Project Report Format

EMERGING METHODS OF EARLY FOREST FIRE DETECTION

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CHAPTER 1
INTRODUCTION

1.1 PROJECT OVERVIEW

Machine learning and deep learning play an important role in computer technology and artificial intelligence. With the use of deep learning and machine learning, human effort can be reduced in recognizing, learning, predictions and in many more areas.

Forest fire detection is the ability of computer systems to recognise Fire from various regions of the forest , such as fire, smoke, and so on. This

the project aims to let users take advantage of machine learning to reduce manual tasks in Detecting forest fires.

1.2 PURPOSE

The main aim of our project is the detection and monitoring the forest fire To minimize the effect of fire breakout by controlling in its early stage and also to protect Domestic by informing about the breakout to the respective forest department as early as possible. We have implemented the IIoTtechnology to achieve our objective.

CHAPTER 2
LITERATURE SURVEY

2.1 EXISTING PROBLEM

Some of the relevant literary works in this field are briefed below:
The one-fourth area of Karnataka is covered by forest, the forest and biodiversity of India are at the considerable chance and under enormous pressure. The general causes of forest fires are extremely hot and aired weather, lightning and human carelessness. To protect these huge stretches of forest land, there need to be taken early caution measures to control of spreading fire

2.2 REFERENCES

1. **A Review on Early Forest Fire Detection Systems Using Optical Remote Sensing**

- P. Barmpoutis, P. Papaioannou, K. Dimitropoulos, N. Grammalidis
- Environmental Science
- Sensors
- 2020

An overview of the optical remote sensing technologies used in early fire warning systems is presented and an extensive survey on both flame and smoke detection algorithms employed by each technology is provided.

2. Forest Fire Detection System using LoRa Technology

- N. Gaitan, Paula Hojbota
- Environmental Science
- 2020

This paper proposes a system capable of quickly detecting forest fires on long wide distances using LoRa (Long Range) technology based on LoRaWAN (Long Range Wide Area Network) protocol which is capable to connect low-power devices distributed in large geographical areas.

3. **Low-Cost LoRa-based Network for Forest Fire Detection**

- Roberto Vega-Rodríguez, Sandra Sendra, Jaime Lloret, Pablo Romero-Díaz, José Luis García-Navas
- Computer Science, Environmental Science

2019 Sixth International Conference on Internet of Things: Systems, Management and Security(IOTSMS) 2019

A low-cost Long Range (LoRa) based network is able to evaluathe te level of fire risk and the presence of a forest fire and the evaluation algorithm is based on the 3030-30rule.

i. **A Survey of Machine Learning Algorithms Based Forest Fires Prediction and Detection Systems**

1. F. Abid
2. Environmental Science, Computer Science
3. Fire Technology
4. 2020

A comprehensive survey of the machine learning algorithms-based on forest fires prediction and detection systems is presented, highlighting the main issues and outcomeswithin each study.

B.PROBLEM STATEMENT DEFINITION

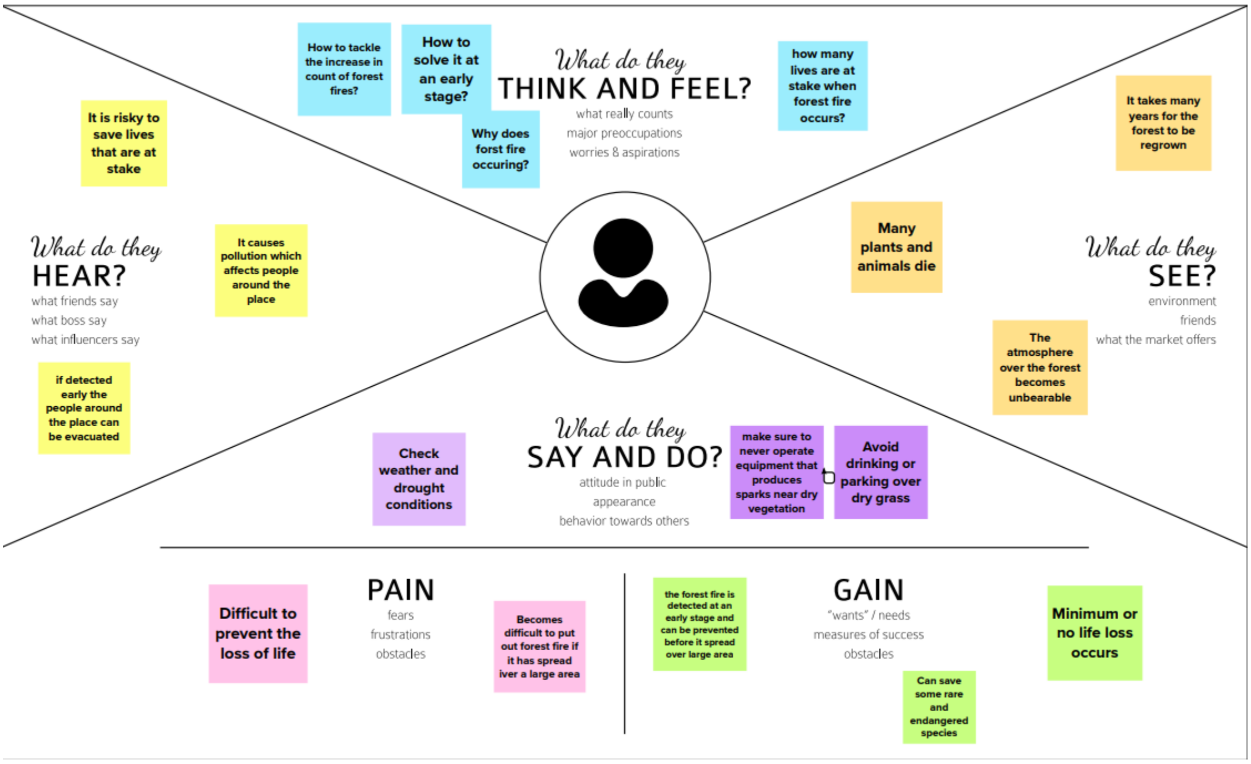
Some people know about the current issues are the most important ones because it is mostly a lot in the news but sometimes other big issues that change our lives are not mentioned in the news because they are issues that canhurt us in the long run or not really important for the modern public. One issue

I can tell you about is the forest fires. Sometimes people don 't notice or now about the forest fires until it is talk in the news and it 's mostly because it has donea great damage.

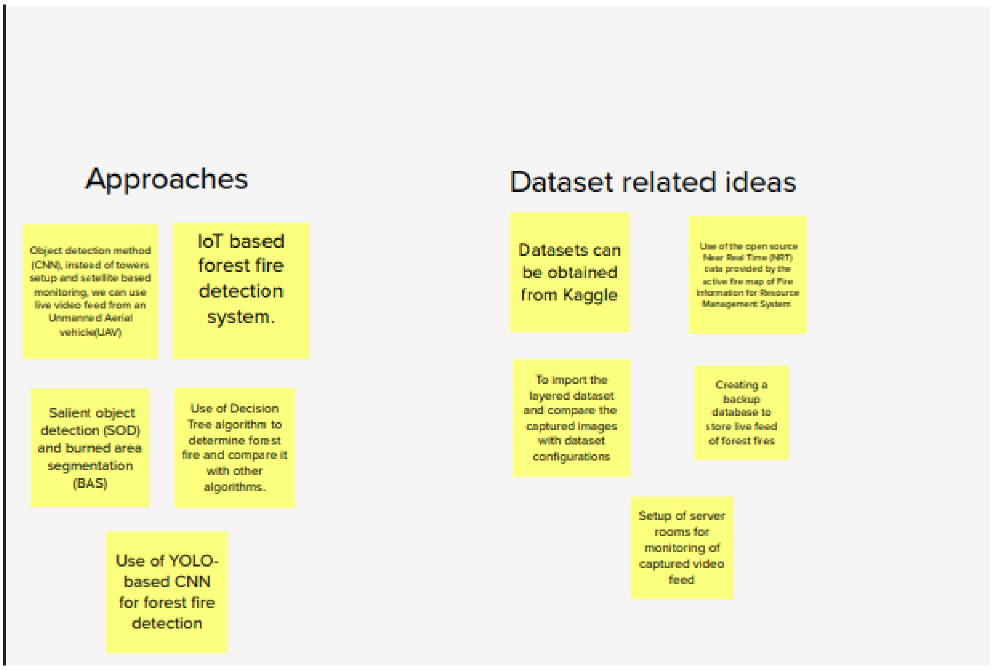
CHAPTER 3

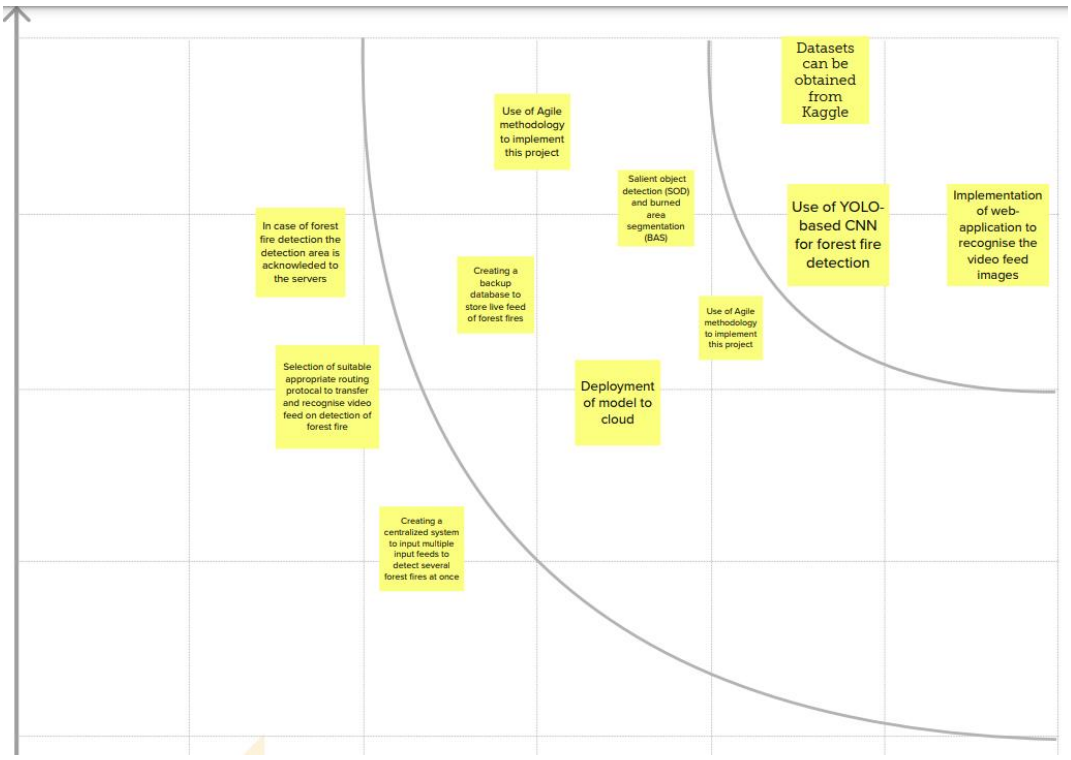
IDEATION AND PROPOSED SOLUTION

EMPATHY MAPPING:



IDEATION & BRAINSTROMING



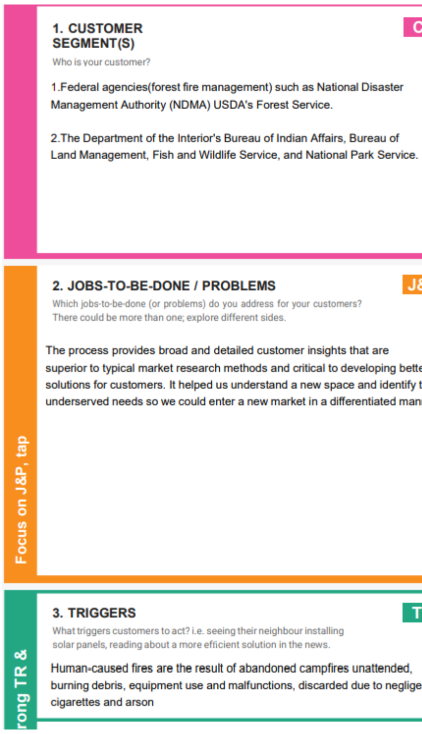


3.3 PROBLEM SOLUTION

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	To find emerging methods for early detection of forest fires using artificial intelligence.
2.	Idea / Solution description	In case of forest fire detection the burning substances are primarily identified as sceptical flame regions using a division strategy to expel the non-fire structures and results are verified by a deep learning model.
3.	Novelty / Uniqueness	Accurate and reliable recognition of sceptical flame regions by means of using YOLO v3 algorithm.

4.	Social Impact / Customer Satisfaction	1. By using this method we can save environmental damage and lives of living beings. 2. It is fast and accurate method to detect the fire easily and give an alert to the forest fire department simultaneously when the fire is detected.
5.	Business Model (Revenue Model)	The software platform to provide the fully autonomous processing of data received from the camera of UAV to obtain live feed in web App.
6.	Scalability of the Solution	It is mainly developed for detecting the forest fire across the world and useful in surveillance the different sections of the forest.

3.4 PROBLEM FIT SOLUTION



CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

Sn. No	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
1.	User Registration	Registration through G-mail.
2.	User Confirmation	Confirmation through OTP. Confirmation through mail.
3.	User Login	Can login through credentials.
4.	User Feed	The live update of the forestcover is sent to user if there is any detection of fire
5.	User Profile	The workers profile created to give the forest management live track of the forest.
6.	User Alert	The user receives thequick response through alert sound or Messages,if any fire is detected.
7.	User Application	Along with the forest management team the citizens residing nearby forest can also download the application for alerts.

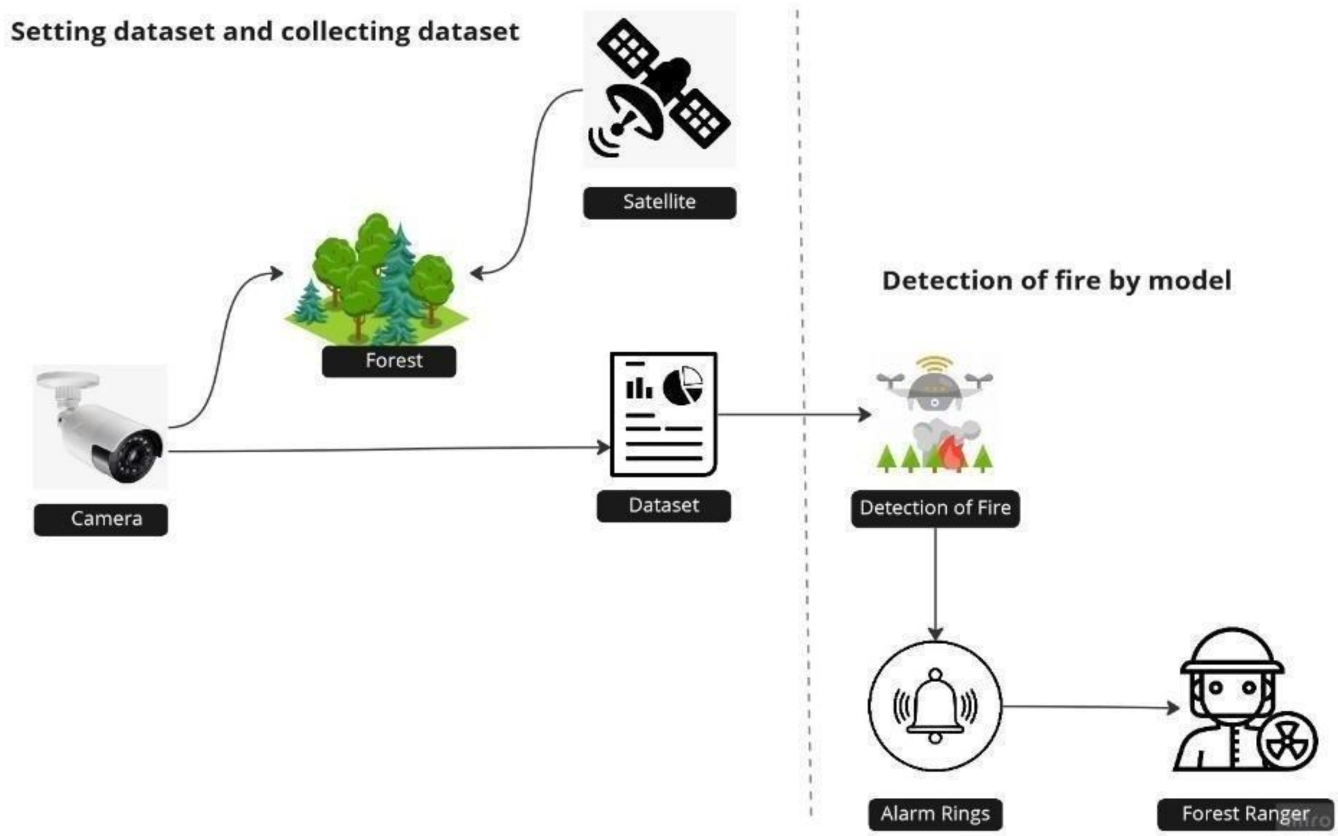
NON-FUNCTIOAL REQUIREMENTS

Sn. No.	Non-Functional Requirement	Description
1.	Usability	Monitoring possible danger areas and early firedetection can greatly reduce the response time and potential damage.
2.	Security	The environment is more secure.
3.	Reliability	The installment of model is safe.

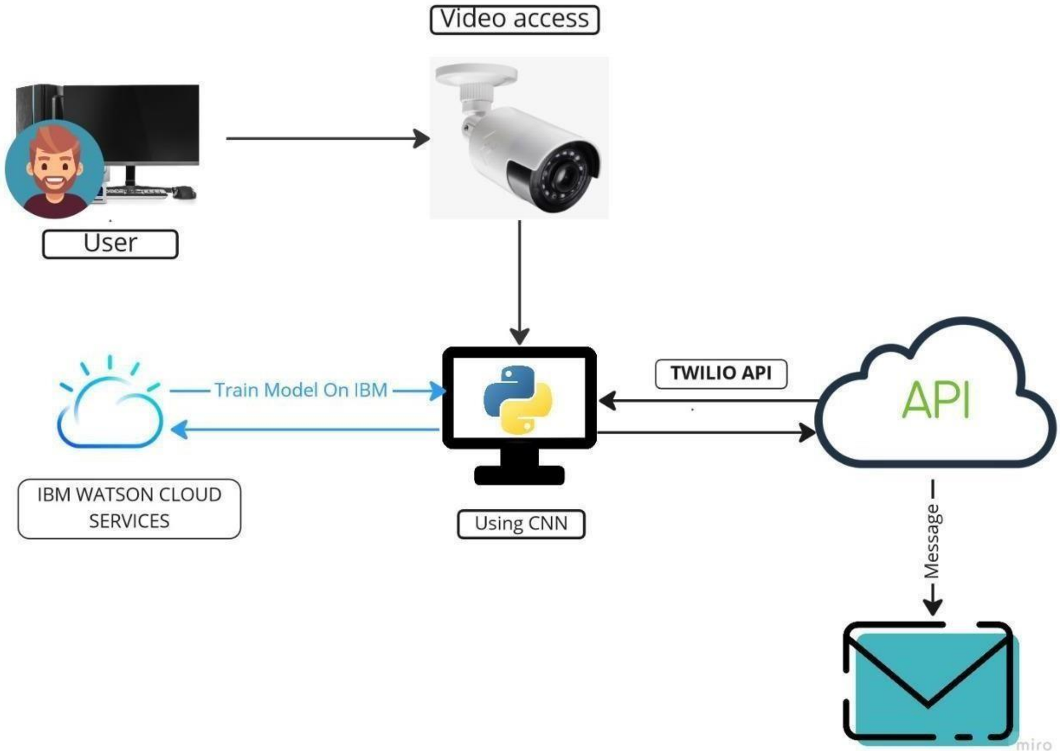
4.	Performance	Model will achieve high accuracy.
5.	Availability	Build model is available all the time.
6.	Scalability	The instant alerts received by the forest team is ensured.

CHAPTER 5

PROJECT DESIGN


Setting dataset and collecting dataset
Satellite
Forest
Camera
Dataset
Detection of fire by model
Detection of Fire
Alarm Rings
Forest Ranger

3.2 SOLUTION & TECHNICAL



5.3 USER STOIRES

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Forest Management Team	Setting up a camera	USN-1	As a user, the forest management team has to survey the forest by adding camera to the fire prone areas.	The live video captured can be monitored	High	Sprint-1
		USN-2	As a user, the forest management team can get video feed which is used for processing	The camera sends video or image to the forest centre	High	Sprint-2
		USN-3	Along with forestteam, the NGO can also get access of the video to take some early measurement of forest fires.	They can also get the view of the live monitoring of forest	Low	Sprint-1
Technica lTeam	Image Classificatio n	USN-4	By using CNN Model, the images captured by the camera is classified accordingly by testing & training the model	The model should be able to identify the difference between fire and a normal smoke	Medium	Sprint-2
	Using Open CV	USN-5	The recorded video is under monitoring continuously to determine the detection of early video	Therefore, by using CNN we can determine the input layer, classify the hidden layers and send warnings through output layer	High	Sprint-2
Alert Team	Dashboard	USN-6	Thus, after successful detection of fire by processing images. This, API sends the alert by buzzing the alarm and sends messages through chatbot	Thus, the immediate response which is required for earlier determination through sending quick responses	High	Sprint-2
Fire Management	Twilio API		They play the most important role to cool the	They take the following measures to	High	Sprint-2

			fire and manage the excess spread of fire further	stop fire from spreading		
User Type	**Functional Requirement (Epic)**	**User Story Number**	**User Story / Task**	**Acceptance criteria**	**Priority**	**Release**
Media & Nearby Residin g People	News, Radio, Alerts,	USN-7	Protecting wildlife, human from the disaster caused	Thus, helping unitshould be sent to protect lives	Medium	Sprint-2

CHAPTER 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	Import the Required, Collecting the Dataset	USN-1	To analyse the fire prone areas and to set the surveillance camera to collect and observe the region continuously for early detection.	2	High	Nakul Anand C Vasanth K Deepak K Santhosh S
Sprint-2	Training & Testing of model	USN-2	The collected data are categorized on the basis of parameters set to identify. To train the model, CNN is used to test repeatedly by storing the datasets in server.	1	High	Nakul Anand C Vasanth K Deepak K Santhosh S
Sprint-3	Model Building, Reviewing the model	USN-3	The main task is to check that the model is efficient to work in real time. Therefore, smallest of error decoded needed to be corrected to avoid future lags	1	Medium	Nakul Anand C Vasanth K Deepak K Santhosh S
Sprint-4	Implementing the model	USN-4	The model after testing all it’s functionalities is been implemented at forest management offices to get quick responses from the model.	2	High	Nakul Anand C Vasanth K Deepak K Santhosh S

Sprint-4	Connecting it with API	USN-5	The model should connect with API named Twilio, which receives &sends the management with messages.	2	High	Nakul Anand C Vasanth K Deepak K Santhosh S

6.2 SPRINT DELIVERY SCHEDULING

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint EndDate (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	15	06 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	10	14 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	5	\ 20 Nov 2022

CHAPTER 7

CODING AND SOLUTIONING

```python
import cv2
import numpy as np
from tensorflow.keras.preprocessing import image
from tensorflow.keras.models import load_model
from twilio.rest import Client
from playsound import playsound
from decouple import config


message_sent = False

model = load_model("./model.h5")

video = cv2.VideoCapture("fire.mp4")

name = ["No fire", "Fire Detected"]


def send_message():
    account_sid = config("ACCOUNT_SID")
    auth_token = config("AUTH_TOKEN")

    client = Client(account_sid, auth_token)
    message = client.messages.create(
        body="Forest Fire detected , Stay safe!!!",
        from_=config("FROM"),
        to=config("TO")
    )
    print(message.sid)
    print("Fire Detected")
    print("SMS Sent!")

playsound("./beep.mp3")
```

```python
while True:
    success, frame = video.read()
    cv2.imwrite("image.jpg", frame)
    img = image.load_img("image.jpg", target_size=(128, 128))
    x = image.img_to_array(img)
    x = np.expand_dims(x, axis=0)
    pred = model.predict(x)
    p = int(pred[0][0])
    cv2.putText(frame, str(name[p]), (100, 100), cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 0), 1)

    if p == 1:
        if not message_sent:
            send_message()
            message_sent = True
        print("Fire Detected , stay safe!!!")
    else:
        print("No Fire Detected")

    cv2.imshow("Image", frame)

    if cv2.waitKey(1) & 0xFF == ord('x'):
        break

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

CHAPTER 8

TESTING

8.1 TEST CASES

Test case ID	Feature Type	Component	Test Scenario	Steps To Execute	Test Data	Expected Result	Actual Result	Status	BUG ID
OP_RT_001	Functional	Page	Check if user can upload theirfile	The sensor senses the fire	Sample 1.png	The input image should be uploaded to the application successfully	Working as expected	PASS	
OP_RT_002	Functional	Page	Check if user cannot upload unsupported files	1) The sensor senses thefire 2)checks with the pre-uploads images	installer.exe	The application should not allow user to select anon image file	User is able to uploadany file	FAIL	BUG_HP_002
OP_RT_003	Functional	Page	Checks whether the page redirects to the result page tothe given output	1) The sensor senses the fire2)checks with the pre-uploaded images 3)checks if there is fire detection	Sample 1.png	The page should redirect to the resultspage	Working as expected	PASS	
MB_RT_001	Functional	Backend	Checks if all the routes areworking properly	1) The sensor senses the fire2)checks with the pre-uploaded images 3)checks if there is firedetection	Sample 1.png	All the routes should properlywork	Working as expected	PASS	
N_DC_001	Functional	Model	Checks whether thecan model various handle sizes image	1) Open the page in a specificdevice 2) Upload the input image 3) Repeat the above stepswith different input	Sample 1.png Sample 1 XS.png Sample 1 XL.png	The model should rescale the image and predictthe results	Working as expected	PASS	
N_DC_002	Functional	Model	Check if the model predictsthe digit	1) Open the page 2) Select the input images	Sample 1.png	The model should predictthe number	Working as expected	PASS	
N_DC_003	Functional	Model	Check if the model can handle complex inputimage	1) Open the page 2) Select the input images 3) Check the results	Complex Sample.png	The model should predict the number in thecompex image	The model fails to identify the digit since the model is not built tohandle such data	FAIL	BUG_M_001
RL_DC_001	Functional	Result Page	Verify the elements	1) Open the page 2) Select the input image 3) Check if all the UI elementsare displayed properly	Sample 1.png	The Result page must be displayed properly	Working as expected	PASS	
RL_DC_002	Functional	Result Page	Check if that image is displayed properly	1) Open the page 2) Select the input image 3) Check if the input imageare displayed	Sample 1.png	The input imageshould be displayed properly	The size of the input image exceeds the display container	FAIL	BUG_RP_001
RL_DC_003	Functional	Result Page	Checks whether the displayed predictionis accurate	1) Open the page 2) Select the input image 3) Check if all the other predictions are displayed	Sample 1.png	The other predictions should be displayedproperly	Working as expected	PASS	

8.2 USER ACCEPTANCE TESTING

8.2.1 DEFECT ANALYSIS

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Total
By Design	1	1	1	0	3
Duplicate	0	0	0	0	0
External	0	0	2	0	2
Fixed	3	1	0	1	5
Not Reproduced	0	0	0	1	1
Skipped	1	0	1	0	2
Won’t Fix	1	0	0	0	1
Total	6	3	4	3	14

8.2.2 TEST CASE ANALYSIS

Section	Total Cases	Not Tested	Fail	Pass
Client Application	10	0	2	8
Security	3	0	2	2
Performance	2	0	1	1
Exception Reporting	3	0	0	3

CHAPTER 9

RESULTS

9.1 PERFORMANCE METRICS

Locust Test Report

During: 13/12/2022, 7:05:40 AM - 13/12/2022, 7:14:47 AM

Target Host: http://127.0.0.1:5000/

Script: locust.py

Request Statistics

Method	Name	# Requests	# Fails	Average (ms)	Min (ms)	Max (ms)	Average size (bytes)	RPS	Failures/s
GET	//	1044	0	14	4	292	1080	2.2	0.0
GET	//predict	1007	0	39649	387	59814	2670	1.8	0.0
	Aggregated	2050	**0**	19464	**4**	**59814**	**1859**	4.0	**0.0**

Response Time Statistics

Method	Name	50%ile (ms)	60%ile (ms)	70%ile (ms)	80%ile (ms)	90%ile (ms)	95%ile (ms)	99%ile (ms)	100%ile (ms)
GET	//	11	12	13	15	20	22	64	290
GET	//predict	44000	46000	47000	48000	50000	52000	55000	60000
	Aggregated	37	**37000**	**43000**	**45000**	49000	**50000**	56000	**60000**


Charts
Total Requests per Second
RPS
Failures/s
6
5
4
3
2
1
0
7:05:43 AM
7:06:38 AM
7:07:33 AM
7:08:28 AM
7:09:23 AM
7:10:18 AM
7:11:13 AM
7:12:08 AM
7:13:03 AM
7:13:58 AM
Response Times (ms)
Median Response Time
95% percentile
60,000
50,000
40,000
30,000
20,000
10,000
0
7:05:43 AM
7:06:38 AM
7:07:33 AM
7:08:28 AM
7:09:23 AM
7:10:18 AM
7:11:13 AM
7:12:08 AM
7:13:03 AM
7:13:58 AM
Number of Users
Users
120
100
80
60
40
20
0
7:05:43 AM
7:06:38 AM
7:07:33 AM
7:08:28 AM
7:09:23 AM
7:10:18 AM
7:11:13 AM
7:12:08 AM
7:13:03 AM
7:13:58 AM

CHAPTER 10

ADVANTAGES & DISADVANTAGES

10.1ADVANTAGES

The proposed system detects the forest fire at a faster rate compared to existing system. It has enhanced data collection feature. The major aspect is that it reduces false alarm and also has accuracy due to the various sensors present. It minimizes human effort as it works automatically. This is very affordable due to which can be easily accessed. The main objective of our project is to receive an alert message throughan app to the respective user.

10.2 DISADVANTAGES

The electrical interference diminishes the effectiveness of the radio receiver.

The main drawback is that it has less coverage range areas.

CHAPTER 11

CONCLUSION

This type of system is the first of its kind to ensure no further damage is then to forests when there is fire breakout and immediately a message is sent to the user through the App. Immediate response or early warning to a fire breakout is mostly the only way to avoid losses and environmental, and cultural heritage damage to a great extent. Therefore the most important goals in firesurveillance are quick and reliable detection of fire. It is so much easier to suppress fire while it is in its early stages. Information about the progress of the fire is highly valuable for managing fire during all its stages. Based on this information the firefighting staff can be guided on target to block fire before it reaches cultural heritage sites and to suppress it quickly by utilizing required firefighting equipment and vehicles. With further research and innovation, this project can be implemented in various forest areas so that we can save our forests and maintain great the environment.

CHAPTER 12
FUTURE SCOPE

This project is far from complete and there is a lot of room for improvement. Some of theimprovements that can be made to this project are as follows:

Additional pump can be added so that it automaticallysends water when there is a fire breakout. Also, industrial sensors can be used for better ranging and accuracy.

- This project has endless potential and can always be enhanced to become better. Implementing this concept in the real world will benefit several industries and reduce the workload on many workers, enhancing overall work efficiency.

APPENDIX

SOURCE CODE

Import the neccessary libraries

```
import keras
import tensorflow

from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

✓ 1m 18.2s Python

```
import tensorflow

from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

Python

```
train_datagen = ImageDataGenerator(rescale=1./255,
                                   shear_range=0.2,
                                   rotation_range=180,
                                   zoom_range=0.2,
                                   horizontal_flip=True)

test_datagen = ImageDataGenerator(rescale=1./255)
```

✓ 0.1s Python

```
x_train = train_datagen.flow_from_directory(r'./Dataset/train_set/',
                                            target_size=(128, 128),
                                            batch_size=32,
                                            class_mode='binary')
```

✓ 0.6s Python

```
Found 436 images belonging to 2 classes.
```

```
x_test = train_datagen.flow_from_directory(r'./Dataset/test_set/',
                                           target_size=(128, 128),
                                           batch_size=32,
                                           class_mode='binary')
```

✓ 0.1s Python

```
Found 121 images belonging to 2 classes.
```

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Convolution2D, MaxPooling2D, Flatten
```

✓ 0.1s Python

```python
model = Sequential()
model.add(Convolution2D(32, (3,3), input_shape=(128, 128, 3), activation="relu"))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())
model.add(Dense(150,activation="relu"))
model.add(Dense(1, activation="sigmoid"))
```

✓ 1.8s Python

```python
model.compile(loss="binary_crossentropy",
              optimizer="adam",
              metrics=["accuracy"])
```

✓ 0.1s

```python
model.fit(x_train, steps_per_epoch=14, epochs=10, validation_data=x_test, validation_steps=4)
```

```
Epoch 1/10
14/14 [==============================] - 64s 4s/step - loss: 3.5440 - accuracy: 0.5665 - val_loss: 0.4052 - val_accuracy: 0.8430
Epoch 2/10
14/14 [==============================] - 23s 2s/step - loss: 0.5222 - accuracy: 0.7431 - val_loss: 0.2283 - val_accuracy: 0.9669
Epoch 3/10
14/14 [==============================] - 23s 2s/step - loss: 0.3097 - accuracy: 0.8647 - val_loss: 0.1622 - val_accuracy: 0.9504
Epoch 4/10
14/14 [==============================] - 22s 2s/step - loss: 0.2392 - accuracy: 0.8945 - val_loss: 0.1137 - val_accuracy: 0.9669
Epoch 5/10
14/14 [==============================] - 23s 2s/step - loss: 0.2125 - accuracy: 0.8968 - val_loss: 0.1337 - val_accuracy: 0.9504
Epoch 6/10
14/14 [==============================] - 23s 2s/step - loss: 0.1922 - accuracy: 0.9243 - val_loss: 0.0887 - val_accuracy: 0.9669
Epoch 7/10
14/14 [==============================] - 23s 2s/step - loss: 0.1773 - accuracy: 0.9266 - val_loss: 0.1454 - val_accuracy: 0.9339
Epoch 8/10
14/14 [==============================] - 21s 2s/step - loss: 0.1678 - accuracy: 0.9427 - val_loss: 0.0835 - val_accuracy: 0.9752
Epoch 9/10
14/14 [==============================] - 24s 2s/step - loss: 0.1733 - accuracy: 0.9243 - val_loss: 0.1079 - val_accuracy: 0.9669
Epoch 10/10
14/14 [==============================] - 25s 2s/step - loss: 0.1647 - accuracy: 0.9335 - val_loss: 0.0716 - val_accuracy: 0.9752

<keras.callbacks.History at 0x1920c974be0>
```

Save the model

```python
model.save("model.h5")
```

Prediction

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

Python

```python
model = load_model("model.h5")
```

Python

Reviewing the model

```python
img = image.load_img("forest-fire.jpg")
x = image.img_to_array(img)
res = cv2.resize(x, dsize=(128, 128), interpolation=cv2.INTER_CUBIC)
x = np.expand_dims(res, axis=0)
```

Python

```python
pred = model.predict(x)
pred = int(pred[0][0])
pred
```

Python

```
1/1 [==============================] - 1s 524ms/step

0
```

```python
import cv2
import numpy as np
from tensorflow.keras.preprocessing import image
from tensorflow.keras.models import load_model
from twilio.rest import Client
from playsound import playsound
from decouple import config


message_sent = False

model = load_model("./model.h5")

video = cv2.VideoCapture("fire.mp4")

name = ["No fire", "Fire Detected"]


def send_message():
    account_sid = config("ACCOUNT_SID")
    auth_token = config("AUTH_TOKEN")

    client = Client(account_sid, auth_token)
    message = client.messages.create(
        body="Forest Fire detected , Stay safe!!!",
        from_=config("FROM"),
        to=config("TO")
    )
    print(message.sid)
    print("Fire Detected")
    print("SMS Sent!")

playsound("./beep.mp3")
```

```python
while True:
    success, frame = video.read()
    cv2.imwrite("image.jpg", frame)
    img = image.load_img("image.jpg", target_size=(128, 128))
    x = image.img_to_array(img)
    x = np.expand_dims(x, axis=0)
    pred = model.predict(x)
    p = int(pred[0][0])
    cv2.putText(frame, str(name[p]), (100, 100), cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 0), 1)

    if p == 1:
        if not message_sent:
            send_message()
            message_sent = True
        print("Fire Detected , stay safe!!!")
    else:
        print("No Fire Detected")

    cv2.imshow("Image", frame)

    if cv2.waitKey(1) & 0xFF == ord('x'):
        break

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

GITBUB LINK:

https://github.com/IBM-EPBL/IBM-Project-20118-1659712725

DEMO VIDEO:

https://youtu.be/m7lL7-dQDrs