Emerging Methods for Early Detection of Forest Fires

A PROJECT REPORT

Submitted by

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ABSTRACT

Forests are potentially and seriously threatened by fires which have caused huge damages and losses of life and properties every year. In general, it is easier to detect smoke than fire in its early stage. Developing an effective and safe smoke detection method is thereby critical for early forest fire fighting and preventing the fire developing into uncontrollable. This paper presents a learning-based fuzzy smoke detection approach intended to achieve an effective and early forest fire detection, while greatly reduce the negative impacts from clouds in the sky, illumination variations, and changes of forest features. First, a fuzzy-logic based smoke detection rule is designed for detecting and segmenting smoke regions in the visual images captured by the camera onboard an unmanned aerial vehicle (UAV). The differences of each two components of red, green, and blue (RGB) model and intensity in hue, saturation, and intensity (HSI) model of images are chosen as inputs of a fuzzy logic rule, while the smoke likelihood is selected as its output. Then, an extended Kalman filter (EKF) is further employed for reshaping the inputs and output of the fuzzy smoke detection rule on-line. It is expected to provide the smoke detection method with additional regulating flexibility adapting to variations of environmental conditions and reliable automatic detection performance. Next, the morphological operation is also adopted to remove imperfections induced by noises and textures distorted nonconvex/concave segments. Finally, extensive studies on several sets of images containing smoke under distinct environmental conditions are conducted to validate the proposed methodology.

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 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, 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.

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 distance using LoRa (Long Range) technology based on LoRaWAN (Long Range Wide Area Network) protocol which is capable to connect low power devices distributed on 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 GarcíaNavas

- 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 able to evaluate level of fire risk and the presence of a forest fire and the evaluation algorithm is based on the 3030-30 rule.

4.ASurvey Of Machine Learning Algorithms Based Forest Fires Prediction and detection systems

F. Abid

- Environmental Science, Computer Science

- Fire Technology

- 2020

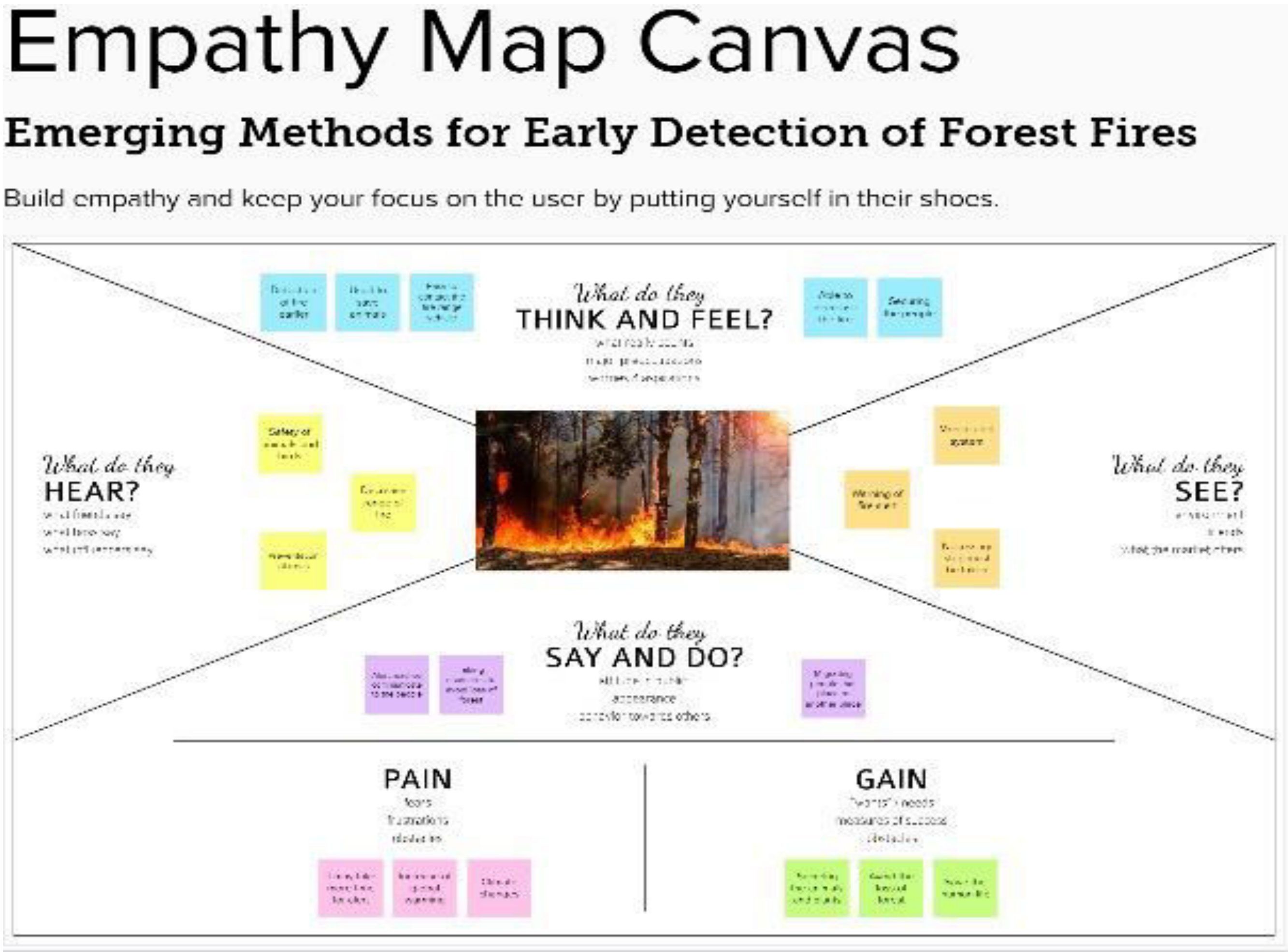
A comprehensive survey of the machine learning algorithms based forest fires prediction and detection systems is presented, highlighting the main issues and outcomees within each study.

2.3 PROBLEM STATEMENT DEFINITION

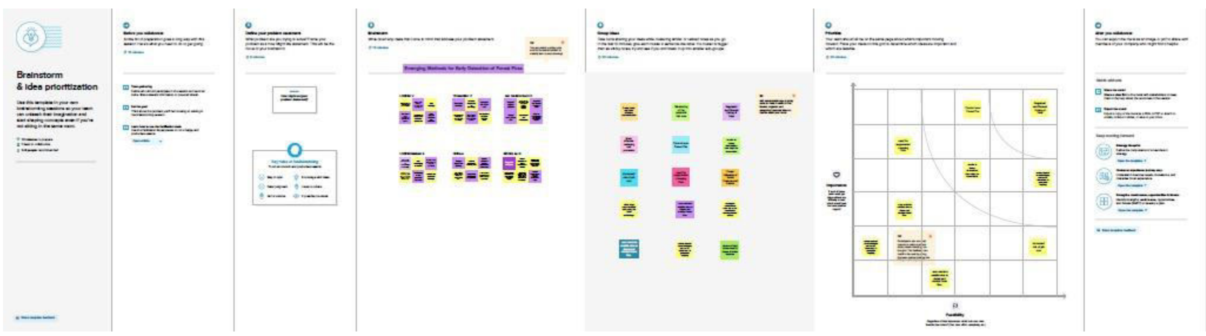
Some people know about the current issues are the most important ones because it is mostly a lot in the news but sometimes other big issues that change our lives are not mentioned in the news because they are issues that can hurt us in the long run or not really important for the modern public. One issue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

CHAPTER 3

IDEATION AND PROPOSED SOLUTION



3.2 IDEATION & BRAINSTORMING



3.3 PROPOSED SOLUTION

S.No.	Parameter	Description
1	Problem Statement (Problem to be solved)	This project deals with the problem of The best way out is early detection of forest fire and prevention, To reduce the risk and prevent the forest fire they are big offerings to fight it like planes, fire brigade trucks, also extinguishers to small areas which depends upon the severity of the fire and leads to large investment by concerned agencies.Forest fires are highly destructive and are uncontrollable when it starts spreading over the area. Fire causes respiratory problems for living beings even they are living several kilometers away. The 2019, Australia wildfires almost 15 million acres have been burned and the fire also killed about one billion animals
2	Idea / Solution description	The key research objectives are as follows: > Forest fires as of late have been annihilating both for normal biological system, biodiversity and woodland economy. >there is an expansion in level of fires that are a significant reason for declining Indian woodlands. >It is about the sensors and dynamic checking framework to dodge a significant fire and genuine harm to woods.
3	Novelty / Uniqueness	Studies carried out in the present area of investigation depicts that fires help in maintaining the open nature of the barrens by retarding woody plant growth. Fire frequencies determine the overstorey of coniferous composition, besides developing a natural space among the stands. Fire may also play a role in recycling nutrients from the groundlayer vegetation and litter to the overstorey trees, thereby counteracting the infertile substrates and arrested decay . Areas under larger burned patches have higher cover of tree seedlings and shrubs, greater densities of opportunistic species, and lower species richness than smaller patches . The size and shape of a burned area determine in

		part the number of new habitats that can be used by animals. Animals can invade new habitats and proliferate because they have relatively few contacts with other animals belonging to their own species or other species.
4	Social Impact / Customer Satisfaction	The results obtained for the NPV, IRR and PP demonstrate that it is possible to think of the forest's sector in a profitable and sustainable way. However, forestry investors must be aware of the difficulties they will encounter, due the lack of forest investments.
5	Business Model (Revenue Model)	Forestry economic sector is characterized by small companies, mainly micro-companies, with, on average, 4.1 people per company. Small size of Portuguese private property and the lack of information about its ownership make it difficult to increase the forest sustainability and profitability. In fact, 61% of forest owners have less than 5 ha, corresponding to 26% of the forest area.
6	Scalability of the Solution	Forest fires lead to destruction of forest wealth and not only that it also destroys the flora and fauna which causes harm to biodiversity. Forest are great resources and to preserve them is a major challenge. As, they are irreparable damage to the ecosystem, so forest fire detection and prevention is utmost important and best way to tackle this problem. But the forest fire early detection and prevention is another major challenge faced all over the world. Several methods for controlling and monitoring of fires have been proposed. In earlier days, manned observation towers were used but this technique was inefficient and failed. After that satellite and camera imaging technologies were tried but this also proved inefficient and ineffective. For example, cameras were installed at different sites in forest but these provide only line of sight pictures. For a very large areas alert system is required as it is really tedious task to monitor all the images.

3.4 PROBLEM SOLUTION FIT

Project Design Phase-I - Solution Fit Template

Project Title: Emerging Methods for Early Detection of Forest Fires

Define CS, fit into CC	**1. CUSTOMER SEGMENT(S)** CS In order to protect the forest resources, which are essential for supporting life on Earth, from sudden fire and smoke outbreaks. The forest management group does require this gadget. in places at risk of fire.	**6. CUSTOMER CONSTRAINTS** CC The devastation is caused by greenhouse gases and changes in the climate. The human tendency to consume resources greedily is another important contributing cause to forest fires	**5. AVAILABLE SOLUTIONS** AS For the purpose of detecting forest fires, existing systems use optical sensors. The sensors alert the office of forest management when a fire is spotted. In addition, satellites are utilised to find IR rays seen in forested areas	Explore AS, differentiate
Focus on J&P, tap into BE, understand RC	**2. JOBS-TO-BE-DONE / PROBLEMS** J&P By releasing a lot of carbon dioxide, carbon monoxide, and fine particulate matter into the environment, the main issue is weather and climate. As a result, air pollution can lead to a variety of health problems, such as respiratory and cardiovascular disorders.	**9. PROBLEM ROOT CAUSE** RC The following are some rationales 1. Lightning, a natural occurrence 2. Man-made causes: cigarettes, naked flames, and electric sparks Therefore, ongoing care and observation are required to protect natural resources in order to save lives.	**7. BEHAVIOUR** BE When fire is detected the sytem which is implemented to 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 recognise the fire as early as possible to prevent spread of fire which will cause further damage and it'll become difficult to control.	Focus on J&P, tap into BE, understand RC
Identify strong TR & EM	**3. TRIGGERS** TR Due to the existence of a great deal of dry grass all around and the possibility of the campfire remaining scorched, the uncontrolled behaviour toward burned cigarettes can spread. **4. EMOTIONS: BEFORE / AFTER** EM Since the variables that affect a wildfire's course and intensity are erratic and subject to alter at any time, they can be very stressful. People who have experienced wildfires may experience severe anxiety and mood swings.	**10. YOUR SOLUTION** SL We have presented a method to detect forest fires early using CCTV camera surveillance, which can detect fire in both indoor and outdoor activities, in order to reduce these losses. In order for the forest management office to stop the damage brought on by the fire, immediate alarms must be given to them	**8. CHANNELS of BEHAVIOUR** CH Online detection: As a result, the chatbot or the API can connect over the internet to provide you with information on the forest's present condition. Offline Detection: As a result, the forest managers can notify surrounding residential areas or raise awareness through the media (news, radio).	Identify strong TR & EM

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

-Following are the functional requirements of the proposed solution

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through G mail
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

Non-functional Requirements:

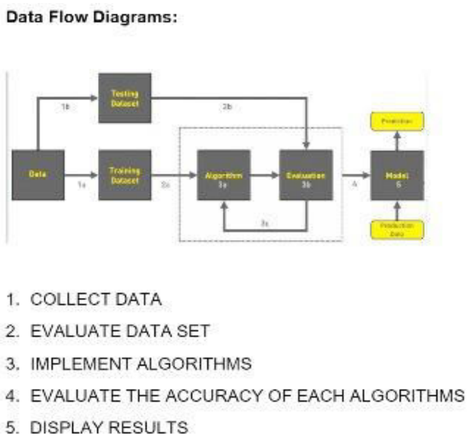
Following are the non-functional requirements of the proposed solution.

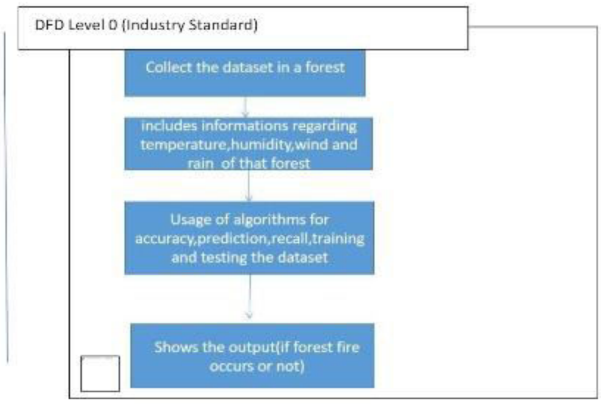
FR No	Non-Functional Requirement	Description
NFR-1	Usability	Alerts according to the user location
NFR-2	Security	Instant live feed with alert of the situation
NFR-3	Reliability	The prediction of the forest fire is 87% accurate
NFR-4	Performance	The feed and the alert message an immediate action without a lag
NFR-5	Availability	The application gives alerts and live feeds 24/7
NFR-6	Scalability	Early detection and alerting users are done efficiently and in a faster means

CHAPTER 5

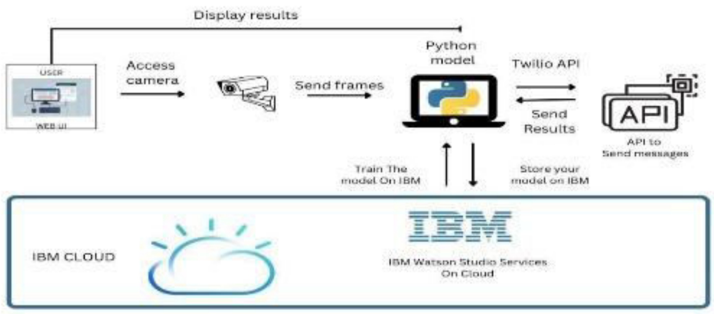
PROJECT DESIGN

Data Flow Diagram





SOLUTION & TECHNICAL ARCHITECTURE



USER STORIES

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 forest team, 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
Technical Team	Image Classification	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	USN-7	They play the most important role to cool the fire and manage the excess spread of fire further	They take the following measures to stop fire from spreading	High	Sprint-2
Media & Nearby Residing People	News, Radio, Alerts,	USN-8	Protecting wildlife, human from the disaster caused	Thus, helping unit should be sent to protect lives	Medium	Sprint-2

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
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
Sprint-2	To analyse the fire prone areas and to set the surveillance camera to collect and observe the region continuously for early detection.	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
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	1	medium

			needed to be corrected to avoid future lags		
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
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

CHAPTER 7

CODING & 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

USER ACCEPTANCE TESTING

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

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

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 & 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 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 maintaingreat 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.

APPENDIX

SOURCE CODE

Import the neccessary libraries

```python
import keras
import tensorflow

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

✓ 1m 18.2s Python

```python
import tensorflow

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

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)
```

✓ 0.1s Python

```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.
```

```python
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.
```

```python
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

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

Python

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

Python

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)
```

Python

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

Python

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

0
```

fire.py

```
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()
```

GITHUB

https://github.com/IBM-EPBL/IBM-Project-49757-1660838060

PROJECT DEMO

https://drive.google.com/file/d/1wm2DXJumnCxdzvUbBKU8vMiNv1YZMXOv/view?usp=sharing