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EMERGING METHODS OF EARLY DETECTION OF FOREST FIRES

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1.INTRODUCTION

1.1 PROJECT OVERVIEW

Traditional forest fire detection methods include satellite monitoring, ground patrols, watch towers, among others, which have high labor and financial costs in return for low efficiency. Current remote sensor technologies are becoming more common, but primarily rely on battery technology for power.

1.2 PURPOSE

Emerging Methods for Early Detection of Forest Fires The project aims to build a model that detects forest fires using convolutional neural networks.

2. LITERATURE SURVEY

2.1 Existing Problem

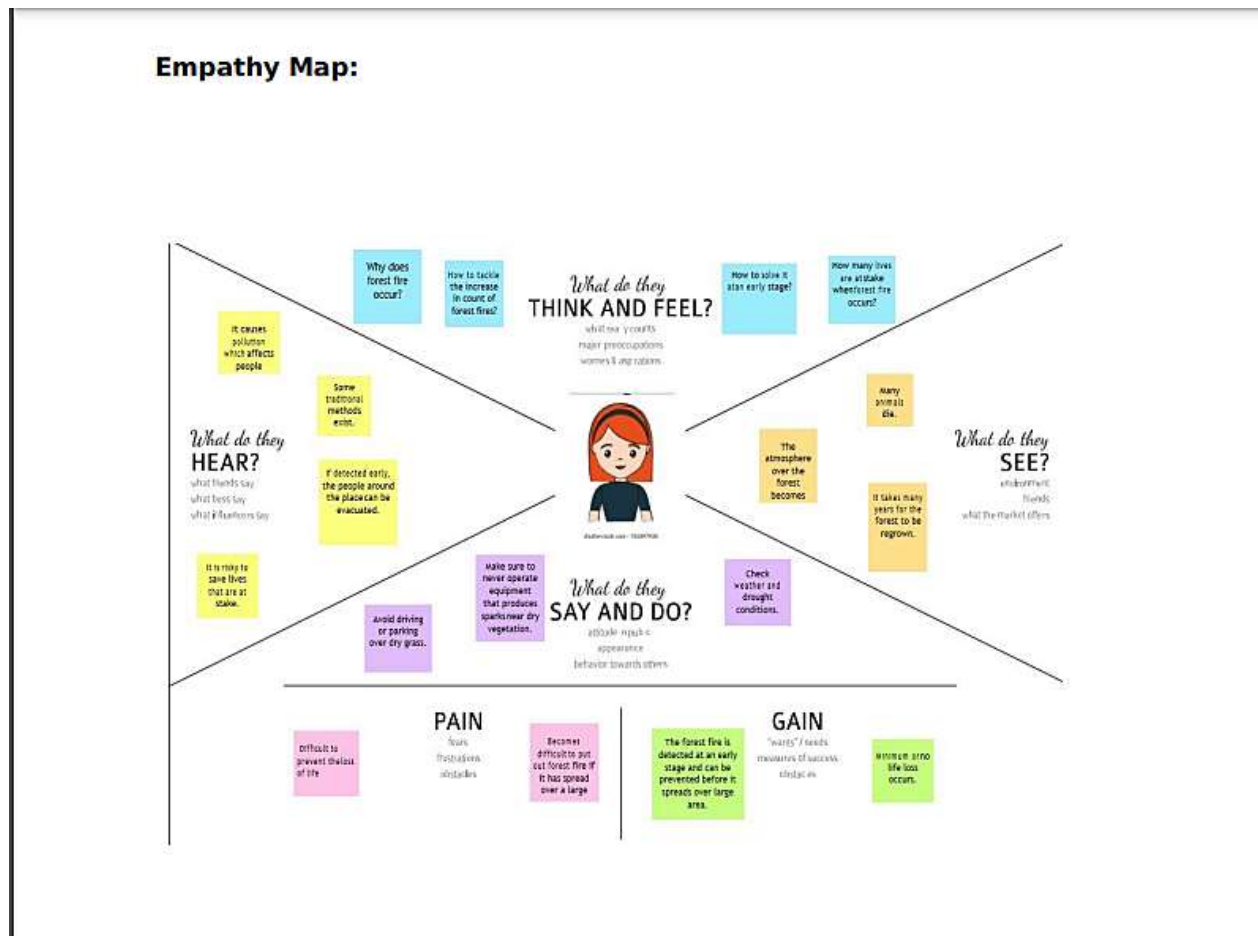
It is difficult to predict and detect Forest Fire in a sparsely populated forest area and it is more difficult if the prediction is done using ground-based methods like Camera or Video-Based approach. Satellites can be an important source of data prior to and also during the Fire due to its reliability and efficiency.

2.2 References

https://www.researchgate.net/publication/334418384_Early_Forest_Fire_Detection_Using_Drones_and_Artificial_Intelligence

3. IDEATION & PROPOSED SOLUTION



3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

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

Template



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 1 hour
1 team of 3-10 people
3-5 people recommended

Share template feedback

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

1. Open gathering

Before your shared session open in this section and send an invite. Share enough information to get ideas flowing.

2. Set the goal

What about the problem are you focusing on during the brainstorming session?

3. Lead through our idea facilitation guide

Our idea facilitation guide helps to set a mood and production session.

Start a guide

Define your problem statement

What problem are you trying to solve? Frame your problem as a how might we customer. This will be the focus of your brainstorm.

5 minutes

10 minutes

How might we customer that we will help by early morning problem?

10 minutes

How might we customer that we will help by early morning problem?

Step-2: Brainstorm, Idea Listing and Grouping

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

TIP
Remember, there is no such thing as a bad idea. Write down all ideas, no matter how silly or outrageous they may seem.

Brainstorming Ideas

Participant	Idea 1	Idea 2
NIVETHA S	Detect by smoke	Detects by climate changes
PAVITHRA V	Detects by flame	Detects any electrical shortage that can cause fire
MANJU MITHRA M	Detects by spark	Detects spark due to lightning
SHARATHASHINI P	Detects by temperature regularly	Monitors 24/7

Grouping
Take time to share your ideas, while clustering similar or related notes as you go. In the last 10 minutes, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

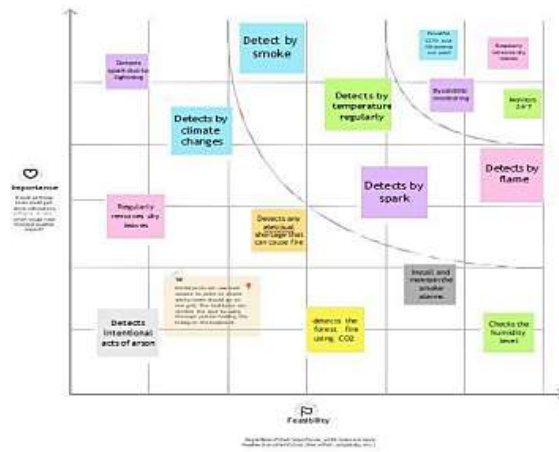
Grouped Ideas

- By detect the forest fire,
- Reduces the air pollution
- Reduces the landslides, soil erosion by protecting strong rooted trees
- No loss of life and resources
- Reduce co2
- No need of manual monitoring

Step-3: Idea Prioritization

Priority

Priority
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.

 Springer

4

After you collaborate, you can export that created content as a single or pull document with members of your company who might find it helpful.

Quick edit

- Question 10**
What is the value of $\sin^{-1}(\sin(\frac{\pi}{3}))$?
- Answer:** $\frac{\pi}{3}$
- Explanation:** The value of $\sin^{-1}(\sin(\frac{\pi}{3}))$ is $\frac{\pi}{3}$ because the sine of $\frac{\pi}{3}$ is $\frac{\sqrt{3}}{2}$ and the inverse sine of $\frac{\sqrt{3}}{2}$ is $\frac{\pi}{3}$.

Soap-making: Forever of

-  **Develop structure:**
Define the components of a new idea or strategy.
-  **Open the discussion:**
A customer representative provides input, understands customer needs, constraints, and what exists for the company.
-  **Develop, brainstorm, ideation, & discuss:**
Identify the right, reasonable, open, relevant, and feasible (ORRIVE) development.
-  **Open the discussion:**

There is a significant positive correlation between the two variables.

Proposed solution

s.no	Parameter	description
1.	Problem Statement (Problem to be solved)	A forestfire risk prediction algorithm, based on support 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 recognition and detection of smoke or fire.
3.	Novelty / Uniqueness	Real time computer program detect forest fire in earliest before it spread to larger area
4.	Impact on society	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 mode enable land cover classification and smoke detection from satellite and ground cameras

Problem Solution fit

Project Title: Emerging Methods for early detection of forest fire

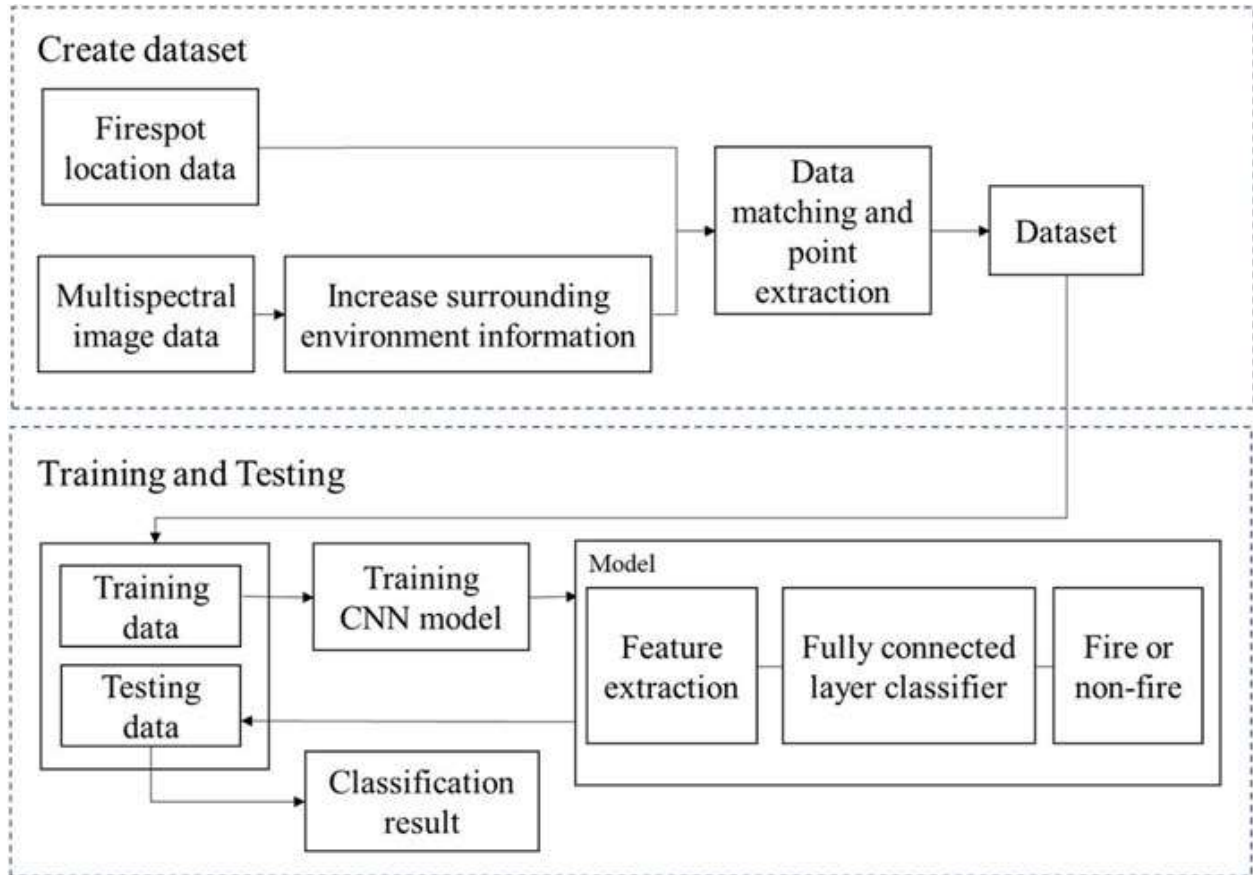
Project Design Phase-I - Solution Fit Template

Team ID: PNT2022TMID15454

Define CS, fit into CC	<p>1. CUSTOMER SEGMENT(S)</p> <p>Who is your customer? i.e. working parents of 0-5 y.o. kids</p> <p>CS</p> <p>The forest resources which plays a vital role in sustaining lives on the earth, therefore to preserve them from unexpected outbreak of fire and smoke. The forest management team do need this device in fire prone areas.</p>	<p>6. CUSTOMER CONSTRAINTS</p> <p>What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices.</p> <p>CC</p> <p>Climatic changes and the greenhouses gases are the reasons behind the destruction. Along with this the human factor to greedily use resources also play a vital reason for the forest fires.</p>	<p>5. AVAILABLE SOLUTIONS</p> <p>Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking</p> <p>AS</p> <p>Existing systems uses optical sensors for detecting forest fires. As fire is detected the sensors sends signal to the office of forest management. Among with that satellites are used to detect IR rays spotted in forest lands.</p>	Explore AS, differentiate
	Focus on J&P, fit into BE, understand RC	<p>2. JOBS-TO-BE-DONE / PROBLEMS</p> <p>Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.</p> <p>J&P</p> <p>The main problem that exists is weather and climate by releasing large number of carbon dioxide, carbon monoxide and fine particulate matter into the atmosphere.</p>	<p>9. PROBLEM ROOT CAUSE</p> <p>What is the real reason that this problem exists? What is the back story behind the need to do this job? i.e. customers have to do it because of the change in regulations.</p> <p>RC</p> <p>The reasons possible are: 1. Due to natural causes- Lightning 2. Man-made causes- Naked flame, cigarette, electric spark</p> <p>Thus, contineous care and monitoring is needed to preserve natural resources to save lives.</p>	

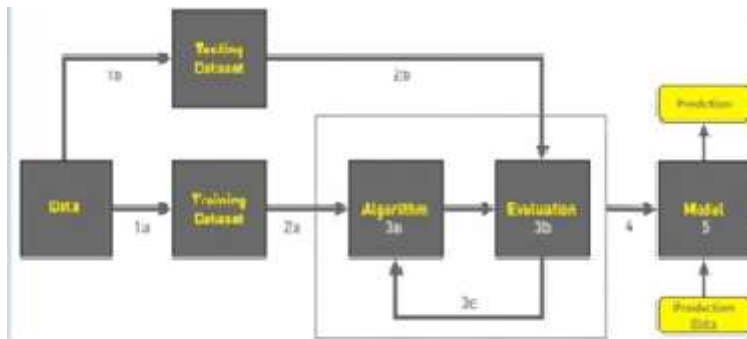
4. REQUIREMENT ANALYSIS

4.1 Functional requirement

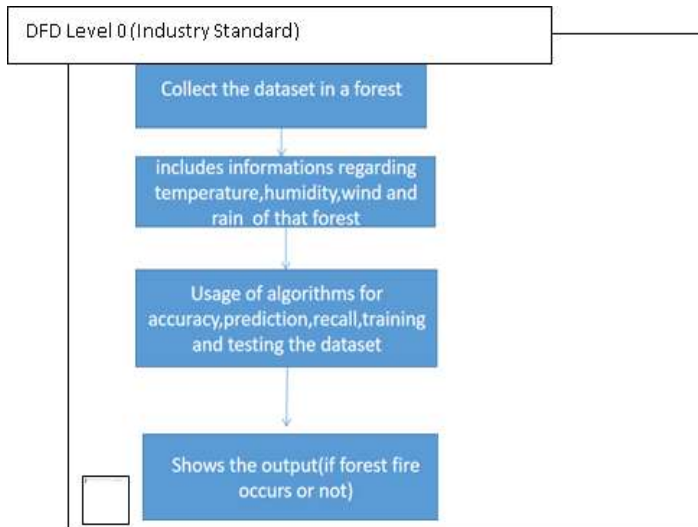


5. PROJECT DESIGN

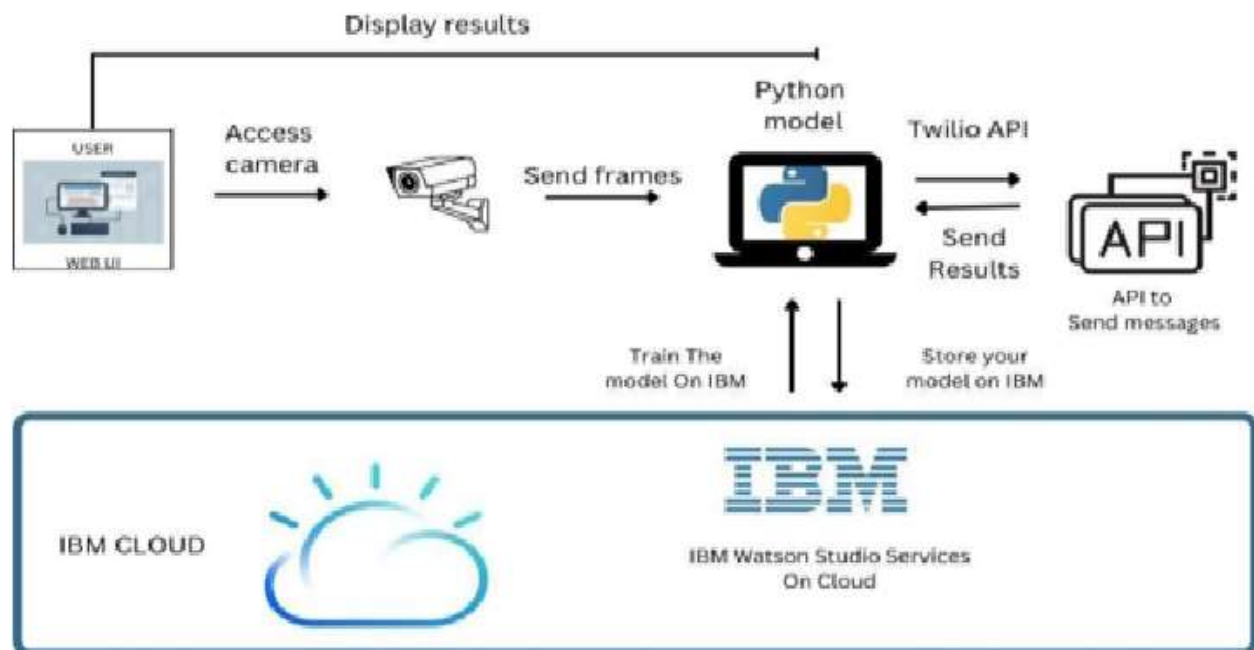
5.1 Data Flow Diagrams



1. COLLECT DATA
2. EVALUATE DATASET
3. IMPLEMENT ALGORITHMS
4. EVALUATE THE ACCURACY OF EACH ALGORITHMS



5.2 Solution & Technical Architecture:



5.3 User Stories:

User Type	Functional Requirement (Epic)	User Story Number	User Story/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 wrong	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
		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
		USN-5	Identify accuracy, precision, recall of each algorithms	These values are important for obtaining the right output	High	Sprint-3
		USN-6	Outputs from each algorithm are obtained	It is highly used to predict the effect and to take precautionary measures.	High	Sprint-4

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	Data Collection	USN-1	Collect Dataset	20	High	Nivetha.S Manju mithra.M Pavithra.V Sharuhashini .P
Sprint-1		USN-2	Image preprocessing	20	High	Nivetha.S Manju mithra.M Pavithra.V Sharuhashini .P
Sprint-2	Model Building	USN-3	Import the required libraries, add the necessary layers and compile the mode	20	High	Nivetha.S Manju mithra.M Pavithra.V Sharuhashini .P
Sprint-2		USN-4	Training the image classification model using CNN	20	High	Nivetha.S Manju mithra.M Pavithra.V Sharuhashini .P

Sprint-3	Training and Testing	USN-5	Training the model and testing the model's performance	20	High	Nivetha.S Manju mithra.M Pavithra.V Sharuhashini .P
Sprint-4	Implementation of the application	USN-6	When it is the wildfire then the alarm system is activated. And the alarm will be sent to the corresponding department and required action will be taken soon to control the fire.	20	High	Nivetha.S Manju mithra.M Pavithra.V Sharuhashini .P

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

7. CODING & SOLUTIONING (Explain the features added in the project along with code)

7.1 Feature 1:

We uploaded the dataset that is given and have divided the classes into train set and data set and preprocessed the image. The output is shown here.

```
In [3]: #Applying ImageDataGenerator functionality to trainset
x_train=train_datagen.flow_from_directory('/content/drive/MyDrive/Dataset/train_set',target_size=(128,128),batch_size=32,class_mode='binary')

Found 439 images belonging to 2 classes.

In [4]: #Applying ImageDataGenerator functionality to testset
x_test=test_datagen.flow_from_directory('/content/drive/MyDrive/Dataset/test_set',target_size=(128,128),batch_size=32,class_mode='binary')

Found 121 images belonging to 2 classes.
```

7.2 Feature 2:

After the image preprocessing we have done the model building. The model building output is shown here.

```
In [27]: #Load the saved model
model = load_model("forest1.h5")

In [29]: img=image.load_img('/content/drive/MyDrive/Dataset/test_set/with fire/180802_CarrFire_010_large_700x467.jpg')
x=image.img_to_array(img)
res = cv2.resize(x, dsize=(128, 128), interpolation=cv2.INTER_CUBIC)
#expand the image shape
x=np.expand_dims(res,axis=0)

In [31]: pred=model.predict(x)

1/1 [=====] - 0s 31ms/step

In [32]: pred

Out[32]: array([[1.]], dtype=float32)

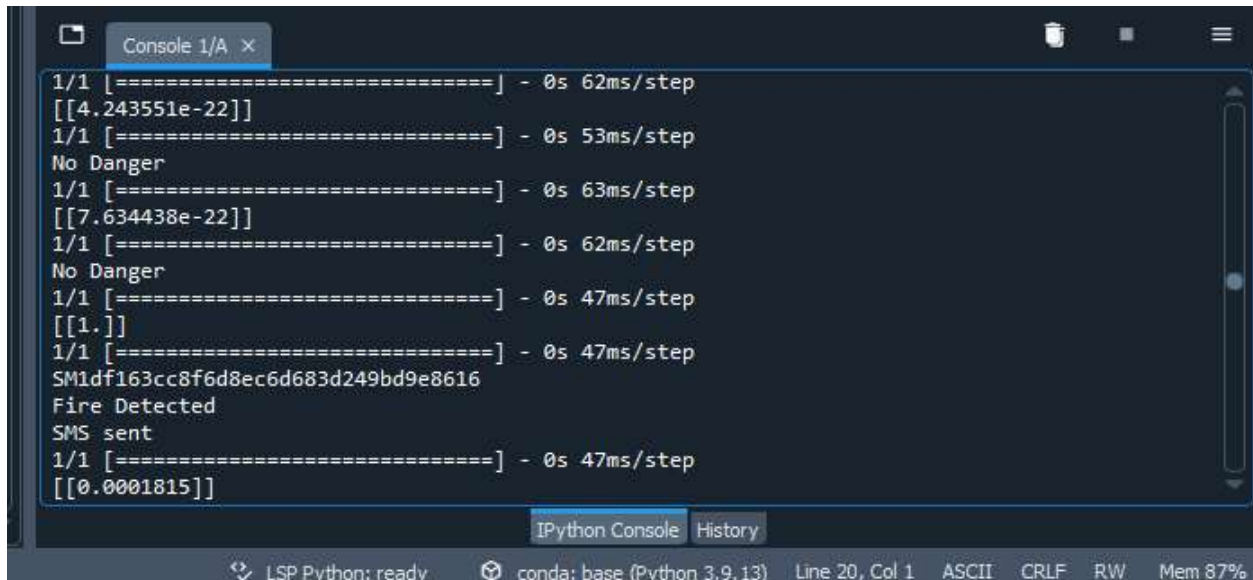
In [ ]:
```

By using the above forest1.h5 model we can take our desired output according to the input.

8. TESTING

8.1 Test Cases:

By the showing image of forest fire the desired output of "Forest fire is detected,stay alert" is sent via SMS form twilio service.By showing the image of forest the desired output is no danger.



```
Console 1/A x
1/1 [=====] - 0s 62ms/step
[[4.243551e-22]]
1/1 [=====] - 0s 53ms/step
No Danger
1/1 [=====] - 0s 63ms/step
[[7.634438e-22]]
1/1 [=====] - 0s 62ms/step
No Danger
1/1 [=====] - 0s 47ms/step
[[1.]]
1/1 [=====] - 0s 47ms/step
SM1df163cc8f6d8ec6d683d249bd9e8616
Fire Detected
SMS sent
1/1 [=====] - 0s 47ms/step
[[0.0001815]]

IPython Console History
LSP Python: ready  conda: base (Python 3.9.13)  Line 20, Col 1  ASCII  CRLF  RW  Mem 87%
```

8.2 User Acceptance Testing:

We have tested our project by showing the image of forest with fire and forest without fire.The output is shown above.

9. RESULTS

9.1 Performance Metrics:

Model evaluation

```
In [27]: #Load the saved model
         model = load_model("forest1.h5")

In [29]: img=image.load_img('/content/drive/MyDrive/Dataset/test_set/with fire/180802_CarrFire_010_large_700x467.jpg')
         x=image.img_to_array(img)
         res = cv2.resize(x, dsize=(128, 128), interpolation=cv2.INTER_CUBIC)
         #expand the image shape
         x=np.expand_dims(res,axis=0)

In [31]: pred=model.predict(x)

         1/1 [=====] - 0s 31ms/step

In [32]: pred

Out[32]: array([[1.]], dtype=float32)

In [ ]:
```

10. ADVANTAGES & DISADVANTAGES

ADVANTAGES:

1. Avoid Smoke Inhalation. The most important reason is perhaps the only one you really need.
2. Early Detection. The earlier a fire is detected, the faster it will be that firefighters will respond.
3. Insurance Discounts.
4. 24/7 Monitoring.
5. Easy & Affordable.

DISADVANTAGES:

1. The system is essentially useless if the batteries aren't charged, since it won't work properly.
2. There is a bit of a burden to business owners to always remember to keep the batteries fresh so the system operates properly when you need it most.

11. CONCLUSION

Early fire detection is best achieved by the installation and maintenance of fire detection equipment in all areas of the forest.

12. FUTURE SCOPE

The future will be with multicriteria detection in which the detector will be more of a sensor, with the detection more for the products of combustion, such as carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxides in addition to heat and particulate matter.

13. APPENDIX

Source Code: Python code

```
#import opencv librariy
import cv2
#import numpy
import numpy as np
#import image function from keras
from keras.preprocessing import image
#import load_model from keras
from keras.models import load_model
#import client from twilio API
from twilio.rest import Client
#imort playsound package
from playsound import playsound

#load the saved model
model = load_model(r'forest1.h5')
#define video
video = cv2.VideoCapture(0)
#define the features
name = ['forest','with forest']

account_sid = 'AC557b4c7a685d072baa73125f61031af3'
auth_token = 'a59cd5e5fdddcc9ab008273557f8f78'
client = Client(account_sid, auth_token)

message = client.messages \
    .create(
        body='Forest fire is detected , stay alert',
        from_='+14247991869',
        to='+918940722793'
    )

print(message.sid)
```

```

#import opencv library
import cv2
#import numpy
import numpy as np
#import images and load_model function from keras
from keras_preprocessing import image
from keras.models import load_model
#import client from twilio API
from twilio.rest import Client
#import playsound package
from playsound import playsound

#load the saved model
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=image.load_img("image.jpg",target_size=(128,128,3))
    x=image.img_to_array(img)
    x=np.expand_dims(x,axis=0)
    pred=model.predict(x)
    p=pred[0]
    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 = 'AC557b4c7a685d072baa73125f61031af3'

```

```
auth_token = 'a59cd5e5fdiddcc9ab008273557f8f78'
client = Client(account_sid, auth_token)
message=client.messages\
.create(
body='Forest Fire is Detected, stay alert',
from_='+14247991869',to='+918940722793')

print(message.sid)
print('Fire Detected')
print('SMS sent')
playsound(r'C:\Users\My\Downloads\buzzer.mp3')

else:
    print("No Danger")

    cv2.imshow("image",frame)

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

GitHub Link:

<https://github.com/IBM-EPBL/IBM-Project-30013-1660138238>

Project Demo Link:

<https://www.youtube.com/embed/97uqCIgVlVI>

