EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

Project Outline

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 NPhard. 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.

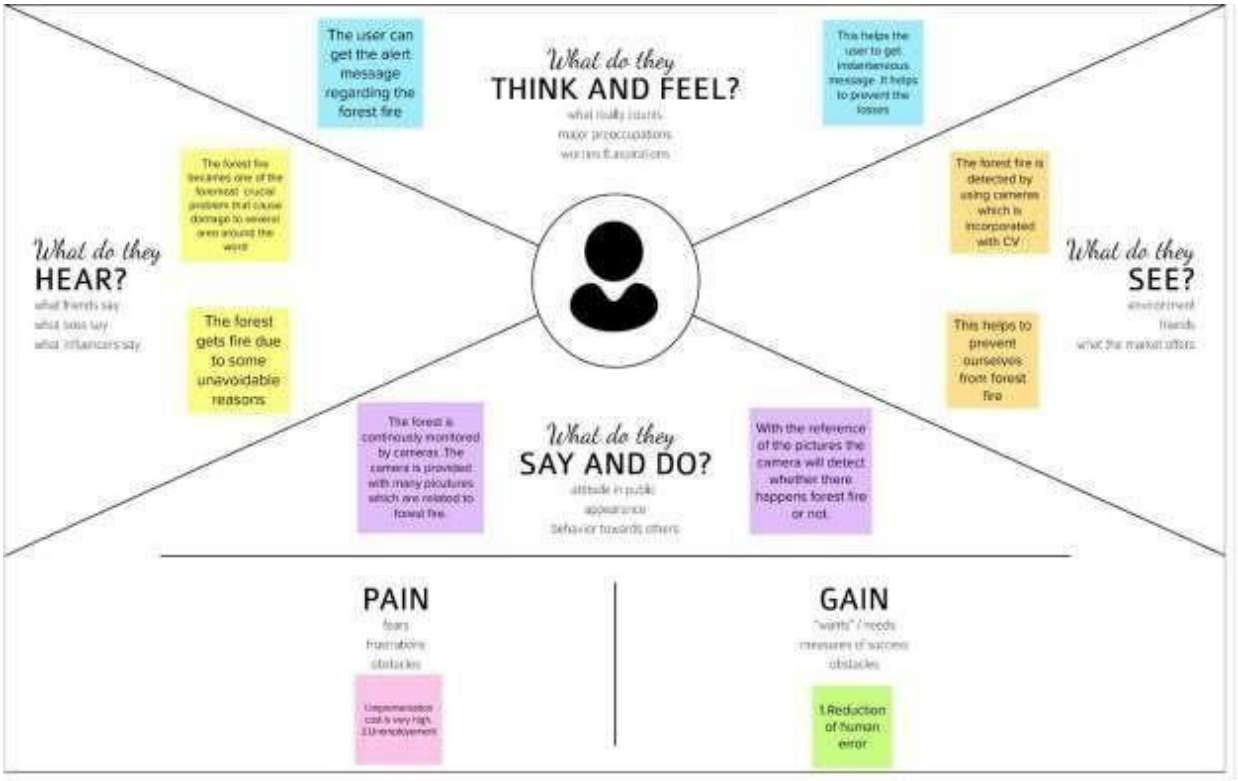
2.3 Problem Statement Definition:

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.

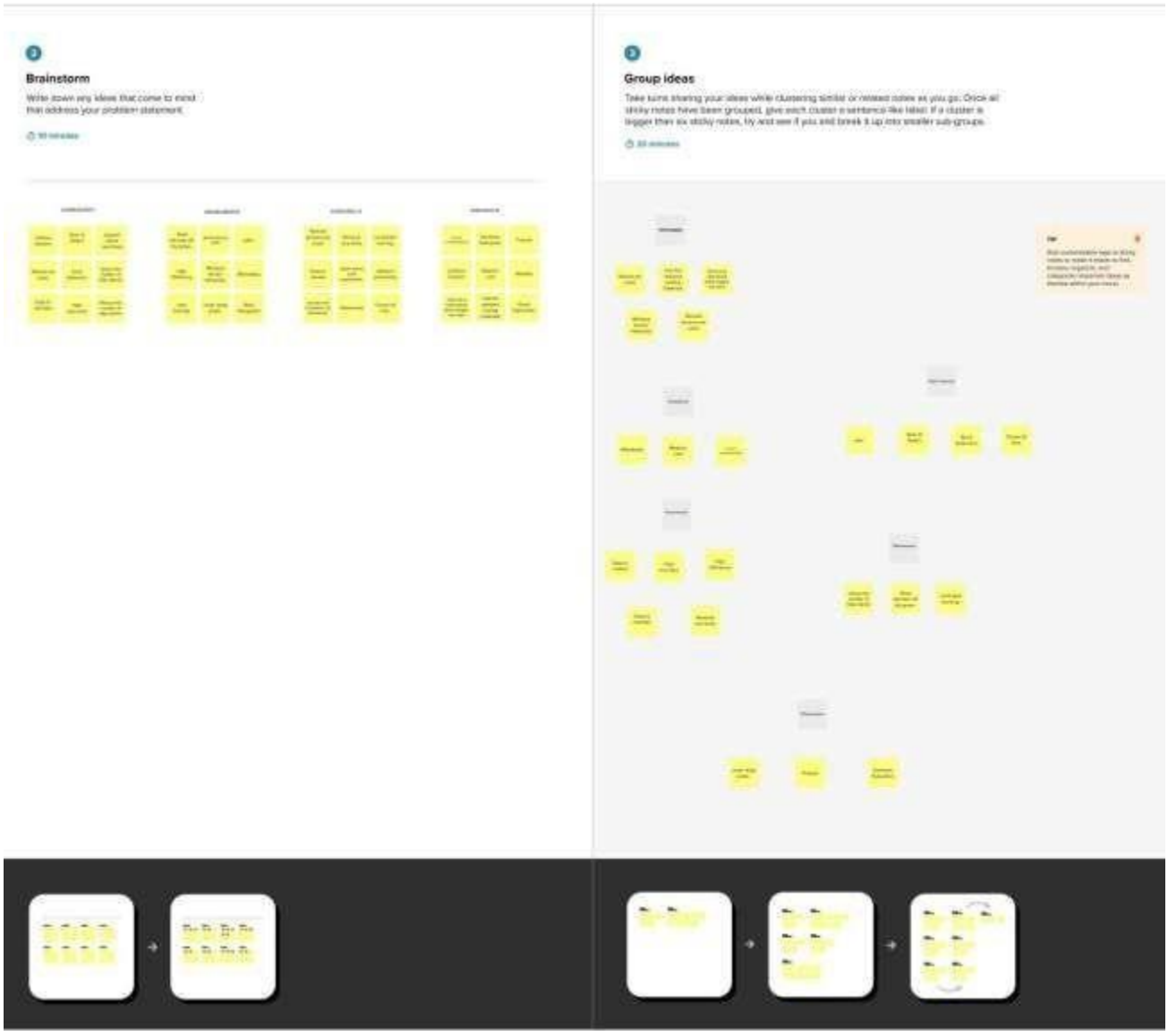


3.2 Ideation & Brainstorming:

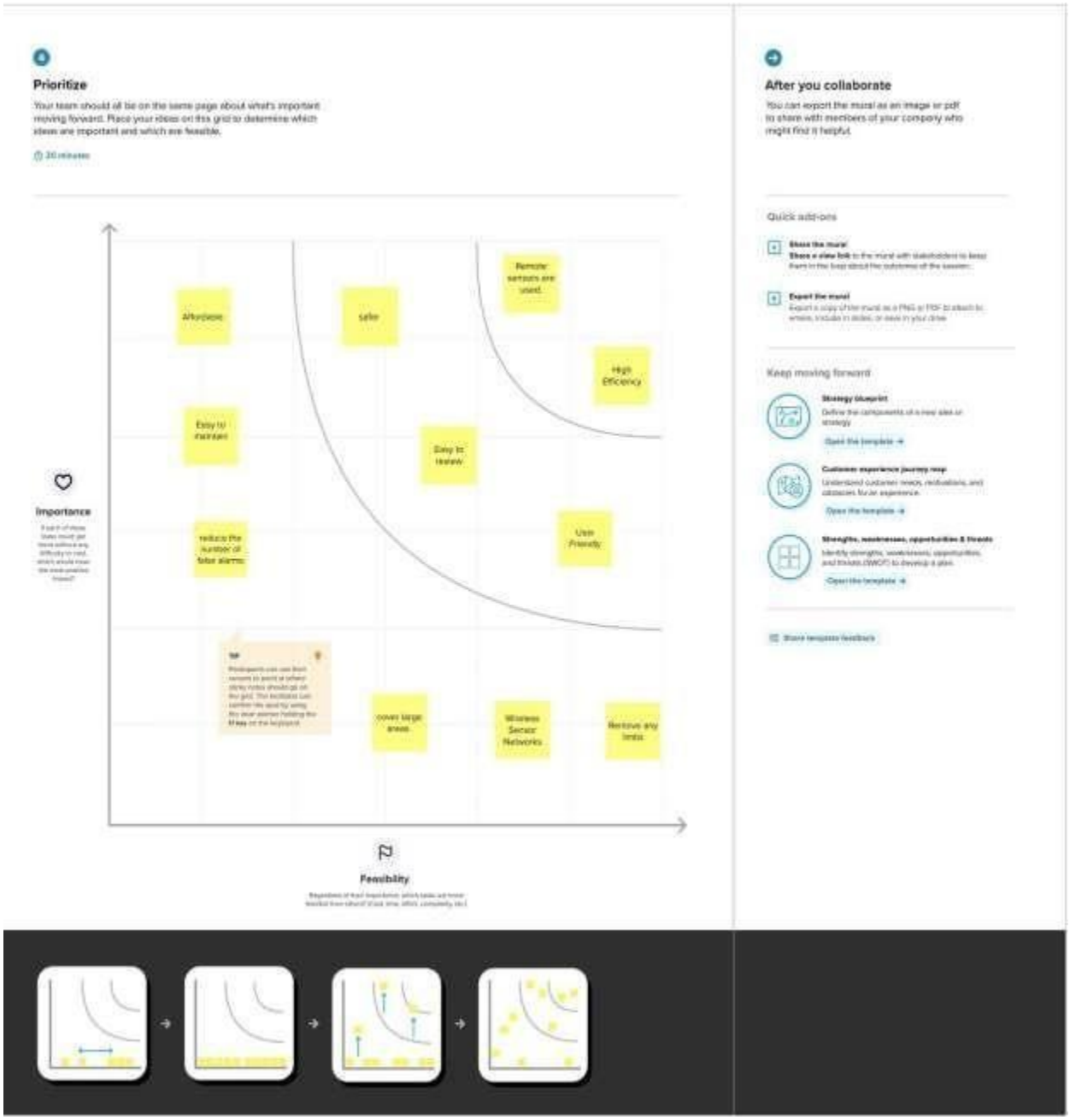
Ideation

Brainstorming

GrouStep-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization

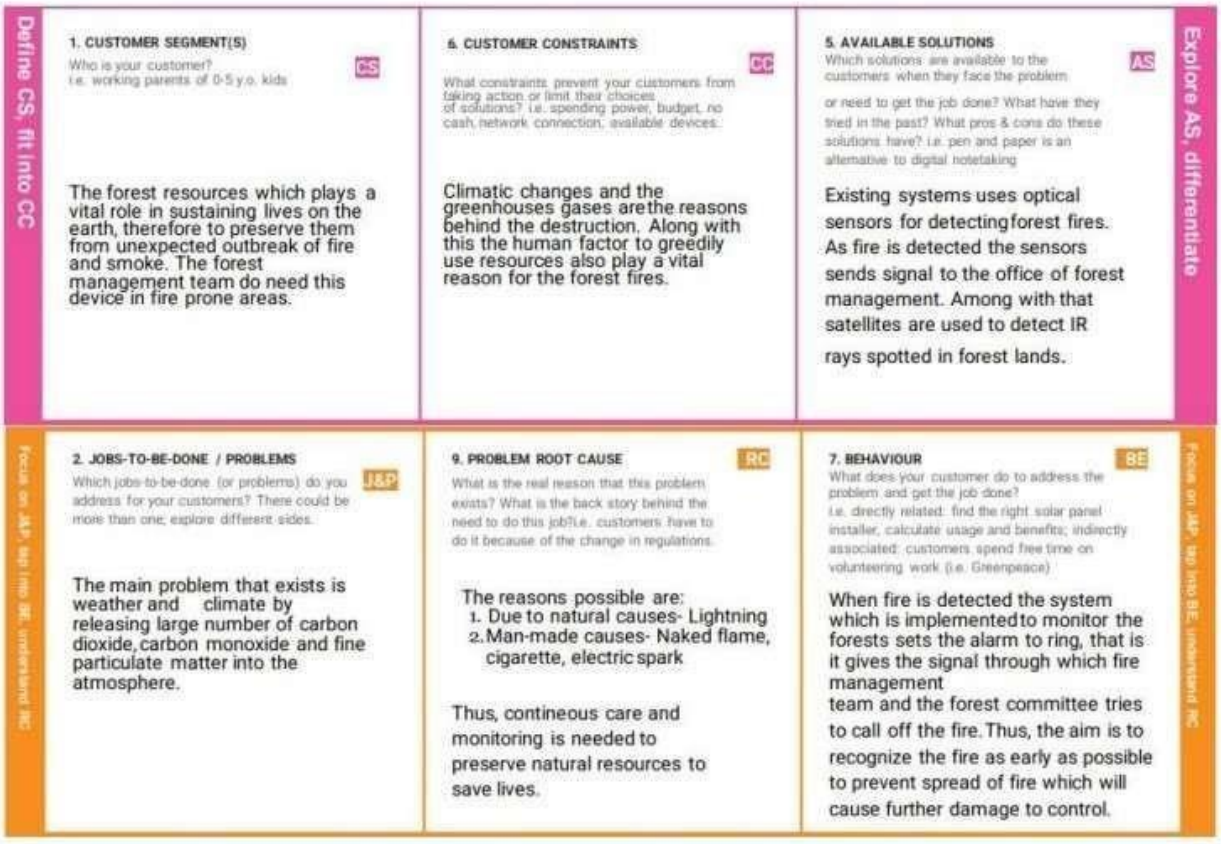


3.3 Proposed Solution:

S/no	Parameter	Description

1	Problem Statement (Problem to be solved)	A forest fire 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 forestfire in earliest before it spread to 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 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 landcover classification and smoke detection from satellite and ground cameras

3.4 Problem Solution fit:



4. REQUIREMENT ANALYSIS

4.1 Functional requirement:

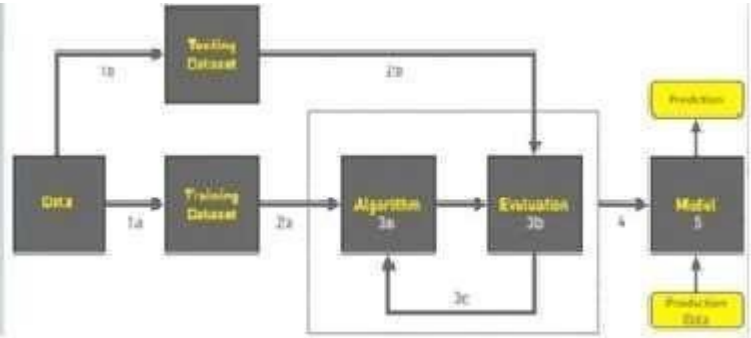
FR No.	Functional Requirement (Epic)	SubRequirement (Story / Sub-Task)
FR-1	User Registration	Registration through Gmail
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User Login	Login using credentials
FR-4	User Search	Search for Info on forest fire occurrence
FR-5	User Profile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

4.2 Non-Functional requirements:

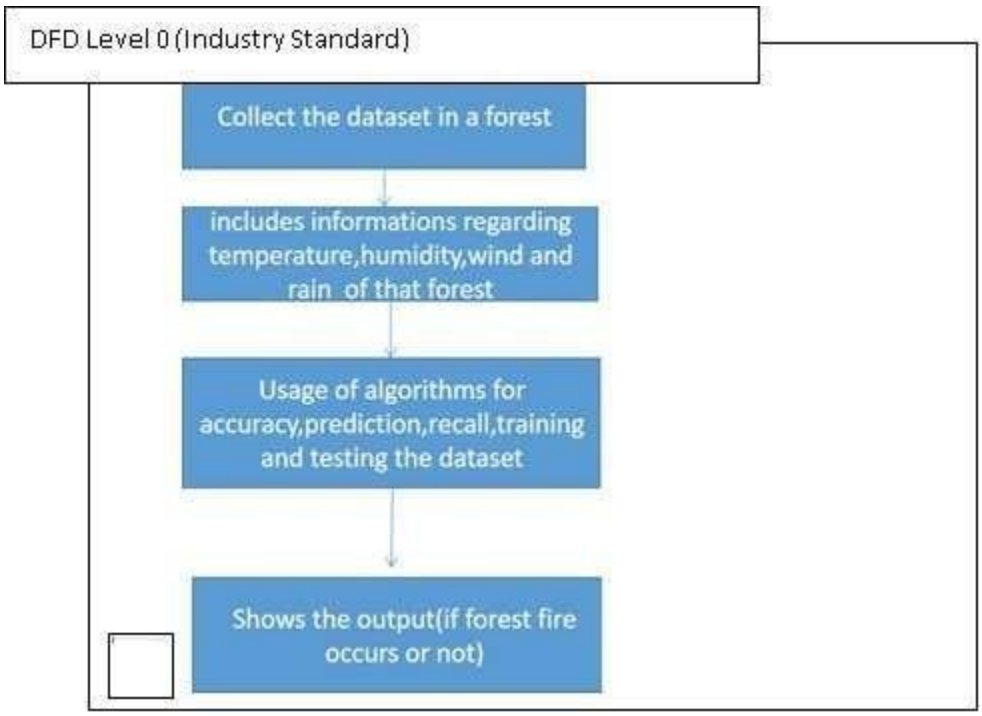
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Alerts according to the user location
NFR-2	**Security**	Instant live feed with alert of the situation
NFR-3	**Reliability**	The prediction of the forest fire is 87% accurate
NFR-4	**Performance**	The feed and the alert message an immediate action without a lag
NFR-5	**Availability**	The application gives alerts and live feeds24/7
NFR-6	**Scalability**	Early detection and alerting users are done efficiently and in a faster means

5. PROJECT DESIGN

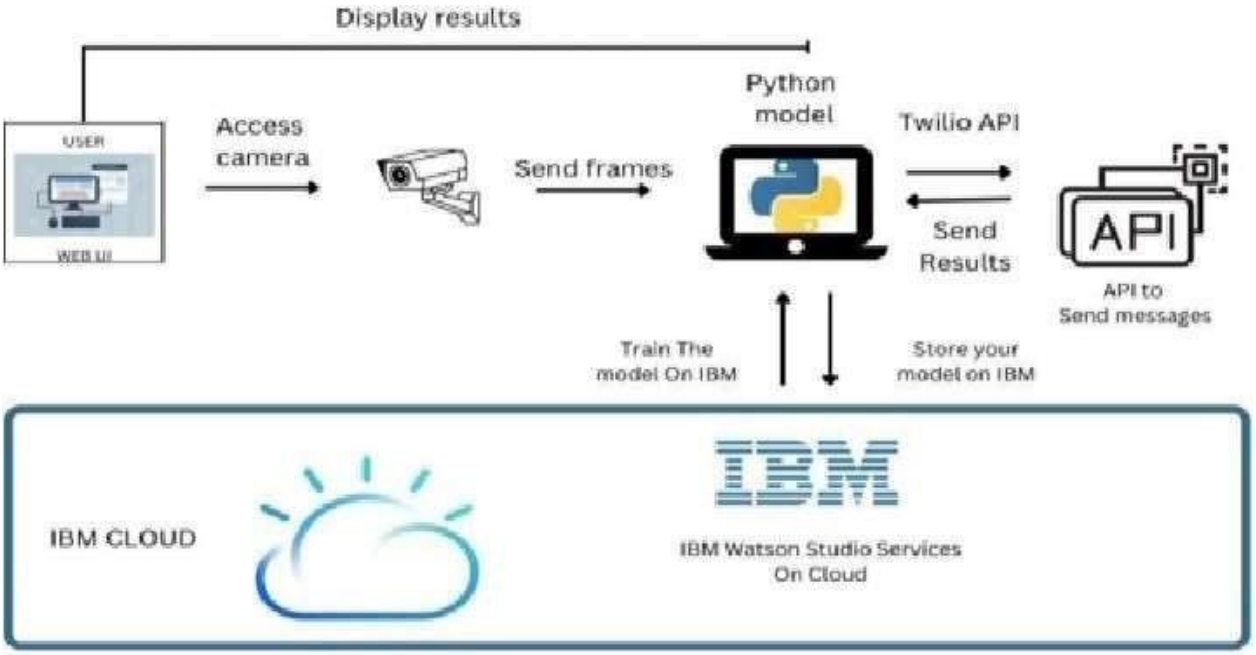
5.1 Data Flow Diagrams:



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 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 be come 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	PIREVEEN KUMAR PRABAKARAN CHANDRU KANNAN
Sprint-1		USN-2	Image preprocessing	20	High	PIREVEEN KUMAR PRABAKARAN CHANDRU KANNAN
Sprint-2	Model Building	USN-3	Import the required libraries, add the necessary layers and compile the mode	20	High	PIREVEEN KUMAR PRABAKARAN CHANDRU KANNAN
Sprint-2		USN-4	Training the image classification model using CNN	20	High	PIREVEEN KUMAR PRABAKARAN CHANDRU KANNAN
Sprint-3	Training and Testing	USN-5	Training the model and testing the model's performance	20	High	PIREVEEN KUMAR PRABAKARAN CHANDRU KANNAN
Sprint-4	Implementation of the application	USN-6	When it is the wildfire then the alarming 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	PIREVEEN KUMAR PRABAKARAN CHANDRU KANNAN

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	26 Oct 2022	31 Oct 2022	20	31 Oct 2022
Sprint-2	20	6 Days	02 Nov 2022	07 Nov 2022	20	07 Nov 2022
Sprint-3	20	6 Days	09 Nov 2022	14 Nov 2022	20	14 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)

6.3 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.

```
train_dataset=test.flow_from_directory("/content/drive/MyDrive/Dataset/Train set",
                                       target_size=(128,128),
                                       batch_size=32,
                                       class_mode='binary' )
```

```
Found 95 images belonging to 2 classes.
```

```
[ ] test_dataset=test.flow_from_directory("/content/drive/MyDrive/Dataset/Test set",
                                          target_size=(128,128),
                                          batch_size=32,
                                          class_mode='binary' )
```

```
Found 100 images belonging to 2 classes.
```

6.4 Feature 2:

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

```
[ ] model = load_model("/content/drive/MyDrive/forest.h5")
```

```
def predictImage(filename):
  img1 = image.load_img(filename,target_size=(128,128))
  Y = image.img_to_array(img1)
  X = np.expand_dims(Y,axis=0)
  val = model.predict(X)
  print(val)
  if val == 1:
    print(" fire")
  elif val == 0:
      print("no fire")
```

```
predictImage("/content/drive/MyDrive/Dataset/Test set/with fire/with fire (1).jpg")
```

```
1/1 [==============================] - 41s 41s/step
[[1.]]
 fire
```

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

7. TESTING

7.1 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.

7.2 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.

8. RESULTS

8.1 Performance Metrics:

Model evaluation

```
[ ]  model = load_model("/content/drive/MyDrive/forest.h5")
```

```
def predictImage(filename):
  img1 = image.load_img(filename,target_size=(128,128))
  Y = image.img_to_array(img1)
  X = np.expand_dims(Y,axis=0)
  val = model.predict(X)
  print(val)
  if val == 1:
    print(" fire")
  elif val == 0:
      print("no fire")
```

```
predictImage("/content/drive/MyDrive/Dataset/Test set/with fire/with fire (1).jpg")
```

```
1/1 [==============================] - 41s 41s/step
[[1.]]
 fire
```

9. 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.

10. CONCLUSION

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

11. 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.

12. APPENDIX

Source Code: Python code

```
 import cv2
from playsound import playsound
from twilio.rest import Client



fire_cascade = cv2.CascadeClassifier('fire_detection.xml')

cap = cv2.VideoCapture(0)

while(True):
   ret, frame = cap.read()
   gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
   fire = fire_cascade.detectMultiScale(frame, 1.2, 5)

   for (x,y,w,h) in fire:
      cv2.rectangle(frame,(x-20,y-20),(x+w+20,y+h+20),(255,0,0),2)
      roi_gray = gray[y:y+h, x:x+w]
      roi_color = frame[y:y+h, x:x+w]
      print("Fire is detected 🔥🔥")
      playsound('audio.mp3')



      account_sid = 'ACf232c8d290c2e56b760b27dcfe4a481e'
      auth_token = '329e940af6e7ee375f8fd4a2a94968bc'
      twilio_number = '+19803757860'
      target_keys = '+919962828967'
      client = Client(account_sid, auth_token)
      message = client.messages.create(
         body="yelaii pathikichuleyyy 🔥",
         from_=twilio_number,
         to=target_keys
      )
      print(message.body)
      exit()
```

```
cv2.imshow('frame', frame)
if cv2.waitKey(1) & 0xFF == ord('q'):
    break
```

GitHub Link:

https://github.com/IBM-EPBL/IBM-Project-46091-1660737286