EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

Team ID : PNT2022TMID50673

1. INTRODUCTION

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

1.1 Project Overview

The idea is to create and develop a system that can identify the effects of the forest fire and it can analyse the forest fire by advanced AI techniques and CNN Algorithm then the Prediction model is Checked and then the model is connected with Twilio account credentials of the Developer consisting of phone numbers of the persons in the surroundings of the people in the area of easy forest fire zone then an security sound alert system is developed to make a alert sound which is downloaded from internet then the entire model is deployed to the IBM Cloud account that we have created.

1.2 Purpose

The forest fires destroys the wildlife habitat, damages the environment, affects the climate, spoils the biological properties of the soil, etc. So the forest fire detection is a major issue in the present decade. At the same time the forest fire have to be detected as fast as possible.

2. LITERATURE SURVEY 2.1 Existing problem

Forest fires have been and still are serious problem for theEuropean Union and for all other countries in Europe. In the year 2000, the EU has established the European Forest Fire Information system (EFFIS) [1], which will soon become part of the European Emergency Management Service, maintainedby the Copernicus Earth Observation Programme [2]. This system provides valuable near real-time and also historical data on the forest fires in Europe, the Middle East and North Africa. Currently EFFIS is being used and supported with data by 25 EU member states and by numerous other countries. According to the annual report of EFFIS for 2016 [3], more than 54 000 forest fires have occurred all around Europe and they have led to nearly 376 thousand hectares of burnt areas.If we compare these values to the average values from the EFFIS reports for the period 2006-2015, the number of forest fires have decreased by 13327 or by nearly 20%. This decrease can be explained with the more severe actions and sanctions towards the arsonists and with the introduction of more advanced technical solutions for early detection of the fires. Even though their number is decreasing, the forest fires continue to be extremely devastating events and they have destroyed just 27 thousand hectares (or 6.6 %) less than the average burnt areas for the period 2006-2015, according to [3]. Confirmation for this are the devastating forest fires form 2018, which took place in the Attica

region of Greece and led to more than 90 fatalities and to more than 200 injured people, as well as to the destruction to thousands of buildings [4]. Forest Fires can be divided into 4 categories in the forests of Hungary based on tree and other vegetation species: • underground burning, peat fire; • fire in undergrowth or dead fallen leaves; • fire in seedlings and saplings; • fire in trunks and shrouds.[5]

2.2 References

[1] Official webpage of the European Forest Fire Information System at: http://effis.jrc.ec.europa.eu/
[2] Official webpage of the Copernicus Earth Observation Programme at: http://www.copernicus.eu
[3] Forest Fires in Europe, Middle East and North Africa 2016, JRC Science for policy report, BN 978-92-79-71292-0, ISSN 1831-9424, doi:10.2760/17690, availabe at: http://effis.jrc.ec.europa.eu/media/cms_page_media/40/Forest_fires_in_Europe_Middle_east_and_North_Africa_2016_final_pdf_JZU7He L.pdf
[4] The 2018 Attica wildfires Wikipedia webpage available at https://en.wikipedia.org/wiki/2018_Attica_wildfires
[5] Rajmund Kuti,"Characteristic of forest fire and its impact on environment",(2016)

2.3 Problem Statement Definition

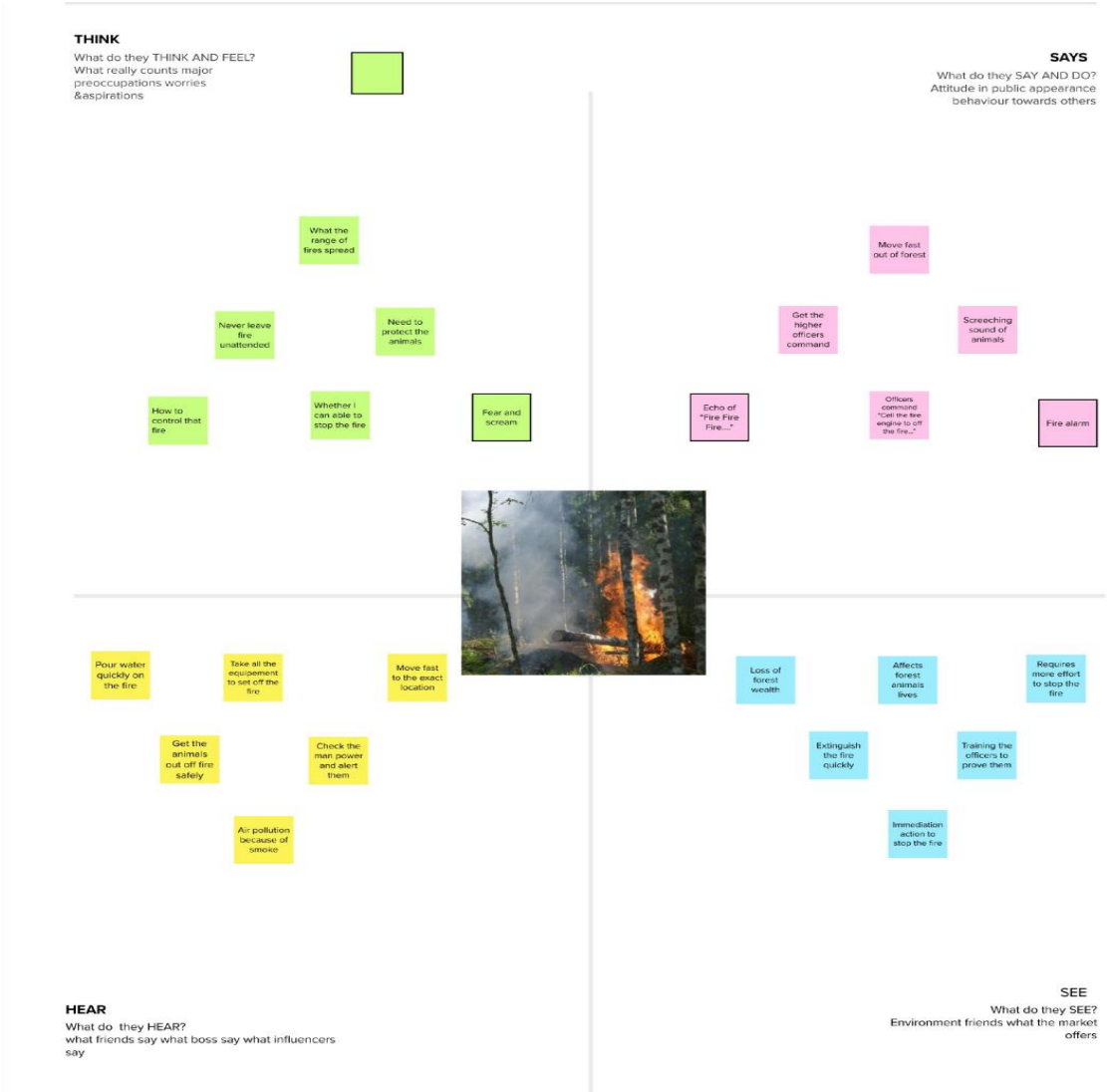
The user interacts with a web camera to read the video.
Once the input image from the video frame is sent to the model, if the fire is detected it is showcased on the console, and alerting sound will be generated and an alert message will be sent to the Authorities.

- Data Collection.
- Collect the dataset or create the dataset.
- Image Preprocessing.
- Import ImageDataGenerator Library.
- Define the parameters /arguments for ImageDataGenerator class
- Applying ImageDataGenerator on trainset and test set.
- Model Building
- Import the model building Libraries
- Initializing the model
- Adding CNN Layers
- Adding Hidden Layer
- Adding Output Layer
- Configure the Learning Process
- Training and testing the model
- Optimize the Model
- Save the Model
- Video Streaming and alerting
- OpenCV for video processing
- Creating an account in Twilio service
- Use Twilio API to send messages.

3. IDEATION AND PROPOSED SOLUTION

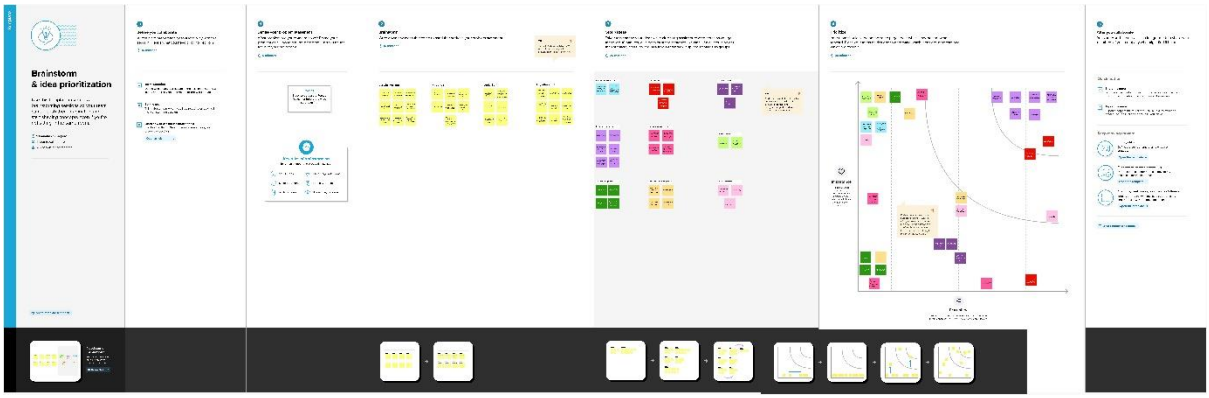
3.1 Empathy Map Canvas

An empathy map canvas is a more in-depth version of the original empathy map, which helps identify and describe the user's needs and pain points.



3.2 Ideation & Brainstorming

organizing the brainstorming session and prioritize the top 3 ideas based on the feasibility & importance.



3.3 Proposed Solution

S.NO.	Parameter	Description
1.	Problem statement (problem to be solved)	The aim is to find the Emerging methods for early Detection of Forest Fires (Using Artificial Intelligent)
2.	Idea/Solution description	**IDEA:** The idea is to create a system that can detect the forest fire and to given an alert message using twilio numbers and give an alert alarm sound using playsound. **SOLUTION:** The model using the pretrained image is constructed using Deep Learning technologies by CNN 2dconv networks to make detection more accurate and then this model is connected with the open Cv2 to make detection in video and image that was being captured then when the presence of fire an immediate alert message was sent to registered twilio account and following that an alert sound is played on the device.
3.	Novelty/ Uniqueness	The system developed was very accurate as it can accurate detect and it is unique as idea was not yet developed.
4.	Social Impact/ Customer Satisfaction	As forest fire was an important social impact that can cause many effects in living surroundings almost every living matters are affected by forest fire, so our developed model can used for prior information about the forest fire to avoid it or to take safety prevention and to make alert of the peoples in the affected area.
5.	Business Model (Revenue Model)	This model is an economical model it can used in the place where the problems arises due to fire so that our model can detect perfectly to make prior warnings.

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

S.NO	component	Description	Technology
1.	Data Collection	Conversion and Analysing the raw image Data.	Jupiter notebook/ python
2.	Image preprocessing	Converting and correcting the image to make image quality and resolution high by rotation images in all possible directions and gaining knowledge.	Jupiter notebook/ python
3.	Trainset and Testset image data generation	Converting and correcting the image to make image quality and resolution high by rotation images in all possible directions and gaining knowledge for both trainset as well as testset data images.	Jupiter notebook/ python
4.	Model building	Logic for model by some Algorithms/ Activation Functions	Jupiter notebook/ python
5.	Saving the model	Data type, configurations etc.	Python
6.	Predicions	Make prediction of the trained model by checking its accuracy for the predictions.	Deeplearning/ python
7.	Video analysis	File storage requirements	IBM block storage or other storage service or local filesystem
8.	Twilio message service	Purpose of external API used in the application	IBM weather API, ect.
9.	Alert sound and message	Sending alert text message using registered twilio account and produce output sound alert alarm.	Twilio / playsound (python)
10.	IBM cloud	Create a IBM cloud account to deploy the CNN model in cloud	Object recognition model/ deployment
11.	Train model on cloud	Application deployment on local system / cloud local server configuration: Cloud server configuration : and to train the deep learning model in IBM cloud.	Local, IBM cloud account

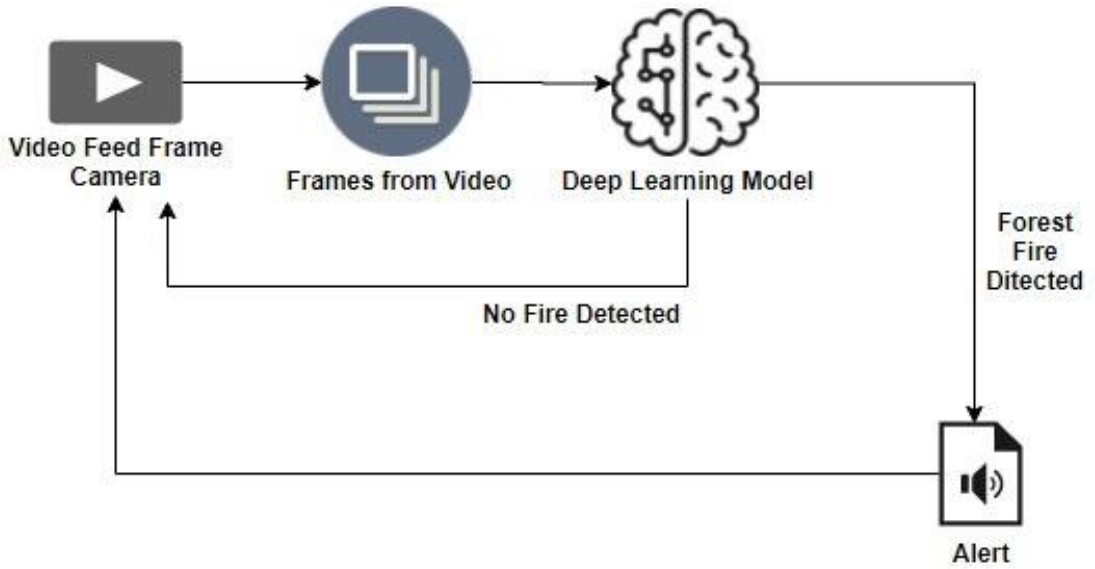
4.2 Non-Functional requirements

S.NO	Characteristics	Description	Technology
1.	Open-source frameworks	Jupyter notebook, twilio, anaconda 3	Python
2.	Security implementations	IBM cloud	Bash/ python

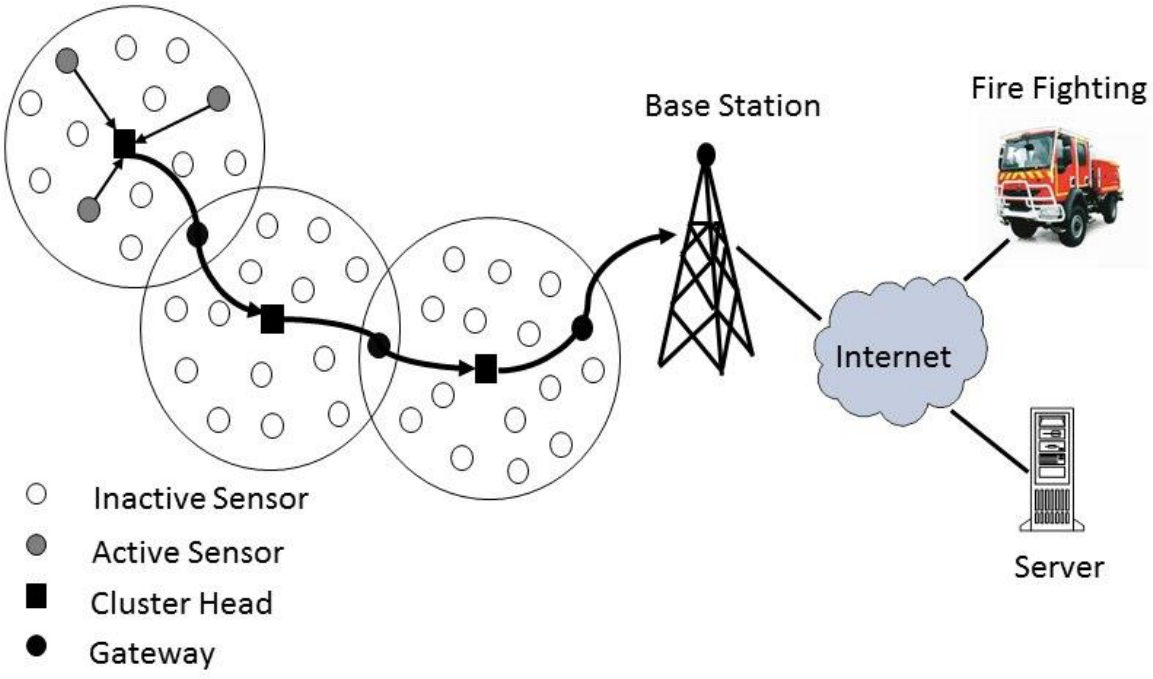
3.	Scalable architecture	Scalable for every situation	Technology used was java/ pyhton
4.	Availability	Available on every windows versions.	Technology used- python
5.	Performance	Detection accuracy of 92%	Python

5. PROJECT DESIGN

5.1 Data Flow Diagrams



5.2 Solution & Technical Architecture



6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

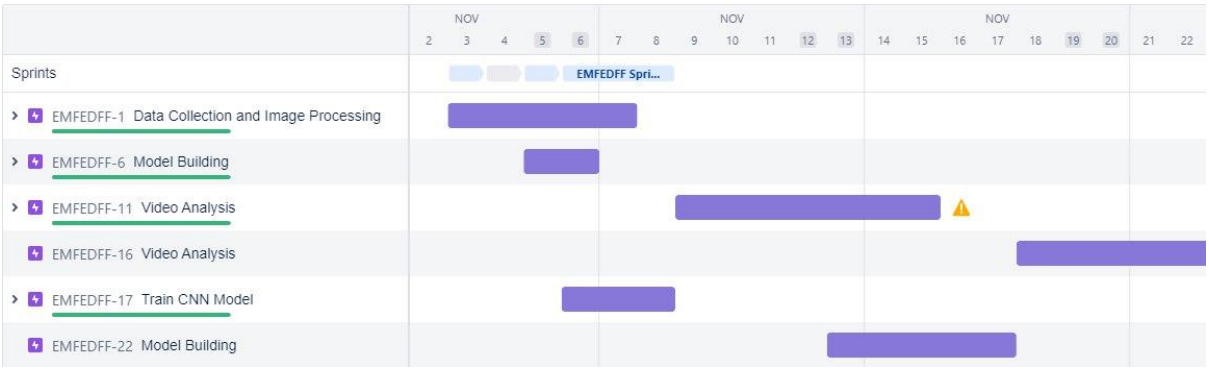
Sprint	Functional requirement (epic)	User story number	User story / test	Story points	Priority	Team members
Sprint-2	Saving the model	USN-2	As a developer saving the model developed for estimation of fire	10	High	Banumathi V Kannika M Mhalakshmi R Ponpriya S
Sprint-3	Video analysis	USN-3		10	Medium	Banumathi V Kannika M Mhalakshmi R Ponpriya S
Sprint-3	Twilio message service	USN-3		10	**L**ow	Banumathi V Kannika M Mhalakshmi R Ponpriya S
Sprint-4	Alert sound and message	USN-4	Sending alert text message using registered twilio account and produce output sound alert alarm	10	Low	Banumathi V Kannika M
Sprint-4	Train model on cloud	USN-5	Application deployment on local system / cloud Local server configuration: Cloud server configuration: and to train the deep learning model in IBM cloud.	10	Medium	Mhalakshmi R Ponpriya S

6.2 Sprint Delivery Schedule

Sprint	Total story points	Duration	Sprint start date	Sprint end date (planned)	Story point computed (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	05Nov 2002	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

The following table shows the sprint works assigned to the members along with the priority and story points assigned with the functional requirements with regards to user story.

6.3 Reports from JIRA



7. CODING & SOLUTION

```
from keras.preprocessing.image import ImageDataGenerator

batch_size = 16

train_datagen = ImageDataGenerator(
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    rescale=1./255,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    fill_mode='nearest'
)

val_datagen = ImageDataGenerator(
    rescale=1./255
)

train_generator = train_datagen.flow_from_directory(
    './Dataset/train_set/',
    target_size=(150, 150),
    batch_size=batch_size,
    class_mode='binary'
)

val_generator = val_datagen.flow_from_directory(
    './Dataset/test_set/',
    target_size=(150, 150),
    batch_size=batch_size,
    class_mode='binary'
)
```

```
from keras.models import Sequential
```

```
from keras.layers import Conv2D, MaxPooling2D
from keras.layers import Activation, Dropout, Flatten, Dense

model = Sequential()
model.add(Conv2D(32, (3, 3), input_shape=(150, 150, 3)))
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))

model.add(Conv2D(32, (3, 3)))
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))

model.add(Conv2D(64, (3, 3)))
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))

model.add(Flatten())  # this converts our 3D feature maps to 1D feature
vectors
model.add(Dense(64))
model.add(Activation('relu'))
model.add(Dropout(0.5))
model.add(Dense(1))
model.add(Activation('sigmoid'))

model.compile(
    loss='binary_crossentropy',
    optimizer='rmsprop',
    metrics=['acc']
)

model.summary()
```

```
model.fit(
    train_generator,
    epochs=10,
    validation_data=val_generator
)
model.save('forest1.h5')
```

```
import cv2
import numpy as np
from keras.utils import load_img, img_to_array
from keras.models import load_model
from twilio.rest import Client
from playsound import playsound

model = load_model(r'forest1.h5')
video = cv2.VideoCapture(0)
name = ['forest', 'with fire']
```

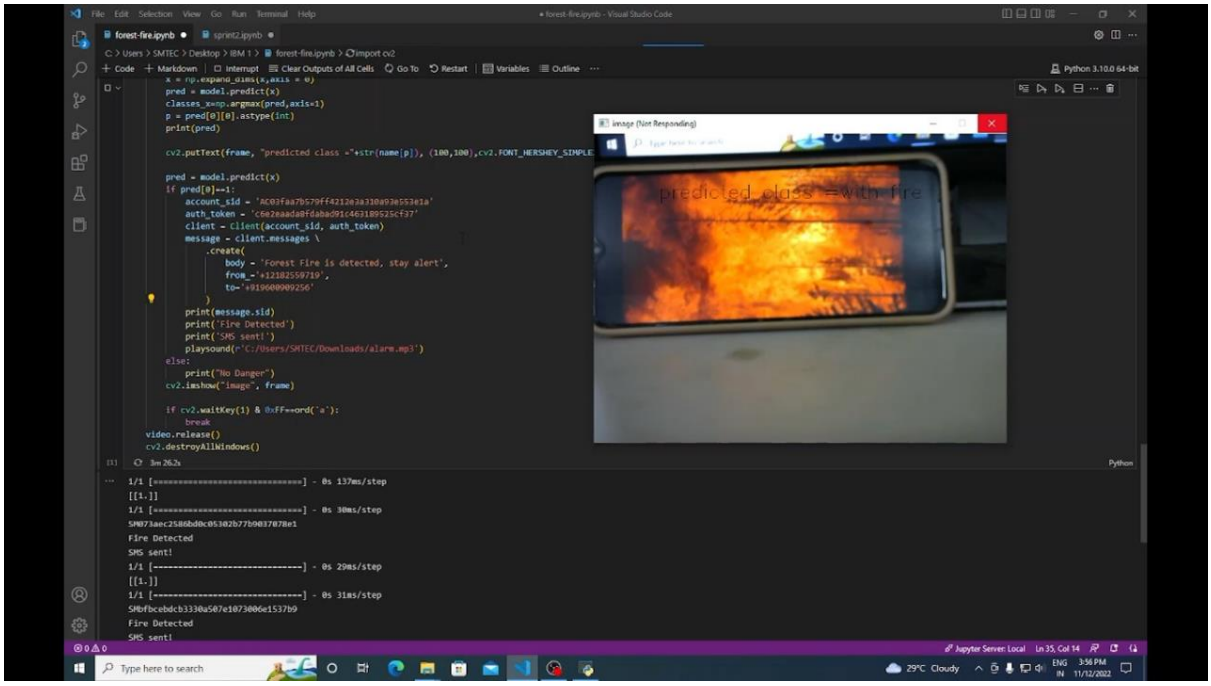
```
while(1):
    success, frame = video.read()
    cv2.imwrite("image.jpg", frame)
    img = load_img("image.jpg", target_size = (150,150))
    x = img_to_array(img)
    x = np.expand_dims(x,axis = 0)
    pred = model.predict(x)
    classes_x=np.argmax(pred,axis=1)
    p = pred[0][0].astype(int)
    print(pred)

    cv2.putText(frame, "predicted class ="+str(name[p]),
(100,100),cv2.FONT_HERSHEY_SIMPLEX, 1, (0,0,0),1)

    pred = model.predict(x)
    if pred[0]==1:
        account_sid = 'AC03faa7b579ff4212e3a310a93e553e1a'
        auth_token = 'c6e2eaada8fdabad91c463189525cf37'
        client = Client(account_sid, auth_token)
        message = client.messages \
            .create(
                body = 'Forest Fire is detected, stay alert',
                from_='+12182559719',
                to='+919600909256'
            )
        print(message.sid)
        print('Fire Detected')
o
        playsound(r'C:/Users/SMTEC/Downloads/alarm.mp3')
    else:
        print("No Danger")
    cv2.imshow("image", frame)

    if cv2.waitKey(1) & 0xFF==ord('a'):
        break
video.release()
cv2.destroyAllWindows()
```

output for user input video stream



7.RESULTS

7.1 Performance Metrics

Loss: 0.3438 – accuracy : 0.8483 - val _loss: 0.2485 – val_accuracy: 0.958

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8. ADVANTAGES & DISADVANTAGES

Advantages

- Easily detect and Estimate the Forest Fire.
- Most Accurate
- Flexible Model which can give maximized outcome
- No Specific Requirements needed to implement the model

Disadvanatges

- Training model is time consuming process.
- Error in Cv can cause damage to camera

• Access of camera are prohibited due to personal issues

9.CONCLUSION

Thus we have constructed a model that can can identify the effects of the forest fire and it can analyse the forest fire by advanced AI techniques and CNN Algorithm then the Prediction model is Checked and then the model is connected with Twilio account credentials of the Developer consisting of phone numbers of the persons in the surroundings of the people in the area of easy forest fire zone then an security sound alert system is developed to make a alert sound which is downloaded from internet then the entire model is deployed to the IBM Cloud account that we have created was made with the studies we have done.

10.FUTURE SCOPES

• It can be developed as a Web or Android Application.
• In future Alternate Advanced technologies can be Implemented.
• The Identification and tracking system can be implemented if possible.