Emerging Methods for Early Detection of Forest Fires

NALAIYA THIRAN PROJECT BASED LEARNING
On

PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

A PROJECT REPORT

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IN
COMPUTER SCIENCE ENGINEERING

HINDUSTHAN INSTITUTE OF TECHOLOGY

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(Affiliated to Anna University, Chennai)

COIMBATORE – 641 032

November 2022

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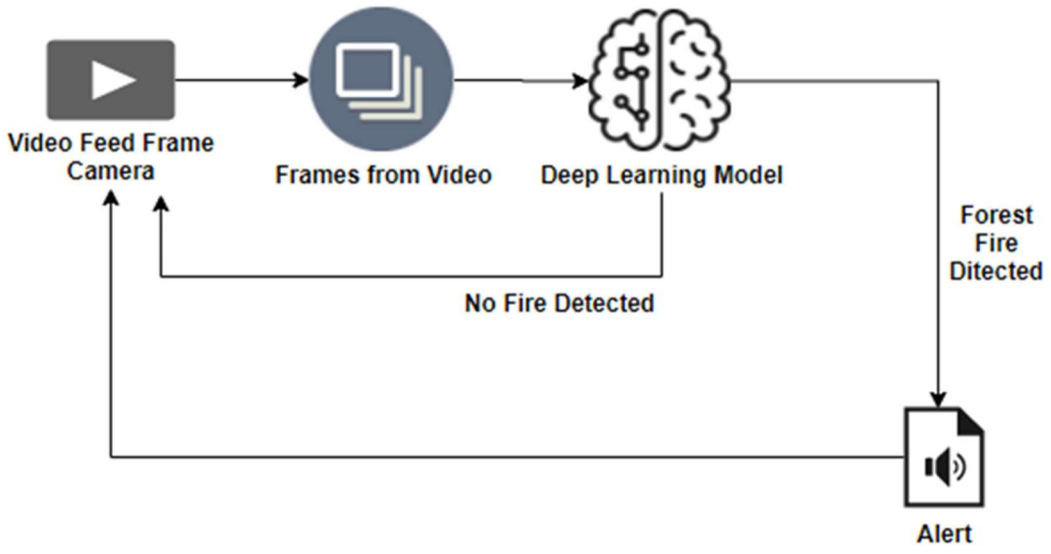
1.INTRODUCTION

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.



2. LITERATURE SURVEY

2.1 Existing Problem

SI NO	TITLE OF THE PAPER	DETAILS OF THE PAPER	OBJECTIVE	METHODOLOGY	TAKE AWAY
1	Early Forest Fire Detection using Dronesand Artificial Intelligence.	Published on2019	To detect forest fires early, the proper categorization of fireand fast response from the firefighting departments.	The fire detection is based on a platform that uses Unmanned Aerial Vehicles (UAVs) which constantly patrol over potentially threatened by fire areas. TheUAVs utilize the benefits from Artificial Intelligence (AI). This allows to use computer vision methods for recognition and detection of smoke or fire, based on images or video input from the drone cameras	From this journal, we use drone cameras and UAVs, because it patrolsthe forest always.

2	A review on early forest fire detection system usingoptical remote sensing	Published on2020	To fight forest fires occurring throughoutthe year with an increasing intensity in the summer and autumn periods.	Detection methods that use optical sensors or RGB cameras combine features that are related to the physical properties of flameand smoke, such as color, motion, spectral, spatial, temporal, and texture characteristics.	From this journal, we use modern optical sensor networks which are knownfor their long range communication capabilities and extremely suitable for sensor and telemetry applications
3	Automatic Early Forest fire Detection based Gaussian Mixture Model.	Published 2018IEEE	To avoid the hugedamage of forest caused by fires.	Based on the slow spread ofsmoke, firstly a time delay parameter improves Gaussian mixture model forextracting candidate smoke regions. Then, two motion features of smoke, the rate of area change and motion style are used to select smoke regions from the candidate regions.	From this journal, we use Gaussian mixturemodel. Because it can reconstruct background with the advantages of small storage space, adaptive learning and good noise toleration.
4	Developing a real-time and automatic early warning system for forest fire.	Published on2018 IEEE	To detect forest firescausing by climatic conditions and also caused by human.	The method using here is making use of stand-alone boxes which are deployed throughout the forest. Thoseboxes contain different sensors and a radio module to transmit data received from these sensors. Each sensor will be tested in individually and XBee modules are configured andpaired using XCTU Software.	From this journal, we use Software solutions which are used for implementing microcontroller kits and to simulate and designing circuit boards.

5	Early Fire Detection System using wireless sensor networks.	Published on2018 IEEE	To detect fires fromhuge cause of forests.	The hierarchical architectureof Wireless Sensor Networks is most efficient and extensible for dense networks which simplifies the management of the forest as well as the communication and the localization of fire and sensors.	From this journal, we use cluster heads as landmark for the rest of sensor for localization in order to define their GPS coordinates according to the cluster head's coordinate.

2.2 REFERENCES

- Official webpage of the European Forest Fire Information System at:

  http://effis.jrc.ec.europa.eu/

- Official webpage of the Copernicus Earth Observation Programme at:
  http://www.copernicus.eu

- Forest Fires in Europe, Middle East and North Africa 2016, JRC Science for policy report, BN 978-92-79-71292-0, ISSN 1831-9424, doi:10.2760/17690, available at:
  http://effis.jrc.ec.europa.eu/media/cms_page_media/40/Forest_fires_in_Europe_Middle_east_and_North_Africa_2016_final_pdf_JZU7He L.pdf

- The 2018 Attica wildfires Wikipedia webpage available at:
  https://en.wikipedia.org/wiki/2018_Attica_wildfires

- László Földi and Rajmund Kuti, Characteristics of Forest Fires and their Impact on the Environment, Academic and Applied Research in Military and Public Management Science(AARMS), Vol. 15, No. 1, 2016, pp. 5–17, ISSN 2064-0021;
  https://www.firedex.com

- Wolfgang Jendsch, Aerial Firefighting, Schiffer Publishing, 352 pp, ISBN 9780764330681

2.3 Problem Statement Definition

The fire detection system starts by forming a color probability model for the segmenting fire region. Then, the model is trained based on a dataset containing varying fire colors. This model would find the fire region candidates in the video frames extracted from the video input. After obtaining the candidates, the machine learning strategies were performed for verifying them based on the color histogram. This research utilized two machines learning methods: support vector machine (SVM) and random forest (RF). SVM is used because of its ability to classify an object into two classes linearly. On the other hand, RF was chosen because of its ability to combine color and motion features in object classification. However, these two methods will be compared in implementation to obtain the most optimal framework. Lastly, further verification was then conducted by checking the motion of fire regions. The fire motion was measured according to the centroid and the area of the region. If the method detects irregular motion in a fire region, then this region was assigned as a fire object and vice versa.

Convolutional Neural Network has become really popular for image classification since the LeNet [16] performed well on the MNIST Data (Hand written Digits Dataset) and achieved an accuracy which is more than humans. Since then, CNN has performed at a state-of the-art level at image classification tasks.

3. IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP

An empathy map is a collaborative tool teams can use to gain a deeper insight into their customers. Much like a user persona, an empathy map can represent a group of users, such as a customer segment.

3.2 Brainstorm & Idea Prioritization Template:

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions.

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 same room.

Reference: https://www.mural.co/templates/empathy-map-canvas

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your teamcan unleash their imagination and start shaping concepts even if you'renot sitting in the same room.

- **10 minutes** to prepare
- **1 hour** to collaborate
- **2-8 people** recommended

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.

10 minutes

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 inthe brainstorming session.

C Learn how to use the facilitation tools
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

1 Define your problem statement

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

5 minutes

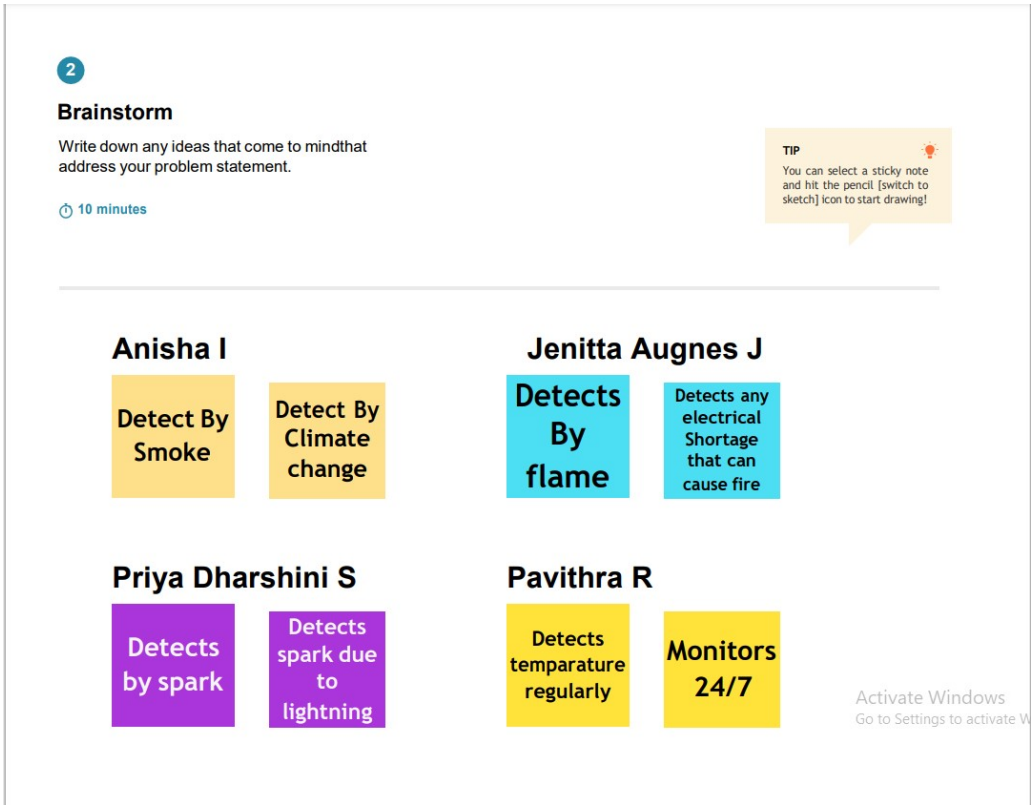
PROBLEM

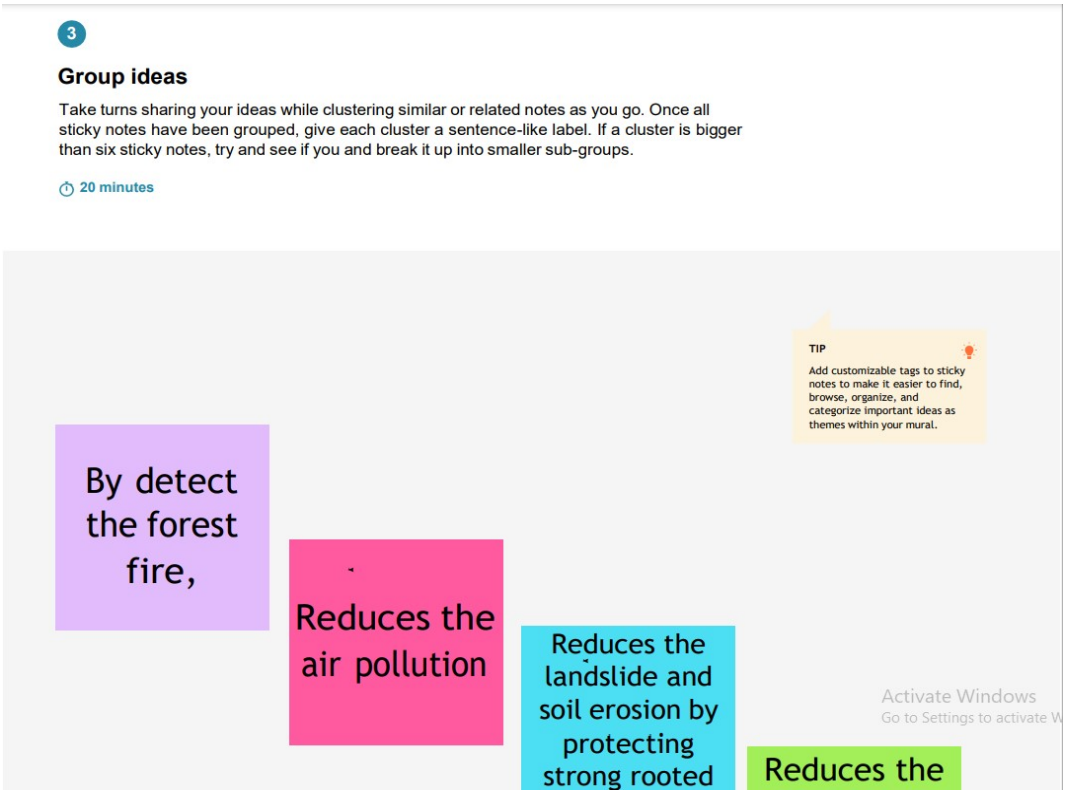
How might we prevent the forest fires by early detecting methods?

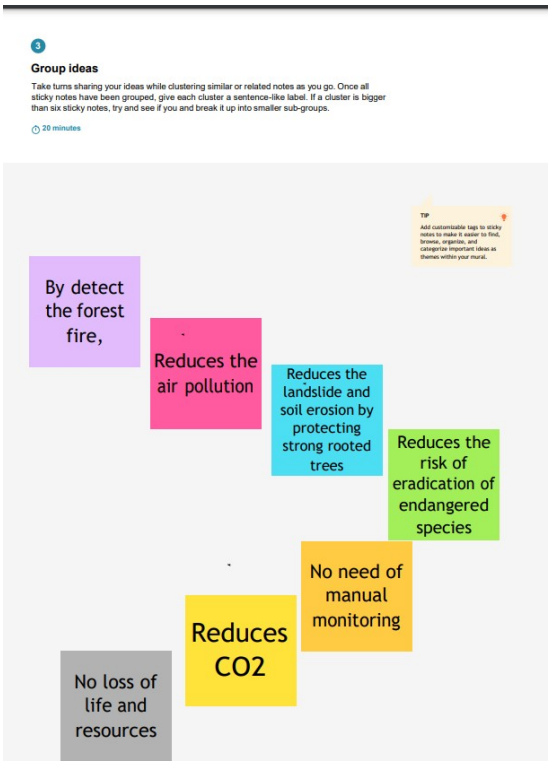
Key rules of brainstorming

To run an smooth and productive session

- Stay in topic.
- Encourage wild ideas.
- Defer judgment.
- Listen to others.
- Go for volume.
- If possible, be visual.


2
Brainstorm
Write down any ideas that come to mindthat address your problem statement.
10 minutes
TIP
You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!
Anisha I
Detect By Smoke
Detect By Climate change
Jenitta Augnes J
Detects By flame
Detects any electrical Shortage that can cause fire
Priya Dharshini S
Detects by spark
Detects spark due to lightning
Pavithra R
Detects temparature regularly
Monitors 24/7
Activate Windows
Go to Settings to activate W


3
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.
20 minutes
TIP
Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.
By detect the forest fire,
Reduces the air pollution
Reduces the landslide and soil erosion by protecting strong rooted
Reduces the
Activate Windows
Go to Settings to activate W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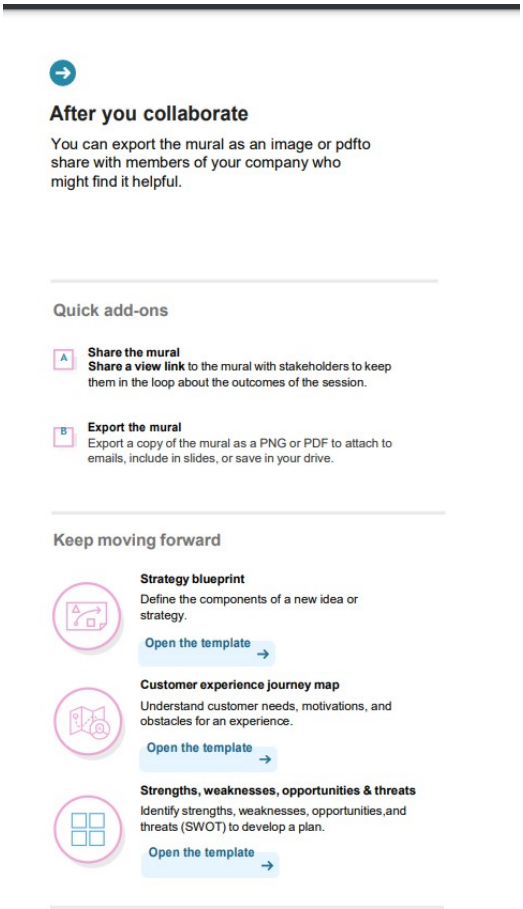
Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.
20 minutes
TIP
Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.
By detect the forest fire,
Reduces the air pollution
Reduces the landslide and soil erosion by protecting strong rooted trees
Reduces the risk of eradication of endangered species
No need of manual monitoring
Reduces CO2
No loss of life and resources


4
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 are feasible.
20 minutes
Importance
If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?
Feasibility
Regardless of their importance, which tasks are more feasible than others? (Cost, time, effort, complexity, etc.)
Detects spark due to lightning
Detect By Smoke
Powerful CCTV and HD cameras are used
Regularly removes dry leaves
By satellite monitoring
Monitors 24/7
Detects temparature regularly
Detects by climate change
Detects by flame
Detects by spark
Regularly removes dry leaves
Detects any electrical shortage that can cause fire
Install and maintain the smoke alarms
TIP
Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the H key on the keyboard.
Detects the forest fire using CO2
Checks the humidity level


After you collaborate
You can export the mural as an image or pdfto share with members of your company who might find it helpful.
Quick add-ons
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.
Keep moving forward
Strategy blueprint
Define the components of a new idea or strategy.
Open the template
Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template
Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities,and threats (SWOT) to develop a plan.
Open the template

3.3 Proposed Solution Template

Project team shall fill the following information in proposed solutiontemplate.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	A forest fire risk prediction algorithm, based on support vectormachines, 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 smokeor fire, based on the still images or the video input from the dronecameras.
3.	Novelty / Uniqueness	Real time computer program detect forest fire in earliest before itspread 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 smokedetection from satellite and ground cameras

3.4 Problem Solution Fit

Project Design Phase-I - Solution Fit Template

Project Title: Emerging Method For Early Detection Of Forest Fires

Team ID: PNT2022TMID51601

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

Forest officer
Common people

6. CUSTOMER CONSTRAINTS

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 forest fire detection, monitoring, management and damage assessment. During a fire event, active fires can be detected by detecting the heat, light and smoke plumes emitted from the fires.
This application uses real-time satellite data to detect and monitor forest fires (sending alerts to mobile devices), and understand fire patterns.

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

3. TRIGGERS TR

Human-caused fires result from campfires left unattended, the burning of debris, equipment use and malfunctions, negligently discarded cigarettes, and intentional acts of arson.

4. EMOTIONS: BEFORE / AFTER EM

BEFORE : unsafe and worries about lives and belongings

AFTER : safety and relief

10. YOUR SOLUTION SL

For this problem we use image processing and video analysis so by using satellite image processing we can able to find the fire at the early stage and stop spreading fire in the forest .
This model is mainly build by using CNN and machine learningand deep learning

8.CHANNELS of BEHAVIOUR CH

ONLINE: fire alert sensor

OFFLINE: Fire awareness program

4. Requirements Analysis

4.1 Functional requirement

Functional Requirements:

Functional requirements of the proposed solution.

S.No	Functional Requirement	Sub Requirement
1.	User Registration	Registration through Twilio services
2.	User Confirmation	Confirmation via Mobile numberConfirmation via OTP
3.	User Login	Login using credentials
4.	User Search	Search for Info on forest fire occurrence
5.	User Profile	User shall be given a live feed of the forest
6.	User Application	User is alerted if there is an forest fire occurrence intheir surroundings

4.2 Non-Functional requirement

Non-functional Requirements:

Non-functional requirements of the proposed solution.

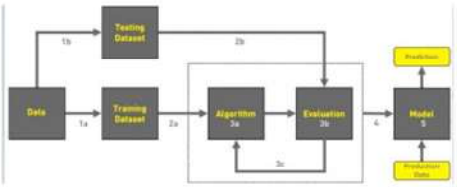
S.No	Non-Functional Requirement	Description
1.	Usability	Alerts according to the user location
2.	Security	Instant live feed with alert of the situation
3.	Reliability	The prediction of the forest fire is 87% accurate
4.	Performance	The feed and the alert message is an immediate actionwithout a lag
5.	Availability	The application gives alerts and live feeds 24/7

5. DESIGN PHASE

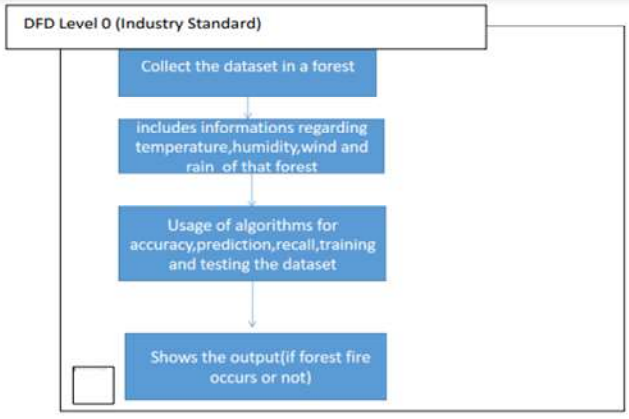
5.1 Data Flow Diagram:

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.

Data Flow Diagrams:



1. COLLECT DATA
2. EVALUATE DATA SET
3. IMPLEMENT ALGORITHMS
4. EVALUATE THE ACCURACY OF EACH ALGORITHMS
5. DISPLAY RESULTS



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
Environmentalist	Collect the data	USN-1	As an Environmental list, 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 levelof each algorithms	Medium	Sprint-2
		USN-3	Identify the accuracy of each algorithms	Accuracy of each algorithm-calculated so that it is easy to obtain the most accurate output	High	Sprint-2
		USN-4	Evaluate the Dataset	Data is evaluated before processing	Medium	Sprint-1
		USN-5	Identify accuracy, precision, recall of each algorithms	These values are important for obtaining theright output	High	Sprint-3
		USN-6	Outputs from each algorithm are obtained	It is highly used to predict the effect and to take precautionary measures.	High	Sprint-4

5.2 Solution & Technical Architecture

A solution architecture (SA) is an architectural description of a specific solution. Solution Architectures combine guidance from different enterprise architecture viewpoints (business, information and technical), as well as from the enterprise solution architecture (ESA).

Solution Architecture Diagram:

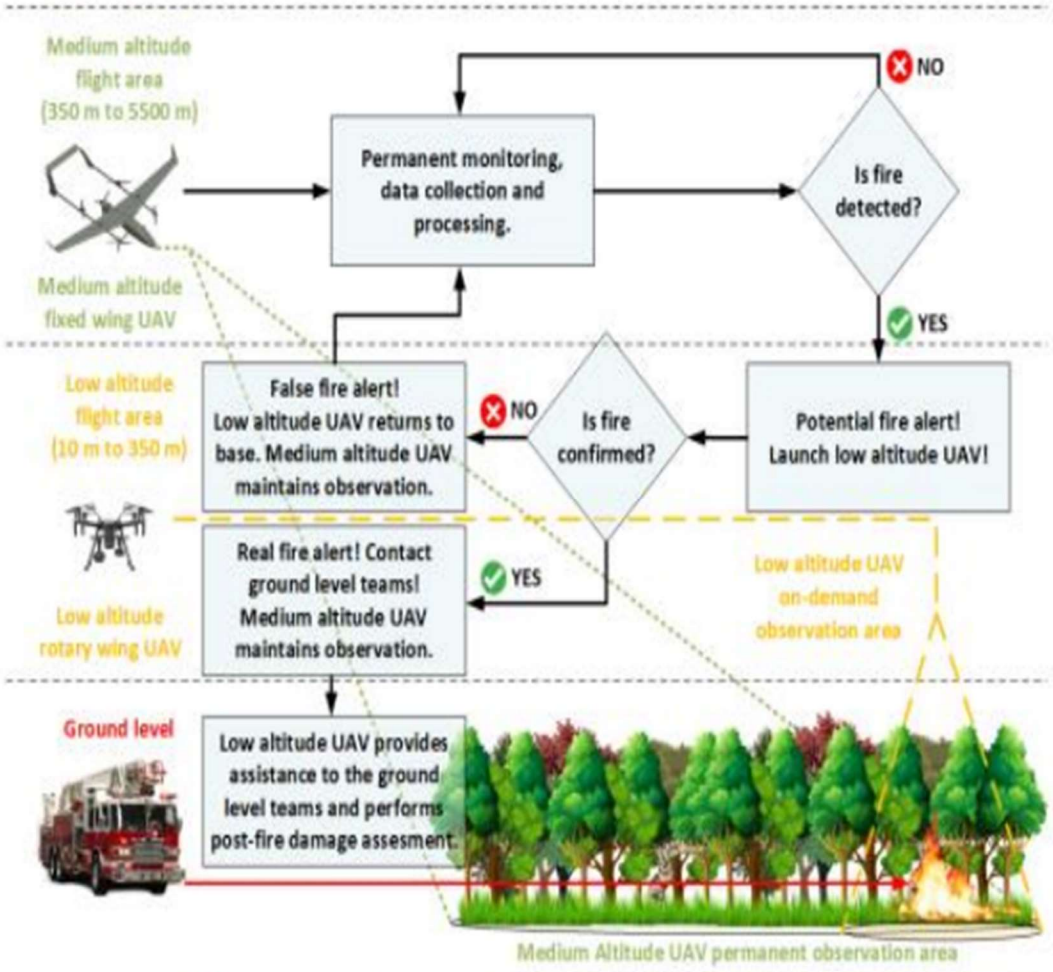


Fig. 1. Conceptual model of the early forest fire detection system with use of fixed wing and rotary wing UAVs

Technical Architecture:

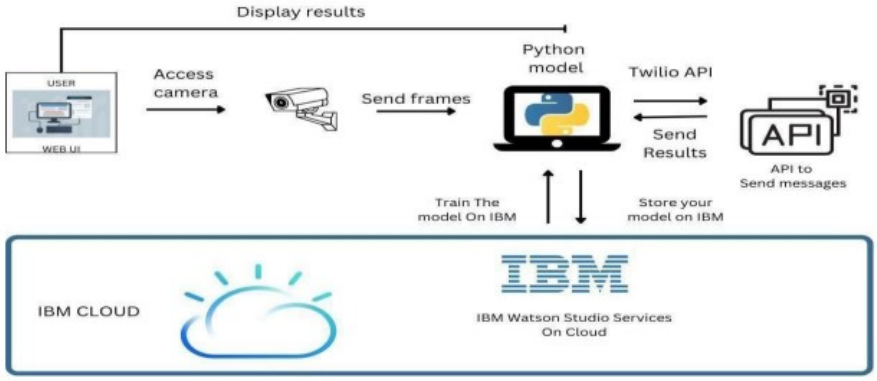


Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	The user uses the console to access the interface	Python/HTML ,CSS , Javascript and react.Js
2.	Input	Video Feed	Web Camera/Video on a site
3.	Conversion	Video inputted is converted into Frames	Frame Converter
4.	Feeding the Model	The Frames are sent to the Deep learning model	Our Model
5.	Dataset	Using Test set and train set , train the model	Data set from Cloud Storage , Database
6.	Cloud Database	The model is trained in the cloud more precise with detections more images can be added later on.	IBM Cloudant , Python Flask.
7.	Infrastructure (Server / Cloud), API	Application Deployment on Local System / Cloud Local ,Cloud Server Configuration , Twilio API tosend messages	Java/python ,React.Js ,JavaScript ,HTML ,CSS ,IBM Cloud ,OPEN CV ,Anaconda Navigator ,Local.

Table-2: Application Characteristics:

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

5.3 User Stories

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

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
Forest Officer	Surveillance	USN-1	As a user, I will receive the live video footages of forest area for monitoring	I can know about what happening in the forest	Medium	Sprint-2
Fire Department	Fire Alert	USN-2	As a user, I will receive the emergency fire alert message and location of fire	I can receive the early alert and able to arrive soon	High	Sprint-1
Environmentalist	Collect the data	USN-3	As a user, I can collect the data of forest such as Wind ,Temperature and Dryness	I can receive necessary information for prediction	High	Sprint-1
Patrol Officer	Patrol the forest	USN-4	As a user, I can get immediate alert if any accident occur	I can get into the accident place immediately and able to minimize the losses	Medium	Sprint-2
Customer	Login	USN-5	As a user, I can log into the application by entering email & password	I can know about the information of forest fire	Low	Sprint-3

6. Sprint Delivery Plan

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	20	High	BALA SAKTHI GANESH M ARAVINTH S KAVIN VIGNESH T JAGATHEESHWARAN
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application usage.	20	High	BALA SAKTHI GANESH M ARAVINTH S KAVIN VIGNESH T JAGATHEESHWARAN
Sprint-2	Input	USN-3	Whenever the fire is detected, the information is given to the database.	20	High	BALA SAKTHI GANESH M ARAVINTH S KAVIN VIGNESH T JAGATHEESHWARAN

Sprint-2		USN-4	When it is the wildfire then the alarming system is activated.	20	High	BALA SAKTHI GANESH M ARAVINTH S KAVIN VIGNESH T JAGATHEESHWARAN
Sprint-3	Output	USN-5	And the alarm also sent to the corresponding departments and made them know that the wildfire is erupted.	20	High	BALA SAKTHI GANESH M ARAVINTH S KAVIN VIGNESH T JAGATHEESHWARAN
Sprint-4	Action	USN-6	Required actions will be taken in order to controlled erupted wildfire by reaching as early as possible to the destination with the help of detecting systems.	20	High	BALA SAKTHI GANESH M ARAVINTH S KAVIN VIGNESH T JAGATHEESHWARAN

Project Tracker, Velocity & Burndown Chart: (4 Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

7. CODING & SOLUTION

Feature 1:

Real time Detection of Forest Fire

In [ ]:

```
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
```

In [ ]:

```
train=ImageDataGenerator(rescale=1./255,shear_range=0.2,rotation_range=180,zoom
_range=0.2,horizontal_flip=True)
train = ImageDataGenerator(rescale=1/255)
test = ImageDataGenerator(rescale=1/255)
```

In [ ]:

```
train_dataset =
train.flow_from_directory("/content/drive/MyDrive/Dataset/train_set",target_size=(1
28,128),batch_size = 32,class_mode = 'binary' )
```

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

In [ ]:

```
test_dataset =
test.flow_from_directory("/content/drive/MyDrive/Dataset/test_set",
target_size=(128,128),batch_size = 32,class_mode = 'binary' )
```

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

In [ ]:

```
test_dataset.class_indices
```

Out[ ]:

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

In [ ]:

```
#to define linear initialisation import sequential
from keras.models import Sequential
#to add layer 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')
```

In [ ]:

```
model = keras.Sequential()
model.add(Convolution2D(32,(3,3),input_shape=(128,128,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Convolution2D(32,(3,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Convolution2D(32,(3,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Convolution2D(32,(3,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())
```

In [ ]:

```
model.add(Dense(150,activation='relu'))
model.add(Dense(1,activation='sigmoid'))
```

In [ ]:

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

In [ ]:

```
r = model.fit(train_dataset, epochs = 5, validation_data = test_dataset)
Epoch 1/5
14/14 [==============================] - 184s 13s/step - loss: 0.6098 -
accuracy: 0.6261 - val_loss: 0.5014 - val_accuracy: 0.7273
Epoch 2/5
14/14 [==============================] - 25s 2s/step - loss: 0.3824 -
accuracy: 0.8417 - val_loss: 0.0858 - val_accuracy: 0.9752
Epoch 3/5
14/14 [==============================] - 27s 2s/step - loss: 0.3452 -
accuracy: 0.8349 - val_loss: 0.2229 - val_accuracy: 0.9008
Epoch 4/5
14/14 [==============================] - 26s 2s/step - loss: 0.2595 -
accuracy: 0.8853 - val_loss: 0.1087 - val_accuracy: 0.9917
Epoch 5/5
14/14 [==============================] - 27s 2s/step - loss: 0.2018 -
accuracy: 0.9243 - val_loss: 0.0621 - val_accuracy: 0.9917
```

In [ ]:

```
predictions = model.predict(test_dataset)
predictions = np.round(predictions)
4/4 [==============================] - 5s 1s/step
```

In [ ]:

```
Predictions
```

In [ ]:

```
print(len(predictions))
121
```

In [ ]:

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

In [ ]:

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

```
import numpy as np
#import cv2
import cv2
```

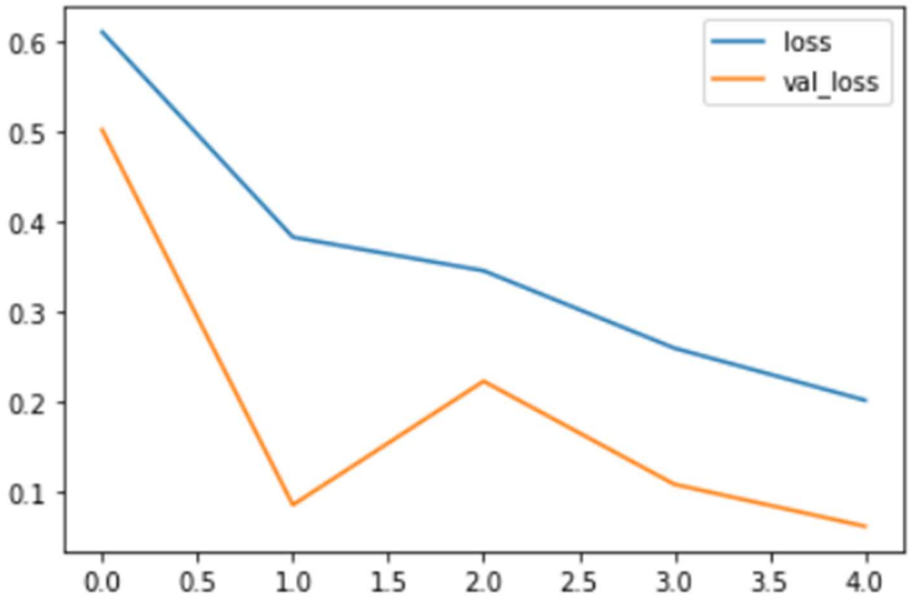
In [ ]:

```
model = load_model("/content/forest1.h5")
```

In [ ]:

```
import matplotlib.pyplot as plt
plt.plot(r.history['loss'],label='loss')
plt.plot(r.history['val_loss'],label='val_loss')
plt.legend()
```

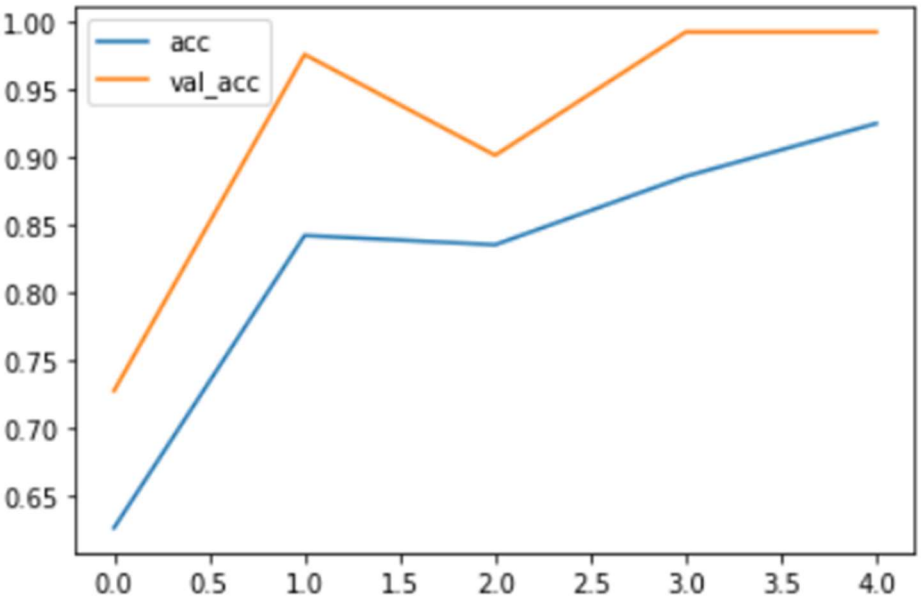
Out[]:



In [ ]:

```
plt.plot(r.history['accuracy'],label='acc')
plt.plot(r.history['val_accuracy'],label='val_acc')
plt.legend()
```

Out[ ]:

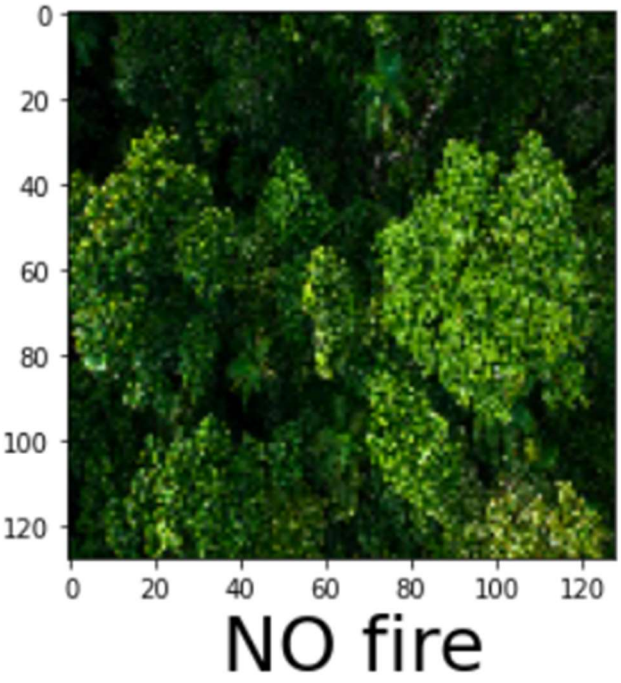


In [ ]:

```
def predictImage(filename):
img1=image.load_img(filename,target_size=(128,128))
plt.imshow(img1)
y=image.img_to_array(img1)
x=np.expand_dims(y,axis=0)
val=model.predict(x)
print(val)
if val==0:
plt.xlabel(" NO fire",fontsize=30)
elif val==1:
plt.xlabel("fire",fontsize=30)
```

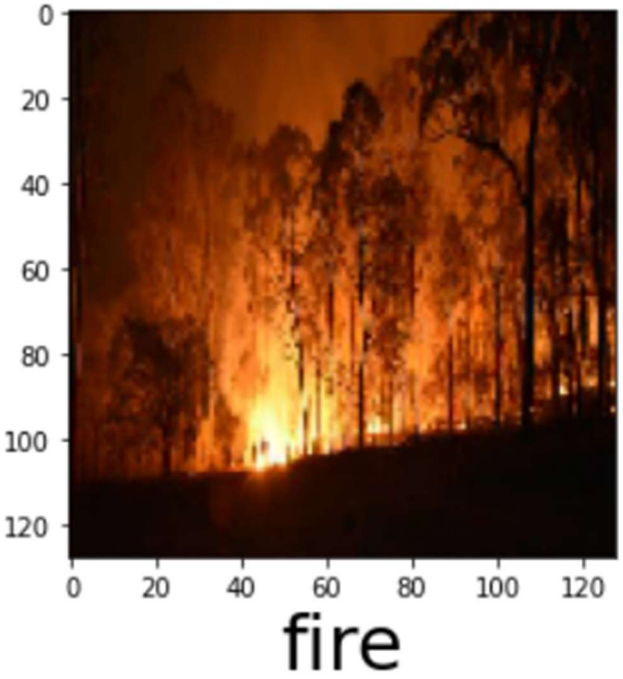
In [ ]:

```
predictImage("/content/drive/MyDrive/forest-1.jpg")
1/1 [==============================] - 0s 93ms/step
[[0.]]
```



In[]:

```
predictImage("/content/drive/MyDrive/forest-fire-1.jpg")
1/1 [==============================] - 0s 20ms/step
[[1.]]
```



Feature 2:

User alert message using Twilio regarding forest fire:

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
(7.15.3)
Requirement already satisfied: PyJWT<3.0.0,>=2.0.0 in
/usr/local/lib/python3.7/dist-packages (from twilio) (2.6.0)
Requirement already satisfied: pytz in /usr/local/lib/python3.7/dist-packages
(from twilio) (2022.6)
Requirement already satisfied: requests>=2.0.0 in
/usr/local/lib/python3.7/dist-packages (from twilio) (2.23.0)
Requirement already 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: chardet<4,>=3.0.2 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.0.0->twilio) (3.0.4)
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)
```

Pip Install Playsound:

```
Looking in indexes: https://pypi.org/simple,
https://us-python.pkg.dev/colab-wheels/public/simple/
Collecting playsound
Downloading playsound-1.3.0.tar.gz (7.7 kB)
Building wheels for collected packages: playsound
Building wheel for playsound (setup.py) ... done
Created wheel for playsound: filename=playsound-1.3.0-py3-none-any.whl
size=7035
sha256=a0ae42b911d3b3fd6d3ac0cb3c1938927416aaaa8fbcda494b55eabd267f16
a3
Stored in directory:
/root/.cache/pip/wheels/ba/f8/bb/ea57c0146b664dca3a0ada4199b0ecb5f9dfcb7
b7e22b65ba2
Successfully built playsound
```

Installing collected packages: playsound
Successfully installed playsound-1.3.0

Pip Install Opencv-Python:

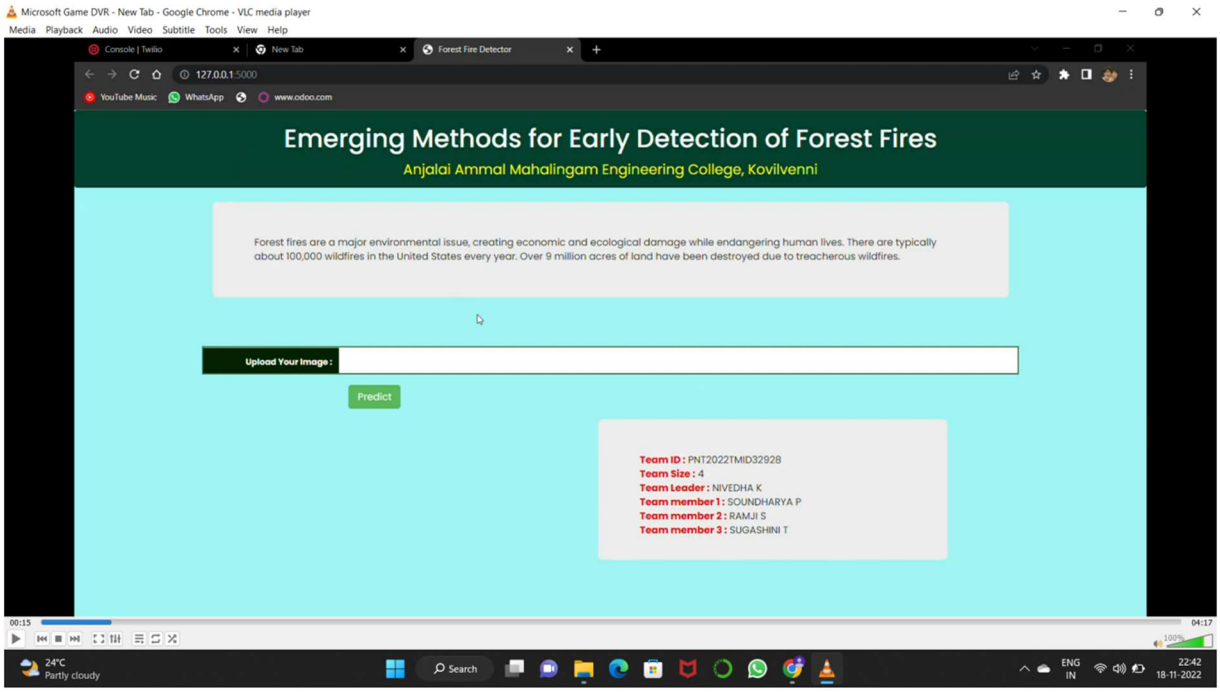
Looking in indexes: https://pypi.org/simple,https://us-python.pkg.dev/colab-wheels/public/simple/Requirement already satisfied: opencv-python in /usr/local/lib/python3.7/dist-packages (4.6.0.66)Requirement already satisfied: numpy>=1.14.5 in/usr/local/lib/python3.7/dist-packages (from opencv-python) (1.21.6)

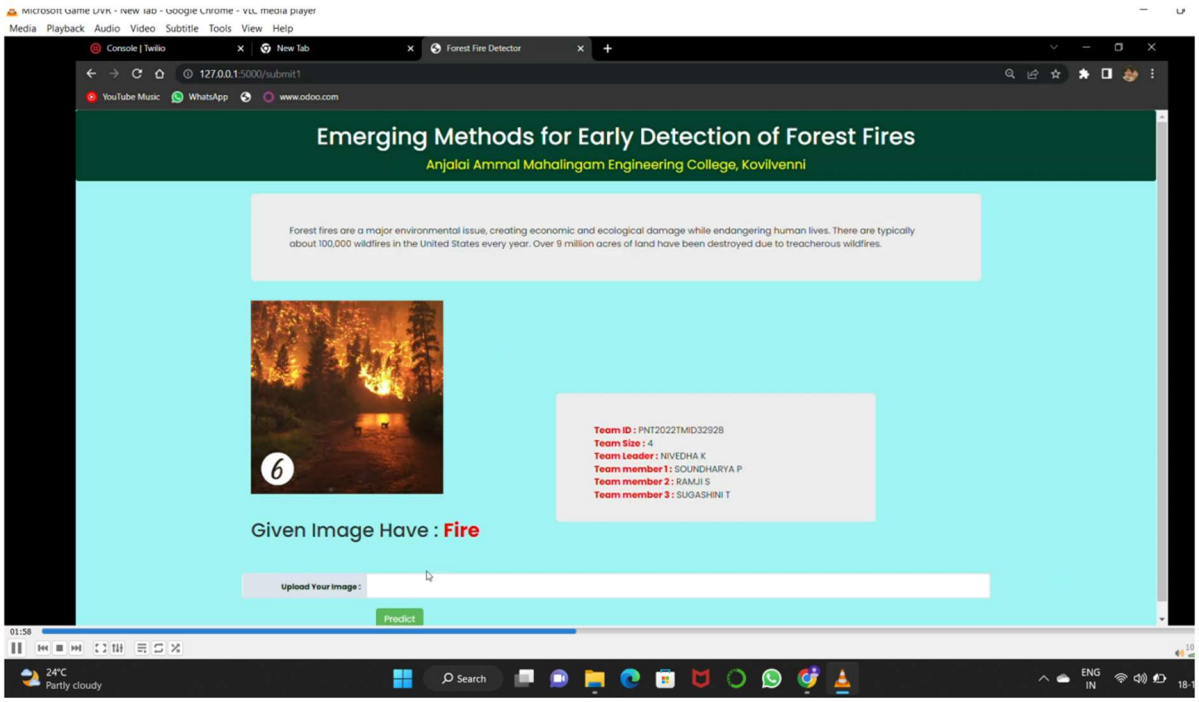
```
import cv2
import numpy as np
from keras.preprocessing import image
from keras.models import load_model
from twilio.rest import Client
from playsound import playsound

#load the saved model
model = load_model(r'/content/forest1.h5')

#define video
video =cv2.VideoCapture('/content/drive/MyDrive/pexels-arnav-kainthola-754365
3.mp4')

#define the features
name = ['forest','with forest']
video.isOpened()

True
from tensorflow.keras.preprocessing import image
from IPython.display import Audio
while(video.isOpened()):
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=pred[0]
print(pred)
cv2.putText(frame,"predicted class = ",(100,100),cv2.FONT_HERSHEY_SIMPLEX,
```

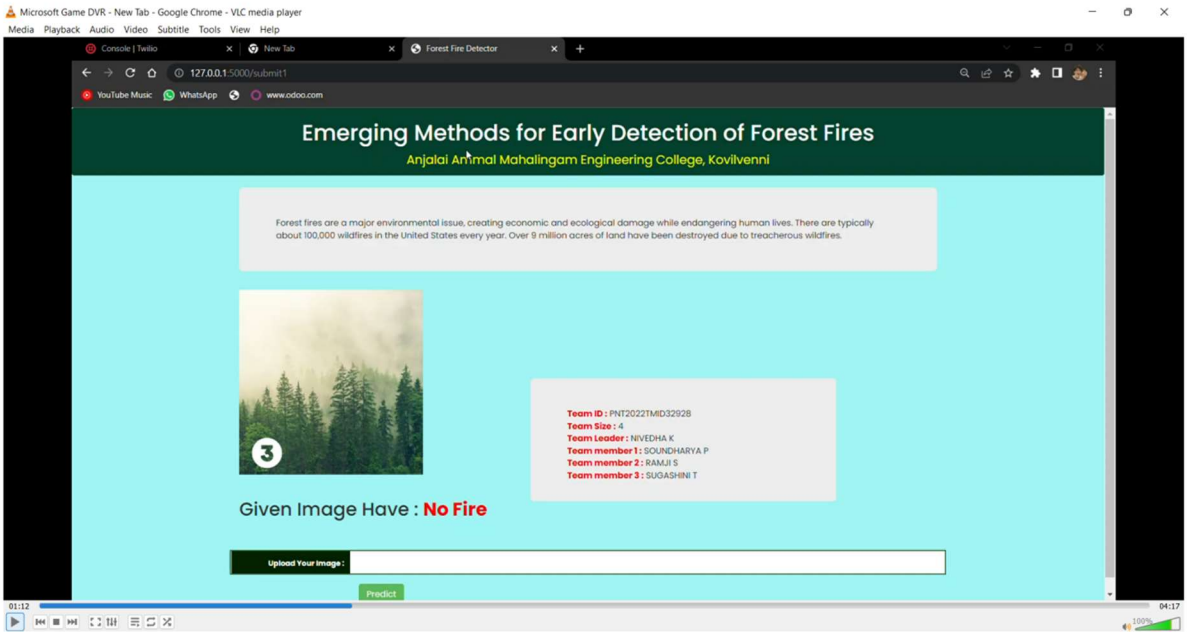
```
        1, (0,0,0), 1)
        if pred[0]==1:
        account_sid='AC78ba7cac649688be703fe64e444ade4a'
        auth_token='9f95514e9bcb9d58bda93aba728f6af5'
        client=Client(account_sid,auth_token)
        message=client.messages \
        .create(
        body="Forest fire is detected ,stay alert",
        from_='+15595464324',
        to='+91 6383095416')
        print(message.sid)
        print('Fire detected')
        print('SMS sent')
        wn=Audio('/content/drive/MyDrive/alarm-sound.mp3',autoplay=True)
        display(wn)
        break
        else:
        print('No danger')
        break
        if cv2.waitKey(1) & 0xFF==ord('a'):
        break
        video.release()
        cv2.destroyAllWindows()

1/1 [==============================] - 0s 81ms/step
[[1.]]
SMc9da8fc345a2ce13c7e598ce055ad8fa
Fire detected
                                        SMS sent
```

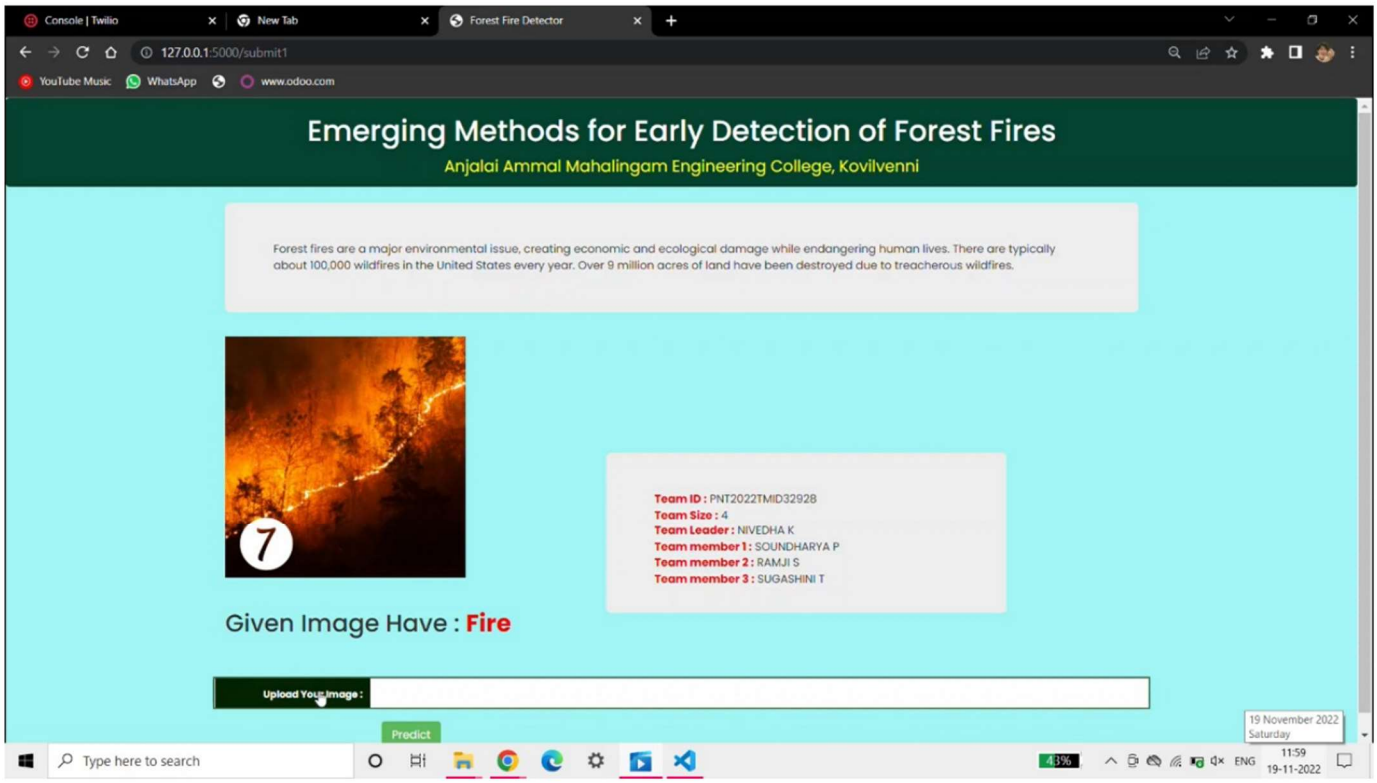
8.1 Testing

Test Case:






Microsoft Game DVR - New Tab - Google Chrome - VLC media player
Media Playback Audio Video Subtitle Tools View Help
Console | Twilio
New Tab
Forest Fire Detector
127.0.0.1:5000/submit1
YouTube Music
WhatsApp
www.odoo.com
Emerging Methods for Early Detection of Forest Fires
Anjalai Ammal Mahalingam Engineering College, Kovilvenni
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.
3
Team ID : PNT2022TMID32928
Team Size : 4
Team Leader : NIVEDHA K
Team member 1 : SOUNDHARYA P
Team member 2 : RAMJI S
Team member 3 : SUGASHINI T
Given Image Have : No Fire
Upload Your Image :
Predict
01:12
04:17


Console | Twilio
New Tab
Forest Fire Detector
127.0.0.1:5000/submit1
YouTube Music
WhatsApp
www.odoo.com
Emerging Methods for Early Detection of Forest Fires
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7
Team ID : PNT2022TMID32928
Team Size : 4
Team Leader : NIVEDHA K
Team member 1 : SOUNDHARYA P
Team member 2 : RAMJI S
Team member 3 : SUGASHINI T
Given Image Have : Fire
Upload Your Image :
Predict
Type here to search
43%
ENG
11:59
19-11-2022
19 November 2022
Saturday

User Acceptance Testing:

2.Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	2	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	77

3.Test Case Analysis

This report shows the number of test cases that have passed, failed, and untested

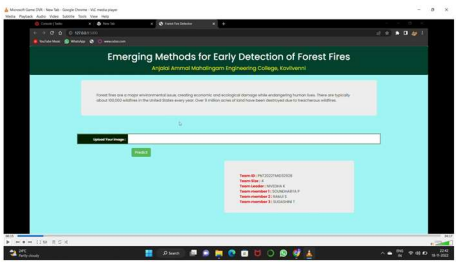
Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	51	0	0	51
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	2	0	0	2

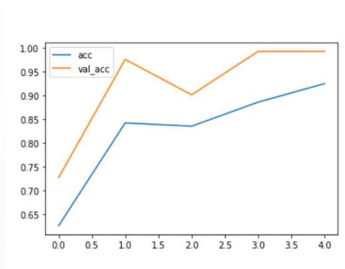
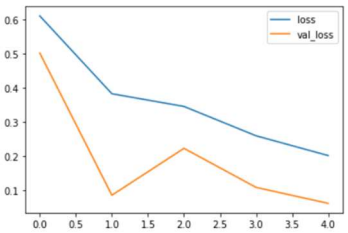
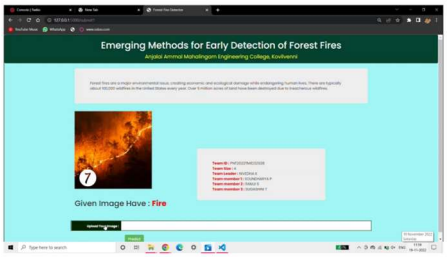
9. RESULTS

Performance Metrics:

Model Performance Testing:

Project team shall fill the following information in model performance testing template

S. No	Parameter	Values	Screenshot
1.	Model Summary	Forest fires are a major environmental issue, creating economic and ecological damage while endangering human lives. There are typically about100,000 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 during the Fire due to its eliability and efficiency. The various real-time forest fire detection and rediction approaches, with the goal of informing the local fire authorities.	

2.	Accuracy	Training Accuracy – 0.96 Validation Accuracy -0.96	 
3.	Confidence Score (Only Yolo Projects)	Class Detected – No Fire Class Detected –Fire detected Confidence Score – 95/100	

10. ADVANTAGES

The advantages of vision based fire detection techniques are listed here:

- The fast response to fires.
- The location of fire is sensed using this method not just the radiation.
- The captured images can be analysed and it can be used for future purposes and storage,
- It can be used for outdoor places which cover a large area.

DISADVANTAGES

The disadvantages of vision based fire detection techniques are listed here:

- Power consumption
- Latency
- Implementation costs

11. CONCLUSION

- The proposed Fire detection system uses Convolution Neural Network and Image Pre-processing techniques to detect Forest fire from the given Image and videos and send alert messages via Twilio API to users.

- The proposed system is implemented with the real time datasets which signifies that the fire detection method is more appropriate for real-time unconstrained motion videos.

12.FUTURE SCOPE

- Fire detection in forest could also be possible if we used temperature sensors and humidity sensors along with the device which can also avoid wastage of valuable trees. Forest not only provides home to the large variety of flora and fauna, the animals but also the major producer of oxygen to the ecosystem.
- The sub server unit can be used between the transmitter unit and the main receiver unit which makes the whole procedure evenly proportional and take preventive measures to alert the forest officer.
- The system can be reformed with lower capacity components and OpenCV, making the system more efficient.
-

13. APPENDIX

Source Code:

GitHub: https://github.com/IBM-EPBL/IBM-Project-4425-1658732114

Project Demo Link:

https://drive.google.com/file/d/10OY0hhLDY7v0BJzotn_2eTft91ZpkhCY/view?usp=share_link