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Fire Detection and Alert System using Convolutional Neural Network

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Abstract: Fire is one of the leading hazards endangering human life and property around the world, may lead to a considerable material damage and serious injury and even death. In order to avoid such losses, we widely practiced to use smoke and flame detectors. However, realization of video surveillance system is more reasonable, because it allows monitoring large areas and open space that the traditional systems of fire and smoke control cannot do. In this project fire is detected using surveillance camera and the alert message along with captured fire image is sent to the Owner / Incharge of the property through an email and also the system produces an alarm in order to take earliest actions and thereby avoid high property loss.

Keywords: Camera, Detection, Image processing, Recognition

I. INTRODUCTION

Fire monitoring and protection has always been an external hot spot, especially some large occasions and important areas, such as the warehouse, forest, substation, railway tunnel etc. Once these places fires, the consequences will be disastrous. The existing fire detection technology is mainly carried out in the process of sensitive detection of fire, gas and temperature, these sensors, such as Fire sensors, have the advantages of high sensitivity, fast response, strong ant interference ability, low cost, long service life and wide application. But in the open-space environment, because of high, large space, air mobility and other reasons, Fire, gas and temperature in the process of transmission of these signals easily fade away, so the fire signal which finally arrived the detector is very weak, making the Fire, temperature, gas and other detectors to reduce the detection accuracy, easy to delay the best time to fire alarm, fire disaster hazards to enlarge. Especially some open places like forests, use the Fire sensor to detector fire is simply impossible. Therefore, for large-space environment, there is a need to monitor the fire in other ways. In order to overcome the shortcomings of the traditional fire detection, with the development of computer vision, digital image processing and pattern recognition technology, video-based fire detection technology has been gradually studied and developed. In this dissertation, the image processing technology is used to replace the traditional detector to collect, analyze and process the image of fire scene of large space, and finally achieves the purpose of real-time fire detection and recognition. Fire monitoring is mainly divided into Fire detection and flame detection. In the process of combustion, the fire not only has distinctive color characteristics, but also has very important morphological characteristics. Fire is one of the leading hazards endangering human life and property around the world. To avoid large scale fire and Fire damage, some point-type thermal and Fire detectors are widely used, but such detectors need to be in a close proximity of the fire and easily to be fail or damaged in a bad environment. Along with the progress of computer vision and image processing, video-based fire detection is currently a fairly common technology which has remarkable advantages over traditional methods, such as fast response and wide detection area. Fire is the forecasting symbol of fire, so Fire detection provides earlier fire range than flame detection. The traditional Fire detection or classification methods can be summarized as two steps, First, calculating manual features which may be the color, texture, shapes, irregularity, flutter, or frequency from the input Fire images Second, training a

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classifier based on the extracted features to test whether an image is Fire. In this way, the performance of these methods depend on whether the manual features are reasonable and human often rely on experience in the choice of features, which is blindness, cumbersome and complex. Although some methods have achieved good results, these manual features are designed for specific data, and if the same features are used to deal with different data sets, the results may not be satisfactory. Nowadays, deep learning can learn representations of data with multiple levels of abstraction and automatically learn. These advanced methods have dramatically improved the state-of-the-art in visual object recognition. Motivated by the success of deep learning, a Fire detection method based on Convolution Neural Networks is proposed which can automatically learn features from the original two-dimensional images. This method can solve the shortcomings of traditional methods of fire detection.

II. LITERATURE SURVEY

For fire detection, the normal method is to use a sensor for detection. One of the defects is that the high false rate because the trigger alarm is predicated on the concentration of particles or the encompassing temperature and is therefore easily disturbed by the surroundings. At an equivalent time, this method cannot know the situation and therefore the real-time status of the hearth. For outdoor scenes, which are notable fire hazards, this sort of sensor cannot provide effective detection. Due to the various problems in traditional fire identification, the way to accurately identify the hearth has received great attention. Therefore, fire detection has achieved rapid development within the direction of fireside detection sensors, improvement in detection equipment, and fire detection supported video images.

Khan et al. [1] proposed a method based on video using flame dynamics and static indoor flame detection, using the color, perimeter, area, and roundness of the flame. Their method takes a little fire like a candle as an unimportant part. By removing then applying the flame growth characteristics to guage , this method may have an enormous problem in early fire warning. Seebam rungsat et al. [2] proposed a rule based on the combination of HSV and YCbCr. Their system requires extra conversion of color space and is therefore better than using only one color space method, but their work only uses the static characteristics of the flame. The method is relatively fragile and not stable enough. Foggia et al. [3] proposed a novel motion detection method based on the disordered nature of the flame-word bag strategy. Chen and Huang [4] proposed a Gaussian model to simulate HSV and analyze the time and space factors of the flame, but the Gaussian mixture model requires higher calculation time and the analysis is fuzzier. However, the utilization of the sensor has limitations thanks to the various properties of the combustion product. Burnett and Wing [5] used a new low-cost camera that can reduce the interference of smoke on the flame and has excellent detection capabilities for RGB and HSV, but there are still some limitations within the recognition and application of this camera. Töreyin et al. [6] proposed a Gaussian mixture background estimation method for detecting motion pixels in video. This method selects candidate fire regions by color model then performs wavelet analysis in time and space domains to figure out high frequency activity within the region. Almost like the previous problem, this method has high computational complexity in practical applications. Han et al. [7] used motion detection supported the Gaussian model and multicolor model and obtained good experimental results. However, since Gaussian models and color models require an outsized amount of computational time, they can not be applied to actual scenes. Chen et al. [8] improved the traditional flame detection method, and thus the flame flickering detection algorithm is incorporated into the scheme to detect fires in color video sequences. Testing results show that the proposed algorithms are effective, robust, and efficient. However, the calculation speed is slow, suitable for $320 * 240$ images. It's going to not be suitable for top quality. Dimitropoulos et al. and Çetin et al. [9, 10] used a variety of flame characteristics to judge and achieved good results.

Research on video analysis for fire detection has become a hot topic in computer vision. However, the conventional algorithms use exclusively rule-based models and features vector to classify whether a frame is fire or not. These features are difficult to define and depend largely on the kind of fire observed [1]. The outcome leads to low detection rate and high false-alarm rate. A different approach for this problem is to use a learning algorithm to extract the useful features instead of using an expert to build them. In this paper, author proposed a convolutional neural network (CNN) for identifying fire in videos. Convolutional neural network are shown to perform very well in the area of object classification. This network has the ability to perform feature extraction and classification within the same architecture. Tested on real video sequences, the proposed approach achieves better classification performance as some of

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relevant conventional video fire detection methods and indicates that using CNN to detect fire in videos is very promising.

III. PROPOSED SYSTEM

A. Architecture Diagram

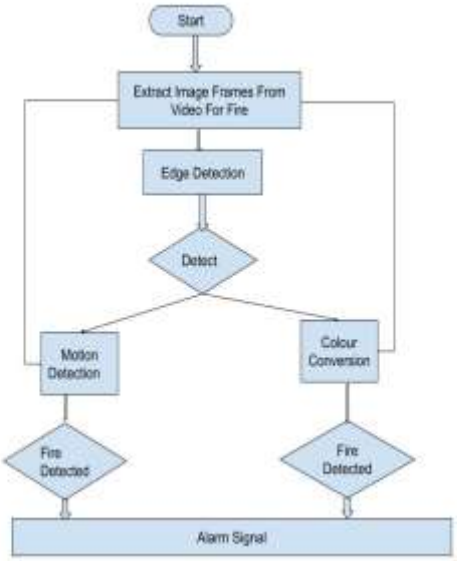

Fig. 1 Architecture diagram

1) *Extract Images Frame from video*

This module is concerned with the video data processing required for the system to work. Its major role in the system is to read the video data and extract image frame from video.

2) *Color Conversion Module*

The video may use different formats or configurations for the processing of raw video data. For the system to work, it needs the data to be homogeneous with the same format and configuration. This module converts the video data to RGB format, which makes further processing of video data easier.

3) *Fire Detector Module*

This module is a crucial component of the system. Convolutional neural network are shown to perform very well in the area of object classification .It is concerned with the pixel and frame analysis, which are two basic methods used in the classification of fire pixels from background pixels and non-fire pixels. Thus this module can be subdivided into these two analysis components and a classifier component.

4) *Alarm Module*

The alarm module is concerned with raising an alarm at the detection of fire in the frame under consideration. This module continuously checks for fire pixels in the final frame submitted by the classifier component. Once the potential fire frame is detected, it raises an alarm to denote the presence of fire.

B. Packages used

NumPy is that the fundamental package for scientific computing in Python. It is a Python library that gives a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic algebra , basic statistical operations, random simulation and far more. At the core of the NumPy package, is that the ndarray object. This encapsulates n-dimensional arrays of homogeneous data types, with many operations being performed in compiled code for performance. Pandas is an open source Python package that gives numerous tools for data analysis. The package comes with several data structures which will be used for several different data manipulation tasks. It also has a variety of methods that can be invoked for data analysis, which comes in handy when working on data science and machine learning problems in Python.

Matplotlib may be a Python 2D plotting library which produces publication quality figures during a sort of hardcopy formats and interactive environments across platforms. Matplotlib can be used in Python scripts, the Python and shells, the Jupiter notebook, web application servers, and four graphical user interface toolkits. Matplotlib tries to form easy things easy and hard things possible. You can generate plots, histograms, power spectra, bar charts, errorcharts, scatterplots, etc., with just a couple of lines of code.

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```
File  Edit  Format  Run  Options  Window  Help
import matplotlib as pyplot
import smtplib
from time import sleep
from email import encoders
from email.mime.base import MIMEBase
from email.mime.multipart import MIMEMultipart
from email.mime.text import MIMEText
from email.utils import formatdate
#fire Modules
import numpy as np
import cv2
import time
import requests
import matplotlib.pyplot as plt
import os
import pygame

def send_an_email():
    email_user ="pythonmathi@gmail.com"
    email_password ="mathi@123"
    email_send ="mathivanan198@gmail.com"
    subject ="FIRE DETECTION"
    msg = MIMEMultipart()
    msg['From'] = email_user
    msg['To'] = email_send
    msg['Subject'] = subject
    body = 'Fire Detected !!!....Please Inform To Fire Department!'
    msg.attach(MIMEText(body,'plain'))
    filename='C:/Users/HP/Desktop/FIRE DETECTION NEW CODE/TrainingImage/ 1.jpg'
    attachment  =open(filename,'rb')
    part = MIMEBase('application','octet-stream')
    part.set_payload((attachment).read())
    encoders.encode_base64(part)
    part.add_header('Content-Disposition',"attachment; filename= "+filename)
    msg.attach(part)
    text=msg.as_string()
    server=smtplib.SMTP('smtp.gmail.com',587)
    server.starttls()
    server.login(email_user,email_password)
    server.sendmail(email_user,email_send,text)
    server.quit()
```

Fig. 2 Code for fire detection

The above Fig. 2 shows the code for detection of fire which uses convolutional neural network (CNN) for identifying fire in videos.

c. *Overview of Technique*

CNNs use relatively little pre-processing compared to other image classification algorithms. This means that the network learns the filters that in traditional algorithms were hand-engineered. This independence from prior knowledge and human effort in feature design is a major advantage.

When programming a CNN, the input is a tensor with shape (number of images) x (image width) x (image height) x (image depth). Then after passing through a convolutional layer, the image becomes abstracted to a feature map, with shape (number of images) x (feature map width) x (feature map height) x (feature map channels).

IV. Experimental Results

The main aim of this study is to automatically detect fire in frame that was extracted from video, using computer vision methods, implemented in real-time with the help of the OpenCV library. Proposed solution must be applicable in existing security systems, meaning with the utilization of normal industrial or personal video cameras.

Fig. 3 Fire detection using camera

The above Fig. 3 shows that the hearth is detected using Camera and produces alarm sound, necessary solution precondition is that camera is static. Given the pc vision and image processing point of view, stated problem corresponds to detection of dynamically changing object, supported this color and moving features. While static cameras are utilized, background detection method provides effective segmentation of dynamic objects in video sequence. Candidate fire-like regions of segmented foreground objects are determined consistent with the rule-based color detection.

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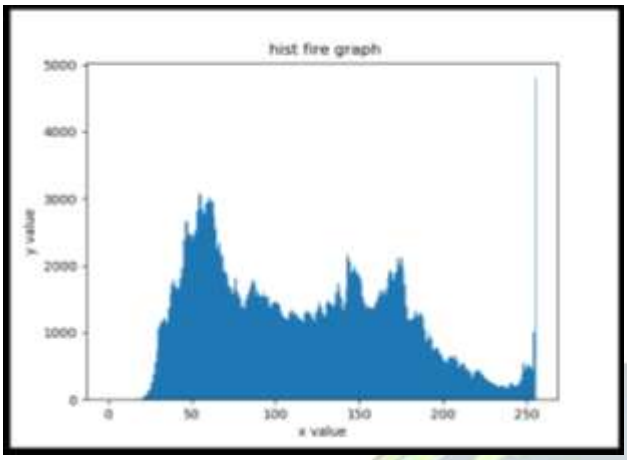

Fig. 4 Visualization of fire range using histogram

The above Fig.5 shows the range of fire and it is used to analyze the range of fire easily. Along with the progress of computer vision and image processing, video-based fire detection is currently a fairly common technology which has remarkable advantages over traditional methods, such as fast response and wide detection area.

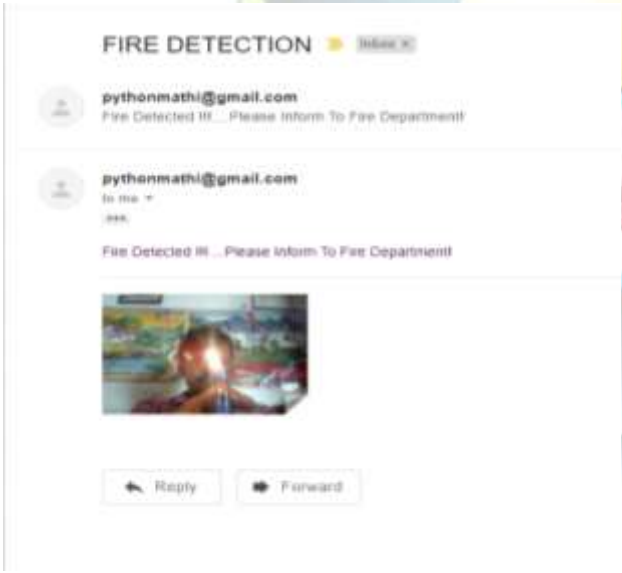

Fig.5 Alert email message along with captured fire image

The above Fig.6 shows the alert email message along with captured fire image.so that the user can contact the fire department immediately and take remedial actions as soon as possible.

V. CONCLUSION

It is concluded that the fire is detected, alarm is produced and the alert message with captured fire image is immediately sent to the owner through an email.So that the owner can immediately contact the fire department and take actions easily and thereby avoiding high property loss. The advantage of using this system is that the cost of using this type of detection is cheaper and the implementation of this type system is greatly simpler compare to those traditional methods. Secondly the response time of detection system is quicker compare to the opposite traditional detection methods since a vision camera- based fire detection system doesn't required any type conditions to trigger the camera and it has the ability to monitor a large area depends on the camera used.

REFERENCES

[1]. R. A. Khan, J. Uddin, S. Corraya, and J. Kim, "Machine vision based indoor fire detection using static and dynamic features," *International Journal of Control and Automation*, vol. 11, no. 6, 2018.

[2]. [2] J. Seebamrungsat, S. Praising, and P. Riyamongkol, "Fire detection in the buildings using image processing," in *Proceedings of the 2014 Third ICT International Student Project Conference (ICT-ISPC)*, pp. 95–98, IEEE, Bangkok, Thailand, March 2014.

[3]. P. Foggia, A. Saggese, and M. Vento, "Real-time fire detection for video-surveillance applications using a combination of experts based on color, shape, and motion," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 25, no. 9, pp. 1545–1556, 2015.

[4]. L. Chen and W. Huang, "Fire detection using spatial-temporal analysis," in *Proceedings of the World Congress on Engineering*, pp. 3–5, London, UK, July 2013.

[5]. J. D. Burnett and M. G. Wing, "A low-cost near-infrared digital camera for fire detection and monitoring," *International Journal of Remote Sensing*, vol. 39, no. 3, pp. 741–753, 2018.

[6]. B. U. Töreyin, Y. Dedeoğlu, U. Güdükbay, and A. E. Çetin, "Computer vision based method for real-time fire and flame detection," *Pattern Recognition Letters*, vol. 27, no. 1, pp. 49–58, 2006.

[7]. X. F. Han, J. S. Jin, M. J. Wang, W. Jiang, L. Gao, and L. P. Xiao, "Video fire detection based on Gaussian mixture model and multi-color features," *Signal, Image and Video Processing*, vol. 11, no. 8, pp. 1419–1425, 2017.

[8]. J. Chen, Y. He, and J. Wang, "Multi-feature fusion based fast video flame detection," *Building and Environment*, vol. 45, no. 5, pp. 1113–1122, 2010.

[9]. K. Dimitropoulos, P. Barmpoutis, and N. Grammalidis, "Spatio-temporal flame modeling and dynamic Texture analysis for automatic

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video-based fire detection," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 25, no. 2, pp. 339–351, 2015.

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Mathivanan R pursuing B Tech (IT) degree in Francis Xavier Engineering college, Tirunelveli, TamilNadu, India. He has participated in various hackathons and project contests conducted by various organizations. He is awarded INSPIRE (Innovation in Science Pursuit for Inspired Research)award for the year 2013-2014. He won various prizes in coding contests. He has attended various guesttalk and Conferences in various colleges. He is awarded as Best Outgoing Student, Department of Information Technology for the year 2016-2020

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