Emerging Methods For Early Detection Of Forest Fires

Project Report

13. **APPENDIX**

13.1Source Code
13.2GitHub & Project Demo Link

Emerging Methods For Early Detection Of Forest Fires

1. INTRODUCTION:

1.1 PROJECT OVERVIEW:

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.

1.2 PURPOSE:

The main objective of this project is to detect the forest fire asa early as possible.Early detection allows for an early response, meaning we have the best chance to keep fires small before they become big and possibly out of control. We can detect a minimal amount of smoke and respond early with both helicopter and ground-based firefighting resources"

2..LITERATURE SURVEY:

2.1 EXISTING PROBLEM:

Temperature Sensor Setup (TSS) and GPS Module are kept in a glass case/ box which are designed to withstand a high temperature and are located few feet above the ground. The TSS consists of Wired/Wireless temperature sensor and its associated circuitry, LNA (low noise amplifier) and power amplifier. Both the TSS and GPS Module are interfaced with the Microcontroller. This arrangement is connected to a Secondary transmitter. The function of the Secondary transmitter is to transmit the data/signals from Microcontroller to the Main transmitter cum antenna. The data from the main transmitter will be communicated to an orbiting small satellite. The main antenna's function is to transmit the signals to the satellite.

The satellite receives all the data from all such transmitters and transmits to the ground station where continuous monitoring of the data/signal takes place. At the ground station, the co-ordinates from the GPS and the TSS reading are decoded.

2.2 REFERENCE:

Hristov, G., Raychev, J., Kinaneva, D., & Zahariev, P. (2018, September). Emerging methods for early detection of forest fires using unmanned aerial vehicles and lorawan sensor networks. In *2018 28th EAEEIE annual conference (EAEEIE)* (pp. 1-9). IEEE.

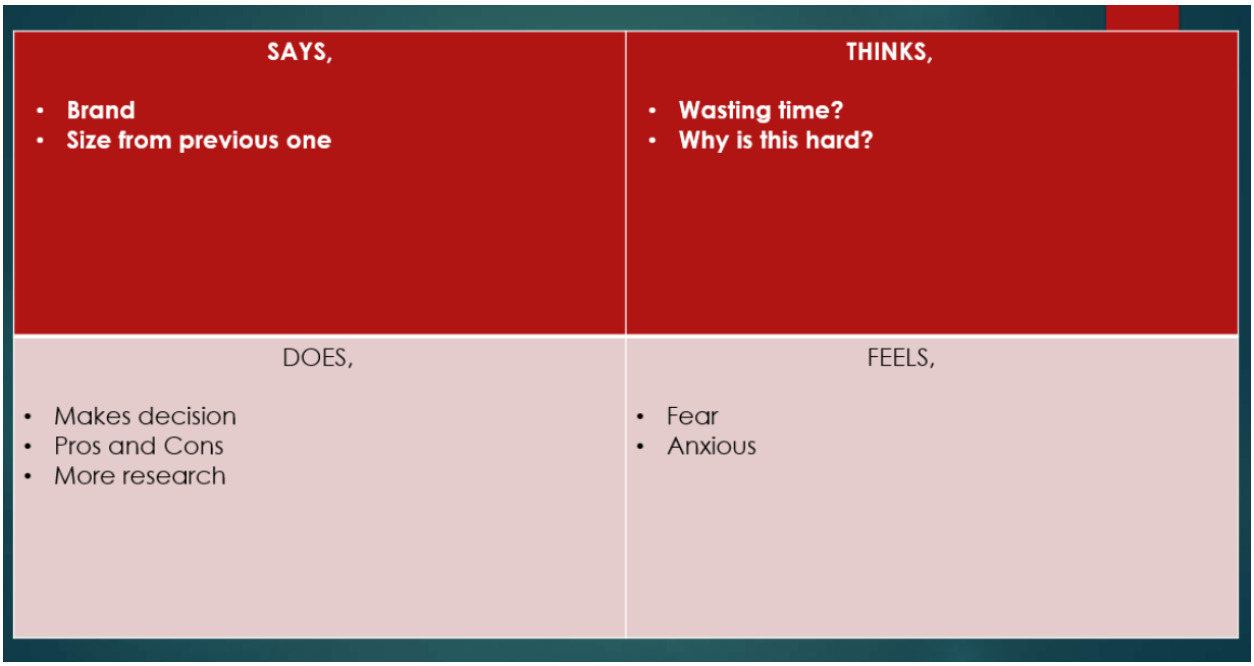
Alkhatib, A. A. (2014). A review on forest fire detection techniques. *International Journal of Distributed Sensor Networks*, *10*(3), 597368.

2.3 Problem Statement Definition:

To reduce the amount of forest cover destroyed due to forest fires.To reduce the amount of carbon di oxide emission due to forest fires

3.IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas:



3.2 Ideation and BrainStroming

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

- **10 minutes** to prepare
- **1 hour** to collaborate
- **2-8 people** recommended

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

A Team gathering
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B Set the goal
Think about the problem you'll be focusing on solving in the brainstorming session.

C Learn how to use the facilitation tools
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

1 Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM
How might we detect the Forest Fires Early to prevent the loss of valuable timber resources?

Key rules of brainstorming

To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.

2 Brainstorm

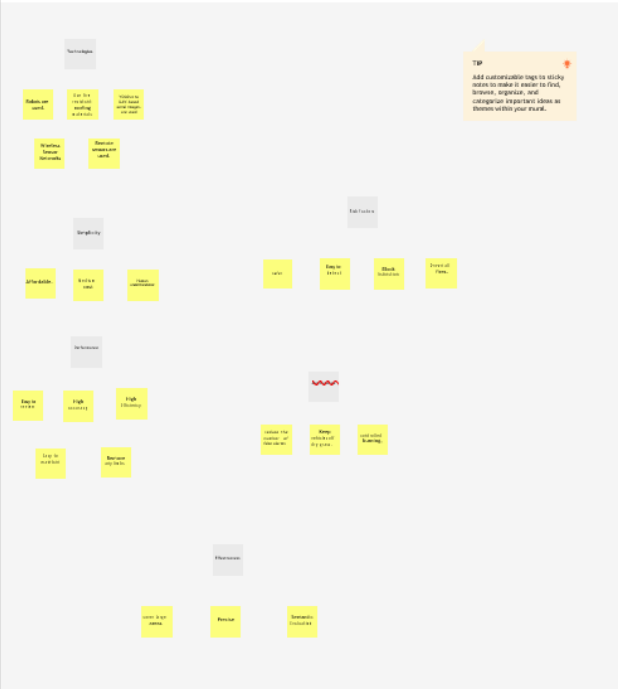
Write down any ideas that come to mind that address your problem statement.

10 minutes

3 Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes



Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

Share the mural
Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

Export the mural
Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint
Define the components of a new idea or strategy.
Open the template →

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template →

Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.
Open the template →

Share template feedback

3.3 Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	A forest fire risk prediction algorithm, based onsupport vector machines, is presented. The algorithm depends on previous weather conditions in order to predict the fire hazard level of a day.
2.	Idea / Solution description	Use computer vision methods for recognitionand detection of smoke or fire, based on the still images or the video input from the drone cameras.
3.	Novelty / Uniqueness	Real time computer program detect forest fire in earliest before it spread to larger area.
4.	Social Impact / Customer Satisfaction	Blocked roads and railway lines, electricity, mobile and land telephone lines cut, destruction of homes and industries.
5.	Business Model (Revenue Model)	The proposed method was implemented using the Python programming language on a Core i3 or greater (CPU and 4GB RAM.)
6.	Scalability of the Solution	Computer vision models enable land coverclassification and smoke detection from satellite and ground cameras

3.4 Proposed Solution Fit:

The problem solution fit simply means that you have found a problem with your customer and that the solution you have realised for it actually solves the customer problem.It helps the entrepreneurs,markets and corporate inovators identify behavioral patterns and recognize what would work and why.

4.REQUIREMENT ANALYSIS

4.1 Functional requirement

FR No.	Functional Requirement (Epic)	Sub Requirement (Story/ Sub-Task)
FR-1	User Registration	Registration through Gmail
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User Login	Login using credentials
FR-4	User Search	Search for Info on forest fire occurrence
FR-5	User Profile	User shall be givena live feed of the forest
FR-6	User Application	User is alerted if there is a forestfire occurrence intheir surroundings

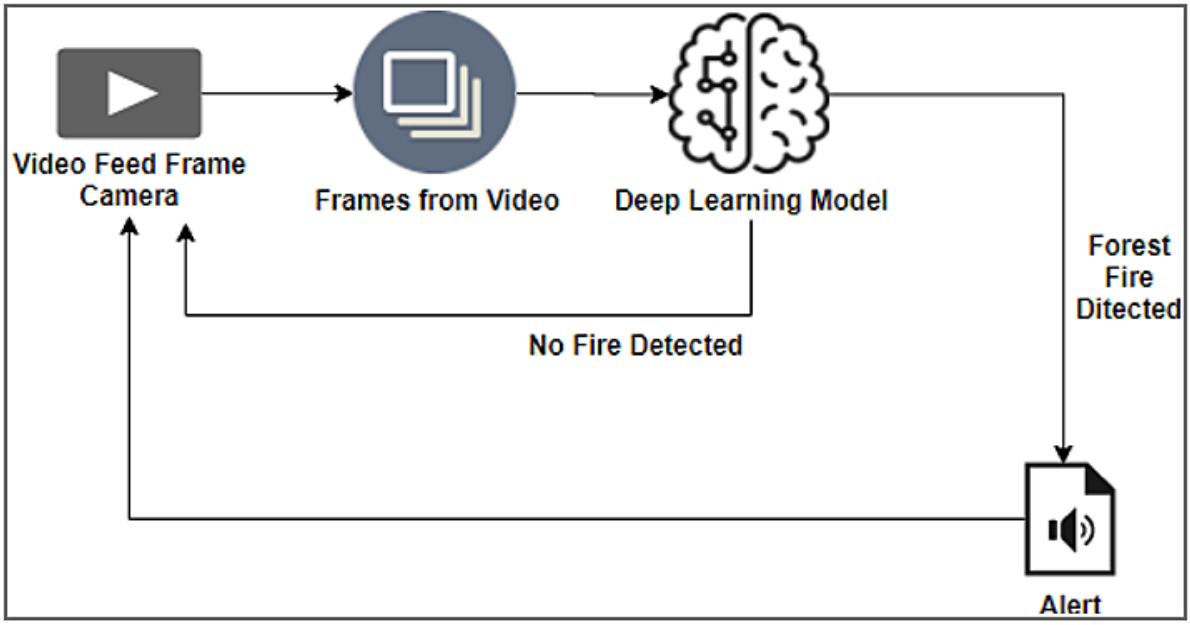
4.2 Non-Functional requirements

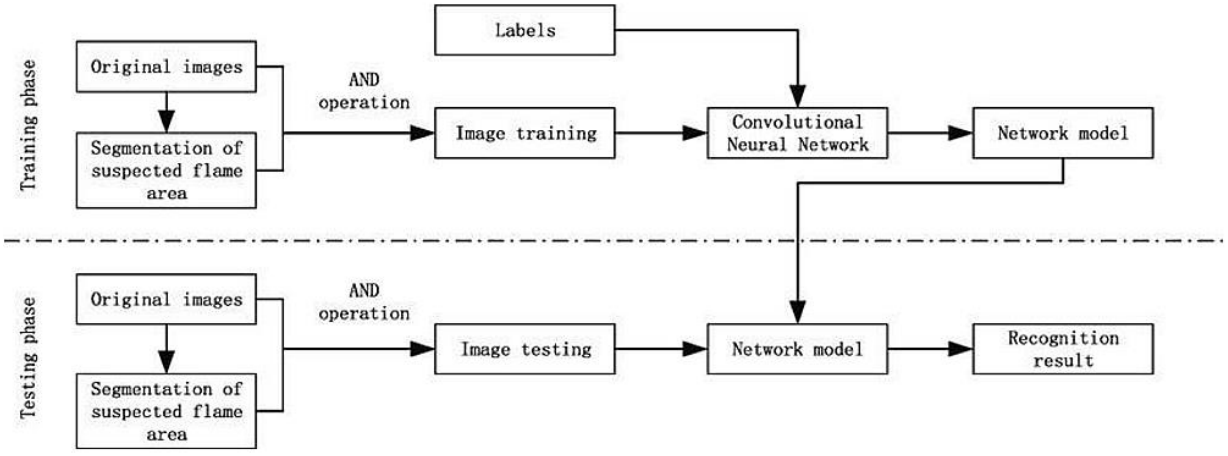
FR No	Non-Functional Requirement	Description
NFR-1	Usability	Alerts according to the user location
NFR-2	Security	Instant live feed withalert of the situation
NFR-3	Reliability	Theprediction of the forest fire is 87% accurate
NFR-4	Performance	The feed and the alert message an immediate action without a lag
NFR-5	Availability	Theapplication gives alerts and livefeeds 24/7

NFR-6		Early detection and alerting usersare done efficiently and ina faster means

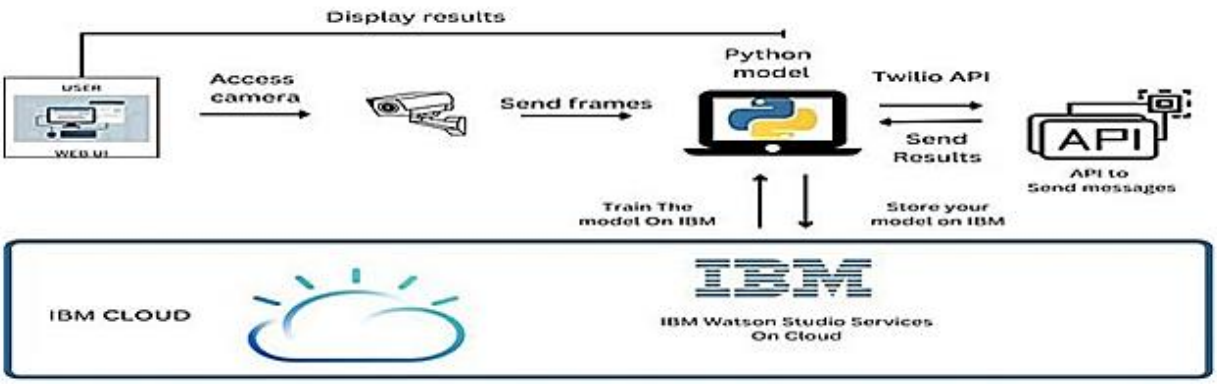
5 PROJECT DESIGN

5.1 Data Flow Diagrams





6 Solution & Technical Architecture



S.No	Component	Description	Technology
1	User Interface	The user uses theconsole to access theinterface	Python/HTML ,CSS ,Javascript and react.Js
2	Input	Video Feed	Web Camera/Videoon a site
3	Conversion	Video inputted isconverted into Frames	Frame Converter
4	Feeding the Model	The Frames are sentto the Deeplearning model	OurModel
5	Dataset	Using Test set andtrainset , train the model	Data set fromCloud Storage , Database
6	Cloud Database	The model is trained in the cloud more precise with detections more images can be added later on.	IBM Cloudant ,PythonFlask.
7	Infrastructure (Server / Cloud),API	Application Deployment on LocalSystem/ Cloud Local ,Cloud Server Configuration , TwilioAPI to send messages	Java/python ,React.Js ,JavaScript ,HTML ,CSS ,IBM Cloud ,OPENCV ,Anaconda Navigator ,Local.

Table-2: Application Characteristics:

S.No	Characteristics	Description	Technology
1	Open-Source Frameworks	Python Flask framework is used	Technology of Opensource framework
2	Security Implementations	Mandatory Access Control (MAC) and Preventative Security Control is used	e.g. SHA-256, Encryptions, IAM Controls, OWASPetc.
3	Scalable Architecture	High scalability with3-tier architecture	Webserver – HTML ,CSS ,JavaScript Application server –Python , Anaconda Database server –IBM DB2
4	Availability	Use of load balancingto distribute traffic across servers	IBMload balancer
5	Performance	Enhance the performance by using IBMCDN	IBM Content Delivery Network

User Stories:

User Type	Functional Requirement (Epic)	User Story Number	User Story I Task	Acceptance criteria	Priority	Release
Environmentalist	Collect the data	USN-1	As an Environmentalist.it is necessary to collect the data of the forest which includes temperature,humidity,wind and rain of the forest	It is necessary to collect the right data else the prediction may become wrona	High	Sprint-1
		USN-2	Identify algorithms that can be used for prediction	To collect the algorithm to identify the accuracy level of each algorithms	Medium	Sprint-2
	Implement Algorithm	USN-3	Identify the accuracy of each algorithms	Accuracy of each algorithm-calculated so that it is easy to obtain the most accurate output	High	Sprint-2
		USN-4	Evaluate the Dataset	Data is evaluated before processing	Medium	Sprint-1
	Evaluate Accuracy of Algorithm	USN-5	Identify accuracy,precision,recall of each algorithms	These values are important for obtaining the riaht output	High	Sprint-3

Project Planning Phase
Project Planning Template (Product Backlog, Sprint Planning, Stories, Story points)

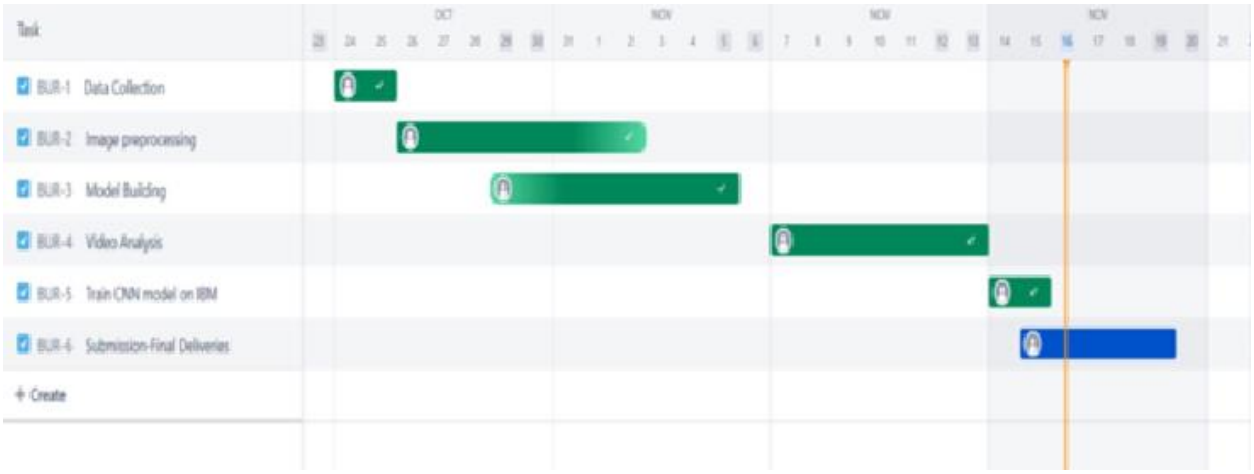
Date	22 October 2022
Team ID	PNT2022TMID20340
Project Name	Emerging methods of early detection of forest fire
Maximum Marks	8 Marks

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Download data set	USN-1	The data is downloaded from the Kaggle website and then the data set is classified into training and testing images.	10	High	S.Vijaya Preetha S.Arun Prasath Ponmaran Muthu Akalya
Sprint-2	Training image	USN-2	In this training phase the ImageDataGenerator arguments is applied to the training images and the model is tested with several images and the model is saved.	20	High	S.Vijaya Preetha S.Arun Prasath Ponmaran Muthu Akalya
Sprint-3	Testing image and prediction	USN-3	In this testing phase the Image processing techniques is applied to the testing images and executed for prediction.	20	High	S.Vijaya Preetha S.Arun Prasath Ponmaran Muthu Akalya
Sprint-4	Video analysis ,Sending Alert message and web application	USN-4	In this phase video is given as input and fire is detected when the fire is detected alert message is sent using twilio service and a frontend application is created.	20	High	S.Vijaya Preetha S.Arun Prasath Ponmaran Muthu Akalya

6.3Reports from JIRA

Burndown Chart:



7 CODING & SOLUTION

7.1Feature 1

In Feature 1 module we have made data collection and Image preprocessing for and Model training.

importing RequiredLibraries:

```
import keras from
keras.preprocessing.imageimport
ImageDataGenerator
import matplotlib.pyplot as plt
import numpy as np
batch_size = 32
```

image resizingand preprocessing :

```
 train_datagen = ImageDataGenerator( shear_range=0.2,
rotation_range=180, zoom_range=0.2,
horizontal_flip=True, )  val_datagen = ImageDataGenerator(rescale=1./255
)
train_generator = train_datagen.flow_from_directory( 'train_set/', target_size=(150,
150),batch_size=batch_size, class_mode='binary' )
val_generator = val_datagen.flow_from_directory( 'test_set/', target_size=(150,
150),batch_size=batch_size, class_mode='binary' )
```

Creating the sequential

model:from

```
keras.models
import Sequential from
keras.layersimport Convolution2D
from keras.layersimport
MaxPooling2D from keras.layers
import Activation from
keras.layers import Dropout from
```

```
keras.layers importFlatten from
keras.layers
import Dense model=Sequential()

model.add(Convolution2D(32,(3,3),input_shape=(150,150,3)))
#Convolutional 2D Layer model.add(Activation('relu'))

model.add(MaxPooling2D(pool_size=(2,2))) # MaxPooling

Layermodel.add(Flatten()) #Flatten Layer to make a array

model.add(Dense(150))

model.add(Activation('relu'))

model.add(Dropout(0.5))

model.add(Dense(1))

model.add(Activation('sigmoid'))
model.compile( loss='binary_crossentropy', optimizer='adam',
metrics=['accuracy'] )
```

Model summary:

```
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 148, 148, 32)      896
_________________________________________________________________
activation (Activation)      (None, 148, 148, 32)      0
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 74, 74, 32)        0
_________________________________________________________________
flatten (Flatten)            (None, 175232)            0
_________________________________________________________________
dense (Dense)                (None, 150)               26284950
_________________________________________________________________
activation_1 (Activation)    (None, 150)               0
_________________________________________________________________
dropout (Dropout)            (None, 150)               0
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 151
_________________________________________________________________
activation_2 (Activation)    (None, 1)                 0
=================================================================
Total params: 26,285,997
Trainable params: 26,285,997
Non-trainable params: 0
```

7.2 Feature 2

```
import cv2
import
numpy as
np
from keras.preprocessing
import image from
keras.models import
```

```
load_model from twilio.rest
importClient from playsound
import playsound
model=load_model('forest1.h
5')
video=cv2.VideoCapture(0)
name=['forest','with fire']
while(True):
  ret,frame=video.read()
  cv2.imshow('frame',frame)
  cv2.imwrite('image.jpg',frame)
  img=image.load_img('train_set/forest/NoFi
  re
(1).bmp',target_size=(64,64))
  x=image.img_to_array(img)
  x=np.expand_dims(x,axis=0)
  pred=model.predict(x)
    index=np.argmax
    (pred)if
    index==0:

account_sid='AC50d663c8a7c2d8b35b1fc09dfda93bda
      '
       auth_token='86f345babfa094d1015a0e1137dbb679
       'client =Client(account_sid,auth_token)
       message=client.messages \
      .create(body='------Fire is detected,Stay Alert !!!---------- ',
              from_='+19457581434',to='+916369  659  356')
       print(message.sid)
      print('Fire detected')
      print("Alert Message
      sent!")
       playsound('tornado-siren.mp3')

   else:
      print('No Danger')
      cv2.imshow("image.jpg",fr
      ame) if
      cv2.waitkey(2)&0xff ==
      ord('q'):
            break
video.release()
cv2.destroyAllWindo
ws()
```

```
SM20002510df1efe889005ac80731425ff
Fire detected
Alert Message sent!
```

```
]:
```

8)TESTING

8.1)Test Cases & User Acceptance Testing Testing with input video recording from user end:

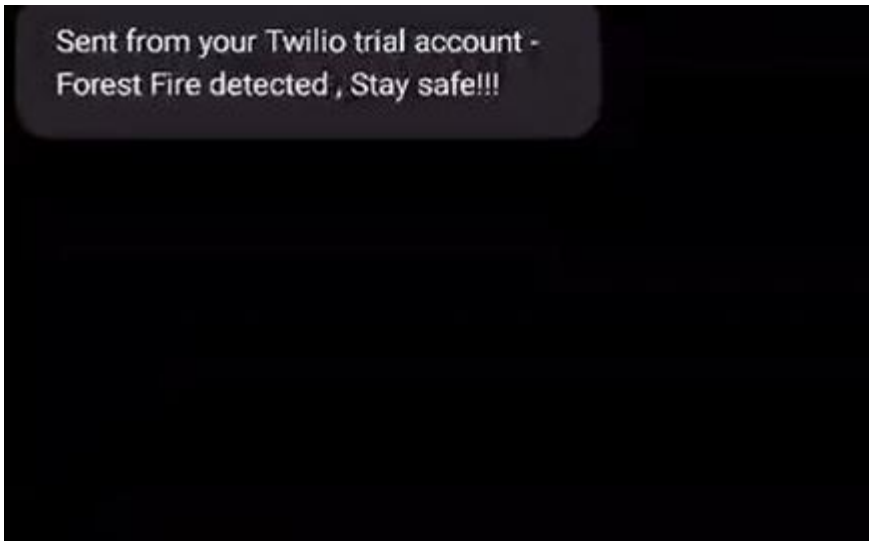
```
import cv2
import numpy as np
from  keras.preprocessing
import image from
keras.models
 import load_model from
twilio.restimport Client from
playsound import playsound
model=load_model('forest1.h
5')
video=cv2.VideoCapture(0)
name=['forest','with fire']
while(True):
    ret,frame=video.read()
    cv2.imshow('frame',fra
    me)
    cv2.imwrite('image.jpg',f
    rame)
    img=image.load_img('train_set/forest/NoFire (1).bmp',target_size=(64,64))
    x=image.img_to_array(img)
    x=np.expand_dims(x,axis=0)
    pred=model.pred
    ict(x)
    index=np.argmax
    (pred)if
    index==0:
        account_sid='AC50d663c8a7c2d8b35b1fc09dfda93
        bda'
        auth_token='86f345babfa094d1015a0e1137dbb679
        ' client =Client(account_sid,auth_token)
        message=client.messages \
        .create(body='------Fire is detected,Stay Alert !!!---------- ',
                from_='+19457581434',to='+916369  659  356')
        print(message.sid)
        print('Fire detected')
```

```
        print("Alert
        Messagesent!")
        playsound('tornado-siren.mp3')

    else:
        print('No Danger')
        cv2.imshow("image.jpg",fr
        ame) if
        cv2.waitkey(2)&0xff ==
        ord('q'):
            break

video.release()
cv2.destroyAllWindows()
```

OUTPUT



9 Result

9.1 Performance Metrics

```
loss: 0.3438 - acc
loss: 0.3816 - acc
loss: 0.4068 - acc
loss: 0.3312 - acc
loss: 0.5621 - acc
```

10 ADVANTAGES & DISADVANTAGES

Advantages :

1. Easily detect and Estimatethe Forest Fire.
2. Most Accurate
3. Flexible Model which can give maximized outcome
4. No Specific Requirements neededto implement the model

Disadvanatges:

5. Training model is time consuming process.
6. Error in CV can cause damageto camera
7. Access of camera are prohibited due to personalissues

11 CONCLUSION :

Thus we have constructed a model 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 numbersof the persons in the surroundings of the peoplein 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 studieswe have done.

12 FUTURE SCOPES :

1. It can be developed as a Web or AndroidApplication.
2. In future Alternate Advancedtechnologies can be Implemented.
3. The Identification and tracking systemcan be implemented if possible.