EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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ABSTRACT

Over the last few decades, forest fires are increased due to deforestation and global warming. Many trees and animals in the forest are affected by forest fires. Technology can be efficiently utilized to solve this problem. Forest fire detection is inevitable for forest fire management. The purpose of this work is to propose deep learning techniques to predict forest fires, which would be cost-effective. The mixed learning technique is composed of YOLOv4 tiny and LiDAR techniques. Unmanned aerial vehicles (UAVs) are promising options to patrol the forest by making them fly over the region. The proposed model deployed on an onboard UAV has achieved 1.24 seconds of classification time with an accuracy of 91% and an F1 score of 0.91. The onboard CPU is able to make a 3D model of the forest fire region and can transmit the data in real time to the ground station. The proposed model is trained on both dense and rainforests in detecting and predicting the chances of fire. The proposed model outperforms the traditional methods such as Bayesian classifiers, random forest, and support vector machines.

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LIST OF ABBREVIATIONS

ABI	Advanced Baseline Imager
ADF	Adaptive Decision Fusion
AHI	Advanced Himawari Imager
AVHRR	Advanced Very-High-Resolution Radiometer
BAT	Broad Area Training
BPNN	Back-Propagation Neural Network
BT	Brightness Temperature
CCD	Charge-Coupled Device
CMOS	Complementary Metal-Oxide-Semiconductor
CNN	Convolutional Neural Network
DC	Deep Convolutional
DL	Deep Learning
DTC	Diurnal Temperature Cycles
ECEF	Earth-Centered Earth-Fixed
EO	Earth Observation

CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEW

Recent advancements in technology have overwhelmingly shaped society, the economy, and the environment. With the help of the various state-of-art technologies such as IoT, blockchain, AI, geospatial mapping, and so on, leading to the fifth industrial revolution, which focuses more on solving climate goals in line with the revolution. New requirements in the ecological environment arise due to the expeditious development of society. Among the various natural disasters, fire hazard seems to own the characteristics of spreading, and also, it becomes very challenging to control, and thus, it results in heavy destruction that might be irrevocable. Over the past few years, there is a tremendous increase in the count, occurrence, and severity of wildfires across the world that has created a great impact on the economy and ecosystem of the country. There are various techniques such as watchtowers, spotter planes, infrared, aerial patrols, and automatic detection systems to detect fire events. There is no need for the exposure of humans to perilous activities when remote sensing is deployed. Various techniques are as follows:

i. Usage of the satellite images to observe, detect, and report fire events
ii. Implementation of the wireless sensor networks to observe the fire events exist in all areas.

Yet there are certain limitations associated with the satellite images. It has an inadequate resolution, and hence, the data pertinent to the corresponding area would be taken as an average, and it is restricted to a particular pixel that results in the detection of small fires. The predominant limitation is that the satellites cover only a limited area and require a preprocessing time before the resurvey of the same region. The other limitations such as the shortage of real-time data and inadequate precision are inapt for persistent monitoring. There is a need for the infrastructure in advance if WSNs are deployed. There is more chance for the destruction of the sensors during the fire, and this might lead to more expensive restoration of the sensors. Several factors such as the static nature of the sensors, their coverage, difficulty in maintenance, the deficit in power independence, and nonscalability are the reasons for the sensor networks to limit their efficiency. Therefore, unmanned aerial vehicles (UAVs) are proposed to overcome the limitations. The sovereignty, less cost, autonomous, and flexibility make the UAV technology the best choice for fire management efforts in the wildland. There are researchers who put more effort into focusing on the development of frameworks and techniques that could be associated with UAVs. The motive of the implementation of UAV is to detect the fire and its coverage in an optimal manner. The aim of this work is to develop a model to detect the fire and its coverage area, and in addition, it also observes the fire in the low region.

1.2 PURPOSE

Emerging Methods For Early Detection Of Forest Fires aims to develop an automatic early warning system integrating multiple sensors to remotely monitor areas of archaeological and cultural interest for the risk of fire and extreme weather conditions. FIRESENSE will take advantage of recent advances in multi-sensor surveillance technologies by employing both optical and infrared cameras to monitor the site and the surrounding area as well as a wireless sensor network capable of measuring different environmental parameters (e.g. temperature, humidity). The signals and measurements collected from these sensors will be transmitted to a monitoring center, which will employ intelligent computer vision and pattern recognition algorithms as well as data fusion techniques to automatically analyze and combine sensor information. The control centre will be capable of generating automatic warning signals whenever a dangerous situation arises, i.e. when fire or smoke is detected. Moreover, the system will read weather data from official meteorological services as well as from local weather stations installed at the site and will issue alerts in case of extreme weather conditions. It will also provide real-time information about the evolution of the fire based on wireless sensor network data. Furthermore, it will be able to estimate the propagation of the fire based on the fuel model of the area and other important parameters such as wind speed and direction and ground morphology. Finally, the estimated fire propagation will be visualized on a 3D Geographic Information System (GIS) environment

CHAPTER 2

LITERATURE SURVEY

2.1 EXISTING PROBLEM

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

The limitations of the satellites are described as follows:

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

Optical/thermal cameras deployed on the observation towers together with the other sensors such as smoke, temperature, and humidity sensors might detect the hazards in the closed environment rather than in the open environment as these sensors need vicinity to the fire or smoke. The information obtained through these sensors is not appropriate. Distance covered by these methods could be limited, and to cover a large area, more sensors have to be deployed that might incur expenses. Through the deployment of UAV, large areas could be covered, and the images with high spatial and temporal resolutions could be captured properly. The operational cost is very low when compared with the other methods.

In detection of forest fire is done through the deployment of YOLOv4 to UAV-based aerial images. The initial phase of the process is that the authors developed the hardware platform and proposed the YOLOv4 algorithm. Frame detection rate through this method obtained is 3.2 fps, and the recognition rate achieved is 83%. This works when the intensity of the fire is huge. The limitation of this algorithm is that the detection rate is very less in the small fire-spot areas. The authors have made use of the NetImage classifier that has the combination of Yolov5 and EfficientDet. The data set used comprises 10,581 images of which 2,976 images are categorized as forest fire and 7,605 as nonfire images. The model undergoes an adequate training process, and an accuracy of 99.6% has been obtained with the 476 fire images, and for 676 images that looked similar to images that display fire, the accuracy achieved was 99.7%. Yet the limitation is that it does not detect the smoke since it is needed in the initial stage of the detection process.

2.2 REFERENCES

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2.3 PROBLEM STATEMENT DEFINITION

In earlier times fires were detected with the help of watching towers or using satellite images. Satellites collect images and send it to the monitoring authority which will decide by seeing images that it is a fire or not. But this approach was very slow as the fire may have spread in the large areas and caused so much damage before the rescue team came. In the watching tower method, there was a man always standing on the tower who would monitor the area and inform if there was fire. This method was also slow because before the man got to know about the fire it may have spread in the inner parts of forest, also it always requires a man who must be present there. Since, we know that some areas, especially forest areas are large so it is practically impossible to put a man in every part of forest from where they can monitor the forest area. So, both these approaches of watching towers and satellite images failed to detect fire as early as possible to reduce the damage done by fire Problems in fire detection: There were mainly two problems in fire detection as discussed: (a). Judging criteria for the fire: Edge is set, on the off chance that the worth is more noteworthy than edge, it is a fire, else not. So, this problem was removed by using machine learning techniques by many researchers. (b). Connection of nodes: Traditional systems used cables to connect alarm with the detectors. Cable was mainly of copper. But copper wire may be costly or it can suffer from fault in the mid-way. So, this problem was removed using wireless sensor networks. So, with the advancement in technology researchers find an efficient method to detect forest fire with the help of Wireless Sensor Network. Fire can be identified by conveying sensor hubs in timberland regions by which they illuminate about fire. Conveying sensor hubs in the timberland regions means placing sensors in every part of the forest and mostly in the prone areas where risk of 9 catching fire is more. With the use of wireless sensor networks, now it is easy to detect the fire in large areas as soon as possible.

CHAPTER 3

IDEATION & PROPOSED SOLUTION

3.1EMPATHY MAP CANVAS

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviors and attitudes.

It is a useful tool to helps teams better understand their users.

Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

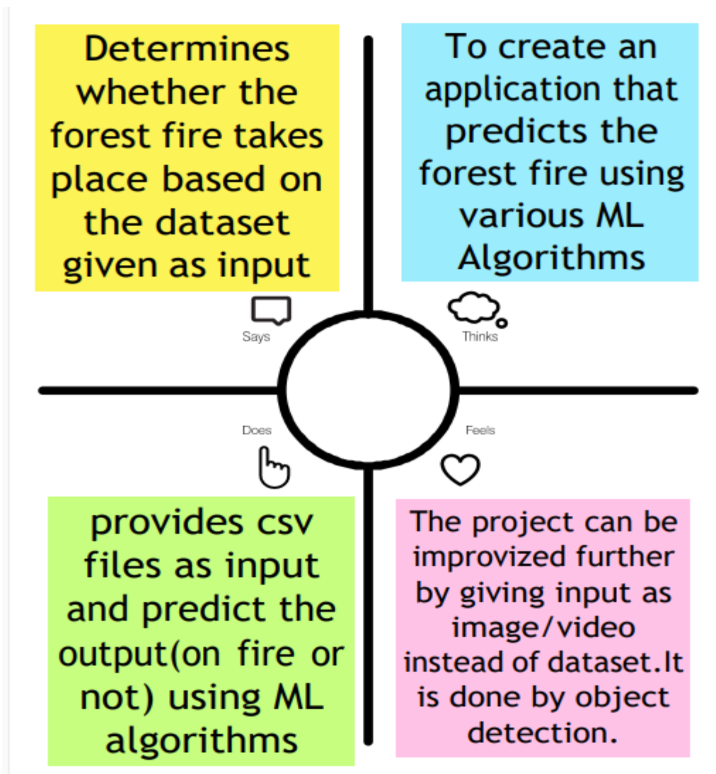


Fig 3.1.1 Empathy Map

3.2 IDEATION & BRAINSTORMING

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the sameroom.

Before you collaborate

A little bit of preparation goes a long way with this session. Here’s what you need to do to get going

A. Team gathering

Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B. Set the goal

Think about the problem you'll be focusing on solving in the brainstorming session.

C. Learn how to use the facilitation tools

Use the Facilitation Superpowers to run a happyand productive session.

Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might Forest fire Detection. This will be the focus of your brainstorm

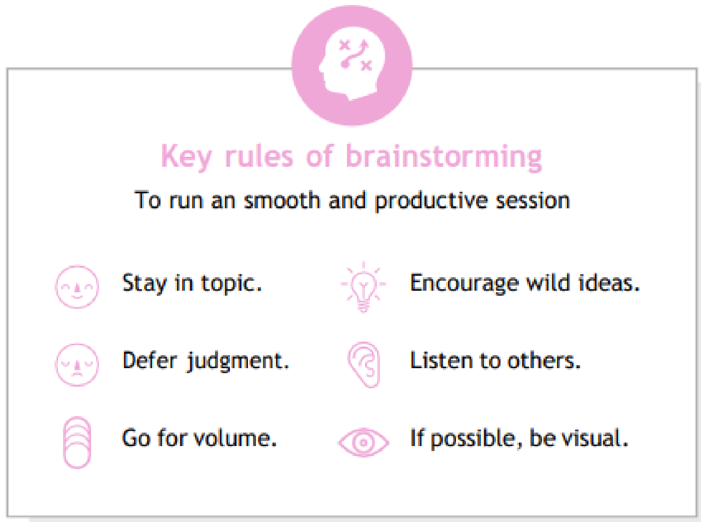


Fig 3.2.1 Ideation & Brainstorming

Brainstorm

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

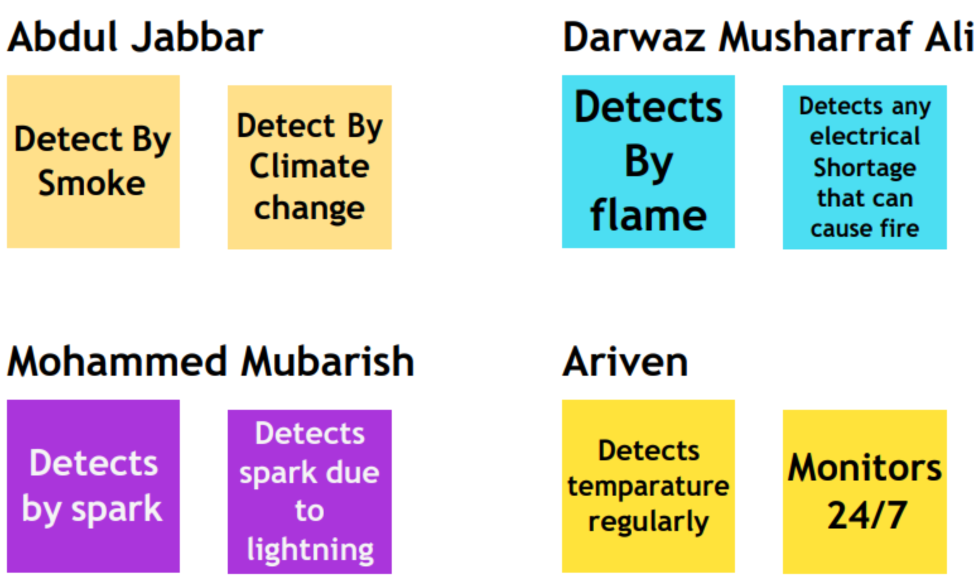


Fig 3.2.2 Ideation & Brainstorming

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

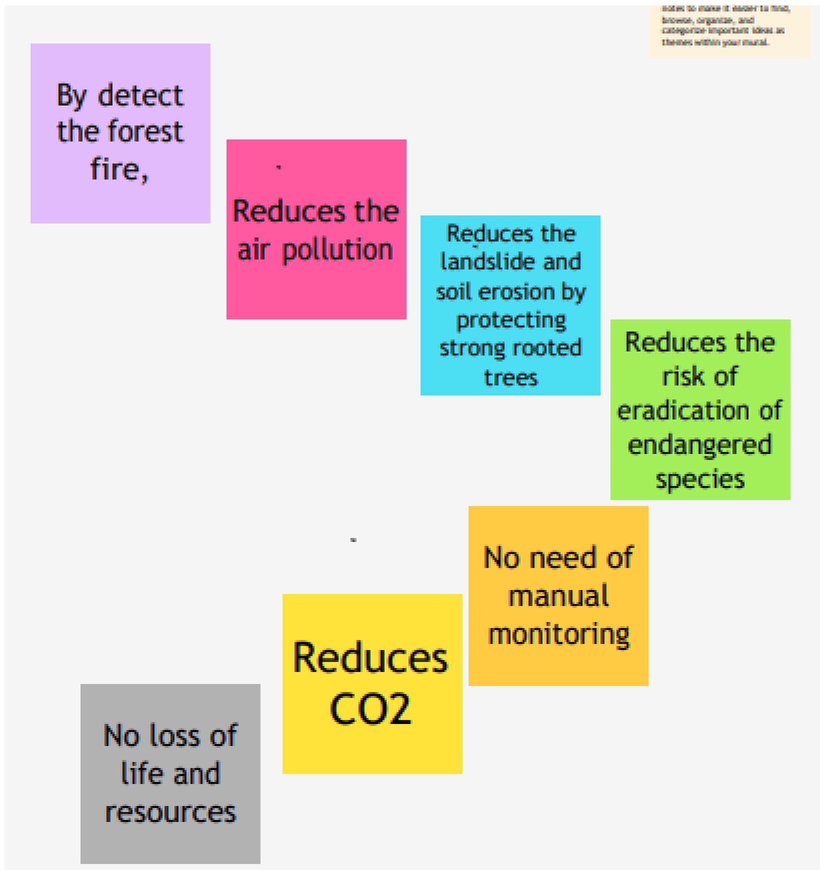


Fig 3.2.3 Ideation & Brainstorming

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which arefeasible

Fig 3.2.4 Ideation & Brainstorming

After you collaborate

A. Share the mural

Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

B. Export the mural

Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive

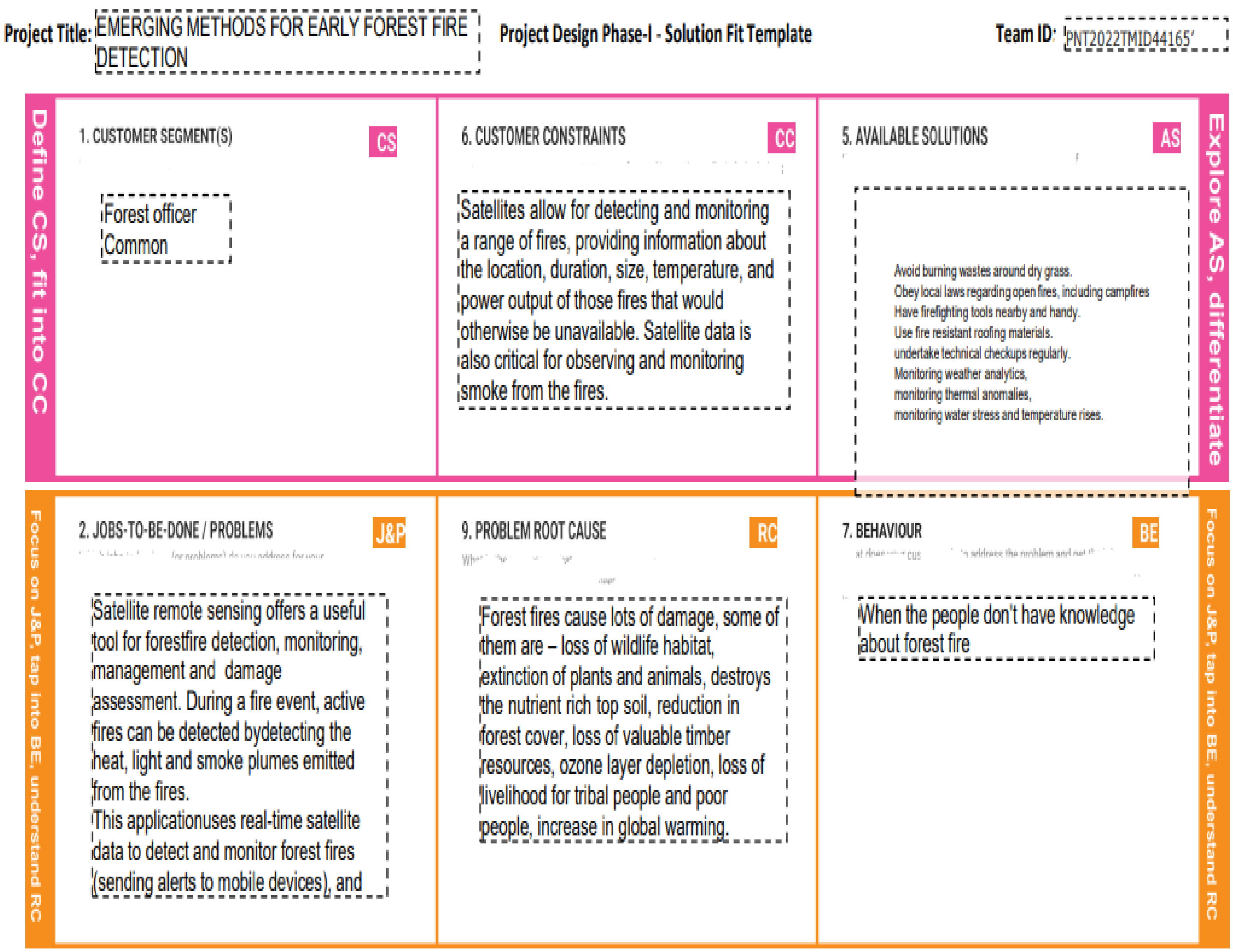
3.3PROPOSED SOLUTION

S.No	Parameter	Description
1.	**Problem Statement (Problem to be solved)**	A forest fire risk prediction algorithm, based on support vector machines, is presented. The algorithm depends on previous weather conditions in order to predict the fire hazard level of a day.
2.	**Idea / Solution description**	Use computer vision methods for recognition and detection of smoke or fire, based on the still images or the video input from the drone cameras.
3.	**Novelty / Uniqueness**	Real time computer program detect forest fire in earliest before it spread to larger area.
4.	**Social Impact / Customer Satisfaction**	Blocked roads and railway lines, electricity, mobile and land telephone lines cut, destruction of homes and industries.
5.	**Business Model (Revenue Model)**	The proposed method was implemented using the Python programming language on a Core i3 or greater (CPU and 4GB RAM.)

6.	**Scalability of the Solution**	Computer vision models enable land cover classification and smoke detection from satellite and ground cameras.

Table 3.3.1 Proposed Solution

3.4PROBLEM SOLUTION FIT



Project Title: EMERGING METHODS FOR EARLY FOREST FIRE DETECTION

Project Design Phase-I - Solution Fit Template

Team ID: PNT2022TMID44165'

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Forest officer
Common

6. CUSTOMER CONSTRAINTS CC

Satellites allow for detecting and monitoring a range of fires, providing information about the location, duration, size, temperature, and power output of those fires that would otherwise be unavailable. Satellite data is also critical for observing and monitoring smoke from the fires.

5. AVAILABLE SOLUTIONS AS

Avoid burning wastes around dry grass.
Obey local laws regarding open fires, including campfires
Have firefighting tools nearby and handy.
Use fire resistant roofing materials.
undertake technical checkups regularly.
Monitoring weather analytics,
monitoring thermal anomalies,
monitoring water stress and temperature rises.

Explore AS, differentiate

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

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

Satellite remote sensing offers a useful tool for forestfire detection, monitoring, management and damage assessment. During a fire event, active fires can be detected bydetecting the heat, light and smoke plumes emitted from the fires.
This applicationuses real-time satellite data to detect and monitor forest fires (sending alerts to mobile devices), and

9. PROBLEM ROOT CAUSE RC

Forest fires cause lots of damage, some of them are – loss of wildlife habitat, extinction of plants and animals, destroys the nutrient rich top soil, reduction in forest cover, loss of valuable timber resources, ozone layer depletion, loss of livelihood for tribal people and poor people, increase in global warming.

7. BEHAVIOUR BE

When the people don't have knowledge about forest fire

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

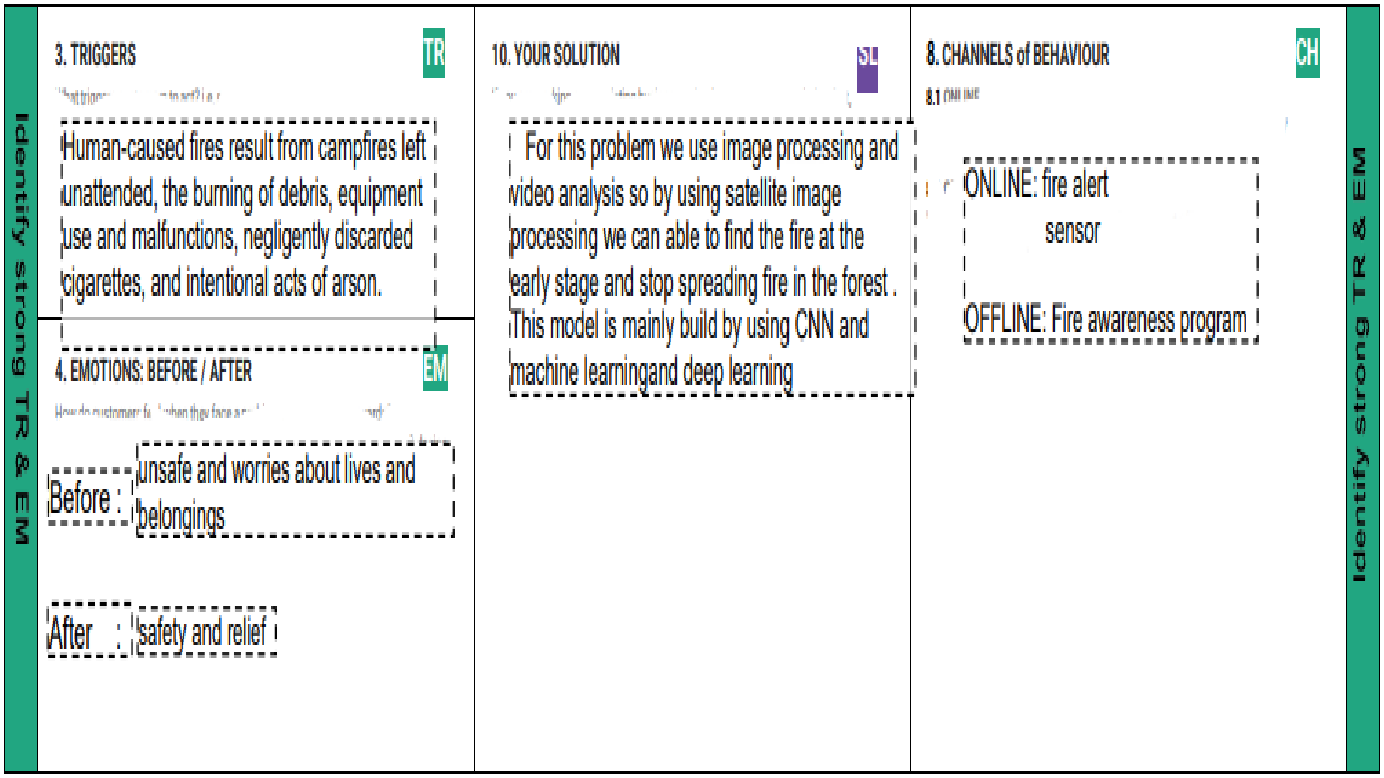


Fig 3.4.1 Problem solution fit

CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS

High Priority

1. The system shall take training sets of fire images and recognize whether there is a fire or the beginning of a fire (smoke) or if there is no fire

2. The system shall send a notification to the admin when it recognizes a fire in the image given

3. The system shall take real inputs of camera images and determine whether the image contains a fire or not

4. The system shall be able to take images with a variety of sizes and convert it to one fixed image to be used throughout the application.

5. The system shall run as a service on either a Windows or Linux operating system.
6. In the event that the computer on which the system is running shuts down, the system service should start automatically when the computer restarts

Medium Priority

1. The system shall provide following facility that will allow web pages that the user is permitted to access. The system must support the following facility:

a. Send alert message

b. Customer data management

Low Priority

1. The system shall allow the user's status to be stored for the next time he returns to the web site. This will save the user x minutes per visit by not having to reenter already supplied data.

2. The system shall provide information about event log of forest.

4.2 NON FUNCTIONAL REQUIREMENTS

Reliability

• The system shall be completely operational at least x% of the time.
• Down time after a failure shall not exceed x hours.

Usability

• Customer should be able to use the system in his job for x days .
• A user who already knows what camera he is using should be able to connect and view that page in x seconds.

Performance
• The system should be able to support x simultaneous users.
• The mean time to view a web page over a 56Kbps modem connection shall not exceed x seconds.

Security
• The system shall provide password protected access to web pages that are to be viewed only by users.

Supportability
• The system should be able to accommodate many camera links.
• The system web site shall be viewable from chrome or any browser.

Interfaces
The system must interface with
• The cloudant db for customer and customer log information
• The acquired web site search engine

CHAPTER 5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAM

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.

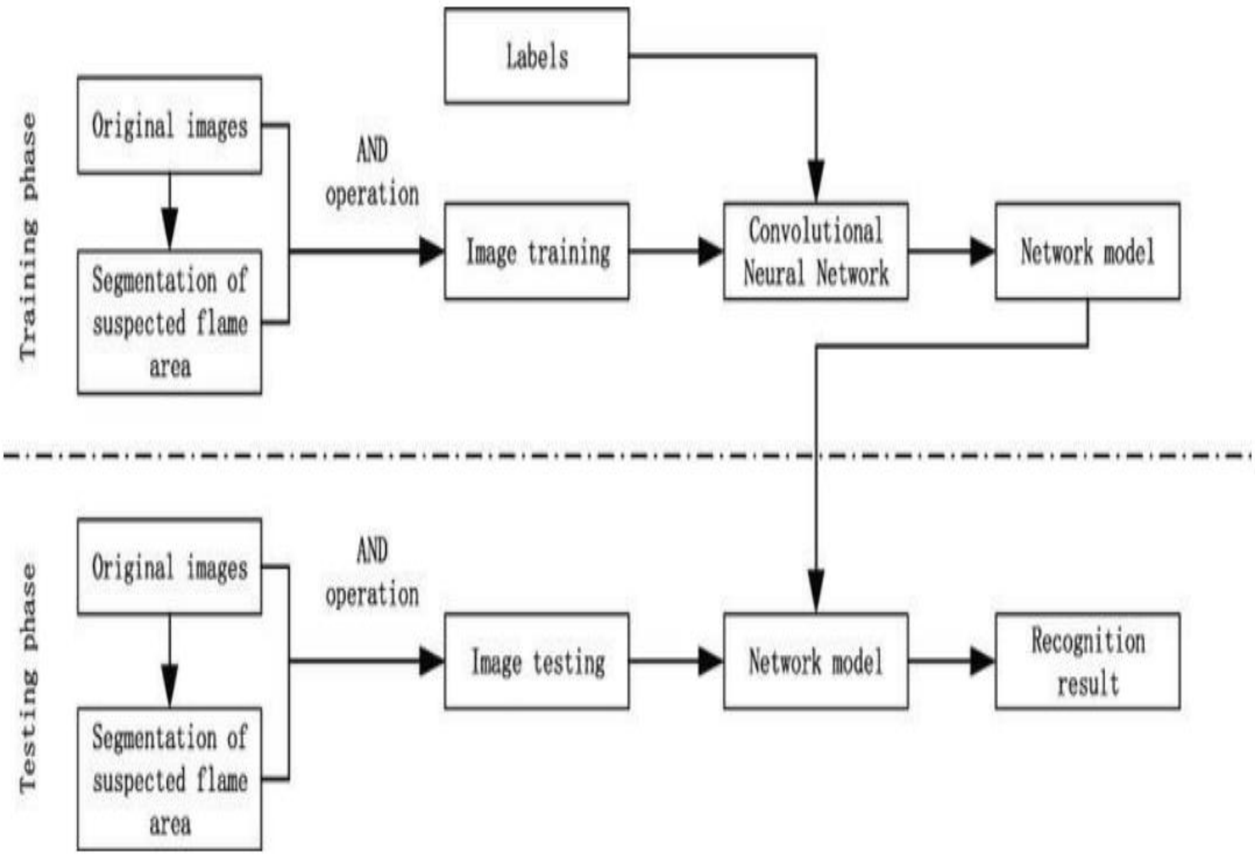


Figure 5.1.1 Data Flow Diagram

5.2 SOLUTION AND TECHNICAL ARTCHITECTURE

The Deliverable shall include the architectural diagram as below and the information as per the table1 & table 2

Example: It shows how data enters and leaves the system.

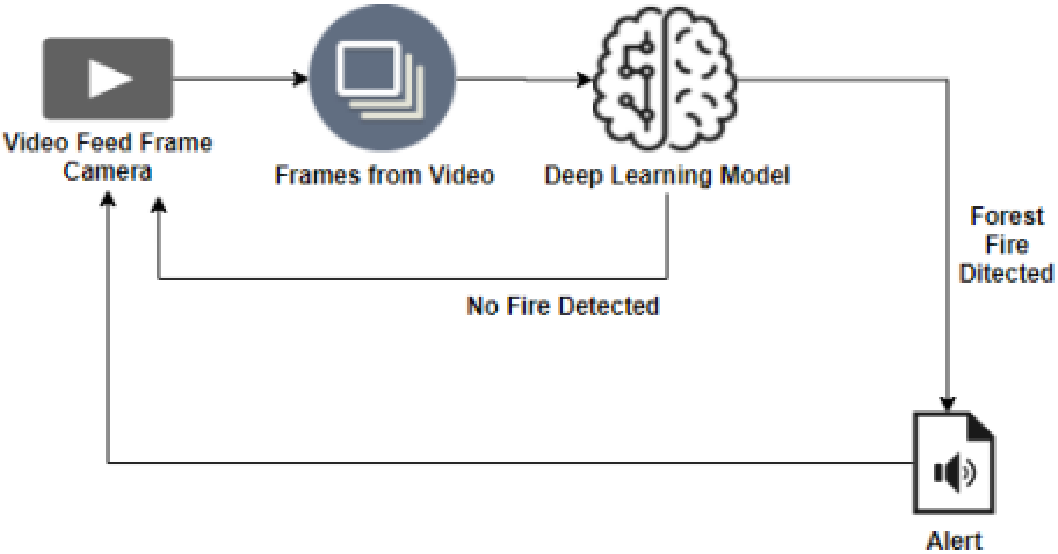


Figure 5.2.1

S.No	Component	Description	Technology
1.	User Interface	How user interacts with application e.g. Mobile App, database system	HTML, CSS, JavaScript / Angular Js / React Js etc.
2.	Application Logic-1	Logic for a process in the application	Java / Python
3.	Camera	Logic for a process in the application	FPV Camera technology
4.	Smoke sensor	Logic for a process in the application	MQZ, etct
5.	Database	Data Type, Configurations etc.	MySQL, NoSQL, etc.
6.	Cloud Database	Database Service on Cloud	IBM DB2, IBM Cloudant etc.
7.	database system	File storage requirements	Other Storage Service or Local Filesystem

8.	Rotary--wing UAV	Purpose of firefighting used in the application	IBM Weather API, etc.
9.	EFixed--wing UAV	Purpose of weather monitoring.used in the application	Aadhar API, etc.
10.	Machine Learning Model	Purpose of Machine Learning Model	Object Recognition Model, etc.
11.	Infrastructure (Server / Cloud)	Application Deployment on Local System / Cloud Local Server Configuration:	Local, Cloud Foundry, Kubernetes, etc.

Table 5.2.1 Solution Architecture

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	List the open-source frameworks used	Technology of Opensource framework
2.	Security Implementations	List all the security / access controls implemented, use of firewalls etc.	e.g. SHA-256, Encryptions, IAM Controls, OWASP etc.
3.	Scalable Architecture	Justify the scalability of architecture (3 – tier, Micro-services)	Technology used
4.	Availability	Justify the availability of application (e.g. use of load balancers, distributed servers etc.)	Technology used
5.	Performance	Design consideration for the performance of the application (number of requests per sec, use of Cache, use of CDN's) etc.	Technology used

Table 5.2.2 Application Characteristics:

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 I Task	Acceptance criteria	Priority	Release
Environment list	Collect the data	USN-1	As an Environmentalist it is necessary to collect the data of the forest which includes temperature, humidity, wind and rain of the forest	It is necessary to collect the right data else the prediction may become wrong	High	Sprint-1
		USN-2	Identify algorithms that can be used for prediction	To collect the algorithm to identify the accuracy level of each algorithms.	Medium	Sprint-2
	Implement Algorithm	USN-3	Identify the accuracy of each algorithms	Accuracy of each algorithm-calculated so that it is easy to obtain the most accurate output	High	Sprint-2
		USN-4	Evaluate the Dataset	Data is evaluated before processing	Medium	Sprint-1
	Evaluate Accuracy of Algorithm	USN-5	Identify accuracy,precision,recall of each algorithms	These values are important for obtaining the riaht output	High	Sprint-3

Table 5.3.1 User Stories

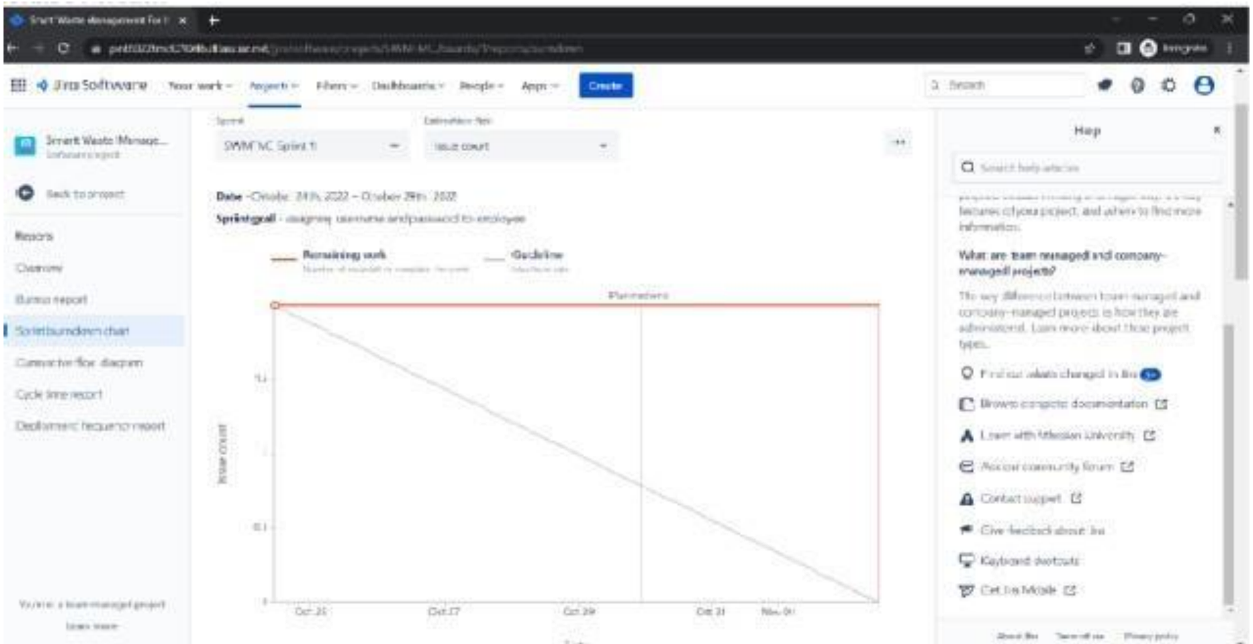
CHAPTER 6

SPRINT PLANNING AND SCHEDULING

6.1 SPRINT PLANNING AND ESTIMATION

Milestone Name	Milestone Number	Description	Mandatory
Project Objectives	M-001	We will be able to learn to prepare dataset, image processing, working withCNN layers, read images using OpenCV and CNN for computer vision AI	Yes
Project Flow	M-002	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-003	To complete this project we should have known following project such asKeras, Tensorflow, Python ,Anaconda, OpenCV, Flask, Scikit-learn etc…	Yes
Prior Knowledge	M-004	One should have knowledge on the Supervised Learning ,CNN and Regression Classification and Clustering, ANN	Yes
Data collection	M-005	We can collect dataset from different open sources like kaggle.com, UCI machine learning etc	Yes
Image Preprocessing	M-006	Importing the ImageDataGenerator libraries, Define Parameters/Arguments for ImageDataGenerator class, Applying Image Data Generator Functionalityto trainset and testset	Yes
Model Building	M-007	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-008	Opencv for video processing, creating an account in twilio service andsending alert message	Yes
Train CNN model	M-009	Register for IBM Cloud and train Image Classification Model	Yes
Ideation Phase	M-010	Prepare Literature Survey on the selected Project and Information Gathering,empathy map and ideation	Yes
Project Design Phase-I	M-011	Prepare Proposed solution , problem-solution fit and Solution Architecture	Yes
Project Design Phase-II	M-012	Prepare Customer journey ,functional requirements,Data flow diagram and Technology Architecture	Yes
Project Planning Phase	M-013	Prepare Milestone list , Activity list and Sprint Delivery Plan	Yes
Project DevelopmentPhase	M-014	Project Development delivery of Sprint 1, Sprint 2, Sprint 3, Sprint 4	Yes

6.2 REPORT FROM JIRA



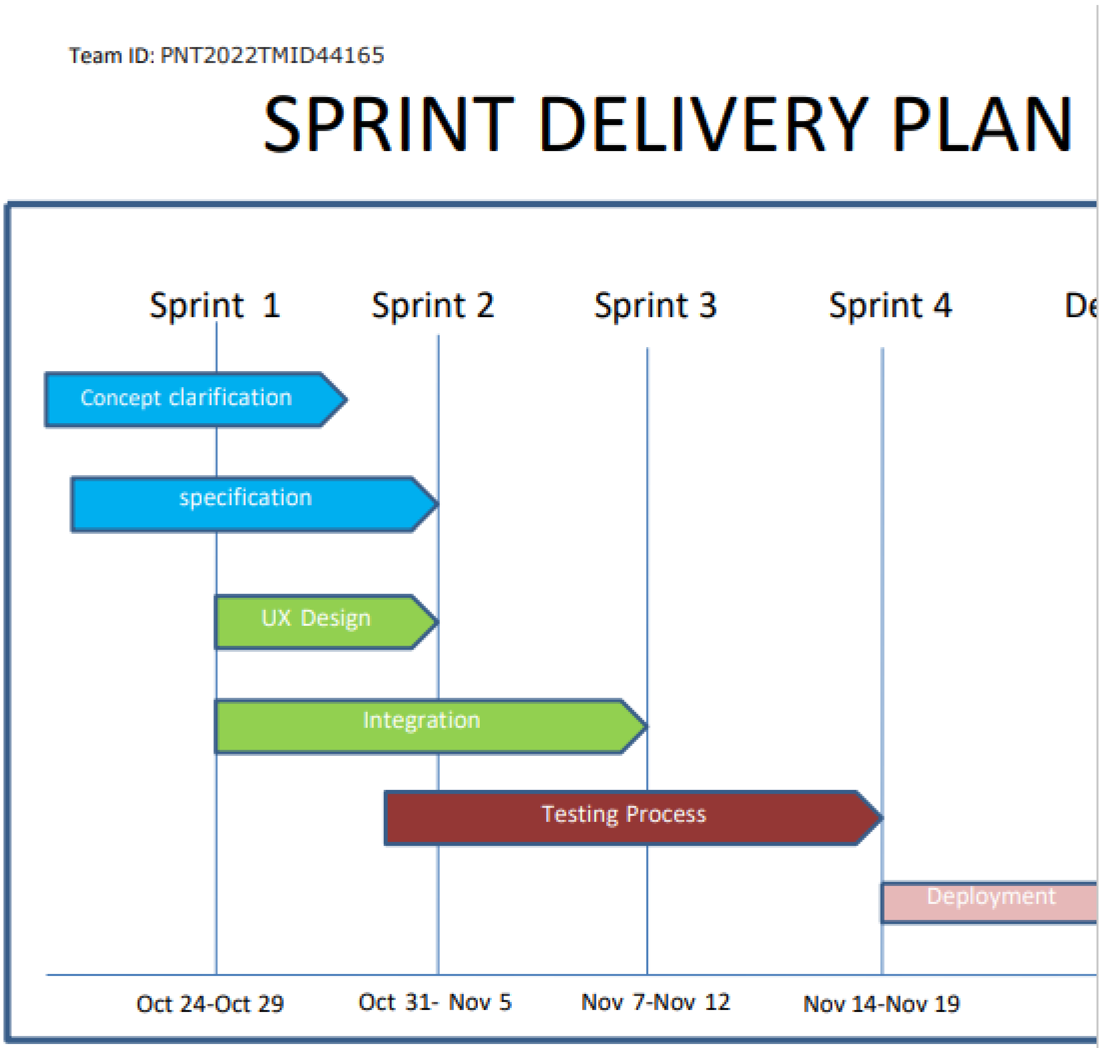
CHAPTER 7

CODING &

SOLUTIONING

7.1 FEATURE 1

7.1.1 User Module



Program:

<u>For Site Routes</u>

Importing The ImageDataGenerator Library

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

Define the parameters/arguments for ImageDataGenerator class

```
train_datagen=ImageDataGenerator(rescale=1./255,shear_range=0.2,rot ati
on_range=180,zoom_range=0.2, horizontal_flip=True)
test_datagen=ImageDataGenerator(rescale=1./255)
```

Applying ImageDataGenerator functionality to trainset

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

Found 436 images belonging to 2 classes

Applying ImageDataGenerator functionality to testset

```
x_test=test_datagen.flow_from_directory(r'/content/drive/MyDrive
/ Dataset/test_set',target_size=(128,128),batch_size=32,
class_mode='binary')
```

Found 121 images belonging to 2 classes.

Import model building libraries

```
#To define Linear initialisation import Sequential
from keras.models import Sequential
#To add layers import Dense
from keras.layers import Dense
#To create Convolution kernel import Convolution2D
from keras.layers import Convolution2D
#import Maxpooling layer
from keras.layers import MaxPooling2D
#import flatten layer
from keras.layers import Flatten
import warnings
warnings.filterwarnings('ignore')
```

Initializing the model

```
model=Sequential()
```

Add CNN Layer

```
model.add(Convolution2D(32,
(3,3),input_shape=(128,128,3),activation='relu'))
#add maxpooling layer

model.add(MaxPooling2D(pool_size=(2,2)))
#add flatten layer
model.add(Flatten())
```

Add Hidden Layer

```
#add hidden layer
model.add(Dense(150,activation='relu'))
#add output layer
model.add(Dense(1,activation='sigmoid')
)
```

Configure the learning process

```
model.compile(loss='binary_crossentropy',optimizer="adam",metrics=[ "ac curacy"])
```

Train the model

```
model.fit_generator(x_train,steps_per_epoch=14,epochs=10,validation_ da
ta=x_test,validation_steps=4)
```

Epoch 1/10
14/14 [==============================] - 97s 7s/step - loss:
1.3060 -
accuracy: 0.7775 - val_loss: 0.5513 - val_accuracy: 0.8512Epoch
2/10
14/14 [==============================] - 26s 2s/step - loss:
0.3178 -
accuracy: 0.8807 - val_loss: 0.1299 - val_accuracy: 0.9421Epoch
3/10
14/14 [==============================] - 26s 2s/step - loss:
0.2226 -
accuracy: 0.9106 - val_loss: 0.1311 - val_accuracy: 0.9421Epoch
4/10
14/14 [==============================] - 31s 2s/step - loss:
0.1836 -
accuracy: 0.9174 - val_loss: 0.1129 - val_accuracy: 0.9339Epoch
5/10
14/14 [==============================] - 30s 2s/step - loss:
0.1675 -

accuracy: 0.9243 - val_loss: 0.0925 - val_accuracy: 0.9669Epoch 6/10

14/14 [==============================] - 26s 2s/step - loss: 0.1884 -

accuracy: 0.9289 - val_loss: 0.1287 - val_accuracy: 0.9339Epoch 7/10

14/14 [==============================] - 28s 2s/step - loss: 0.1724 -

accuracy: 0.9335 - val_loss: 0.0926 - val_accuracy: 0.9752Epoch 8/10

14/14 [==============================] - 26s 2s/step - loss: 0.1510 -

accuracy: 0.9404 - val_loss: 0.0757 - val_accuracy: 0.9752Epoch 9/10

14/14 [==============================] - 26s 2s/step - loss: 0.1732 -

accuracy: 0.9174 - val_loss: 0.0537 - val_accuracy: 0.9835

Epoch 10/10

14/14 [==============================] - 26s 2s/step - loss: 0.1546 -

accuracy: 0.9312 - val_loss: 0.0573 - val_accuracy: 0.9835

<keras.callbacks.History at 0x7f05d66a9c90>

Save The Model

```
model.save("forest1.h5")
```

Predictions

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

```
#load the saved model
model = load_model("forest1.h5")

img=image.load_img(r'/content/drive/MyDrive/Dataset/te
st_set/forest/ 0.48007200_1530881924_final_forest.jpg')
x=image.img_to_array(img)
res = cv2.resize(x, dsize=(128, 128),
interpolation=cv2.INTER_CUBIC)
#expand the image shape
x=np.expand_di

ms(res,axis=0)

pred=

model.predict(x)

1/1 [==============================] - 0s
126ms/step

pred

array([[0.]], dtype=float32)
```

OpenCV For Video Processing

```
pip install twilio
```

```
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/ Requirement
already satisfied: twilio in
/usr/local/lib/python3.7/dist-packages (7.15.1)
Requirement already satisfied: pytz in /usr/local/lib/python3.7/dist-packages
(from twilio) (2022.5)
Requirement already satisfied: requests>=2.0.0 in
/usr/local/lib/python3.7/dist-packages (from twilio) (2.23.0)Requirement
already satisfied: PyJWT<3.0.0,>=2.0.0 in
/usr/local/lib/python3.7/dist-packages (from twilio) (2.6.0) Requirementalready
satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.0.0-
>twilio) (1.24.3)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.0.0->twilio)
(2022.9.24)
Requirement already satisfied: idna<3,>=2.5 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.0.0->twilio)(2.10)
Requirement already satisfied: chardet<4,>=3.0.2 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.0.0->twilio)(3.0.4)
```

```
pip install playsound
```

```
Looking in indexes: https://pypi.org/simple, https://us-
python.pkg.dev/colab-wheels/public/simple/ Requirement
already satisfied: playsound in
/usr/local/lib/python3.7/dist-packages (1.3.0)
```

```
 #import opencv library
import cv2
 #import numpy
import numpy as np
 #import image function from keras
from keras.preprocessing import
```

```
image #import load_model from
keras
from keras.models import load_model
#import client from twilio API
from twilio.rest import Client
#import playsound package
from playsound import playsound
```

WARNING:playsound:playsound is relying on another python subprocess. Please use `pip install pygobject` if you want playsound torun more efficiently.

```
#load the saved model model=load_model("forest1.h5") #define video
video=cv2.VideoCapture(0) #define the features name=['forest','with fire']
```

CHAPTER 8

TESTING

8.1 TEST CASES

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product. It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user exceptions and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

8.2 USER ACCEPTANCE TESTING

User Acceptance Testing (UAT) is a type of testing performed by the end user or the client to verify/understand the software system before moving the software application to the invention environment. UAT is done in the final phase of testing after functional, integration and system testing is done.

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements

Test Results: All the test cases mentioned above are passed approximately with somedefects encountered.

CHAPTER 9

RESULTS

9.1 PERFORMANCE METRICES

In the context of the FIRESENSE project, an automatic early warning system integrating multiple sensors to remotely monitor areas of archaeological and cultural interest for the risk of fire and extreme weather conditions was developed. The system integrates various sensors including optical cameras, infrared cameras at different wavelengths, passive infrared (PIR) sensors, a wireless sensor network of temperature and humidity sensors as well as local weather stations on the deployment sites. The signals and measurements collected from these sensors are transmitted to the control centre, which employs intelligent computer vision and pattern recognition algorithms as well as data fusion techniques to automatically analyze and combine sensor information. The control centre is capable of generating automatic warning signals for smoke/flame detection, abrupt temperature rise and extreme weather conditions. It also allows inspection of the site through the cameras, manipulation of cameras and sensors and provision of statistical data on user demand. Moreover, it estimates the propagation of the fire based on the fuel model of the area, the local weather conditions and the ground morphology. Finally, the estimated fire propagation can be visualized on a Google Earth based 3D interface. In the following, the main science and technology results of the FIRESENSE project are summarized per workpackage.

CHAPTER 10

ADVANTAGES & DISADVANTAGES

ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- More dynamic and wider detection as compared to fixed sensors.
- Reduction in cost.
- Unreachable areas can now be controlled by MBSs.
- To defect poaching, and monitor comprehensive animal deaths.
- Proposed methods are very convenient and can easily detect.

DISADVANTAGES:

- Neither easy to capture suitable animals from the environment nor equip them with sensors.
- possibility of lack of appropriate animals for special forests.
- Determining climate conditions, daily temperature difference, seasonal normal temperature values, etc. are problematic.
- use of batteries create environmental pollution, introducing extra radiation and cadmium to the forest and animals’
- Moreover, each battery needs to be changed periodically, but capturing the MBS to do this is not easy.

CHAPTER 11

CONCLUSION

Conclusion

Evolution emerges in the processing, computation, and algorithms. This strives many researchers to pay attention in many domains where they work in the processing of surveillance video streams so that abnormal or unusual actions could be detected. The usage of UAVs is recommended in the detection of forest fire due to the high mobility and ensures the coverage areas at various altitudes and locations at a low cost. Hence, an efficient and scalable UAV is used for detection. This work aims in developing the 3D model for the captured scene. YOLOv4 tiny network is deployed to detect the fire. The accuracy of the detection rate achieved through this model is 91%. The proposed model outperforms the other existing techniques in terms of detecting in the early stage. However, this model is sensitive to the forest with dense fogs and clouds. This is because smoke appears as the same as fog, and the model may misclassify the fog as smoke. As our future works, focus to meet practical detection and meet the necessity of early detection including the generation of the mixed reality model of the forest fire area that gives more information, and prevention analysis will be made easy. The 3D modeling techniques presented in this paper can also be extended to various natural disaster prediction models.

CHAPTER 12
FUTURE SCOPE

Future scope

This concept is just a basic one. The further development of the project can be done in a larger configuration by using the better and reliable sensor not only a temperature sensing kind of sensor and which has multifunctional features which are embedded in/on the same component or an IC. These may be implemented in an operational scenario, once the concept is demonstrated. The parameters we are checking are smoke and temperature. For this we are using temperature sensors and smoke detectors. These sensors continuously sense the surrounding environment and continuously send their data to the microcontroller then this microcontroller send the respective data to the host computer through RF module. We have set the threshold values for all the sensors. All the parameters are checked and compared their values with the threshold values which we have set. If any of the parameters are giving value more than the threshold value which we have set then the preventive system gets started. In this we are using water sprinkler as a preventive system. We can use Nano-satellite / Pico-satellite (small satellite) which is very small compared to normal satellite. A group/cluster of Pico satellites may be used to receive the data from the transmitter which is at the forest region and then transmitting to the ground station.we may also consider using small satellites for different purposes like monitoring the forest fire, vegetation of the forest, for monitoring the climate changes of that particular area like this in low cost. Since the proposed project is easy for the installation due to the simple arrangements, the time frame for developing and integrating the sub-systems and installation process is less. Even for the demonstration purpose we can put up the fire manually in any plain land and we can test for the working of these components.

CHAPTER 13

APPENDIX

Source code

Github Link

https://github.com/IBM-EPBL/IBM-Project-40419-1660629266

Demonstration Link

EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

```
https://www.kaggle.com/arbethi/forest-fire?select=Dataset is stored as FFD in google drive
```