Emerging Methods for Early Detection of Forest Fires

A PROJECT REPORT

Submitted by

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IN

INFORMATION TECHNOLOGY

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1. INTRODUCTION

1.1 Project Overview

Forest fires are a major environmental issue, creating economic and ecological damage while endangering human lives. There are typically about 100,000 wildfires in the United States every year. Over 9 million acres of land have been destroyed due to treacherous wildfires. It is difficult to predict and detect Forest Fire in a sparsely populated forest area and it is more difficult if the prediction is done using ground-based methods like Camera or Video-Based approach. Satellites can be an important source of data prior to and also during the Fire due to its reliability and efficiency. The various real-time forest fire detection and prediction approaches, with the goal of informing the local fire authorities.

A research study shows an automatic fire detection can be divided into three groups: aerial, ground and borne detection. The ground-based systems use several staring black and white video cameras are used in fire detection which detect the smoke and compares it with the natural smoke. The main benefit of using this system is high temporal resolution and spatial resolution. So that, the detection is easier (Eric den breejen, 1998). But these mechanisms still have some drawbacks in detecting the early stage of the fire. So that, it is highly important to introduce a system to detect the fire early as possible.

1.2 Purpose

The existing system for detecting fire are smoke alarms and heat alarms. The main disadvantage of the smoke sensor alarm and heat sensor alarms are that just one module is not enough to monitor all the potential fire prone places. The only way to prevent a fire is to be cautious al the time. Even if they are installed in every nook and corner, it just is not sufficient for an efficient output consistently. As the number of smoke sensor requirement increase the cost will also increase to its multiple. The proposed system can produce consistent and highly accurate alerts within seconds of accident of the fire. It reduces cost because only one software is enough to power the entire network of surveillance. Research is active on this field by data scientists and machine learning researchers. The real challenge is to minimize the error in detection of fire and sending alerts at the right time.

2. LITERATURE SURVEY

2.1 Existing problem

[1].In this paper, the author uses CNN-convolutional neural networks to detect fire with the help of live video footage through anti-fire surveillance systems. The paper proposes YOLOv2 convolutional neural network is one of the best solutions for detecting fire and smoke both indoor and outdoor environment. You only look once (YOLO) is a deep learning model for object detection, YOLOv2 is the next version which has been upgraded to rectify the setbacks of YOLO namely the inaccuracy to locate and mark the region of interest in the images and the lower recall rate compared to other region-oriented algorithms. Thus, increasing the efficiency of the architecture. They started with an

input image of size 128x128x3. They used convolutional layers to map the features on the input image. The features extracted are then given as input to YOLOv2 object detection subnetwork. YOLOv2 Transform layer is implemented to improve network stability for object localization.

[2]This paper proposes that forest fires can be detected by vision-based fire detection systems which can be mounted to an unmanned aerial vehicle (UAVs) for strategically scanning acreage of fire prone areas. This paper also strongly recommends Convolutional neural networks for identifying smoke and fire through video frames which is taken as images. They have collected the dataset from different internet sources. They have resized the images to canonical size of 240x320. In this paper, the basic idea is to find the fire patches in an image. The authors propose two methods for the algorithm to build the model. First was to apply fire patch classifier from scratch. Second was to teach a full image classifier and apply fine-tuned patch classifier if the image contains fire. Then they compare SVM-pool5 (Support vector machines) with CNN-pool5, the accuracies recorded are 95.6% and 97.3% respectively with a detection rate of 84.8%, making CNN-pool5 network more accurate than SVM-pool5 classifier.

[3]In this paper, Environment can be destroyed by the forest fire, and it could be making a huge amount of loss. Recently, the amazon forest has had a fire and it remained for over 15 days. This resulted a huge loss and it affected negatively to the diversity and global conditions. The wireless sensor networks help in detecting the forest fire. It can give a warning as soon as if there any unusual event occurs.

Sometimes, these networks can be making false alarms according to the wrong detection. In such cases, machine learning mechanism can be used to prevent such cases. Earlier, satellite-based systems are used to detecting fire. But it may not be possible to finding the distraction as it took pictures of surface of the earth in every two days. As a result, it may not be considered as an effective method. Also, the weather conditions may be affected in the quality of the pictures. Another method for the fire detection was using watch towers. It was handled manually by watching the whole forest area in a tower and finding if there any fire occurs. Another one is using optical sensors and digital camera. It would not be much effective as the vision can be distracted by the high trees or hills.

[4]Fire can be detected by using the amount of smoke. The smoke sensors are used to measure the amount of smoke from the fire, and it could be compared with a threshold value and if it is beyond that value, it is considered as a fire scenario. Using image processing, fire can be detected as soon as possible. Fixing the CCTV camera everywhere and the images from these cameras can be processed to monitor the fire. If any changes occur, it is easy to detect and extinguish the fire quickly. This system has a water extinguisher for extinguish the fire when the alarm turns on. The CCTV camera is used for recording the video of a particular spot and it is connected to a mini- computer called Raspberry-pi. So that it could get the constant video recording of a particular area. The captured video pictures are processed frame by frame and once the fire detected, the alarm would be turn on. Also, the alarm would be turned off when the fire extinguished completely. The Virtual Network Computing is used for the execution of the program,

where the details of video are transferred from the raspberry-pi to the viewing computer. This system includes detection, alert, fire extinguish, software and network modules.

[5] In fire detection, the color of the image from a camera is highly important. Sometimes, it does not possible to watch the entire forest images according to the size as it may be some difficulties in detecting the fire.So that, using Convolutional Neural Network(CNN) technology would be easier to avoid the blindness and accurate level of fire identification. It uses the support vector mechanism for the image classification. In this technique, the image is segmented based on the color of the flame and transferred to the CNN network. This would be found out more attributes and decide there is a fire occurs or not. Fire can be detected by analyzing the color of the flame in a picture. Finding the fire by using the number of pixels plotted in a picture according to the fire color and can be measure the intensity of the fire. So that, it should be easier to detect fire and stamp out the fire. The system should be trained and tested using a large amount of data. Algorithms are used for the segmentation of images and in finding the fire. This method should be more effective and reliable in identifying the fire. The accuracy should be much better than the other methods.(Yuanbin Wang, 2019)

[6]This paper the authors propose a system that mimics the human fire detection system. It uses Faster R-CNN which is a region-based algorithm to detect suspicious Point of interest. After marking the region of interest, the features extracted from the bounding boxes are passed to LSTM Long Short-Term Memory to classify if there is fire or

not in short interval of time. Faster R-CNN exploits the features of CNN and introduce a region proposal network which is used to map the features in the input image. It extracts features through the ROI pooling operation and then classifies according to the class scores of the object position.

[7] In this paper, a novel method for fire detection is proposed based on ensemble learning. The dataset is created using 10581 images from various public sources like BowFire [8], FD-Dataset [9], ForestryImages[10], VisFire[11]. The dataset is preprocessed and fed into not just one but two individual object detectors, YOLOv5 and EfficientDet integrated in parallel mode to achieve better accuracy than a single object detector. Although it uses integrated object detectors, this does not take the whole image into consideration. Therefore, another classifier is introduced to solve this problem. Efficient Net takes the image as whole and evaluates the image to enable total advantage of the information. The results will be decided by a decision strategy algorithm which takes the opinion of the three individual object detectors into account which in turn improves the performance of the model and decrease the rate of False positives. This paper claims that they have achieved a superior trade-off average accuracy, average recall, false positive and latency.

[8] This paper put forward an approach in real-time forest fire detection using wireless sensor network paradigm. This method can detect and forecast the fire more accurately than the other methods used in forest fire detection. Firstly, the sensor networks acquire the details about the humidity, smoke, temperature, and wind speed as

these factors affect the forest fire. The sensor nodes are placed widely in the forest, and it is arranged into clusters. The sensor nodes use GPS to track their location as they can sends these location details along with the data such as measurements of temperature to the cluster head. Then, using a neural network method, the cluster header computes the weather index and then these information sends to the manager node. The wind speed is calculated by the wind sensor nodes, which are manually placed in the forest. The users get information from the manager node when an abnormal event occurs like high temperature and smoke. As well as manager node gives information about the levels of forest fire risk rate according to the weather index from different clusters. So that, users can easily find out the exact location of fire in the forest if it occurs. Also, they could protect the forest from the fire hazard due to the early detection (Liyang Yu, 2005).

[9] According to a research method, Light detection and ranging (LIDAR) system is used for the forest fire detection with the help of neural network. LIDAR is mainly used in the environmental and atmospheric studies. A lidar contains a photo detector, radiation emitter, signal receiver and signal processing hardware and software. Here, the neural network is needed to train well with the Neyman-Pearson criterion. The committee machine trained with all possibilities including the false alarm in the validation test sets, to obtain an accurate level of detection. These committee machines are composed of neural networks. Each committee machine having its' on duty like each one solving significant problems in a recognition problem. Different neural networks can be added together to find solutions to the complex problems as different networks can have different

capabilities. In the case of committee machines, two types of neural networks are participated. One is single layer perceptrons, which have many input nodes and a neuron. The other one is using a cascade architecture with two processing neurons where one is connected to the previous neuron and the other one is connected to the input nodes. As a result, the automatic detection of forest fire using committee machine with the help of LIDAR is useful than the traditional ones (Vilar, 2003).

[10] A research study proposes a system which is a combination of using neural networks, computer vision rules, and other expert rules helps in detecting the forest fire. Different approaches are applied to build this system; visual infrared image matching, using the previous hazards memory, image processing, location, size, and geographical data. Here, infrared cameras, visual cameras, meteorological sensors are using for the collection of input data. The image processing tool is combined with the visual and infrared processing. Infrared processing is a combination of detection, oscillation, and alarm processing processes. The growing-region algorithm is used to separate the false alarms. The visual processing finds out the exact location of the visual image from the infrared analysing process. By using different algorithms, it can be detected and easily reject the false alarms. The meteorological information used to detect the humidity, temperature and other factors which affect the forest fire. So that, it is easy to estimate the possibility of fire. Using this proposed system, it can be detecting the forest fire in early stage and avoid the false detection (Begoña C. Arrue, 2000)

2.2 References

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[2]Qingjie Zhang, Jiaolong Xu, Liang Xu and Haifeng Guo, Deep Convolutional Neural Networks for Forest Fire Detection. IFMEITA 2016.

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[8]BoWFire Dataset. Available online: https://bitbucket.org/gbdi/bowfire-dataset/downloads/ (accessed on 1 January 2021). 29.

[9]FD-Dataset. Available online: http://www.nnmtl.cn/EFDNet/ (accessed on 1 January 2021).

[10] ForestryImages. Available online: https://www.forestryimages.org/browse/subthumb.cfm?sub=740 (accessed on 1 January 2021). 31

2.3 Problem Statement Definition

1. In earlier times fires were detected with the help of watching towers or using satellite images.

2. Satellites collect images and send it to the monitoring authority which will decide by seeing images that it is a fire or not.

3. But this approach was very slow as the fire may have spread in the large areas and caused so much damage before the rescue team came.

4. In the watching tower method, there was a man always standing on the tower who would monitor the area and inform if there was fire.

5. This method was also slow because before the man got to know about the fire it may have spread in the inner parts of forest, also it always requires a man who must be present there.

6. Since, we know that some areas, especially forest areas are large so it is practically impossible to put a man in every part of forest from where they can monitor the forest area.

7. So, both these approaches of watching towers and satellite images failed to detect fire as early as possible to reduce the damage done by fire Problems in fire detection:

9. There were mainly two problems in fire detection as discussed:

(a). Judging criteria for the fire: Edge is set, on the off chance that the worth is more noteworthy than edge, it is a fire, else not. So, this problem was removed by using machine learning techniques by many researchers.

(b). Connection of nodes: Traditional systems used cables to connect alarm with the detectors.

10. So, this problem was removed using wireless sensor networks

11. So, with the advancement in technology researchers find an efficient method to detect forest fire with the help of Wireless

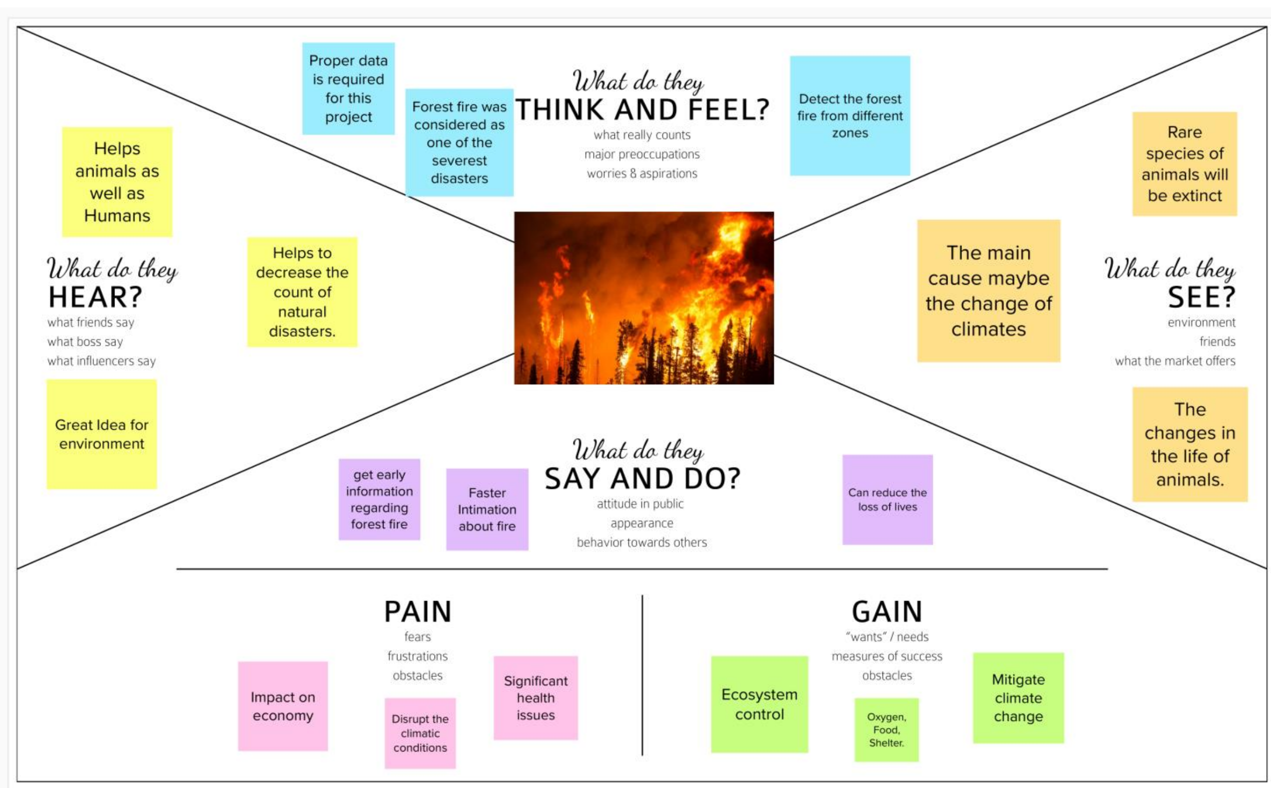
Sensor Network.

12. Fire can be identified by conveying sensor hubs in timberland regions by which they illuminate about fire.

13. Conveying sensor hubs in the timberland regions means placing sensors in every part of the forest and mostly in the prone areas where risk of 9 catching fire is more. With the use of wireless sensor networks, now it is easy to detect the fire in large areas as soon as possible

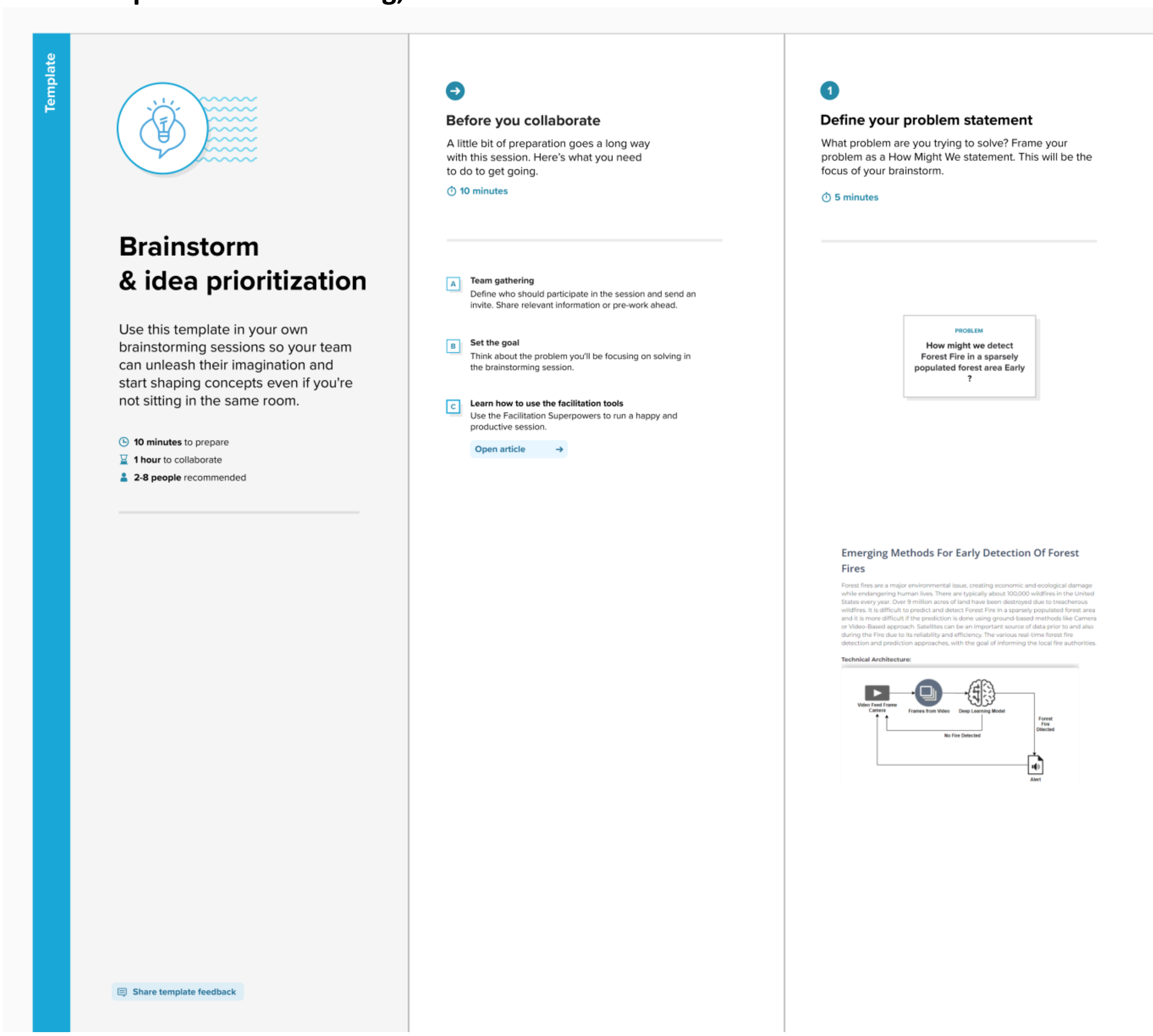
3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

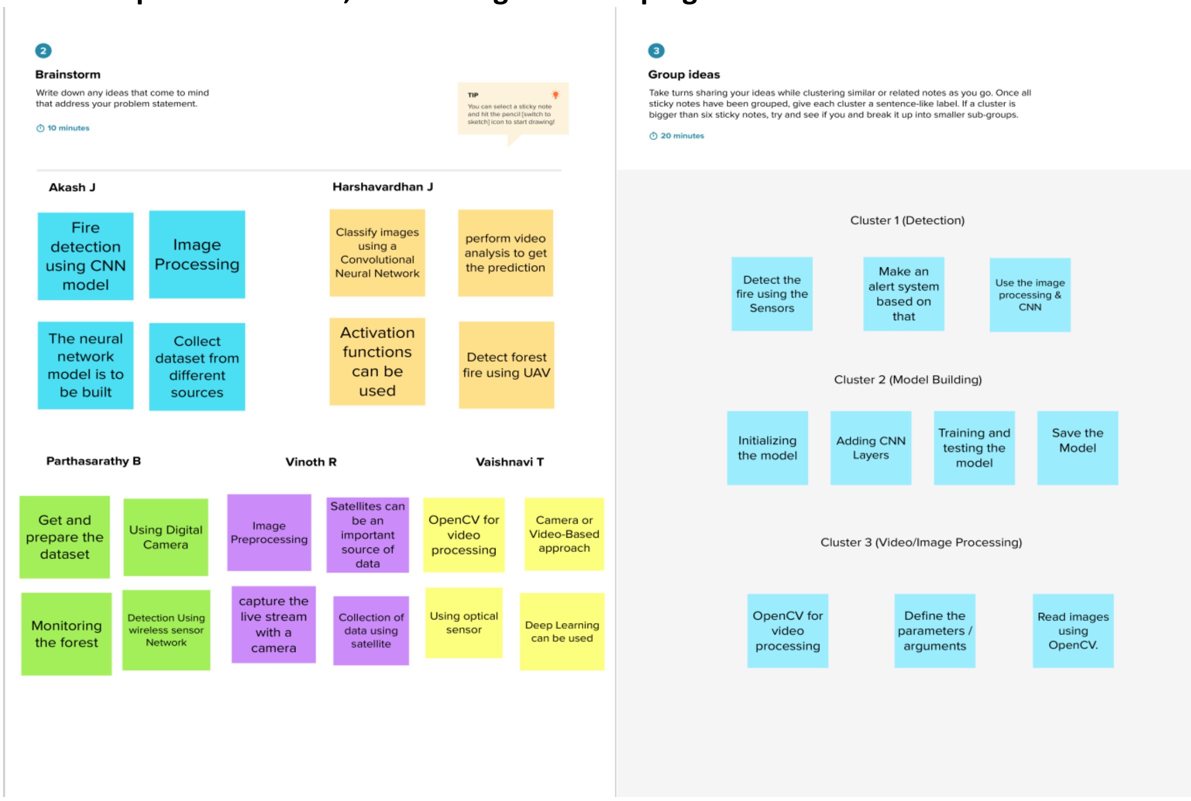


3.2 Ideation & Brainstorming

Step-1: Team Gathering, Collaboration and Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization

3.3 Proposed Solution

The proposed framework utilizes the advantages of a convolutional neural network. The CNN receives input, it is preprocessed and pools them using region of proposals. Then the region-based object detection algorithm in CNN classifies those proposals into fire and non-fire in the region of interest (ROI) with the help of convolutional layers.

A. Convolutional Neural Networks (CNN)
Convolutional neural networks are special kind of artificial neural network that can mimic thehuman brain activity to analyze data with supervised learning. CNN is modified multilayer perceptron, which meansfully connected network. It consists of several layers namely, input layer, output layer and many hidden layers to make it happen. These hidden layers are convolutional hence the name convolutional neural networks. It offers beyond the limit abilities to perform object detection. These convolutional layers use several mathematical models to critically evaluate and analyze data. Then these outputs of the previous layers are passed to the next layers. There is chance of overfitting since the network is fully connected. To avoid this situation, the CNN exploit the hierarchical pattern in the data and sort them according to their complexity from simpler to complex patterns engraved in the layers. The input is given as tensor with number of inputs x height x width x channels of input. Now the image is in an abstract form, then the layers convert this abstract image into a feature map. This is repeated layer after layer which simulates the working of brain neurons. Since it is fully connected network all the output gets filtered and combined as a single output in the output layer. The number of filters directly proportional to the feature map size.

B.Architecture
The architecture of a Convolutional neural network comprises of

convolutional layers. CNN is different from other object detection algorithms because of the ability to generate region of interest in the original image using image transform filters called as convolutional kernels. While other algorithms take the weighted sums and connection weights to build the model. The number of feature maps generated will be equal to the number of kernels. The pixel color in the feature maps represents activation points. White pixels in the feature map are points in the original image with strong activation points. The fire region in the original image is reddish orange so the convolutional kernel changes the pixels to white. Each neuron in the convolution neural network receives an input from a restricted part of the previous layer. Each neuron in the network gives an output by executing functions in the output of previous layers. These functions are determined by the weights of the input values. A unique feature of Convolutional neural networks is that it can share the same functions on every layer.The feature extractor used in network is called AlexNet deep CNN, which is a simple application of CNN which enables easy object detection in an image.Fig. 1 depicts the simple architecture of Convolutional neural networks.

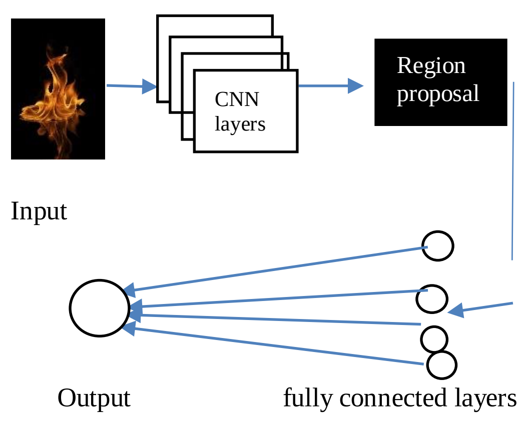


Fig 1. Architecture of CNN

The above figure Fig.1 represents the basic architecture of Convolutional neural networks, the data is given as input, images of fire in this case. Then the layers of the network make an abstract form of the image removing all background noises and highlight the object that needs to be detected. The layers produce region of proposals that are later combined to build a machine learning model in the fully connected layers and the decision-making algorithm analyze output from layers to reach a conclusion.

3.4 Problem Solution fit

Project Title: Emerging Methods for Early Detection of Forest Fires **Project Design Phase-I - Solution Fit Template** **Team ID:** PNT2022TMID42321

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

1 . Forest Department Officers
2 . Tribal and Common People
3 . Bureau of land management

6. CUSTOMER CONSTRAINTS CC

1 . Network connection for the devices.
2 . Power supply interruptions.
3 . Need of waterproof cameras.
4 . Cost of the equipments.

5. AVAILABLE SOLUTIONS AS

1 . Creating an alarm system for nearby stations.
2 . Remote sensing methods such as satellites.
3 . Send notifications via digital media.
4 . Monitor the change on a regular basis.

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS J&P

1 . The cameras should be always on motion.
2 . Active fires should be detected using fire.
3 . The detection sensors should be on all the time.
4 . Detecting small sparkles of fire is difficult.
5 . The main problem is climate change.

9. PROBLEM ROOT CAUSE RC

1 . Forest fire causes a lot of damages.
2 . Extinction of plants and animals.
3 . Main cause of fire are human actions and lightning.
4 . High temperature always results in forest fires.
5 . So it can be either man made or natural.

7. BEHAVIOUR BE

1 . Always checking and monitoring the forest temperature.
2 . Checking the campfire and other causes frequently.
3 . Monitoring the climate change often.
4 . Sharing the information regarding the fire detection and prevention.

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TR

1 . Need for protecting the wildlife.
2 . Not knowing when the fire starts.
3 . Reading about the effects of forest fire.
4 . Knowing the importance of forest.

4. EMOTIONS: BEFORE / AFTER EM

Before : Insecure, Unsafe worries about lives and belongings.

After : Confident, In control, no worries.

10. YOUR SOLUTION SL

1 . Forests can be monitored using several cameras.
2 . using the methods for image processing and video processing.
3 . Enabling the video surveillance method on larger forest areas to make the process easy.
4 . Deep learning methods can be used to find the amount of fire.
5 . Instant alerts can be sent to the forest department.

8. CHANNELS of BEHAVIOR CH

Online :
The chatbot or the API can connect through the internet to feed you with the current status of the forest.

Offline :
The forest management can arrange an awareness program.
The alerts can also be sent via offline messaging system.

Identify strong TR & EM

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

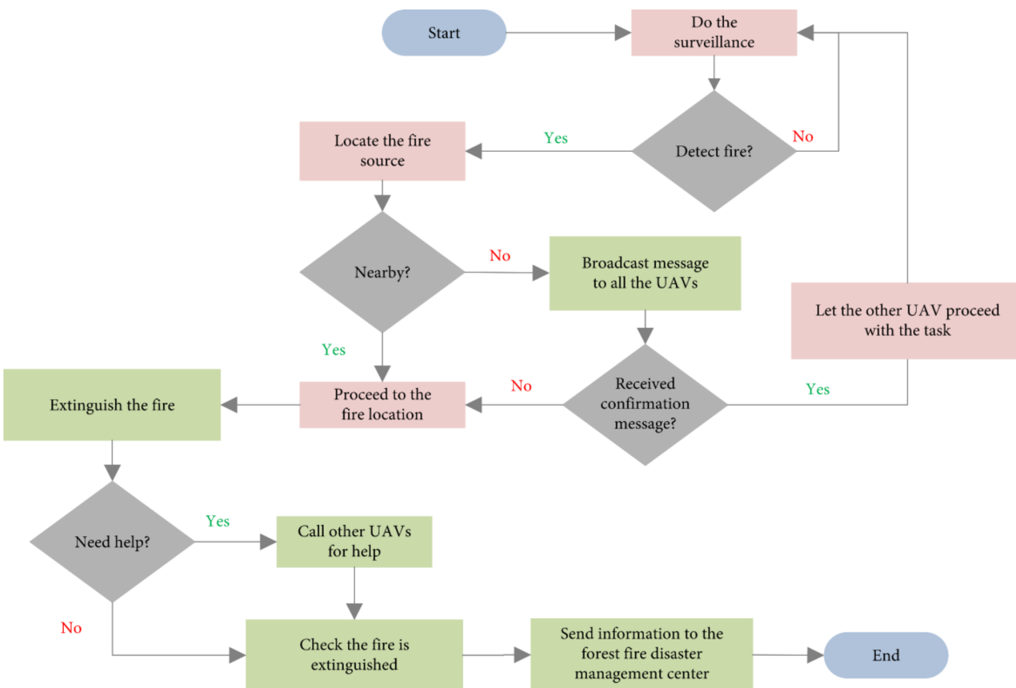
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Gmail Registration through Form
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Image recognition	The Input image data from the satellites should be able to analyze and recognize the image contains fire or not.
FR-4	Forest Monitoring	The forests should be monitored all the time.
FR-5	Alert	The alert message should be sent to the fire department and customers.
FR-6	Detection	System will detect if there is fire or not using the data sets provided.
FR-7	Operating system	The system should be able to run on either Window or Linux operating systems.

4.2 Non-Functional requirements

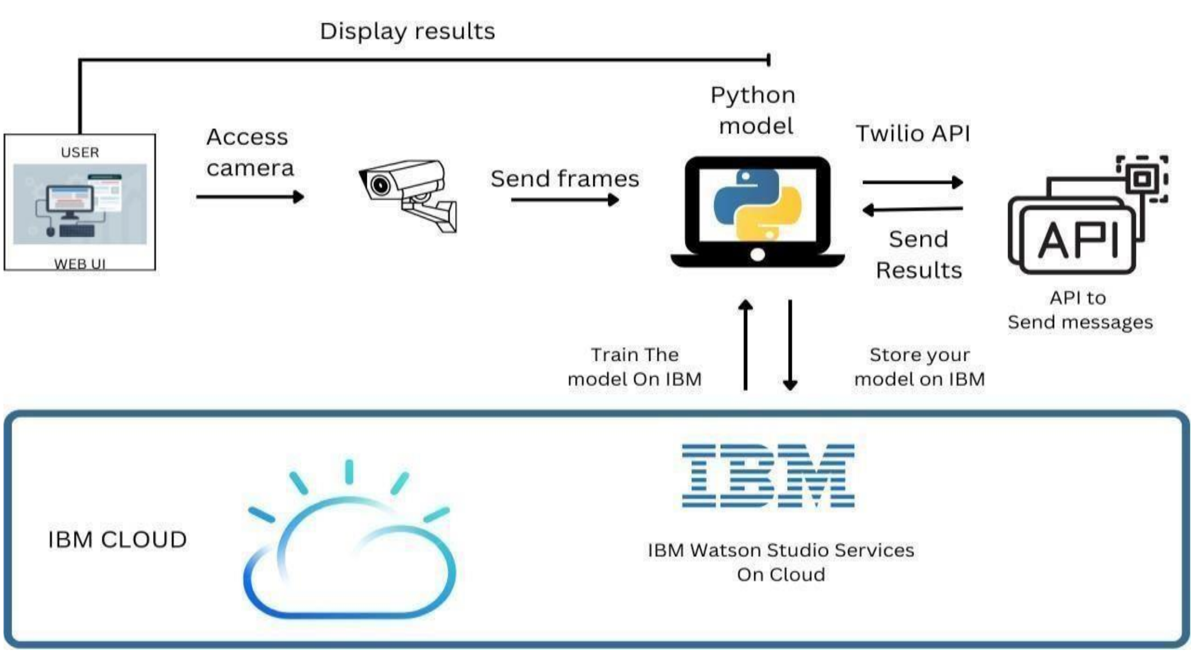
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Very effective model and Easy to use , user friendly model.
NFR-2	**Security**	The environment is Secure.
NFR-3	**Reliability**	Model is safe to install and use.
NFR-4	**Performance**	Model will achieve high accuracy and provide spontaneous response.
NFR-5	**Availability**	Model is available for all the time and can access all the time.
NFR-6	**Scalability**	Model can easily adapt to every environment and also can handle large amount of data.

5. PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution & Technical Architecture



5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Gmail		Medium	Sprint-1
	Login	USN-4	As a user, I can log into the application by entering email & password		High	Sprint-1
Customer (Web user)	Web Registration	USN-1	Users have to register by giving their personal Information like Gmail and Password.	User will get confirmation mail in their registered Gmail.	High	Sprint-1
	Login	USN-2	User have to login their account by using their username and password		High	Sprint-1
Customer Care Executive	Address Queries	USN-1	Learn if the customers have any Issues and try to solve the issues.		Medium	Sprint-1
Administrator	Admin Registration	USN-1	Admin register through direct verification Admin will get separate username and password		High	Sprint-1

6. PROJECT PLANNING & SCHEDULING

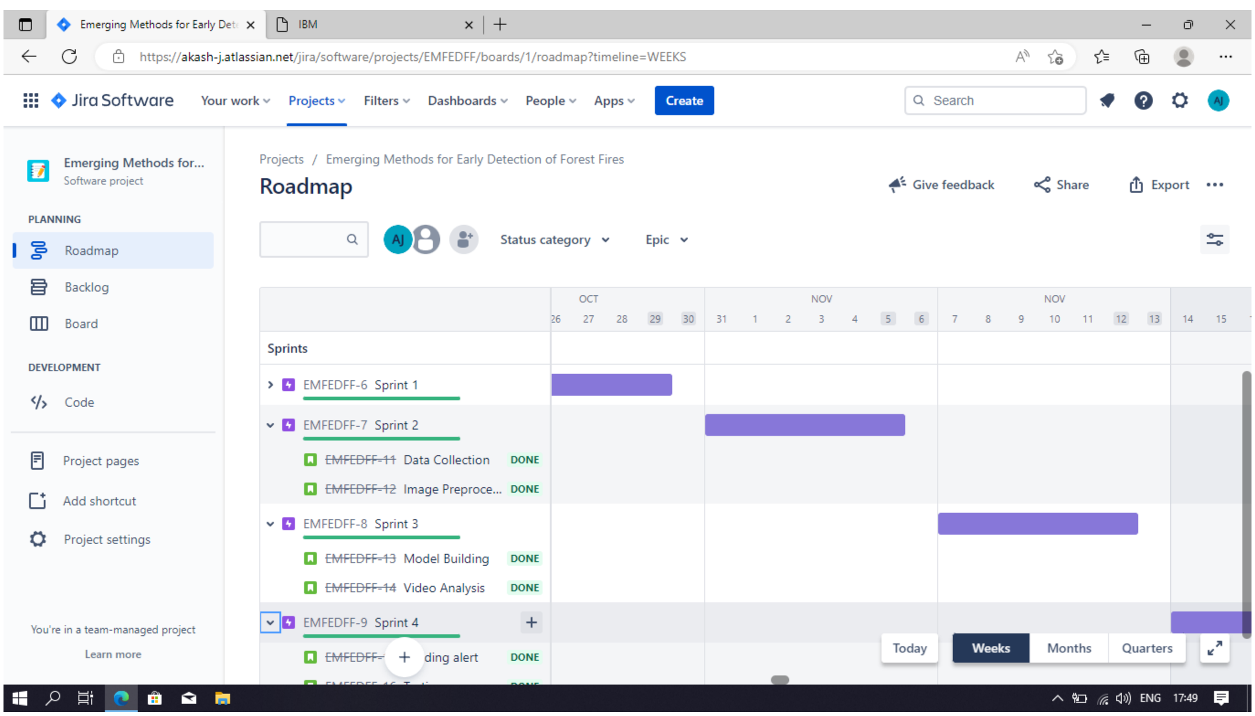
6.1 Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the applicationby entering my email, password, and confirming my password.	2	High	AKASH J HARSHAVARDHAN J PARTHASARATHY B VINOTH R VAISHNAVI T
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	AKASH J HARSHAVARDHAN J PARTHASARATHY B VINOTH R VAISHNAVI T
Sprint-2	Input	USN-3	As the input dataset is given whenever the fire detected the information is given to the database	2	High	AKASH J HARSHAVARDHAN J PARTHASARATHY B VINOTH R VAISHNAVI T
Sprint-2		USN-4	The alarm system is activated when the fireis detected using the system.	2	Medium	AKASH J HARSHAVARDHAN J PARTHASARATHY B VINOTH R VAISHNAVI T
Sprint-3	Login	USN-5	As a user, I can log into the application by entering email & password	2	High	A AKASH J HARSHAVARDHAN J PARTHASARATHY B VINOTH R VAISHNAVI T
Sprint-3	Dashboard	USN-6	The final dashboard is made accessible tothe user.	2	Medium	AKASH J HARSHAVARDHAN J PARTHASARATHY B VINOTH R VAISHNAVI T
Sprint-4	Output	USN-7	The alarm system make it possible that the message is sent to the corresponding user.The required actions will be taken.	2	High	AKASH J HARSHAVARDHAN J PARTHASARATHY B VINOTH R VAISHNAVI T

6.2 Sprint Delivery Schedule

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.3 Reports from JIRA



7. CODING & SOLUTIONING

7.1 Feature 1

Image Preprocessing

import keras Library

import keras

import ImageDataGenerator class from keras

from keras.preprocessing.image import ImageDataGenerator

Define The Parameters /Arguments for ImageDataGenerator Class :

Define the parameters/arguments for ImageDataGenerator class

train_datagen = ImageDataGenerator(rescale=1./255,shear_range=0.2
,zoom_range=0.2,horizontal_flip=True)

test_datagen = ImageDataGenerator(rescale=1./255)
Applying ImageDataGenerator Functionality To Trainset and Testset
:

x_train = train_datagen.flow_from_directory(r"/content/drive/MyDriv
e/Dataset/test_set",target_size=(64,64),batch_size=32, color_mode="r
gb",class_mode="sparse")

Found 121 images belonging to 2 classes.

x_test = test_datagen.flow_from_directory(r"/content/drive/MyDrive/
Dataset/train_set",target_size=(64,64),batch_size=32, color_mode="r

gb",class_mode="sparse")

Found 436 images belonging to 2 classes.

Model Building:

Import model building libraries:

```
#import keras libraries
import numpy as np
import tensorflow
from tensorflow.keras.models import Sequential
from tensorflow.keras import layers
from keras.layers import Dense
from keras.layers import Conv2D
from keras.layers import MaxPooling2D,Dropout
from keras.layers import Flatten
```

Initializing the model:

```
model=Sequential()
```

Giving access to the dataset in drive:

```
# giving access to my drive

from google.colab import drive
drive.mount('/content/drive')
```

Add CNN Layer:

```
# add Convolutional layer
model.add(Conv2D(32, (3,3), activation = "relu", input_shape = (64,6
4,3) ))
```

```
model.add(MaxPooling2D(pool_size=(2,2)))

# add flatten layer
model.add(Flatten())
```

Add Hidden Layer:

```
model.add(Dense(units=128, activation='relu'))

model.add(Dense(units=46, activation='softmax'))
```

Configure the learning process:

```
# configure the learning process
model.compile(optimizer='adam',loss='sparse_categorical_crossentro
py',metrics=['accuracy'])
```

Train the model:

```
train_datagen = ImageDataGenerator(rescale=1./255,shear_range=0.2
,zoom_range=0.2,horizontal_flip=True)
test_datagen = ImageDataGenerator(rescale=1./255)

x_train = train_datagen.flow_from_directory(r"/content/drive/MyDriv
e/Dataset/train_set",target_size=(64,64),batch_size=32, color_mode=
"rgb",class_mode="sparse")
x_test = test_datagen.flow_from_directory(r"/content/drive/MyDrive/
Dataset/test_set",target_size=(64,64),batch_size=32, color_mode="rg
b",class_mode="sparse")

model.fit(x_train, epochs=10, steps_per_epoch=len(x_train))
```

Save The Model:

```
model.save("forestfire13.h5")
```

Predictions:

```
# import load_model from keras.model
from keras.models import load_model
# import image class from keras
from tensorflow.keras.preprocessing import image
# import numpy
import numpy as np
# import cv2
import cv2

model = load_model("forestfire13.h5")

img = image.load_img(r'/content/drive/MyDrive/Dataset/train_set/wit
h fire/with fire (2).jpg')
x = image.img_to_array(img)
res = cv2.resize(x,dsize=(128,128),interpolation=cv2.INTER_CUBIC
)

# import opencv library
import cv2
import numpy as np
from keras.preprocessing import image
from keras.models import load_model
from twilio.rest import Client
from playsound import playsound
```

7.2 Feature 2

Video Analysis

openCV.ipynb:

```
from google.colab import drive
drive.mount('/content/drive')

import cv2
import numpy as np
from google.colab.patches import cv2_imshow
from matplotlib import pyplot as plt
import librosa
from tensorflow.keras.preprocessing import image
from keras.models import load_model

# Create a VideoCapture object and read from input file
# If the input is the camera, pass 0 instead of the video file name
cap = cv2.VideoCapture('/content/drive/MyDrive/Dataset/forestfire.m
p4')

# Check if camera opened successfully
if (cap.isOpened()== False):
  print("Error opening video stream or file")

# Read until video is completed
while(cap.isOpened()):
  # Capture frame-by-frame
  ret, frame = cap.read()
  if ret == True:
    x=image.img_to_array(frame)
```

```
    res=cv2.resize(x,dsize=(64,64),interpolation=cv2.INTER_CUBIC)
    #expand the image shape
    x=np.expand_dims(res,axis=0)
    model=load_model("/content/drive/MyDrive/Dataset/forest.h5")
    cv2_imshow(frame)
    pred=model.predict(x)
    pred = int(pred[0][0])
    pred
    int(pred)
    if pred==0:
      print('Forest fire')
      break
    else:
      print("no danger")
      break

# When everything done, release the video capture object
cap.release()

# Closes all the frames
cv2.destroyAllWindows()
```

8. TESTING

8.1.Test Cases:

Purpose of Document:

The purpose of this document is to briefly explain the test coverage and open issues of the [Early detection of forest fire using Deep Learning] project at the time of the release to User Acceptance Testing (UAT).

Defect Analysis:

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity1	Severity2	Severity3	Severity4	Subtotal
By Design	5	1	1	1	8
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	7	2	4	10	23
Not Reproduced	0	0	0	0	0
Skipped	0	0	1	1	2
Won'tFix	0	3	2	1	6
Totals	15	9	11	14	49

8.2.User Acceptance Testing:

Test Case Analysis:

This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	5	0	0	5
Client Application	30	0	0	30
Security	2	0	0	2
Out source Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	2	0	0	2

9. RESULTS

9.1 Performance Metrics

S.No.	Parameter	Values
1	Model Summary	As a threat of forest fire increases due to climate changes, the need for finding a detection system increase .We proposed a Deep Learning-based model for early detection of forest fire. The Proposed model successfully classifies the images into fire and no fire, and sends an alert message in case of fire. Thus, the Deep Learning algorithms proved their efficiency in detecting different objects.
2	Accuracy	Training Accuracy - 93% - 98% Validation Accuracy - 95%

10. ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Continuous monitoring of forest fires: all year round, on the whole or part of the territory, day and night.
- Time saving: real-time visualization of the disaster, immediate transmission of alarms, precise localization of the source of the fire thanks to a triangulation system. Thanks to the cameras and especially the doubt-removal camera, verification and confirmation is much faster than an emergency call.
- Elimination of human risks: no more isolated men on watch towers.
- Long-term monitoring: data storage enables continuous improvement of forest fire monitoring and detection.
- Early detection of forest fire will help to save the nature and environment for the animals.
- Can control the forest fire if detect them earlier and we can save lots of lives and plants.
- There is no need to be afraid about not knowing the fire is started and can make ourselves safe with the time.
- The system will be a huge help for the local fire department and the people who are living near the forest areas.

DISADVANTAGES:

- The initial cost for the equipments required for the detection system is high.
- It takes some time to initiate the project in large forest areas because of the area.
- The need for largest storage area is high.
- Individual learner is responsible for learning global information to avoid false positives.
- The limited learning and perception ability of individual learners is not sufficient to make them perform well in complex tasks.
- Proper connectivity and maintenance will be a complex task.
- To ensure long-term monitoring we will need a large data storage system.
- There is a possibility of loss of equipments because of the thieves and the wild animals.

11. CONCLUSION

The scope of using video frames in the detection of fire using machine learning is challenging as well as innovative. If this system with less error rate can be implemented at a large scale like in big factories, houses, forests, it is possible to prevent damage and loss due to random fire accidents by making use of the Surveillance systems. The proposed system can be developed to more advanced system by integrating wireless sensors with CCTV for added protection and precision. The algorithm shows great promise in adapting to various environments.

12. FUTURE SCOPE

- It is well known, there will be large variations/increase in temperature from the normal temperature whenever forest fire occurs.
- This can be detected/ monitored continuously by using temperature sensors and in accordance with the simple arrangement of transmitters. This concept is quite reliable and cost-effective in detecting of forest fire.
- Forest fire leads to destruction of excess of species, by using this technique we can save the life and environment.
- Integrate live satellite data and process real time processing of the fires.
- Enhance the time complexity of the detection of forest fires to improve the speed.
- All the accidents that could have caused by the fire can be prevented using this detection system.

13. APPENDIX

Source Code:

Final Deliverables - Source Code.ipynb - Colaboratory (google.com)

GitHub & Project Demo Link:

GitHub link - IBM-EPBL/IBM-Project-31988-1660207227: Emerging Methods for Early Detection of Forest Fires (github.com)

Project Demo video link - https://youtu.be/hkXD4ExKav8