the Pooling layer, and the fully connected layer are the four processing layers that make up a convolution neural network. One layer's output is used as the input for another layer.
1. The convolution layer, which forms the foundation of CNN, maps several kernels onto the input data before performing a dot product to produce a feature map. 2. The Relu layer replaces negative numbers with 0 while leaving other values alone. 3. To minimise and produce translation invariance, select the maximum value for the pooling layer in a limited area around these maps. The fourth layer of CNN is known as the fully connected layer. This layer receives as its input the output of the previous three levels. A fully connected layer will classify the photos using the training data it has collected using the provided weights.



Implementation

VI. ADVANTAGES

1) Easy to detect Fire or NOT.
2) Improve Accuracy.
3) Time Saving.
4) Easy to use.
5) It is User Friendly Application.

VII. APPLICATIONS

1) Fire Detection System.
2) Helps in Fire Fighting

VIII. CONCLUSIONS

In conclusion, a sizable archive of recordings of forest fires in a range of scene conditions has been used to investigate an aerial-based forest fire detection approach. The chromatic and motion characteristics of a forest fire are first extracted, and then they are rectified using a rule to highlight the burning region, in order to increase the detection rate. Second, smoke is also extracted using our suggested algorithm to address the issue of dense smoke that almost completely engulfs the fire. In the actual application of aerial forest fire monitoring, the proposed System framework demonstrates its robustness with a high accuracy rate of detection and a low false alarm rate. Making difficult and specific scene comprehension data sets for fire detection methods and in-depth trials may be the main focus of future research.
Additionally, fire detection systems can be integrated with reasoning theories and information-hiding algorithms to intelligently observe and authenticate the video stream and start the necessary actions in an autonomous manner.

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