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EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

Project Outline

1. INTRODUCTION **3**
- 1.1 Project Overview **3**
- 1.2 Purpose **3**

2. LITERATURE SURVEY **4**
- 2.1 Existing problem **4**
- 2.2 References **4**
- 2.3 Problem Statement Definition **6**

3. IDEATION & PROPOSED SOLUTION **7**
- 3.1 Empathy Map Canvas **7**
- 3.2 Ideation & Brainstorming **8**
- 3.3 Proposed Solution **10**
- 3.4 Problem Solution fit **11**

4. REQUIREMENT ANALYSIS **12**
- 4.1 Functional requirement **12**
- 4.2 Non-Functional requirements **12**

5. PROJECT DESIGN **13**
- 5.1 Data Flow Diagrams **13**
- 5.2 Solution & Technical Architecture **14**
- 5.3 User Stories **15**

6. PROJECT PLANNING & SCHEDULING **16**
- 6.1 Sprint Planning & Estimation **16**
- 6.2 Sprint Delivery Schedule **17**

7. CODING & SOLUTIONING (Explain the features added in the project along with code) **18**
- 7.1 Feature 1 ..... **18**
- 7.2 Feature 2 ..... **18**

8. TESTING **19**
- 8.1 Test Cases **19**
- 8.2 User Acceptance **19**

9. RESULTS **20**
- 9.1 Performance Metrics **20**

10. ADVANTAGES & DISADVANTAGES **20**

11. CONCLUSION **21**

12. FUTURE SCOPE **21**

13. APPENDIX **22**
- Source Code **24**
- GitHub & Project Demo Link **24**

1. INTRODUCTION

1.1 Project Overview:

Forest fires are occurring throughout the year with an increasing intensity in the summer and autumn periods. These events are mainly caused by the actions of humans, but different nature and environmental phenomena, like lightning strikes or spontaneous combustion of dried leafs or sawdust, can also be credited for their occurrence. Regardless of the reasons for the ignition of the forest fires, they usually cause devastating damage to both nature and humans. Forest fires are also considered as a main contributor to the air pollution, due to the fact that during every fire huge amounts of gases and particle mater are released in the atmosphere. To fight forest fires, different solutions were employed throughout the years. They ware primary aimed at the early detection of the fires. The simplest of these solutions is the establishment of a network of observation posts - both cheap and easy to accomplish, but also time-consuming for the involved people. The constant evolution of the information and communication technologies has led to the introduction of a new generation of solutions for early detection and even prevention of forest fires.

1.2 Purpose:

The main purpose of the project is to detect the forest fires early.This can be done by using the artificial intelligence technique.

2. LITERATURE SURVEY

2.1 Existing problem:

Frequent fires in the Himalayan region of Uttaranchal in the Indian Himalayas have been blamed for forest deterioration. It is true that frequent fires on large scales cause air pollution, mar quality of stream water, threaten biodiversity and spoil the aesthetics of an area, but fire plays an important role in forest ecosystem dynamics. Moreover, it is not fire, but other anthropogenic activities plus fire that are degrading the forest of the Indian Himalayas. In the present study the role of fire in shaping forest structure and composition is analysed. If fire is managed wisely it can be used as the cheapest means of forest management. For this purpose different fire characteristics are assessed together with their interrelationship with forest flora.

2.2 References:

Georgi Hristov et.al. [1] Forest Fires are mainly caused by the actions of humans, but different nature and environmental phenomena, like lightning strikes or spontaneous combustion of dried leaves or sawdust, can also be credited for their occurrence. Regardless of the reasons for the ignition of the forest fires, they usually cause devastating damage to both nature and humans. Forest fires are also considered as a main contributor to the air pollution, due to the fact that during every fire huge number of gases and particle mater are released in the atmosphere. To fight forest fires, different solutions were employed throughout the years. They ware primary aimed at the early detection of the fires. The simplest of these solutions is the establishment of a network of observation posts - both cheap and easy to accomplish, but also time-consuming for the involved people. The constant evolution of the information and communication technologies has led to the introduction of a new generation of solutions for early detection and even prevention of forest fires. ICT-based networks of cameras and sensors and even satellite-based solutions were developed and used in the last decades. These solutions have greatly decreased the direct involvement of humans in the forest fire detection process, but have also proven to be expensive and hard to maintain. In this paper we will discuss and present two different emerging solutions for early detection of forest fires. The first of these solutions involves the use of unmanned aerial vehicles (UAVs) with specialized cameras. Several different scenarios for the possible use of the drones for forest fire detection will be presented and analysed, including a Date 18 September 2022 Team ID PNT2022TMID06660 Project Name Emerging Methods for Early Detection of Forest Fires Maximum Marks 2 Marks solution with the use of a combination between a fixed-wind and a rotary-wing UAVs. In the next chapter of the paper, we will present and discuss the possibilities for development of systems for early forest fire detection using Lora WAN sensor networks

and we will analyse and present some of the hardware and software components for the realisation of such sensor networks.

Chi Yuan et.al. [2] Over the last decade, UAV-based forest fire fighting technology has shown increasing promise. This paper presents a systematic overview of current progress in this field. First, a brief review of the development and system architecture of UAV systems for forest fire monitoring, detection, and fighting is provided. Next, technologies related to UAV forest fire monitoring, detection, and fighting are briefly reviewed, including those associated with fire detection, diagnosis, and prognosis, image vibration elimination, and cooperative control of UAVs. The final section outlines existing challenges and potential solutions in the application of UAVs to forest firefighting.

Mohamed Hefeeda et.al. [3] Early detection of forest fires is the primary way of minimizing their damages. We first present the key aspects in modelling forest fires according to the Fire Weather Index (FWI) System which is one of the most comprehensive forest fire danger rating systems in North America. Then, we model the forest fire detection problem as a node kcoverage problem ($k \geq 1$). We propose approximation algorithms for the node k-coverage problem which is shown to be NP-hard. We present a constant-factor centralized algorithm, and a fully distributed version which does not require sensors know their locations.

Priyadarshini M Hanamaraddi et.al. [4] Forests can purify water, stabilize soil, cycle nutrients, moderate climate, and store carbon. They can create habitat for wildlife and nurture environments rich in biological diversity. They can also contribute billions of dollars to the country's economic wealth. However, hundreds of millions of hectares of forests are unfortunately devastated by forest fire each year. Forest fire has been constantly threatening to ecological systems, infrastructure, and public safety. In the image processing-based forest fire detection, method adopts rule-based colour model due to its less complexity and effectiveness. The method not only separates fire flame pixels but also separates high temperature fire centre pixels by taking in to account of statistical parameters of fire image like mean and standard deviation. This paper presents a literature study on Image processing for forest fire detection.

5. Dr. Panagiotis Barmpoutis, Periklis Papaioannou, Dr. Kosmas Dimitropoulos, Dr. Nikos GRAMMALIDIS , Published in: 11 November 2020.

6. Vinay Chowdary , Mukul Kumar Gupta , Rajesh Singh, Published in:2018

7. Majid Bahrepour, Nirvana Meratnia, Paul Havinga , Published in: January 2008.

8. Dr.L.Latha , Published in: January 2015

9. P. Piccinini, S. Calderara, and R. Cucchiara , Published in: September, 2006.

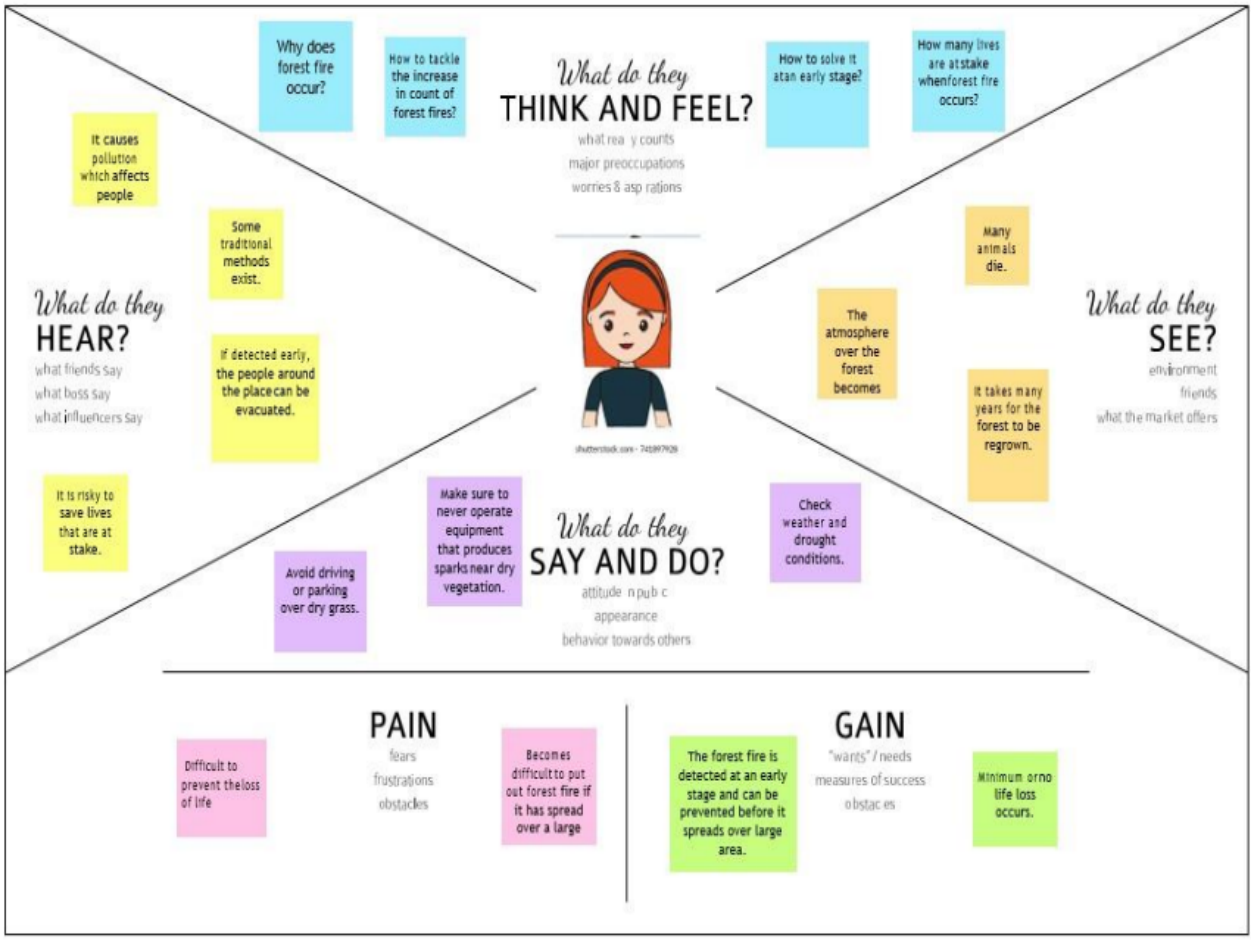
2.3 Problem Statement Definition:

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.

3. IDEATION & PROPOSED SOLUTION

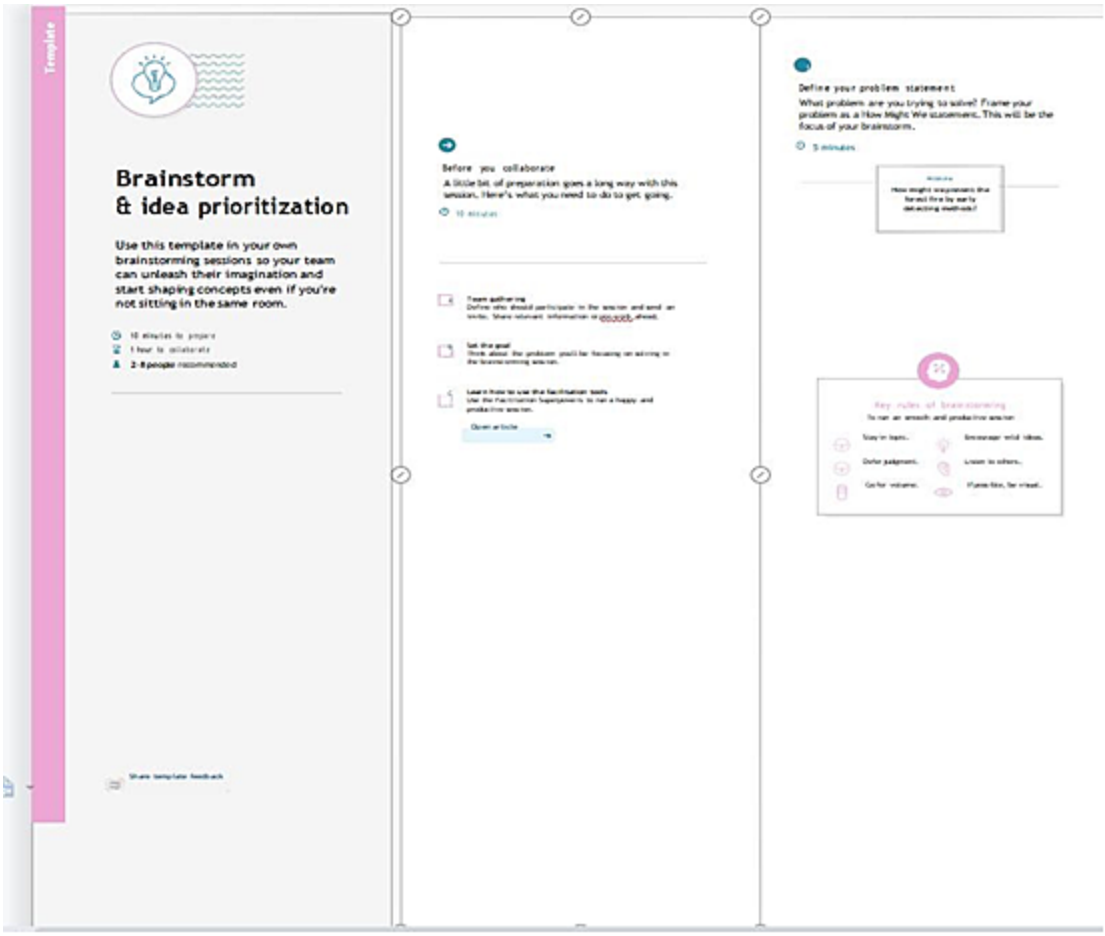
3.1 Empathy Map Canvas:

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool to helps teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.



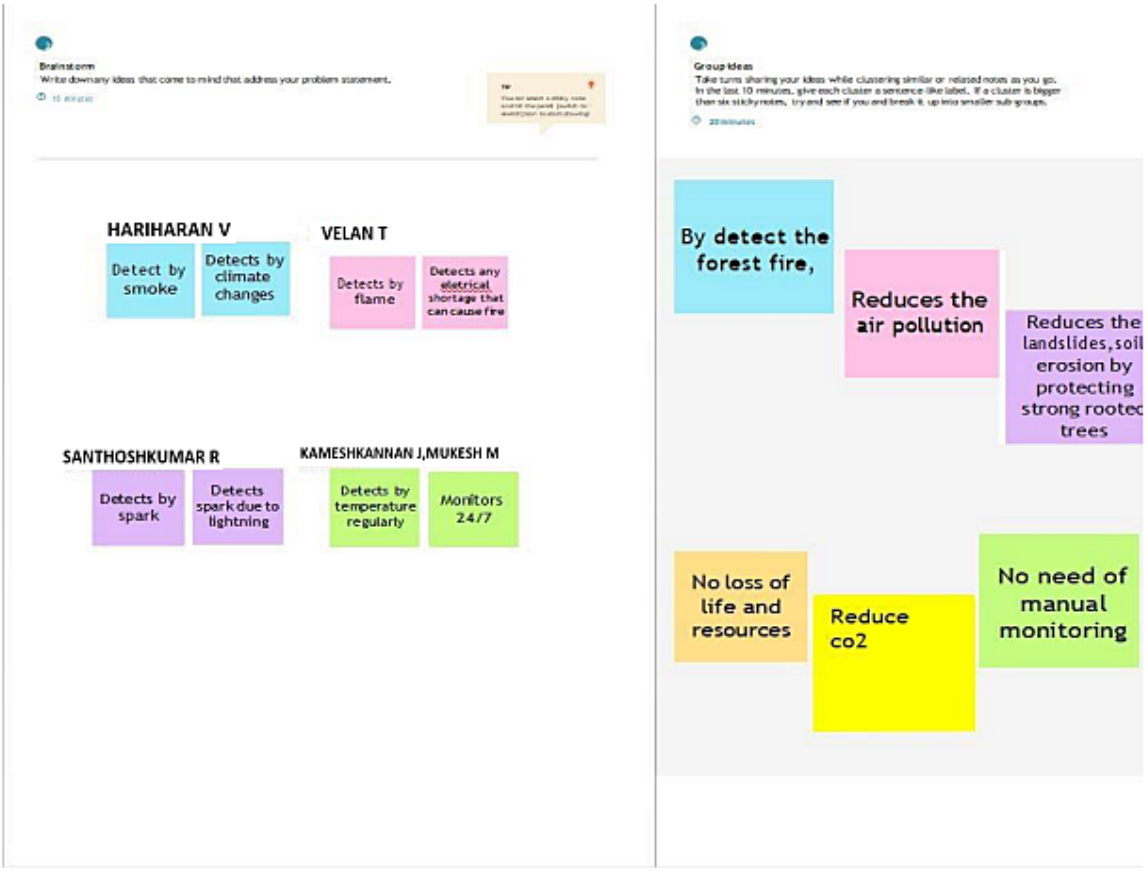
3.2 Ideation & Brainstorming:

Ideation



Brainstorming

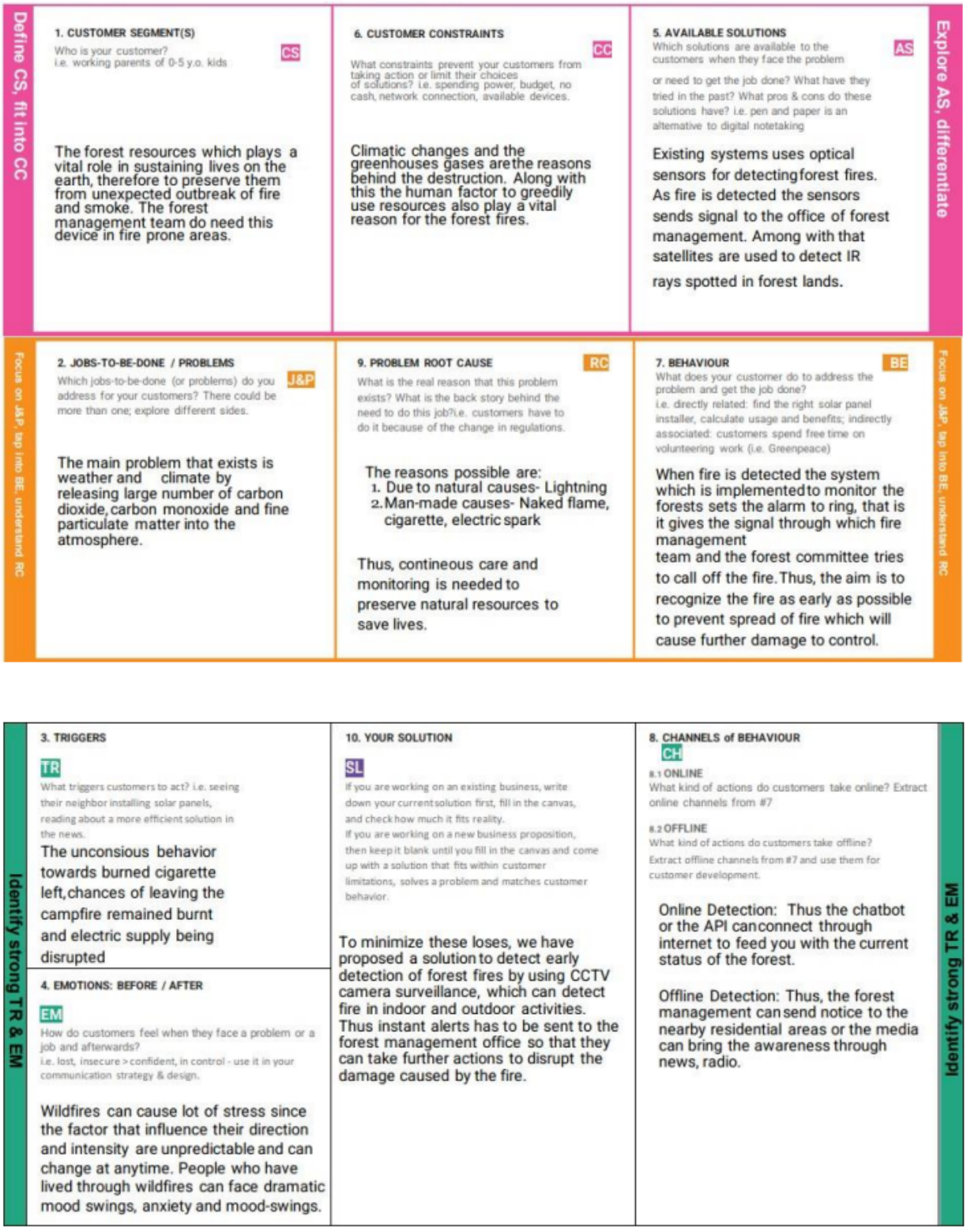
Step-2: Brainstorm, Idea Listing and Grouping



3.3 Proposed Solution:

S/no	Parameter	Description
1	Problem Statement (Problem to besolved)	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.
3	Novelty / Uniqueness	Real time computer program detect forestfirein earliest before it spreadto larger area.
4	Impact on society	Blocked roads and railway lines,electricity, mobile and land telephone linescut,destruction of homes and industries.
5	Business Model(Revenue Model)	The proposed methodwas implemented using the Python programming language on a Core i3or greater (CPU and 4GB RAM.)
6	Scalability of the Solution	Computer visionmodels enable landcover classification and smoke detection from satellite and ground cameras

3.4 Problem Solution fit:



4. REQUIREMENT ANALYSIS

4.1 Functional requirement:

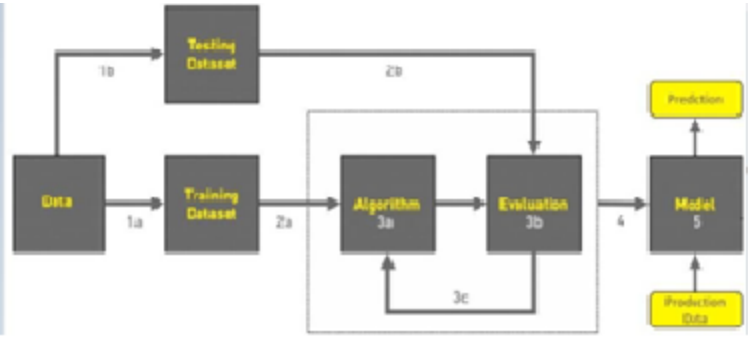
FR No.	Functional Requirement (Epic)	SubRequirement (Story / Sub-Task)
FR-1	User Registration	Registration throughGmail
FR-2	User Confirmation	Confirmation via EmailConfirmation via OTP
FR-3	User Login	Login usingcredentials
FR-4	User Search	Search forInfo on forestfire occurrence
FR-5	User Profile	User shall be givena live feedof the forest
FR-6	User Application	User is alerted if there is a forestfire occurrence intheirsurroundings

4.2 Non-Functional requirements:

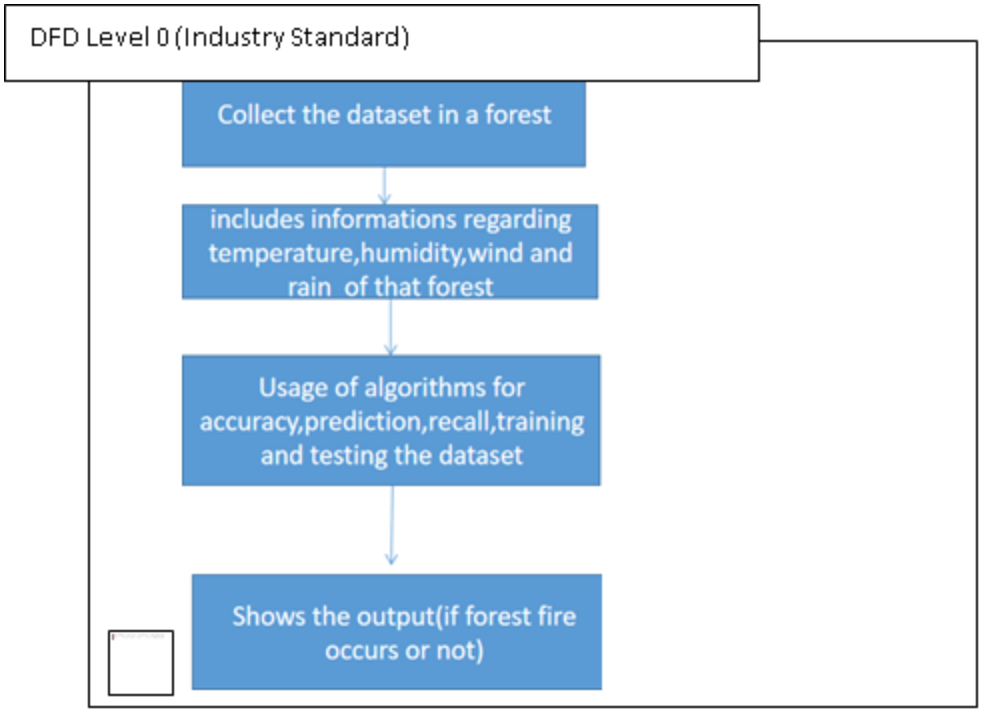
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Alerts according to the userlocation
NFR-2	**Security**	Instant live feed withalert of thesituation
NFR-3	**Reliability**	The prediction of the forest fire is 87% accurate
NFR-4	**Performance**	The feed and the alert message an immediateaction withouta lag
NFR-5	**Availability**	The application gives alertsand live feeds24/7
NFR-6	**Scalability**	Early detection and alerting usersare doneefficiently and in a faster means

5. PROJECT DESIGN

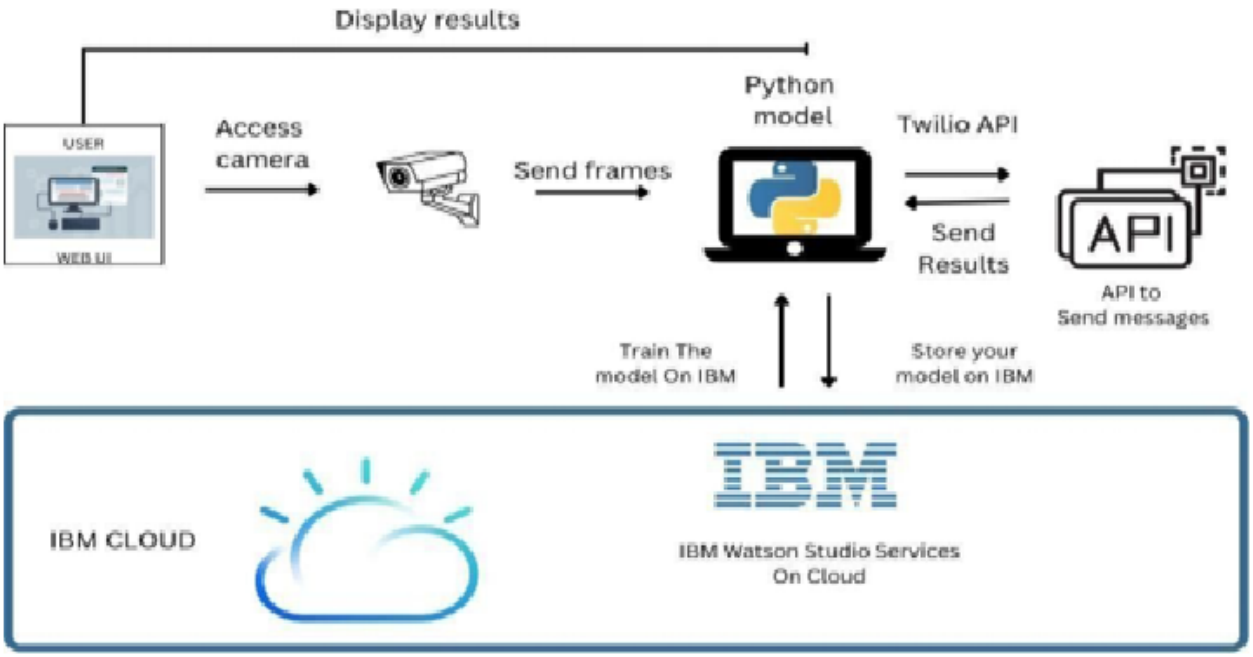
5.1 Data Flow Diagrams:



1. COLLECT DATA
2. EVALUATE DATA SET
3. IMPLEMENT ALGORITHMS
4. EVALUATE THE ACCURACYOF EACH ALGORITHMS
5. DISPLAY RESULTS



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 thedata of theforest which includes temperature,humidity,wind and rain of theforest	It is necessary to collectthe right data else the prediction may becomewrong	High	Sprint-1
		USN-2	Identify algorithms that can be used forprediction	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 themost 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 theright output	High	Sprint-3
		USN-6	Outputs from eachalgorithm are obtained	It is highly used to predictthe 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	Hariharan V Velan T Mukesh M Kameshkannan J Santhosh Kumar R
Sprint-1		USN-2	Image preprocessing	20	High	Hariharan V Velan T Mukesh M Kameshkannan J Santhosh Kumar R
Sprint-2	Model Building	USN-3	Import the required libraries, add the necessarylayers and compile the mode	20	High	Hariharan V Velan T Mukesh M Kameshkannan J Santhosh Kumar R
Sprint-2		USN-4	Training theimage classification model using CNN	20	High	Hariharan V Velan T Mukesh M Kameshkannan J Santhosh Kumar R
Sprint-3	Training and Testing	USN-5	Training the model and testing the model's performance	20	High	Hariharan V Velan T Mukesh M Kameshkannan J Santhosh Kumar R
Sprint-4	Implementation of theapplication	USN-6	When it is the wildfire then the alarmingsystem 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	Hariharan V Velan T Mukesh M Kameshkannan J Santhosh Kumar R

6.2 Sprint Delivery Schedule:

Sprint	Total story points	Duration	Sprint StartDate	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)
```

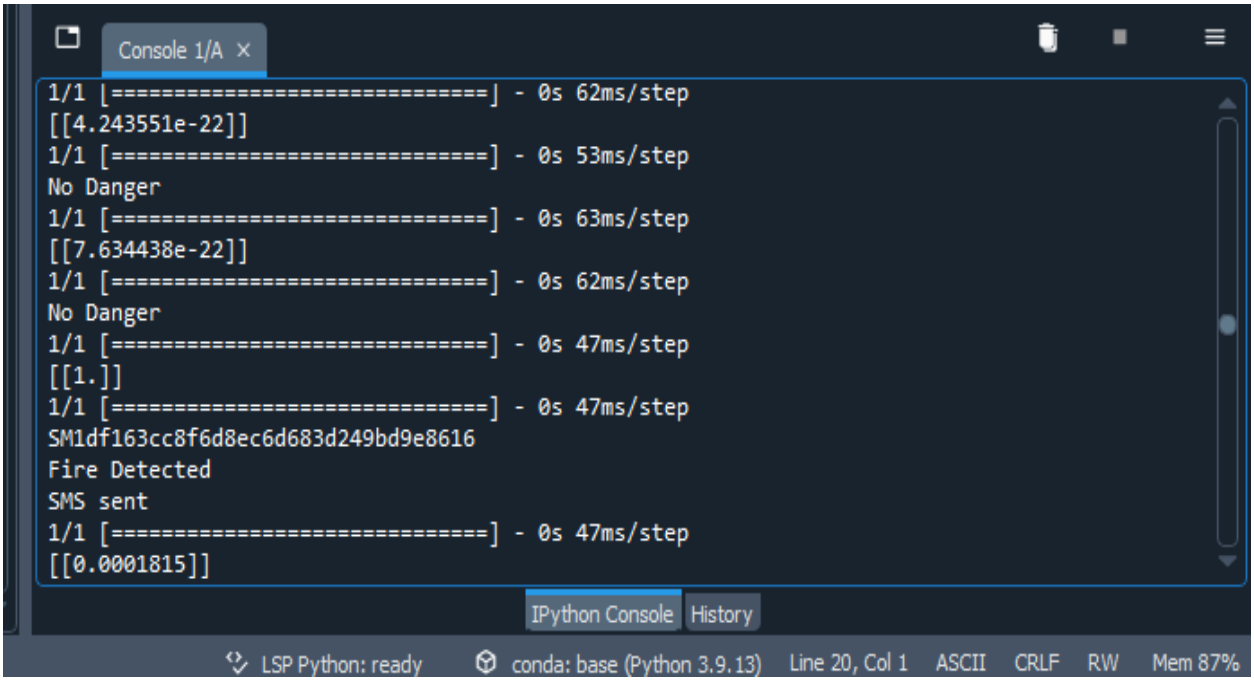
In [ ]:
```

```

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.



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:

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

DISADVANTAGES:

- The system is essentially useless if the batteries aren't charged, since it won't work properly.
- 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 = 'a59cd5e5fdfddcc9ab008273557f8f78'
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 = 'a59cd5e5fdfddcc9ab008273557f8f78'
        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-30317-1660144027

Project Demo Link:

https://www.youtube.com/watch?app=desktop&v=Gx_6e-lpxTc