PROJECT REPORT

EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

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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 recognize 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.

1.2 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

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 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, lighting 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.

2.2 LITERATURE SURVEY:

1. Sudhakar S., Vijayakumar V., Kumar C. S., Priya V., Ravi L., Subramaniyaswamy V. Unmanned Aerial Vehicle (UAV) Based Forest Fire Detection and Monitoring. Computer Communications.

2. Jiao Z., Zhang Y., Xin X., et al. A deep learning based forest fire detection approach using UAV and YOLOv3. Proceedings of the 2019 1st International Conference on Industrial Artificial Intelligence (IAI); July, 2019; Shenyang, China. pp. 1–5.

3. Girshick R. Fast r-cnn. Proceedings of the IEEE International Conference on Computer Vision; December, 2015; Santiago, Chile. pp. 1440–1448.

4. Yuan C., Liu Z., Zhang Y. Fire Detection Using Infrared Images for UAV-Based Forest Fire Surveillance. Proceedings of the 2017 International Conference on Unmanned Aircraft Systems (ICUAS); June, 2017; Miami, FL, USA.

5. Cortez P., Morais A. A Data Mining Approach to Predict Forest Fires Using Meteorological Data. 2017.

6. Kinaneva D., Hristov G., Raychev J., Zahariev P. Early forest fire detection using drones and artificial intelligence. Proceedings of the 2019 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO); May, 2019; Opatija, Croatia. pp. 1060–1065.

7. Chen P., Zhang T., Xin K., Yi N., Liu D., Liu H. A UAV-based forest fire detection algorithm using convolutional neural network. Proceedings of the

2018 37th Chinese Control Conference (CCC); June, 2018; Wuhan, China. pp. 10305–10310.

8. Wu X., Leung X., Leung H. An adaptive threshold deep learning method for fire and smoke detection. Proceedings of the 2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC); October, 2017; Banff, AB, Canada. pp. 1954–1959.

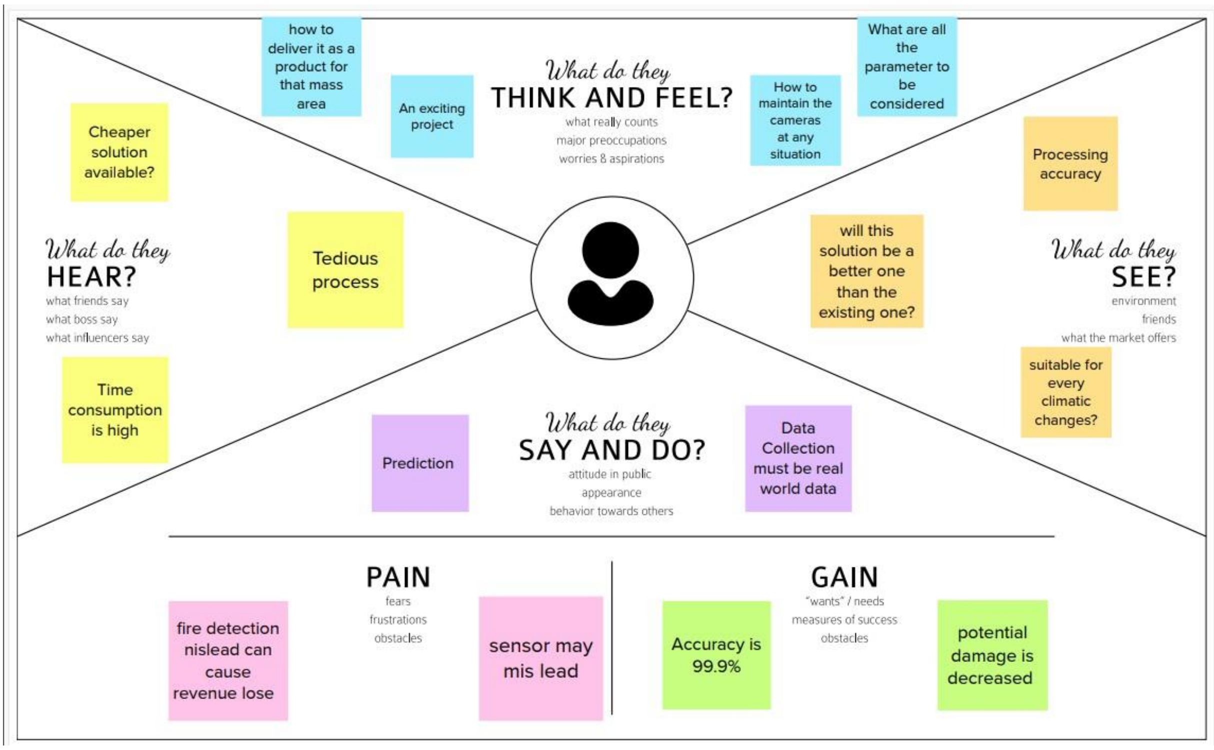
2.3 PROBLEM STATEMENT:

Forest fires pose a serious threat to the environment because they harm the economy, and the ecosystem, and put people in danger. 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. In the United States, there are about 100,000 wildfires per year. Dangerous flames have burned more than 9 million acres of land. In a sparsely inhabited forest area, it is challenging to anticipate and detect forest fires, and it is even more challenging if the prediction is made using ground-based techniques like the camera or video-based approaches. Forest fires are a serious environmental problem because they harm the environment and the economy.

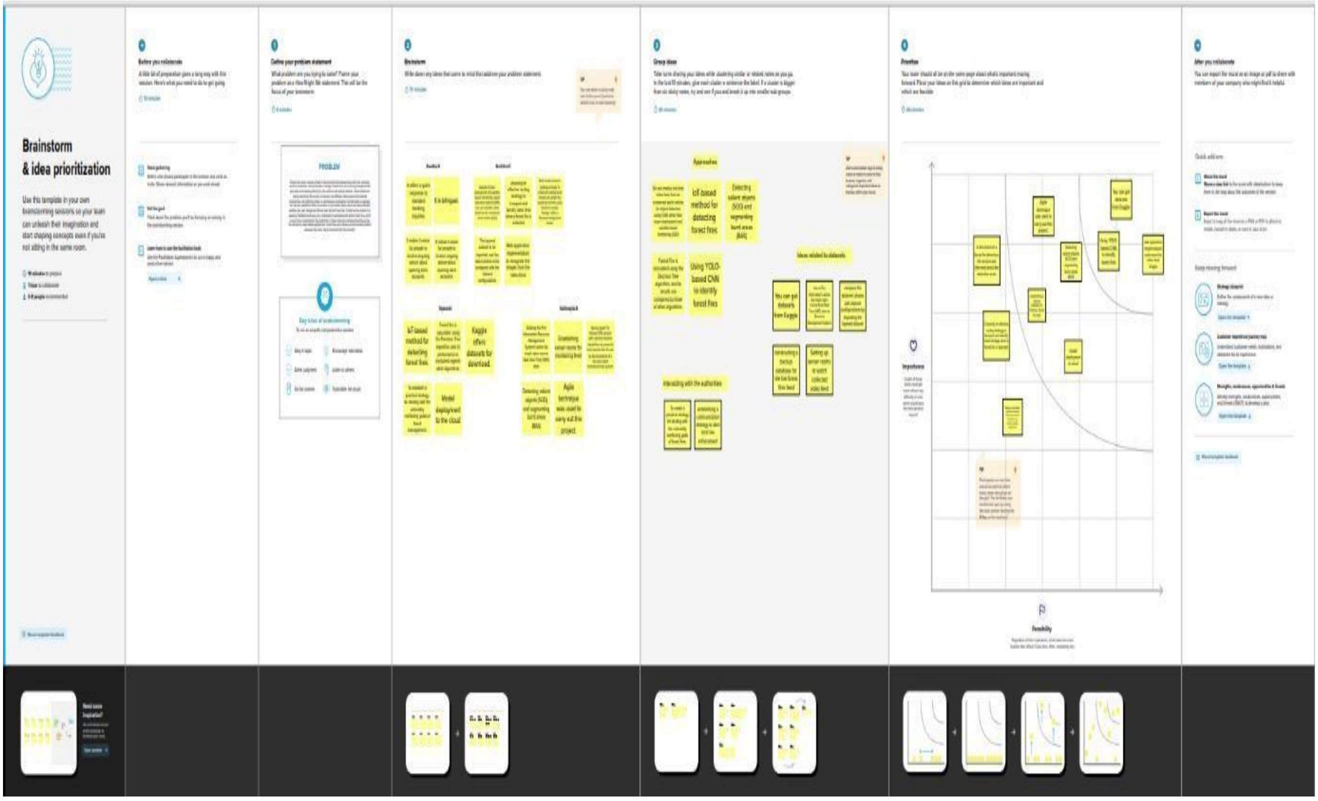
CHAPTER 3

IDEATION AND PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS:



3.2 IDEATION AND BRAINSTORMING:



3.3 PROPOSED SOLUTION:

S.No.	Parameter	Description
1.	**Problem Statement (Problem to be solved)**	Wildfires can have immediate and long-term effects on the quality of rivers, lakes, and streams. The most noticeable impact of wildfires is stormwater runoff. Depending on the temperature and time of year a wildfire occurs, vegetation can be significantly impacted. Plants on the forest floor or smaller trees are often destroyed by wildfires, while larger trees can survive as long as the fire does not spread into the tree canopy.

		The flames from these fires destroy the food source and homes of many animals, threatening their survival.
2.	**Idea / Solution description**	Forest fires pose a serious threat to the environment because they harm the economy and the ecosystem. In order to fight against these disasters, it is necessary to adopt a comprehensive, multifaceted approach that enables continuous situational awareness and instant responsiveness. In this, we proposed a new approach for fire detection, in which modern technologies are used. In particular, we proposed a platform for Artificial Intelligence. The computer vision methods for recognition and detection of smoke and fire, are based on still images or the video input from the cameras. Deep learning method “convolution neural network” can be used for finding the amount of fire. This will enable the video surveillance systems in the forest to handle more complex situations in the real world. The accuracy is based on the algorithm which we are going to use and the datasets and splitting them into train sets and test sets.
3.	**Novelty / Uniqueness**	Due to the complex background and large Wildfire room image, sure wildfires pose difficulties in the identification process. Applying **convolutional neural network (CNN)** technology to image recognition can reduce visual impairment and randomness to a large extent in the feature extraction process and theoretically extract deeper features that could greatly improve the accuracy of flame image recognition.

4.	**Social Impact / Customer Satisfaction**	A fire-detection system can reduce the emission of harmful combustion products and greenhouse gases by detecting fires fast and precisely (i.e., without sacrificing speed or setting off false alarms) and sending out early warning notifications. Systems for detection and alarm play a crucial role in your overall fire protection strategy. Early fire detection helps to conserve wildlife, limit ecological damage, and stop the loss of flora and fauna.
5.	**Business Model (Revenue Model)**	Firefighters and the Forest Service can use this concept to help avoid disasters. India's annual losses from forest fires have been conservatively calculated at US$ 107 million (Rs 440 crores). We utilize a CNN model based on artificial intelligence to combat this. Subscription fees are CNN's main source of income. 50 percent of its overall revenue comes from subscription fees, and the remaining 50 percent comes from advertising and other revenue sources. CNN's primary source of income is through subscription and advertising payments.
6.	**Scalability of the Solution**	Each year, fires consume millions of hectares of forest. These fires spread quickly and consume a lot of space, emitting more carbon monoxide than cars. The expense of battling a fire can be drastically reduced by keeping an eye on potential danger areas and spotting fires early. This can also greatly limit the amount of potential damage.

3.4 PROPOSED SOLUTION FIT:

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS:

Sn. No	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
1.	Video surveillance start	Start surveillance through remote control
2.	Forest monitoring	Continuous monitoring through camera
3.	Detect fire	Fire is detected through CNN model
4.	Alert	Alert the forest officials through message

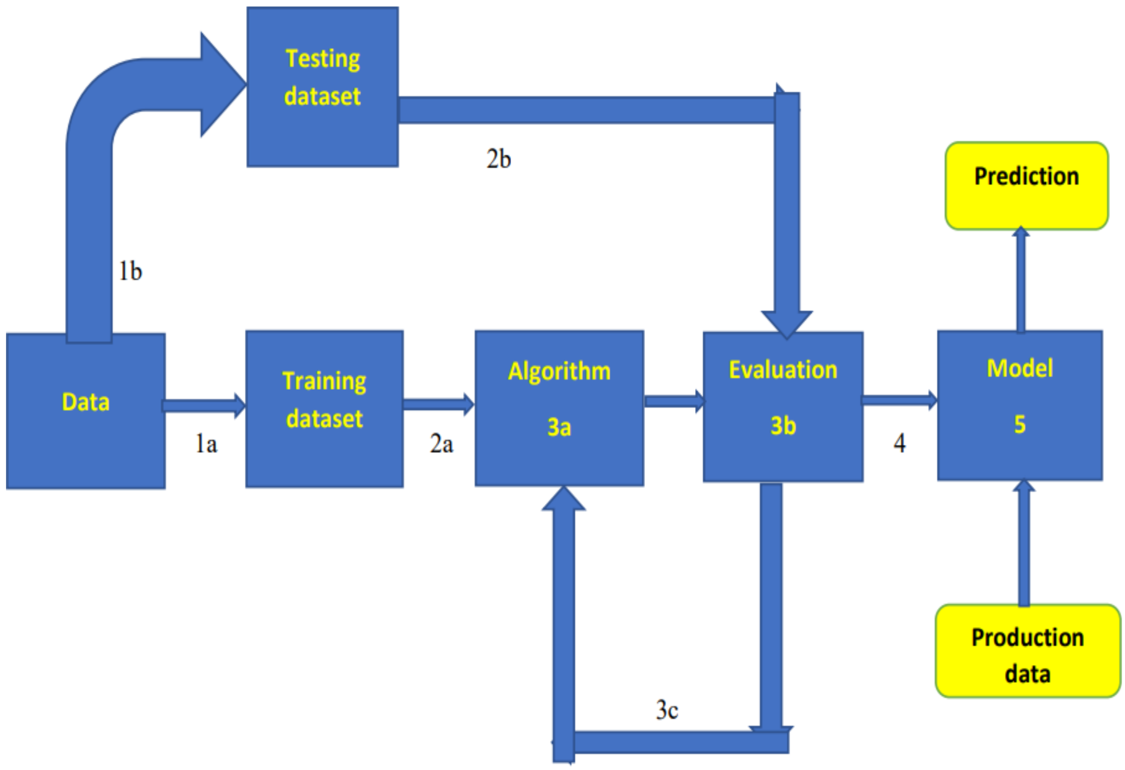
4.2 NON-FUNCTIONAL REQUIREMENTS:

Sn. No.	Non-Functional Requirement	Description
1.	Usability	Monitoring possible danger areas and early fire detection can greatly reduce the response time, as well as the potential damage and firefighting expenses.
2.	Security	More secure environment.
3.	Reliability	Model is safe to install.
4.	Performance	Model will achieve high accuracy.
5.	Availability	Build model is available all the time.
6.	Scalability	A fire must be discovered by a cargo compartment detection system within one minute and must be so tiny by that point that it poses little risk to the aeroplane. The business is also plagued with nuisance alarms, with up to 90% of fire alarms being false alerts.

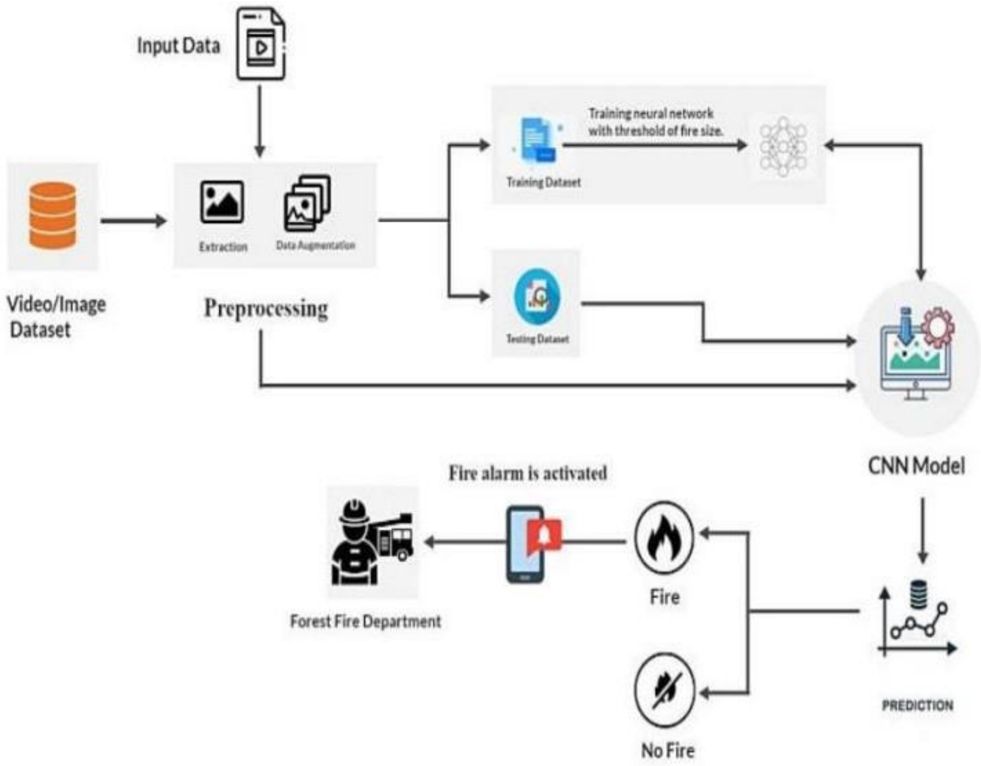
CHAPTER 5

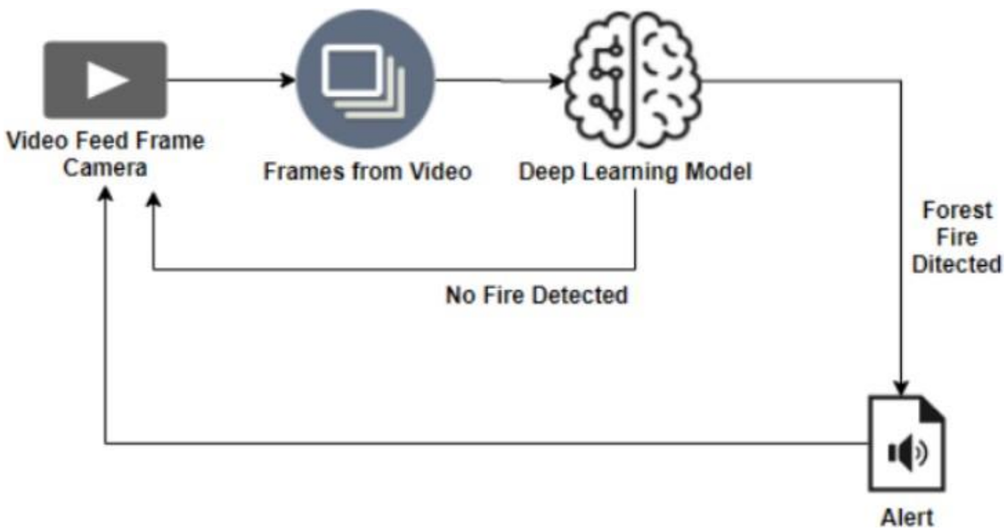
PROJECT DESIGN

5.1 DATA FLOW DIAGRAM:



5.2 SOLUTION AND TECHNICL ARCHITECTURE:


Input Data
Training neural network with threshold of fire size.
Training Dataset
Extraction
Data Augmentation
Video/Image Dataset
Preprocessing
Testing Dataset
CNN Model
Fire alarm is activated
Forest Fire Department
Fire
No Fire
PREDICTION


Video Feed Frame Camera
Frames from Video
Deep Learning Model
Forest Fire Detected
No Fire Detected
Alert

CHAPTER 6

PROJECT PLANNING AND SCHEDULING

6.1 SPRINT PLANNING AND 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 analyze the fire prone areas and to set the surveillance camera to collect and observe the region continuously for early detection.	1	High	Swetha.S
Sprint-1	Image processing	USN-2	The collected data are categorized on the basisof parameters set to identify. To train the model, CNN is used to test repeatedly by storing the datasets in server.	1	High	Vallimayila.R
Sprint-2	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 detectedneed to be corrected to avoid future lags, after testing all functionalities, it is been implemented.	2	High	Tejaswini.K.G Suchitra.V
Sprint-3	Video analysis, Sending alert message	USN-4	The video Analysis of the model must be recorded. The model should connect with APInamed Twilio, which receives & sends the management with messages.	2	High	Tejaswini.K.G Swetha.S Suchitra.V
Sprint-4	IBM cloud deployement	USN-5	The model should connect with API named Twilio, which receives & sends the management with messages.	2	High	Tejaswini.K.G Swetha.S Suchitra.V Vallimayila.R

6.2 SPRINT DELIVERY SCHEDULE:

Sprint	**Total story points**	**Duration**	**Sprint start date**	**Sprint end date (as 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	5 Nov 2022	15	6 Nov 2022
Sprint-3	20	6 days	7 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

```
import cv2
import numpy as np
from google.colab.patches import cv2_imshow
from matplotlib import pyplot as plt
import librosa
from tensorflow.keras.preprocessing import image
from keras.models import load_model
```

```
def video_test(vid_path):
    cap = cv2.VideoCapture(vid_path)
    if (cap.isOpened()== False):
      print("Error opening video stream or file")
    while(cap.isOpened()):
      ret, frame = cap.read()
      if ret == True:
        x=image.img_to_array(frame)
        res=cv2.resize(x,dsize=(128,128),interpolation=cv2.INTER_CUBIC)
        x=np.expand_dims(res,axis=0)
        model=load_model("/content/forest.h5")
        cv2_imshow(frame)
        pred=model.predict(x)
        pred = int(pred[0][0])
        pred
        int(pred)
        if pred==0:
          print('ALERT!!!! FOREST FIRE DETECTED')
          break
        else:
          print("NO FOREST FIRE")
          break

# When everything done, release the video capture object
cap.release()

# Closes all the frames
cv2.destroyAllWindows()
```

```python
from twilio.rest import Client
from playsound import playsound
if pred==0:
  print('Forest fire')
  account_sid = "ACb8327485cef89b8ed3adbe5cb710752f"
  auth_token = "d91caa0af197919cf188fb7ea0db9fb5"

  client = Client(account_sid, auth_token)
  message = client.messages.create(

  body="Forest Fire detected , Stay safe!!!",
  from_=("+18087364790"),
  to=("+917358598519")
  )
  print("ALERT!!!!FIRE DETECTED")
  print("SMS Sent")
elif pred==1:
  print('No DANGER....NO FIRE DETECTED')
```

```
Forest fire
ALERT!!!!FIRE DETECTED
SMS Sent
```

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	Executed By
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	TEJASWINI.K.G SUCHITRA.V
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	SWETHA.S VALLIMAYILA.R
OP_RT_003	Functional	Page	Checks whether the page redirects to the result page to the given output	1) The sensor senses the fire 2)checks with the pre-uploaded images 3)checks if there is fire detection	Sample 1.png	The page should redirect to the results page	Working as expected	PASS	TEJASWINI.K.G
MB_RT_001	Functional	Backend	Checks if all the routes are working properly	1) The sensor senses the fire 2)checks with the pre-uploaded images 3)checks if there is firedetection	Sample 1.png	All the routes should properlywork	Working as expected	PASS	VALLIMAYILA.R
N_DC_001	Functional	Model	Checks whether thecan model various handle sizes image	1) Open the page in a specific device 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	SWETHA.S SUCHITRA.V
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	TEJASWINI.K.G VALLIMAYILA.R
N_DC_003	Functional	Model	Check if the model can handle complex input image	1) Open the page 2) Select the input images 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 tohandle such data	FAIL	SUCHITRA.V SWETHA.S
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	VALLIMAYILA.R TEJASWINI.K.G
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 image should be displayed properly	The size of the input image exceeds the display container	FAIL	SWETHA.S SUCHITRA.V

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 predictionsshould be displayed properly	Working as expected	PASS	SWETHA.S SUCHITRA.V

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	1	2
Performance	2	0	0	2
Exception Reporting	3	0	0	3

CHAPTER 9

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 AND DISADVANTAGES

ADVANTAGES:

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 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 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 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 suppress fire 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 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 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: Additional pump can be added so that it automatically sends 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**.**

Github link:

https://github.com/IBM-EPBL/IBM-Project-21663-1659787380/blob/6be46c3535122362c383a708d2aad22ae00ebda8/Final%20deliverables/Final%20Code/Forest_Fire_Detection.ipynb