# PROJECT REPORT

# EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES


**SUBMITED BY**

**TEAM ID:PNT2022TMID01419**

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# CHAPTER 1

# INTRODUCTION

**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 region of forest , such as fire, smoke, and so on. This project aims to let users take advantage of machine learning to reduce manual tasks in Detecting the forest fire.

## PURPOSE:

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

# CHAPTER 2

# LITERATURE SURVEY

## 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 bio-diversity of the India are at the considerable chance and beneath enormous pressure. General causes of forest fire are extreme hot and aired weather, lightning and human carelessness. In order to protect these huge stretches of forest land, there need to be taken early caution measures to control of spreading fire.

## REFERENCES:

1. T.Chen et al. developed a set of rules to separate the fire pixels using R, G and B information.
2. B.U. Totryin et al. used a mixture of Gaussians in RGB colour space which is developed from a training set of fire pixels, instead of using a rule base colour model .
3. Wen- Homg et al. used HSI colour model to separate the fire pixels. They have developed the rules for brighter and darker environments. After segmenting the fire region based on HSI rules the lower intensity and lower saturation pixels are removed to avoid fire aliases (fire like region). They also formed a metric based on binary counter

difference images to measure the burning degree of fire flames such as no fire, small, medium, and big fires.

4. Akshata & Bhosale. proposed another method where Local Binary Pattern acts as a base for fire detection and Wavelet Decomposition is used to detect fire. Pixel level analysis is required in this method. This method uses YCbCrcolor model to detect fire. Detection is based on three phases. The first phase involves segmentation of image using LBP. LBP is a texture operator whose value is computed using image's center and neighboring pixel values. Further accuracy is improved using Wavelet Transform and complicated data is classified using this approach. 2D Discrete Wavelet Transform is used for decomposition in this system. images should be used as input and the sub bands of every image are compared with the other, if sub bands are equal the images are same else different.

5. T. Celik et al. [5] formed number of rules using normalized (rgb) values in order to avoid the effects of changing illumination. In this method statistical analysis is carried out in rg, rb and gb planes. In each plane three lines are used to specify a triangular region representing the region of interest for fire pixels. A pixel is declared as fire pixel if it falls in to the triangular region of rg, rb and gb planes. Even though the normalized RGB colour space overcomes the effects of variation in illumination to some extent further improvement can be achieved by using YCbCr colour space which separates luminance from chrominance.

6. Turgay Celik et al. [9] proposed a generic colour model to segment the flame pixel from the background using YCbCr colour model. This method segments the flame region except the flame centre. But thismethod classifies fire pixels only based on colour information.

7. Dimitropoulos (2015) [1] proposed an algorithm where a computer vision approach for fire-flame detection is used to detect fire at an early stage. Initially, background subtraction and color analysis is used to define candidate fire regions in a frame and this approach is a non-parametric model. Following this, the fire behavior is modeled by employing various Spatio-temporal features such as color probability, flickering, spatial and spatiotemporal energy. After flame modeling the dynamic texture analysis is applied in each candidate region using Linear Dynamical Systems, Histogram and Mediods.

LDS is used to increase the robustness of the algorithm by analyzing temporal evolution of pixel intensities. Pre-processing is done after this to filter non-candidate regions. Spatio-temporal analysis is done to increase the reliability of the algorithm..

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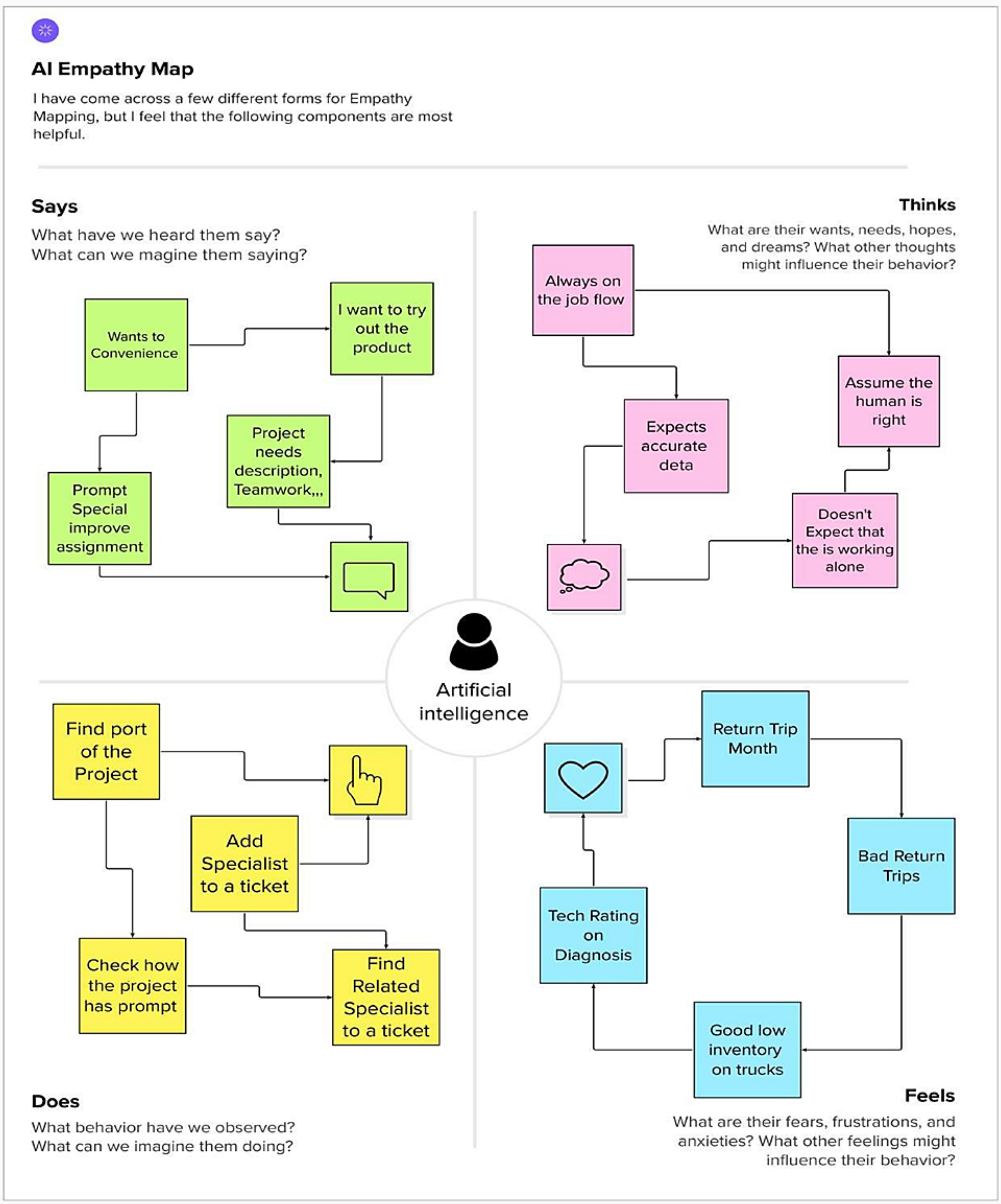
## PROBLEM STATEMENT:

Forest fires are a major environmental issue creating economic and ecological damage while endangering human lives. There are typically about 100,000 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

# CHAPTER 3

# IDEATION AND PROPOSED SOLUTION

**EMPATHYMAP CANVAS:**



# Brainstorm

2

**Brainstorm**

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

## Vishnu Prasad

- Based on Gaussian mixture model
- Emerging methods like LoraWAN Sensor Networks
- Image processing
- Fire Dection Using CNN Model

## Siddharth

- Collecting Data Using Satellite Image
- Monitoring the forest Using satellites
- Implementing ground level sensor for data
- Deep Learning can be used

## Vignesh Raj

- Detection using wireless sensor network
- Using microwave sensor
- Using cluster heads to determine the GPS
- Using optical sensor and digital camera

## Sidhaarth

- Prediction using machine learning
- Early detection using unmaned Aerial Vehicle
- Utilising Neural Network
- Using radio Acoustic Sounding System

## PROPOSED SOLUTION:

| S.No. | Parameter | Description |
|---|---|---|
| 1. | Problem Statement (Problem to be solved) | To findemerging methods forearly detection offorest 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 deeplearning 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 damageand lives of livingbeings.<br>2. It is fast and accurate methodto detect thefire 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 cameraof 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. |

# PROBLEM SOLUTION FIT:

Define CS, fit into CC

**1. CUSTOMER SEGMENT(S)** CS

Who is your customer?
i.e. working parents of 0-5 y.o. kids

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.

**6. CUSTOMER CONSTRAINTS** CC

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.

Climatic changes and the greenhouses gases arethe reasons behind the destruction. Along with this the human factor to greedily use resources also play a vital reason for the forest fires.

**5. AVAILABLE SOLUTIONS** AS

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

Existing systems uses optical sensors for detectingforest 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.

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

**2. JOBS-TO-BE-DONE / PROBLEMS** J&P

Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.

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.

**9. PROBLEM ROOT CAUSE** RC

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.

The reasons possible are:

1. Due to natural causes- Lightning
2. Man-made causes- Naked flame, cigarette, electric spark

Thus, contineous care and monitoring is needed to preserve natural resources to save lives.

**7. BEHAVIOUR** BE

What does your customer do to address the problem and get the job done?
i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)

When fire is detected the system which is implementedto monitor the forests sets the alarm to ring, that is it gives the signal through which fire management team and the forest committee tries to call off the fire. Thus, the aim is to recognize the fire as early as possible to prevent spread of fire which will cause further damage to control.

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

**3. TRIGGERS** TR

What triggers customers to act? i.e. seeing their neighbor installing solar panels, reading about a more efficient solution in the news.

The unconsious behavior towards burned cigarette left, chances of leaving the campfire remained burnt and electric supply being disrupted

**4. EMOTIONS: BEFORE / AFTER** EM

How do customers feel when they face a problem or a job and afterwards?
i.e. lost, insecure > confident, in control - use it in your communication strategy & design.

Wildfires can cause lot of stress since the factor that influence their direction and intensity are unpredictable and can change at anytime. People who have lived through wildfires can face dramatic mood swings, anxiety and mood-swings.

**10. YOUR SOLUTION** SL

If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.
If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behavior.

To minimize these loses, we have proposed a solution to detect early detection of forest fires by using CCTV camera surveillance, which can detect fire in indoor and outdoor activities. Thus instant alerts has to be sent to the forest management office so that they can take further actions to disrupt the damage caused by the fire.

**8. CHANNELS of BEHAVIOUR** CH

8.1 ONLINE
What kind of actions do customers take online? Extract online channels from #7

8.2 OFFLINE
What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.

Online Detection: Thus the chatbot or the API canconnect through internet to feed you with the current status of the forest.

Offline Detection: Thus, the forest management cansend notice to the nearby residential areas or the media can bring the awareness through news, radio.

Identify strong TR & EM

# CHAPTER 4

# REQUIREMENT ANALYSIS

## 4.1 FUNCTIONAL REQUIREMENTS:

FUNCTIONAL REQUIREMENTS:

| FR No. | Functional Requirement (Epic) | Sub Requirement (Story / Sub-Task) |
|---|---|---|
| FR-1 | User Registration | Registration through Gmail |
| FR-2 | User Confirmation | Confirmation via Email<br>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 feedof the forest |
| FR-6 | User Application | User is alerted if there is an forestfire occurrence intheir surroundings |

## 4.2 NON-FUNCTIONALREQUIREMENTS:

-

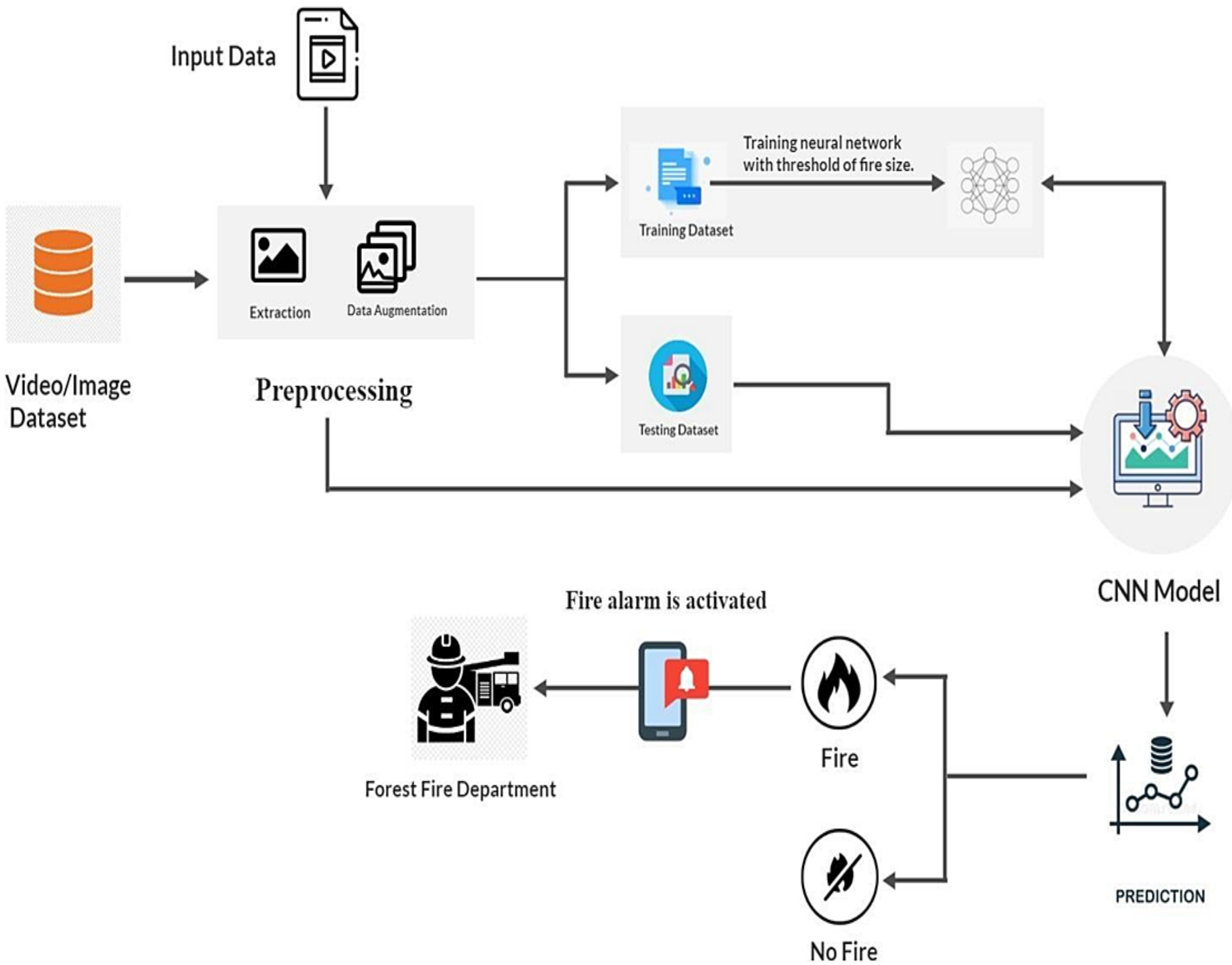
NON-FUNCTIONAL REQUIREMENTS:

| FR No. | Non-Functional Requirement | Description |
|---|---|---|
| NFR-1 | **Usability** | Alerts according to theuser 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 is an immediateaction without a lag |
| NFR-5 | **Availability** | The application gives alerts and livefeeds 24/7 |
| NFR-6 | **Scalability** | Early detection and alerting users are done efficiently andin a faster means |

# CHAPTER 5

# PROJECT DESIGN

## SOLUTION ARCHITECTURE:



## USER STORIES:

Use the below template to list all the user stories for the product.

| USER TYPE | FUNCTIONAL REQUIREMENTS | USN | USER STORY TASK | ACCEPTANCE CRITERIA | PRIORITY | RELEASE |
|---|---|---|---|---|---|---|
| ENVIROMENTAL LIST | COLLECT THE DATA | USN-1 | As an Environmentalist,it is necessary to collectthe data of the forestwhich include temperature, humidity,wind and rain of theforest | It is necessary to collectthe right data else the prediction may become wrong | HIGH | SPRINT-1 |
| | | USN-2 | Identify algorithms that can be usedfor prediction | To collect the algorithm to identify the accuracy levelof each algorithms | MEDIUM | SPRINT-2 |
| | | USN-3 | Identify the accuracy of each algorithms | Accuracy of each algorithm-calculated so that it is easy to obtainthe most accurate output | HIGH | SPRINT-3 |
| | | USN-4 | Evaluate the Dataset | Datais evaluated beforeprocessing | MEDIUM | SPRINT-1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | USN-5 | Identify accuracy,precision,recall of eachalgorithms | 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 predictthe effect. | HIGH | SPRINT-4 |

# CHAPTER 6

# PROJECT PLANNING AND SCHEDULLING

## 6.1 SPRINT PLANNING AND ESTIMATION

| Sprint | Functional Requirement(epic) | User Story Number | User Story / Task | Story Point | Priority | Team Members |
|---|---|---|---|---|---|---|
| sprint-1 | Image Processing | USN-1 | Processing the image tofind the fire is detected or not. | 1 | Medium | 1.Vishnuprasad .V2.Vignesh raj.T 3.Siddharth. K 4.Sidhaarth P.S |
| sprint-2 | Video Processing | USN-2 | The drone videos will be split intoframes to detect the fire. | 3 | High | 1.Vishnuprasad .V2.Vignesh raj.T 3.Siddharth. K 4.Sidhaarth P.S |
| sprint-3 | Alerting | USN-3 | After the fireis detected the alert message has to be sent. | 2 | High | 1.Vishnuprasad .V2.Vignesh raj.T 3.Siddharth. K 4.Sidhaarth P.S |
| sprint-4 | Location Tracking | USN-4 | The exact location ofthe drone will be predicted and sent along withthe alert | 2 | High | 1.Vishnuprasad .V2.Vignesh raj.T 3.Siddharth. K 4.Sidhaarth P.S |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | message | | | |

## 6.2 PROJECT DELIVERY SCHEDULE

| Sprint | Total StoryPoints | Duration | Sprint Start Date | Sprint EndDate (Planned) | Story Points Completed(as on planned end date) | Sprint Release Date (actual) |
|---|---|---|---|---|---|---|
| Sprint-1 | 20 | 3 Days | 27 Oct 2022 | 29 Oct 2022 | 20 | 29 Oct 2022 |
| Sprint-2 | 20 | 3 Days | 30 Oct 2022 | 1 Nov 2022 | 20 | 1 Nov 2022 |
| Sprint-3 | 20 | 3 Days | 3 Nov 2022 | 5 Nov 2022 | 20 | 5 Nov 2022 |
| Sprint-4 | 20 | 3 Days | 7 Nov 2022 | 9 Nov 2022 | 20 | 9 Nov 2022 |

# CHAPTER 7

# CODING AND SOLUTIONING

```python
import cv2
import numpy as np
from keras.utils import load_img, img_to_array
from 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("ACc0047c29cd24dafb68b7dda975cf6759")
    auth_token = config("ec286dd22874115f1add0b264317cb7b")

    client = Client(account_sid, auth_token)
    message = client.messages \
        .create(
        body="Forest Fire detected , Stay safe!!!",
        from_=config("+15136439256"),
        to=config("+91 86101XXXXX")
    )
    print(message.sid)
    print("Fire Detected")
    print("SMS Sent!")
```

```python
while True:
    success, frame = video.read()
    cv2.imwrite('Z:\\Fist\\image.jpg', frame)
    img = load_img('Z:\\Fist\\image.jpg', target_size=(128, 128))
    x = img_to_array(img)
    x = np.expand_dims(x, axis=0)
    pred = model.predict(x, verbose=0)
    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!!!")
        playsound("./beep.mp3")
    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 | Executed By |
|---|---|---|---|---|---|---|---|---|---|---|
| OP_RT_001 | Functional | Page | Check if user can upload their file | The sensor senses the fire | Sample 1.png | The input image should be uploaded to the application successfully | Working as expected | PASS | | siddharth.k |
| OP_RT_002 | Functional | Page | Check if user cannot upload unsupported files | 1) The sensor senses the fire<br>2)checks with the pre-uploads images | installer.exe | The application should not allow user to select a non image file | User is able to upload any file | FAIL | BUG_HP_002 | vigneshraj |
| OP_RT_003 | Functional | Page | Checks whether the page redirects to the result page to the given output | 1) The sensor senses the fire<br>2)checks with the pre-uploaded images<br>3)checks if there is fire detection | Sample 1.png | The page should redirect to the results page | Working as expected | PASS | | sidhaarth.p.s |
| MB_RT_001 | Functional | Backend | Checks if all the routes are working properly | 1) The sensor senses the fire<br>2)checks with the pre-uploaded images<br>3)checks if there is fire detection | Sample 1.png | All the routes should properly work | Working as expected | PASS | | vishnuprasad |
| N_DC_001 | Functional | Model | Checks whether the model can handle various image sizes | 1) Open the page in a specific device<br>2) Upload the input image<br>3) Repeat the above steps with different input | Sample 1.png<br>Sample 1 XS.png<br>Sample 1 XL.png | The model should rescale the image and predict the results | Working as expected | PASS | | vigneshraj |
| N_DC_002 | Functional | Model | Check if the model predicts the digit | 1) Open the page<br>2) Select the input images | Sample 1.png | The model should predict the number | Working as expected | PASS | | sidhaarthp.s |
| N_DC_003 | Functional | Model | Check if the model can handle complex input image | 1) Open the page<br>2) Select the input images<br>3) Check the results | Complex Sample.png | The model should predict the number in the compex image | The model fails to identify the digit since the model is not built to handle such data | FAIL | BUG_M_001 | visnuprasad |
| RL_DC_001 | Functional | Result Page | Verify the elements | 1) Open the page<br>2) Select the input image<br>3) Check if all the UI elements are displayed properly | Sample 1.png | The Result page must be displayed properly | Working as expected | PASS | | siddharth.k |
| RL_DC_002 | Functional | Result Page | Check if that image is displayed properly | 1) Open the page<br>2) Select the input image<br>3) Check if the input image are displayed | Sample 1.png | The input image should be displayed properly | The size of the input image exceeds the display container | FAIL | BUG_RP_001 | vigneshraj |
| RL_DC_003 | Functional | Result Page | Checks whether the displayed prediction is accurate | 1) Open the page<br>2) Select the input image<br>3) Check if all the other predictions are displayed | Sample 1.png | The other predictions should be displayed properly | Working as expected | PASS | | vigneshraj |

## 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 |
| Wont fix | 1 | 0 | 0 | 0 | 0 |
| Total | 6 | 3 | 4 | 3 | 16 |

### 8.2.2 TEST CASE ANALYSIS

| Section | Total test 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/

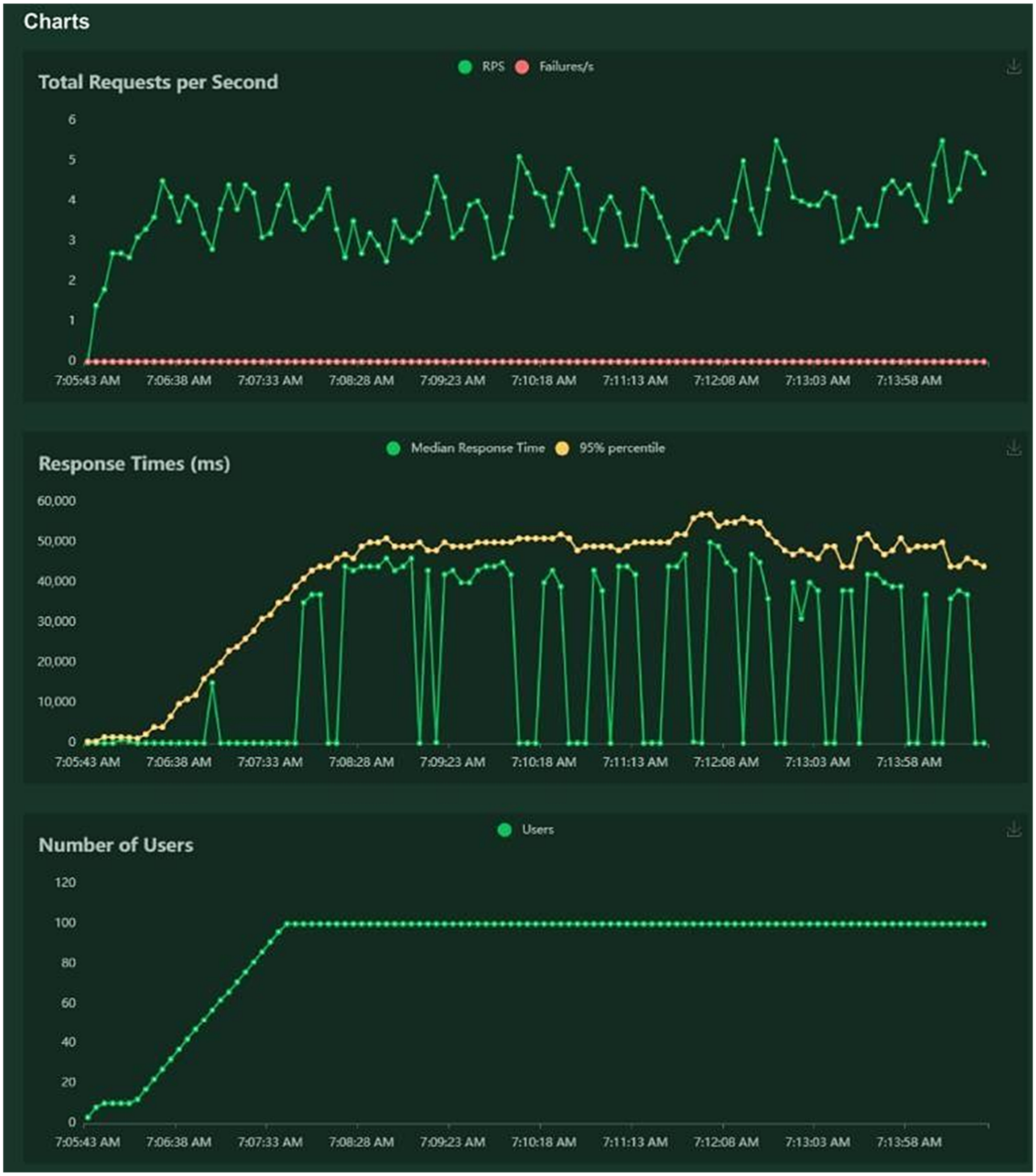
Script: locust.py

#### 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
Number of Users
Users
120
100
80
60
40
20
0

# CHAPTER 10

# ADVANTAGES AND DISADVANTAGES

## ADVANTAGES:

The proposed system detects the forest fire at a faster rate compared to system. It has enhanced data collection feature. The major aspect is that it reduces false alarm and also has accuracy due to various sensors present. It minimizes the 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 through an app to the respective user.

## DISADVANTAGES:

The electrical interference diminishes the effectiveness of radio receiver. The main drawback is that it has less coverage range areas.

# CHAPTER 10

# 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 ways to avoid losses and environmental, cultural heritage damages to a great extent. Therefore the most important goals in fire surveillance are quick and reliable detection of fire. It is so much easier to suppressfire while it is in its early stages. Information about progress of fire is highly valuable for managing fire during all its stages. Based on this information the firefighting staff can be guidedon 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, thisproject can be implemented in various forest areas so that we can save our forests and maintain great environment.

# CHAPTER 12

# FUTURE SCOPE

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

Continuous monitoring of open space is of the utmost importance for the protection of forests against fire. Collected data in real time provide fast intervention of relevant services to extinguish the fire. Timely information about the appearance of fire reduce the number of areas affected by this fire and thereby minimizes the costs of fire extinguishing and the damage caused in the woods. The current way of detecting fire in an open area in Serbia is not in real time, and due to this, it is necessary to implement modern technology of collecting data related to early detection of fires. This paper presents an integral project of forest-fire protection on the territory of Serbia in order to provide the reference for the application of terrestrial automated system for early detection and prediction of forest fires. An automated system could be comprised of infrared and high-resolution TV camera surveillance, covering a large part of the forest area and forest land.

# APPENDIX

# SOURCE CODE:

```python
import keras
import tensorflow

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

[1]

Python

```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)
```

Python

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

Python

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

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

Python

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

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

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"))
```

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

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

[8]

```
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

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

[9]

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

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

## Reviewing the model

```
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)
```

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

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

0
```

**FIRE .PY(MAIN FILE):**

```python
import cv2
import numpy as np
from keras.utils import load_img, img_to_array
from 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("ACc0047c29cd24dafb68b7dda975cf6759")
    auth_token = config("ec286dd22874115f1add0b264317cb7b")

    client = Client(account_sid, auth_token)
    message = client.messages \
        .create(
        body="Forest Fire detected , Stay safe!!!",
        from_=config("+15136439256"),
        to=config("+91 86101XXXXX")
    )
    print(message.sid)
    print("Fire Detected")
    print("SMS Sent!")
```

```
while True:
    success, frame = video.read()
    cv2.imwrite('Z:\\Fist\\image.jpg', frame)
    img = load_img('Z:\\Fist\\image.jpg', target_size=(128, 128))
    x = img_to_array(img)
    x = np.expand_dims(x, axis=0)
    pred = model.predict(x, verbose=0)
    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!!!")
        playsound("./beep.mp3")
    else:
        print("No Fire Detected")

    cv2.imshow("Image", frame)

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

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

## GITHUB:

https://github.com/IBM-EPBL/IBM-Project-5168-1658749920

## PROJECT DEMO:

**https://drive.google.com/file/d/1rFvRLeo_Hwbfg8UVAZMK1UL5G9pZ97rc/view?usp=sharing**