EMERGING FOREST FOR EARLY DETECTION OF FOREST FIRES

PROJECT REPORT

Submitted By

TEAM ID – PNT2022TMID45949

INDUSTRY MENTOR: SHANTHI

FACULTY MENTOR: J.RAJA

TEAM LEADER : G.SAMSON – 814619106301

TEAM MEMBERS: B.S.THARANI - 814619106901

M.SUBHASH – 814619104019

C.SARANYA – 814619104016

BACHELOR OF ENGINEERING IN

INSTRUMENTATION AND COMMUNICATION

TRICHY ENGINEERING COLLEGE

ANNA UNIVERSITY, CHENNAI

NOVEMBER 2022

LIST OF TABLE

Project Report

EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

1.INTRODUCTION

Forest fires are occurring throughout the year with an increasing intensity in the summer and autumn periods. These events are mainly caused by the actions of humans, but different nature and environmental phenomena, like lightning strikes or spontaneous combustion of dried leafs or sawdust, can also be credited for their occurrence. Regardless of the reasons for the ignition of the forest fires, they usually cause devastating damage to both nature and humans. Forest fires are also considered as a main contributor to the air pollution, due to the fact that during every fire huge amounts of gases and particle mater are released in the atmosphere. To fight forest fires, different solutions were employed throughout the years. They ware primary aimed at the early detection of the fires.

1.1 Project Overview

The simplest of these solutions is the establishment of a network of observation posts - both cheap and easy to accomplish, but also time-consuming for the involved people. The constant evolution of the information and communication technologies has led to the introduction of a new generation of solutions for early detection and even prevention of forest fires. ICT-based networks of cameras and sensors and even satellite-based solutions were developed and used in the last decades. These solutions have greatly decreased the direct involvement of humans in the forest fire detection process, but have also proven to be expensive and hard to maintain. In this paper we will discuss and present two different emerging solutions for early detection of forest fires. The first of these solutions involves the use of unmanned aerial vehicles (UAVs) with specialized cameras. Several different scenarios for the possible use of the drones for forest fire detection will be presented and analysed, including a solution with the use of a combination between a fixed-wind and a rotary-wing UAVs. In the next chapter of the paper, we will present and discuss the possibilities for development of systems for early forest fire detection using LoRaWAN sensor networks and we will analyze and present some of the hardware and software components for the realization of such sensor networks. The paper will also provide another point-of-view, which will present the involvement of students in the development and in the use of both systems and we will analyze the advantages and the benefits, which the students will gain from their work on and with these solutions.

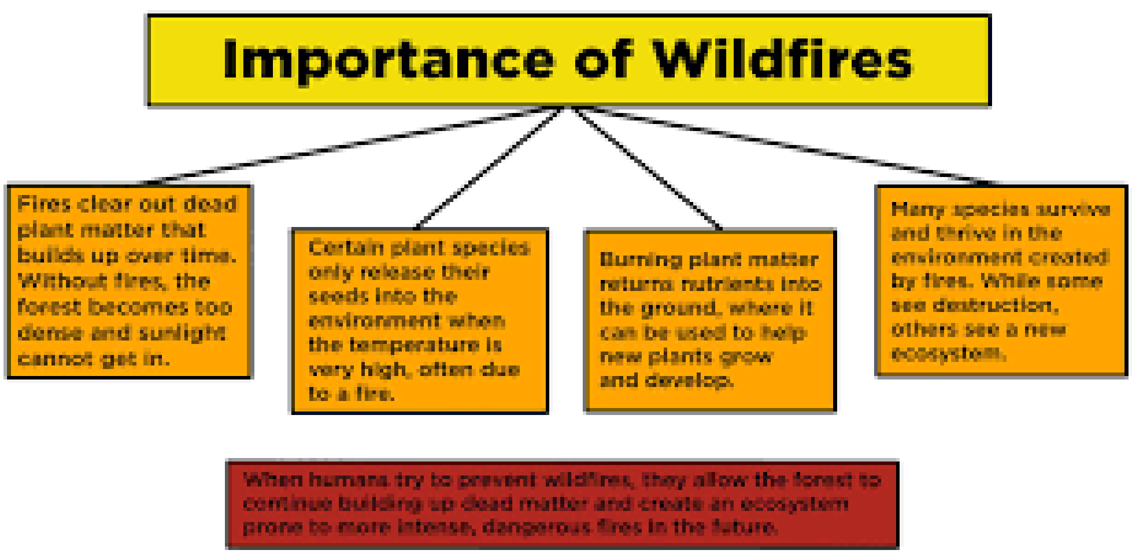
1.2 Purpose

Detection of forest fire and smoke in wild land areas is done through remote sensing-based methods such as ***satellites, high-resolution static cameras fixed on the ground, and unmanned aerial vehicles (UAVs).***

(i)Images that are captured through the satellites have poor resolution, and hence, it becomes difficult to detect the particular area.

(ii)Continuous information about the status of the forest could not be obtained due to the restrictions in the monitoring of forests.

(iii)Weather might not be stable in all situations as it might vary, and thus, it results in the collection of noisy images.

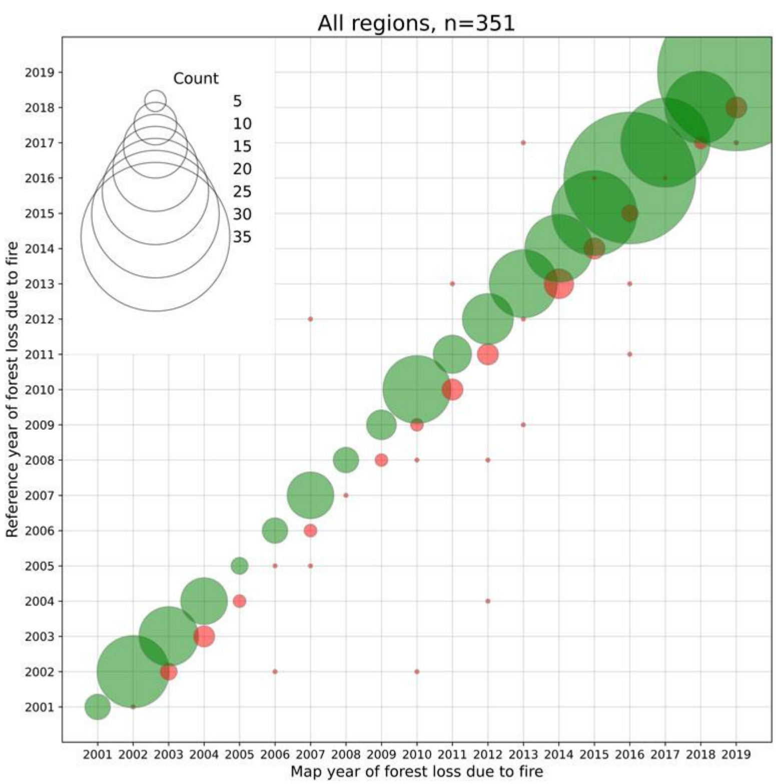


LITERATURE REVIEW

S.NO	REFERENCES	EXISTING PROBLEM	PROBLEM STATEMENT DEFINITION
1	Suhas G,Chetan Kumar ,Abhishek B S / 2020	Fire Detection Using Learning	From sprawling urbans to dense jungles, fire accidents pose a major threat to the world
2	Diyana Kinaneva / 2018	Emerging methods for early detection of forest fires using unmanned aerial vehicles and LoRaWAN sensor networks	The constant evolution of the information and communication technologies has led to the introduction of a new generation of solutions for early detection and even prevention of forest fires
3	Amit Sharma ,Pradeep Kumar Singh / 2020	Sustainable Cities and Society	In the current scenario, the concept of Smart Cities is one of the emerging and challenging research areas. It is observed that the proposed system has a higher fire detection rate to improve the true detection

			of forest fire from 95 to 98 percent.
4	Debasis Parida / 2021	IoT Based Forest Fire Detection System using Arduino and GSM Module	It could be avoided if a robust system could be deployed in forest areas to detect the fire and alert to Fire extinguishing authority to take immediate action.
5	Jijitha R, Shabin P / 2019	A Review on Forest Fire Detection	In order to prevent the natural resources and human safety and property. Early detection in forest fire can be significant impact on the control of forest fire. Many forest fire detection techniques have been proposed by different researchers. There are so many

			techniques to detect the occurrence of forest fire.
	Priyadarshini M Hanamaraddi / 2016	Image Processing for Forest Fire Detection	A colour model is an abstract mathematical model describing the way colours can be represented as tuples of numbers (e.g. triples in RGB or quadruples in CMYK).

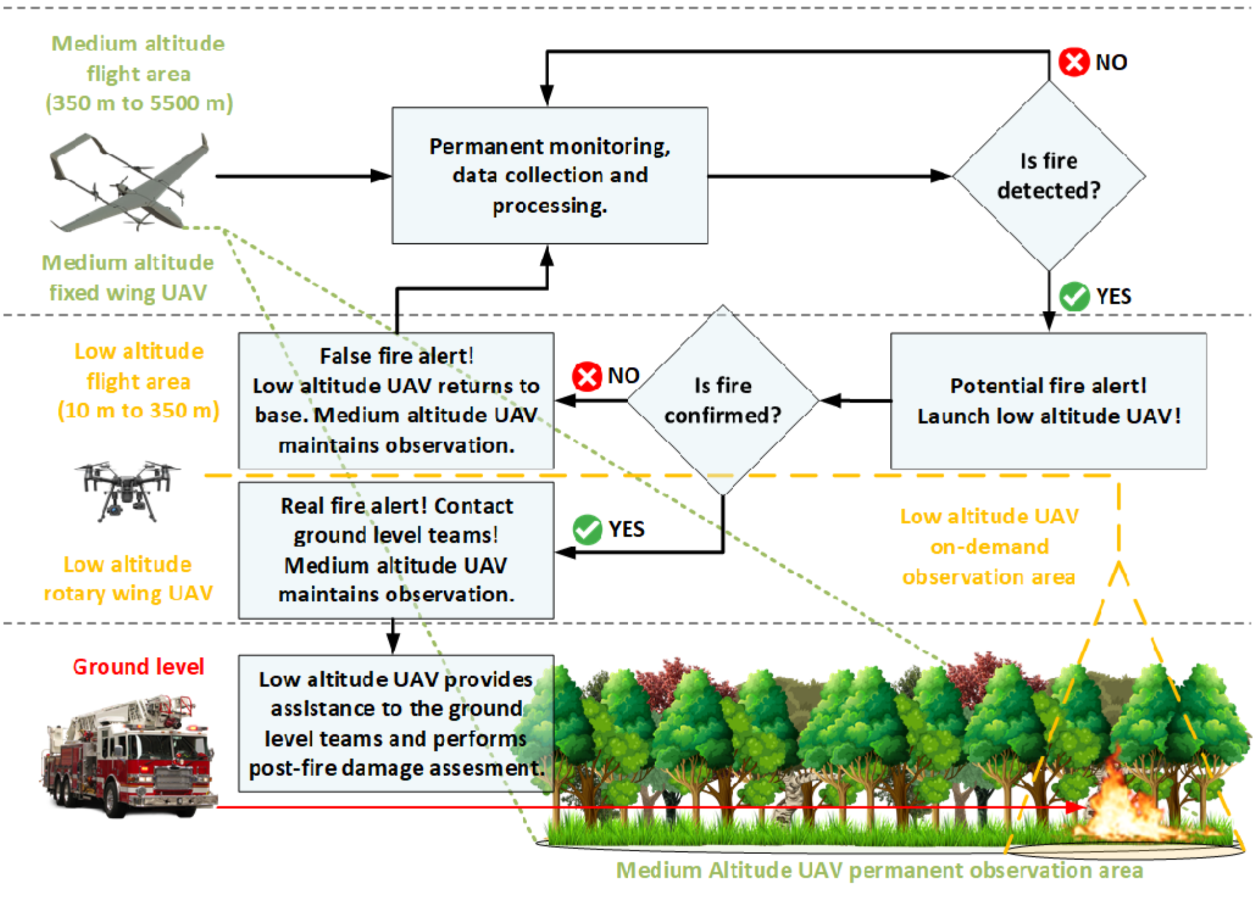


2.3 Problem Statement Definition

- Processing of symptoms of a forest fire.
- Processing inputs from various sensors.
- Images of a video are fed to a CNN model to extract high level features.
- Processing of those images.
- Alert people as well as animals.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

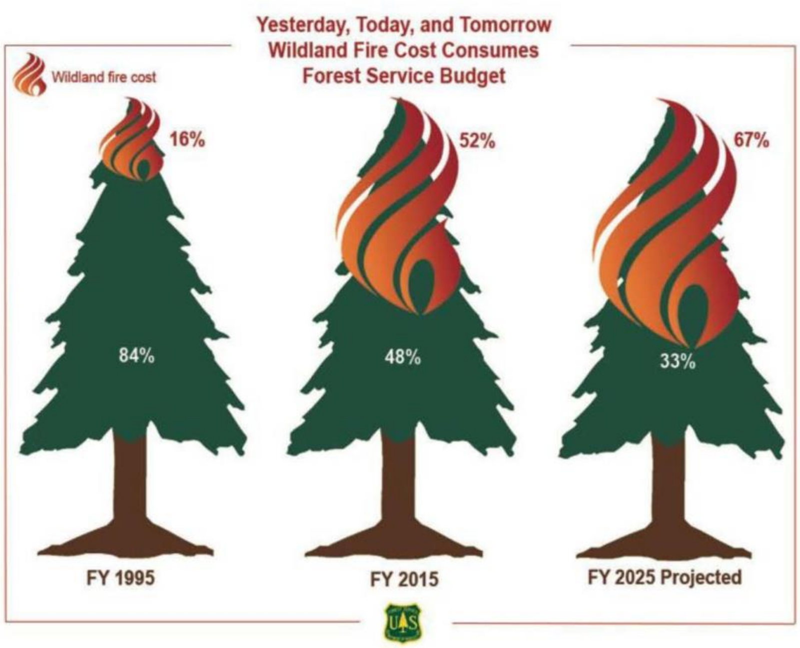


3.2 Ideation & Brainstorming

3.3 PROPOSED SOLUTION:

Serial No.	Parameter	Description
1	Problem Statement (Problem to be solved)	Forest fires pose a serious threat to the environment because they harm the economy, the ecosystem, and put people in danger. In a sparsely populated forest area, it is difficult to predict and detect forest fires, and it is even more challenging if the prediction is done using ground based technologies such as camera or video-based approaches.
2	Idea / Solution description	When there are any signs of a forest fire or other suspicious activity, the video of fire is streamed on the console, an alerting sound is produced, and an alert message is sent to the respective forest authorities.
3	Novelty / Uniqueness	Due to their dependability and effectiveness, satellites can be a valuable source of data both before and during the Fire since ground based techniques makes the prediction more challenging. Applying convolutional neural network (CNN) technology to image recognition can theoretically extract deeper features and minimize blindness and unpredictability to a substantial extent in the feature extraction process, which can significantly increase the accuracy of flame image recognition.
4	Social Impact / Customer Satisfaction	A fire-detection system can limit the emission of harmful byproducts of combustion as well as globalwarming gases produced by the fire by delivering early warning notification. Early fire detection helps to rescue countless acres of forest land,

		limits environmental damage caused by wildlife, and saves the loss of plants and animals
5	Business Model (Revenue Model)	This device can only be utilized by a large firm or by the government to monitor vast forest reserves
6	Scalability of the Solution	While controlling wildfires has advanced over the past few decades, there is still a need to increase disaster risk reduction capabilities, including early detection systems and real-time data transmission at all phases and stages of a forest surveillance system. Monitoring the possible danger areas and early fire detection can considerably minimize the response time, potential damage, and firefighting expenses. Regardless of the geographical distance between resources and users, the system is regionally expandable and maintains its usability and usefulness.



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	6. CUSTOMER CONSTRAINTS CC	5. AVAILABLE SOLUTIONS AS
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.	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	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	9. PROBLEM ROOT CAUSE RC	7. BEHAVIOUR BE
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.	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.	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

	10. YOUR SOLUTION SL	8. CHANNELS of BEHAVIOUR CH
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.	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	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

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 the registered government ID
FR-2	User Confirmation	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	Overall Surveillance Report	Helps to understand the current scenario in the forest by giving report as “no fire” or “negative”
FR-7	Cloud Server Access	To save and run the model from the camera footage
FR-8	Live Camera Feed	Real-time monitoring by the forest officials
FR-9	GSM Module	To alert the nearest forest range officer and the local fire department
FR-10	Alert	The system will send notification to the user when fire is detected

4.2 Non-functional Requirements:

Following are the non-functional requirements of the proposed solution

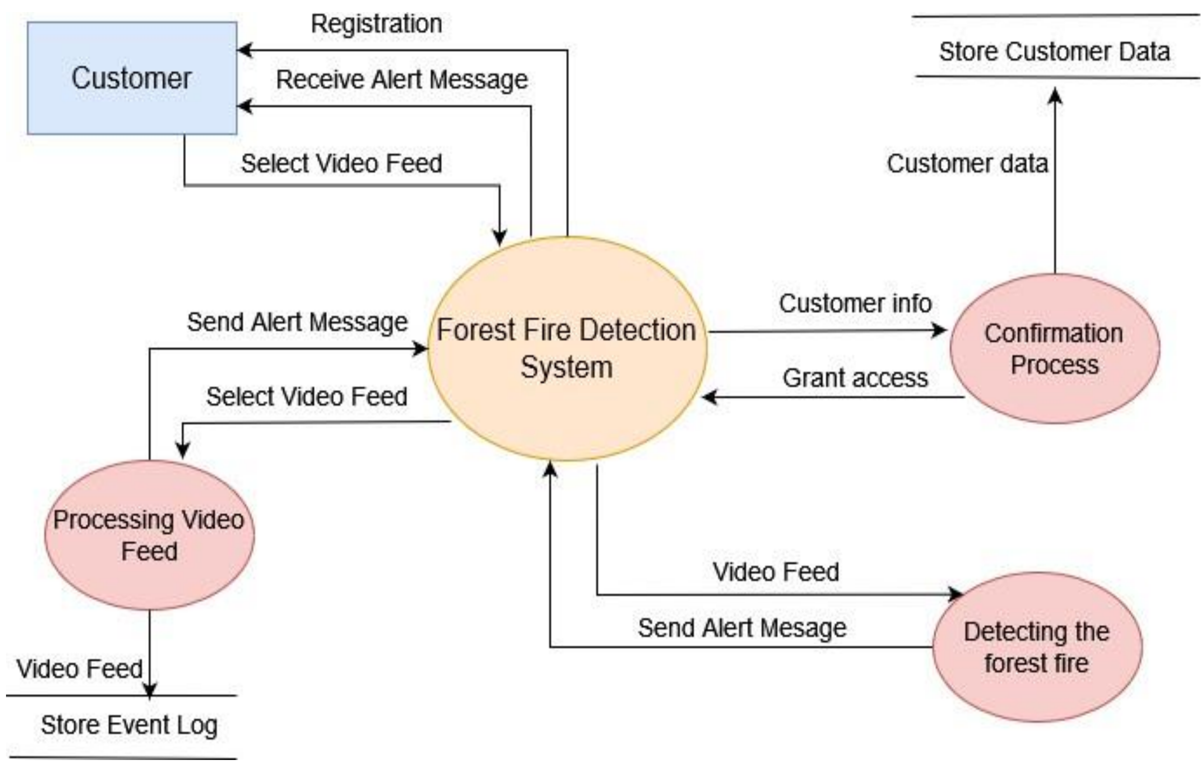
FR No.	Non-Functional Requirement	Description
NFR-1	Usability	Governments who manage reserve forests, large corporations that own acres of land where they grow trees for profit, NGOs that work to conserve forests, and the forest department can all make use of this project as a service to track the activity of endangered species.

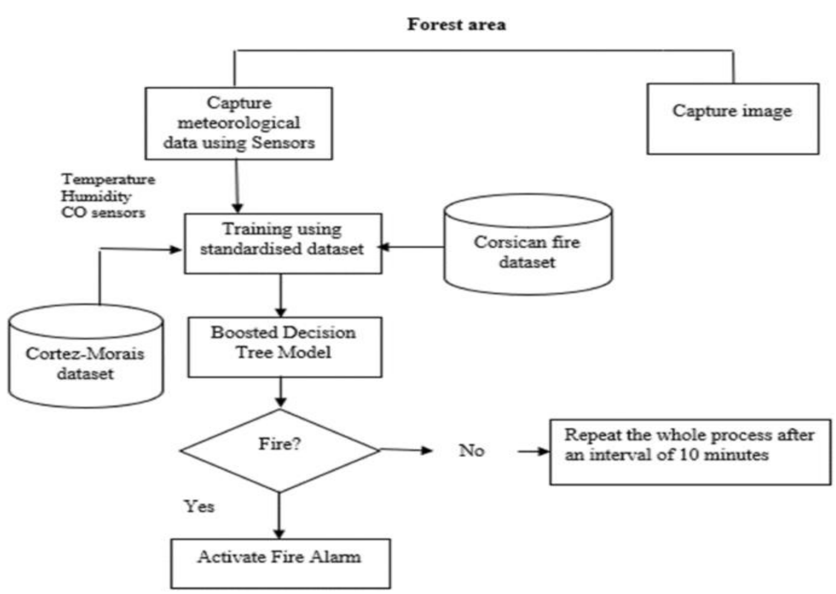
NFR-2	Security	The server is an IBM cloud, which has very excellent encryption standards, to assure security in the monitoring process. Only government of company's officials have access to these files. OTP will conduct additional security checks as confirmation. The backup videos will be kept on the IBM cloud server.
NFR-3	Reliability	The project is very much reliable compared to an previous generation open-source forest monitoring system where the data can be easily manipulated and this is much robust as the initial cost is higher while there will be no need for any maintenance cost
NFR-4	Performance	This initiative outperforms other technologies for detecting forest fires, such as satellite monitoring, IOT sensors, and the usage of IR sensor-based cameras. Over time, this model becomes more accurate.
NFR-5	Availability	This data is only accessible to officials since it contains sensitive information about thousands of acres of forest lands. As the AI model is connected to the IBM server, this can therefore be opened anywhere by the authorised individual.
NFR-6	Scalability	The initial setup costs more than other ways, but there will be reduced or no maintenance costs, and the cost to halt a forest fire and the pollution and wildlife lost is considerably greater than the initial setup costs. Given that they are much easier to implement, the project can readily be scaled to encompass bigger areas of the forests

5.PROJECT DESIGN

5.1 Data Flow Diagrams:

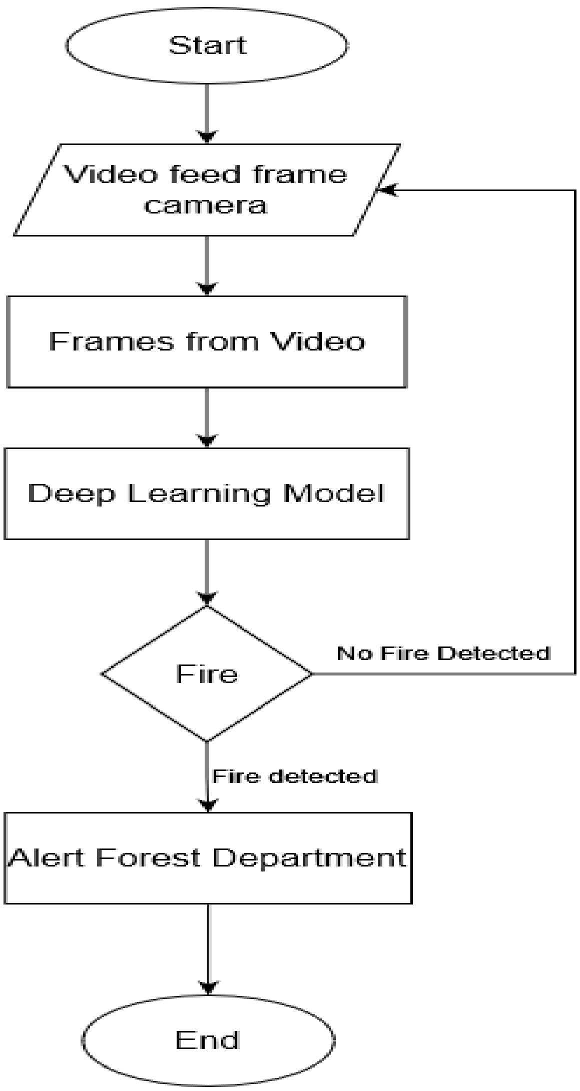
A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.





5.2 Flow Diagram

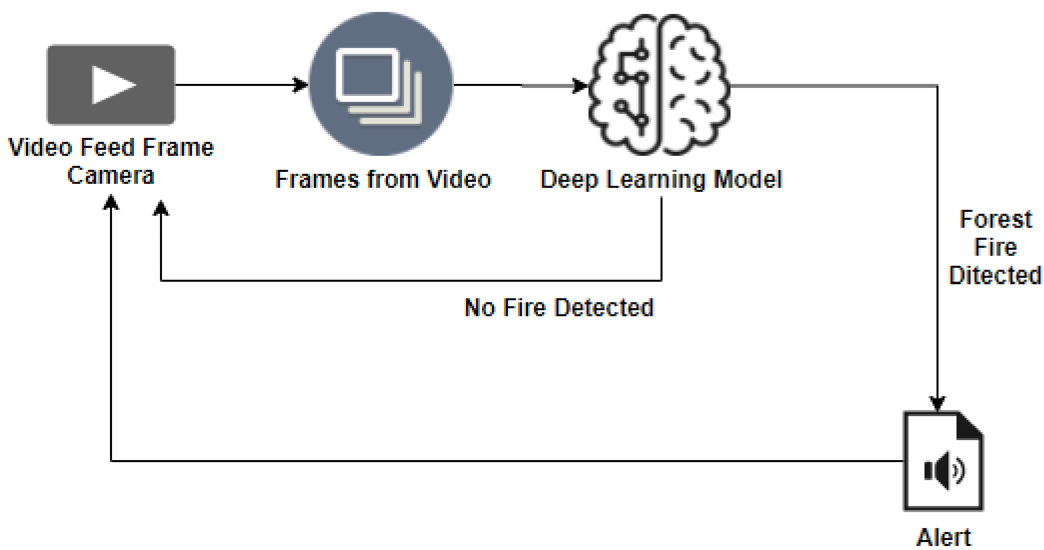
A flow diagram is a visualization of a sequence of actions, movements within a system and/or decision points. They're a detailed explanation of each step in a process, no matter the level of complexity of that process.

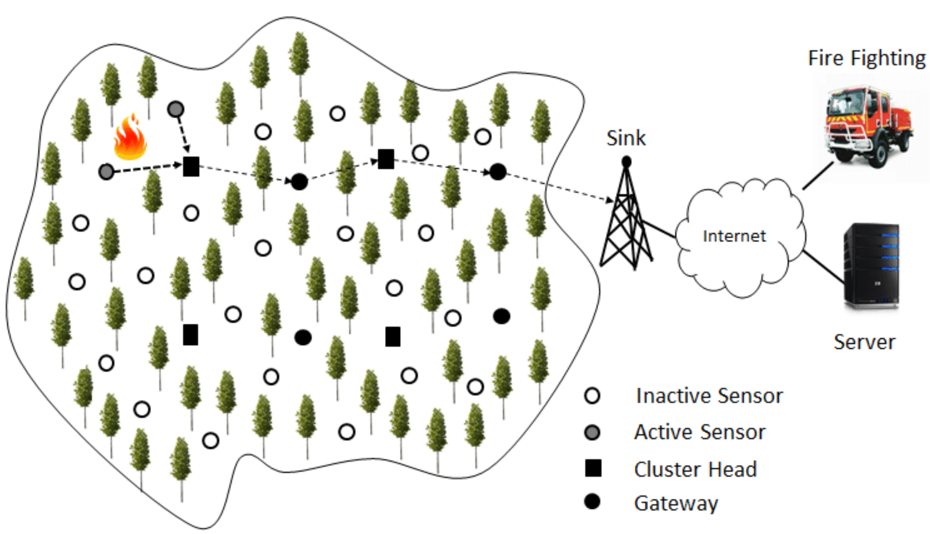


5.3 Solution & Technical Architecture:

- Forest fires are a major environmental issue, creating economic and ecological damage while endangering human lives.
- There are typically about 100,000 wildfires in the United States every year. Over 9 million acres of land have been destroyed due to treacherous wildfires.
- It is difficult to predict and detect Forest Fire in a sparsely populated forest area and it is more difficult if the prediction is done using ground-based methods like Camera or Video-Based approach.
- Satellites can be an important source of data prior to and also during the Fire due to its reliability and efficiency.
- The various real-time forest fire detection and prediction approaches, with the goal of informing the local fire authorities.

Example - Solution Architecture Diagram:





5.3 User Stories

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

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation emailonce I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the applicationthrough Facebook	I can register & access the dashboard with Facebook Login	high	Sprint-2
		USN-4	As a user, I can register for the applicationthrough Gmail		Low	Sprint-1
	Login	USN-1	As a user, I can log into the application byentering email & password	They can access the details and dashboard	High	Sprint-1
Customer (Web user)	Registration	USN-3	Login into executive portal to help the user	Help in accessing the moment and the acess	High	Sprint-1
Customer Care Executive	Help dashboard	USN-2	Can provide the necessary details of help through desired way like email mobiles andSMS		Medium	Sprint-1
Administrator	User account control	USN-4	The person who is responsible for the website control and other management activities	Provides support to forestfire predection	High	Sprint-1

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

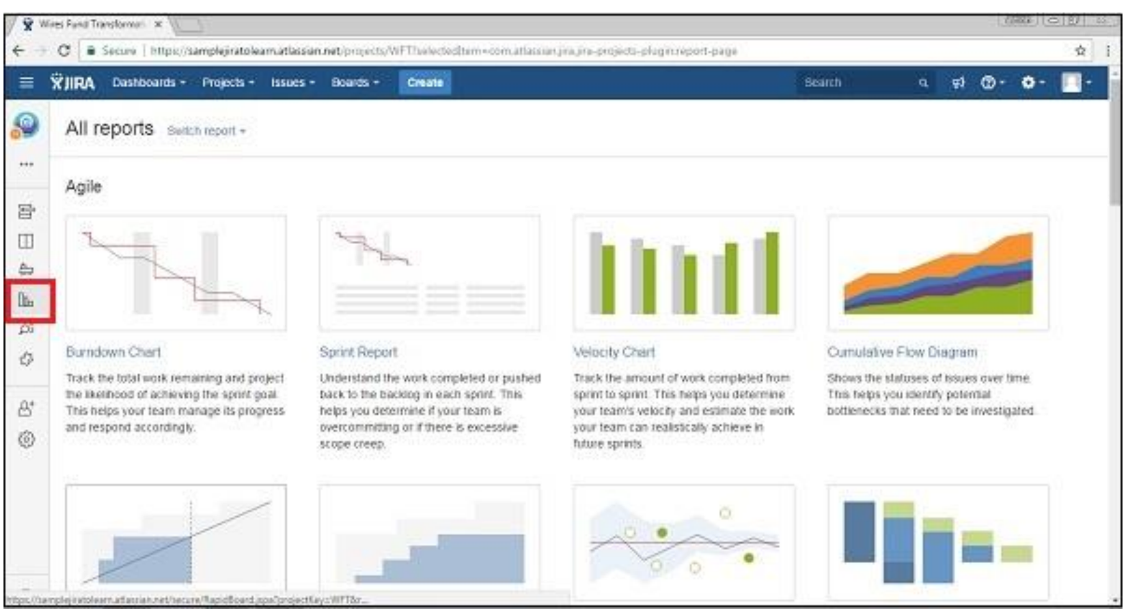
Milestone Name	Milestone Number	Description	Mandatory
Project Objectives	M-01	We will be able to learn to prepare dataset, image processing, working with CNN layers, read images using OpenCV and CNN for computer vision AI	Yes
Project Flow	M-02	A project management process flowchart is a graphical aid,designed to visualize the sequence of steps to be followed throughout the project management process	Yes
Pre-Requisites	M-03	To complete this project, we should have known following project such as Keras, Tensor Flow, Python ,Anaconda, OpenCV,Flask, Scikit-learn etc.…	Yes
Prior Knowledge	M-04	One should have knowledge on the Supervised Learning ,CNN and Regression Classification and Clustering, ANN	Yes
Data collection	M-05	We can collect dataset from different open sources like kaggle.com, UCI machine learning etc.	Yes
Image Preprocessing	M-06	Importing the ImageDataGenerator libraries, Define Parameters/Arguments for ImageDataGenerator class, Applying Image Data Generator Functionality to train set and test set	Yes
Model Building	M-07	Importing the model building libraries, Initializing the model, Adding CNN layers, Adding Dense layers, Configuring the learning Process, Train the model, Save the model, Predictions.	Yes
Video Analysis	M-08	Opencv for video processing, creating an account in twilio service and sending alert message	Yes
Train CNN model	M-09	Register for IBM Cloud and train Image Classification Model	Yes

6. 2 Sprint Delivery Schedule

Ideation Phase	M-10	Prepare Literature Survey on the selected Project and Information Gathering, empathy map and ideation	Yes
Project Design Phase-I	M-11	Prepare Proposed solution , problem-solution fit and Architecture	Yes
Project Design Phase-II	M-12	Prepare Customer journey ,functional requirements, Dataflow diagram and Technology Architecture	Yes
Project Planning Phase	M-13	Prepare Milestone list , Activity list and Sprint Delivery Plan	Yes
Project Development Phase	M-14	Project Development delivery of Sprint 1, Sprint 2, Sprint 3, Sprint 4	Yes

6.3 Reports from JIRA

- Packages. Host and manage packages.
- Security. Find and fix vulnerabilities.
- Instant dev environments.
- Copilot. Write better code with AI.
- Manage code changes.
- Issues. Plan and track work.
- Discussions. Collaborate outside of code.



7. CODING & SOLUTIONING (Explain the features added in the project along with code)

7.1 Feature 1

```
train_dataset=test.flow_from_directory("/content/drive/MyDrive/Datas et/Train set",

target_size=(128,128),

batch_size=32,

class_mode='binary' )



Found 95 images belonging to 2 classes.

[ ] test_dataset=test.
            flow_from_directory("/content/drive/MyDrive/Dataset/Test set",



target_size=(128, 128),

patch_size=32,

class_mode='binary' )

Found 100 images belonging to 2 classes.
```

7.2 Feature 2

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

```
[ ] model = load_model("/content/drive/MyDrive/forest.h5") def
predictImage(filename) :
img1 = image. load_ing(filename, target_size=(128, 128) ) Y = image.
ing_to_array (img1)
X = np. expand_dims(Y, axis=0)

val = model. predict(X)



print(val)

if val == 1:

print(" fire")

elif val == 0:
```

```
print("no fire")



predictImage("/content/drive/MyDrive/Dataset/Test set/with fire/with fire (1).jpg")
1/1 [ ===
(=====] - 41s 41s/step
[[1. ]]
```

OUTPUT

{'forest': 0, 'with fire': 1}

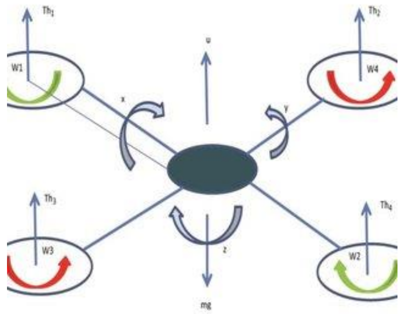
8. TESTING

8.1 Test Cases

Comparison	Human based observation	Satellite system	Optical cameras	Wireless sensor networks
Cost	Low	Very high	High	Medium
Efficiency and practicality	Low	Low	Medium	High
Faulty alarms repetition	Low	Low	Medium	Medium
Fire localising accuracy	Low	Medium	Medium	High
Detection delay	Long	Very long	Long	Small
Fire behaviour information	--	Yes	--	Yes
Can be used for other purposes	No	Yes	No	Yes

8.2 User Acceptance Testing

Resolution	Severity1	Severity2	Severity3	Severity4	Subtotal
By Design	10	4	2	2	19
Duplicate	1	1	3	0	5
External	2	3	1	1	7
Fixed	11	2	5	20	38
Not Reproduced	0	0	0	0	0
Skipped	0	0	1	1	2
Won'tFix	0	5	2	1	8
Totals	24	14	13	26	77



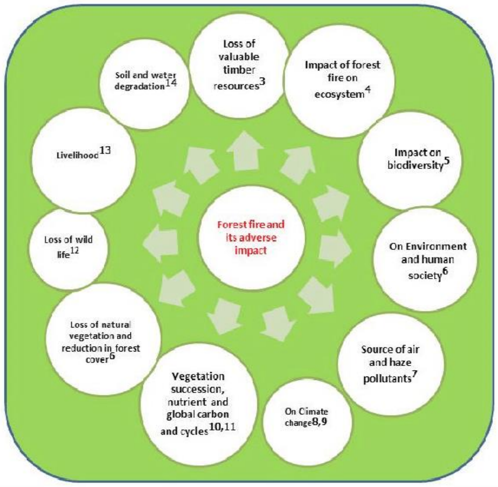
Testing analysis

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	52	0	0	52
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	5	0	0	5
Version Control	2	0	0	2

9. RESULTS

9.1 Performance Metrics

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	Python Flask framework is used	Technology of Open source framework
2.	Security Implementations	Mandatory Access Control (MAC) and Preventative Security Control is used	e.g. SHA 256, Encryptions,IAMControls, OWASP etc.
3.	Scalable Architecture	High scalability with 3-tier architecture	Web server – HTML ,CSS ,JavaScript Application server – Python , AnacondaDatabase server –IBM DB2
4.	Availability	Use of load balancing to distribute traffic acrossservers	IBM load balancer
5.	Performance	Enhance the performance by using IBM CDN	IBM Content Delivery Network



10. ADVANTAGES & DISADVANTAGES

Advantages

- They kill and displace wildlife, alter water cycles and soil fertility, and endanger the lives and livelihoods of local communities.
- They also can rage out of control.
- It allows the person and their family to educate themselves, seek support that works for them, and make informed decisions and plans.
- Low cost to produce and maintain
- Versatile mounting hardware
- Relays vital weather information Limited battery capabilities
- Provides the customer with wildfire detection and monitoring to minimize damage caused by wildfires.
- Small form minimizes wildlife disruption .

Disadvantages

- Does not have global market penetration like other competitors
- Limited battery capabilities.
- Limited data transfer and communications capabilities
- Will only be available on the west coast at product.
- It cannot be used without internet connection.

11. CONCLUSION

The only effective way to minimize damage caused by forest fires is their early detection and fast reaction, apart from preventive measures. Great efforts are therefore made to achieve early forest fire detection, which is traditionally based on human surveillance. Technically more advanced forest fire surveillance systems is based on video camera monitoring units mounted on monitoring spots and distant monitoring from operation center in conjunction with satellite monitoring. Infrared and laser-based systems are more sensitive and they generate less false alarms, but their price is quite high in comparison to video cameras sensitive in visible spectra. In all those systems automatic forest fire detection is based on smoke recognition during the day and flame recognition during the night.

Wildfire will continue to affect source water quality resulting to increasing treatment, maintenance and operating costs. Therefore, forest and watershed managers and water suppliers have to be well informed about wildfire impacts so as to develop mitigation strategies to build resiliency to wildfire in water supply. Recommended strategies to be fully developed and implemented, they should collect substantial information about magnitude and timing of post-fire impacts. But the bottom line is that wildfire impacts should be incorporated into routine planning, protection and operations of forests watersheds and water sources.

Recommendations:

- Forest managers should ensure proper forest management practices through tree thinning by removing dry trees and branches which act as fuel to fires. They should also have post-wildfire mitigation strategies in place such that proper assessment and monitoring is conducted to minimize causes of forest fires, as well as, establishment of landscape emergency stabilization plans to reduce sediment and ash transport into open water sources. Additionally, forest restoration and rehabilitation on the burnt landscape should be done soon after forest fires to minimize pollutants that could be carried from the area.
- Watershed managers should introduce source water protection by having restriction to forests watershed having the water sources used for drinking water supply. This way anthropogenic activities that might cause forest fires are eliminated. Proper land management practices should be ensured through close monitoring of all human activities happening such as logging, mining and residential developments. Also, they should implement run-off control measures on the steep landscape such as stream channel erosion controls or using wood-straw mulch on burnt area that is being rehabilitated or restored.
- Water Providers should modify their designed treatment infrastructures into robust plants that are able to remove pollutants released by forest fires. There should be constant water quality monitoring to understand the key pollutant sources considering all burnt areas that could be exposing the pollutants to the water reservoirs. Highly optimized treatment processes with highly trained operators having knowledge about wildfire water quality impacts should be considered so as to meet drinking water quality standards during post-wildfire periods.

12. FUTURE SCOPE

- Life casualties and avoid loss of properties
- Loss of valuable timber resources;
- Degradation of water catchment areas resulting in loss of water;
- Biodiversity and extinction of plants and animals
- Wild Life Habitat And Depletion Of Wild Life
- Natural regeneration and reduction in forest cover and production;
- Global warming resulting in normal temperature;
- Carbon Sink Resource And Increase In Percentage Of Co2 In The Atmosphere
- Change In The Micro Climate Of The Area Resulting In Healthy Living Conditions
- Soil erosion disaffecting productivity of soils and agricultural production;
- Avoid Ozone Layer Depletion

REFERENCES

1. Abrha H, Adhana K. 2019. Desa'a national forest reserve susceptibility to fire under climate change. Forest Science and Technology. 15(3):140–146. [Taylor & Francis Online], [Web of Science ®], [Google Scholar]
2. Alexander D. 1993. Natural disaster. London: UCL Press Ltd.; p. 632. [Google Scholar]
3. Aponte C, de Groot WJ, Wotton BM. 2016. Forest fires and climate change: causes, consequences and management options. Int J Wildland Fire. 25(8):i–ii. [Crossref], [Web of Science ®], [Google Scholar]
4. Babu KVS, Roy A, Prasad PR. 2016. Forest fire risk modelling in Uttarakhand Himalaya using TERRA satellite datasets. Eur J Remote Sens. 49(1):381–395. [Taylor & Francis Online], [Google Scholar]

5. Bahuguna VK, Upadhay A. 2002. Forest fires in India: policy indicatives for community participation. Int Forest Rev. 4(2):122–127. [Crossref], [Web of Science ®], [Google Scholar]
6. Bajracharya KM. 2002. Forest fire situation in Nepal. Int For Fire News. 26:84–86. [Google Scholar]
7. Bhujel KD, Maskey-Byanju R, Gautam AP. 2017. Wildlife dynamics in Nepal from 2000–2016. Nep Jnl Environ Sci. 5:1–8. [Crossref], [Google Scholar]
8. Brown AA, Davis KP. 1959. Forest fire control and use. Graw-Hill series in forest resources, New York, McGraw-Hill [1973] xii, 686 p. illus. 24 cm. [Google Scholar]
9. Cha S, Kim CB, Kim J, Lee AL, Park KH, Koo N, Kim YS. 2020. Land-use changes and practical application of the land degradation neutrality (LDN) indicators: a case study in the subalpine forest ecosystems, Republic of Korea. Forest Science and Technology. 16(1):8–17. [Taylor & Francis Online], [Web of Science ®], [Google Scholar]
10. Darmawan M, Aniya M, Tsuyuki S. 2001. Forest fire hazard model using remote sensing and geographic information systems: towards understanding of land and forest degradation in lowland areas of east Kalimanthan, Indonesia. Paper presented in 22nd Asian Conference on Remote Sensing, 509 November 2001, Singapore. [Google Scholar]

13. APPENDIX

Source Code

```
# prerequisities

# conda create –n tensorflow python=3.5

# activate tensorflow

# pip install –ignore—installed –upgrade tensorflow


!pip install tensorflow

!pip install opencv-python

!pip install opencv-contrib-python

import tensorflow as tf

import numpy as np

from tensorflow import keras

import os

import cv2

from tensorflow.keras.preprocessing.image import ImageDataGenerator

from tensorflow.keras.preprocessing import image

import matplotlib.pyplot as plt


#its important to split the training and testing - Data set is stored in the path specified.
```

```
train = ImageDataGenarator(rescale=1/255)

test = ImageDataGenerator(rescale=1/255)

train_dataset = train.flow_from_directory("D:/archive/fire_dataset/Training and validation/",
                                          target_size=(150,150),
                                          batch_size =32,
                                          class_mode = 'binary')



train_dataset = test.flow_from_directory("D:/archive/fire_dataset/Testing/",
                                          target_size=(150,150),
                                          batch_size =32,
                                          class_mode ='binary')


test_dataset.class_indices


# we shall build the model here!

# simple CNN shall do the task, you can try other tech as well.

# Try with other activation functions also.

model = keras.Sequential()

model.add(keras.layers.Conv2D(32,(3,3),activation='relu',input_shape=(150,150,3)))

model.add(keras.layers.MaxPool2D(2,2))

model.add(keras.layers.Conv2D(64,(3,3),activation='relu'))

model.add(keras.layers.MaxPool2D(2,2))

model.add(keras.layers.Conv2D(128,(3,3)),activation='relu'))

model.add(keras.layers.MaxPool2D(2,2))

model.add(keras.layers.Conv2D(128,(3,3)),activation='relu'))

model.add(keras.layers.MaxPool2d(2,2))

model.add(keras.layers.Flatten())
```

```
model.add(keras.layers.Dense(512,activation='relu'))

model.add(keras.layers.Dense(1,activation='sigmod'))



# It is time to compile the model, let us
compile.model.compile(optimizer='adam',loss='binary_crossentropy',metrics=['accuracy'])

# let's get the model fit.

r = model.fit(train_dataset, epochs = 7, validation_data = test_dataset)

# Epochs you can vary!


# Can we work on the testing dataset,the prediction happen here.

predictions = model.predict(test_dataset)

predictions = np.round(predictions)


predictions


print(len(prediction))


# it's time to plot it! lets plot loss.

import matplib.pyplot as plt

plt.plot(r.history['loss'], label='loss')

plt.plot(r.history['val_loss'], label='val_loss')

plt.legend()


# This helps in taking individual images from the Dataset, load and check results.

def predictImage(filename):

   img1 = image.load_img(filename,target_size=(150,150))

   plt.imshow(img1)
```

```
    Y = image.img_to_array(img1)
    X = np.expand_dims(Y,axis=0)
    val = model.predict(X)
    print(val)
    if val ==1:
        plt.xlabel("No fire",fontsize=30)
    elif val == 0:
        plt.xlabel("fire",fontsize=30)

predictImage("")
```

GitHub & Project Demo Link

https://github.com/IBM-EPBL/IBM-Project-41277-1660640872

https://drive.google.com/file/d/17jIRdA5Njj551nP3fgzFbvCGAKwViooc/view?usp=sharing