EMERGING METHODS FOR EARL DETECTION OF FOREST FIRES

PROJECT REPORT

Submitted by

AKALI ASMI MOL A (960219104010)

AMALA BENSIT M (960219104012)

ANNIE J ALEX B (960219104017)

ANUSRI V (960219104020)

Team ID: PNT2022TMID33969

BACHELOR OF ENGINEERING IN COMPUTER SCIENCE AND ENGINEERING

ANNA UNIVERSITY: CHENNAI 600025

NOVEMBER 2022

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Project Overview:

Fire can make major hazards in this hectic world. All buildings and vehicles used in public transportation have fire prevention and fire protection systems due to the accelerated number in the fire incidents. Also, many of the firms conduct a mock fire drill in every occurrence of months to protect their employees from the fire. This would help them to understand what to do or what not to do when a fire situation happens. Forests are one of the main factors in balancing the ecology. It is very harmful when a fire occurs in a forest. But most of the time, the detection of forest fire happens when it spread over a wide region. Sometimes, it could not be possible to stop the fire. As a result, the damage of the environment is higher than predictable. The emission of large amount of carbon dioxide (CO2) from the forest fire damages the environment. As well as it would lead to complete disappearance of rare species in the world. Also, it can make an impact on the weather, and this make major issues like earthquakes, heavy rains, floods and so on. The forest is a large surface of area filled with trees, lots of dried leaves, woods and so on.

1.2 Purpose:

Forest fires have become a major threat around the world, causing many negative impacts on human habitats and forest ecosystems. Climatic changes and the greenhouse effect are some of the consequences of such destruction. Interestingly, a higher percentage of forest fires occur due to human activities. Therefore, to minimize the destruction caused by forest fires, there is a need to detect forest fires at their initial stage.

Furthermore, to acquire more accurate fire detection, a machine learning regression model is proposed. Because of the primary power supply provided by rechargeable batteries with a secondary solar power supply, a solution is readily implementable as a standalone system for prolonged periods. Moreover, in-depth attention is given to sensor node design and node placement requirements in harsh forest environments and to minimize the damage and harmful effects caused by wild animals, weather conditions, etc. to the system.

2.LITERATURE SURVEY

2.1 Existing problem:

Author name: Georgi Hristov, Jordan Raychev
Year Of Publishing: 2018
Description:

Forest fires are occurring throughout the year with an increasing intensity in the summer and autumn periods. Theseevents 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.

Author name: Ahmad A.A.Alkhatib
Year Of Publishing: 2014
Description:

In this study he had been discovers Forests are the protectors of earth's ecological balance. Unfortunately, the forest fire is usually only observed when it has already spread over a large area, making its control and stoppage arduous andeven impossible at times. The result is devastating loss and irreparable damage to the environment and atmosphere (30% of carbon dioxide (CO2) in the atmosphere comes from forest fires), in addition to irreparable damage to the ecology.

Author name: U Dampage
Year Of Publishing: 2022
Description:

Forest fires have become a major threat around the world, causing many negative impacts on human habitats and forestecosystems. Climatic changes and the greenhouse effect are some of the consequences of such destruction. Interestingly, ahigher percentage of forest fires occur due to human activities. Therefore, to minimize the destruction caused by forest fires, there is a need to detect forest fires at their initial stage. This paper proposes a system and methodology that can be used todetect forest fires at the initial stage using a wireless sensor network. Furthermore, to acquire more accurate fire detection, a machine learning regression model is proposed.

2.2 References:

[1] T. Mladenović: *"Visinska struktura reljefa zemljišta u SFR Jugoslaviji"*, Vojnogeografski institut, 1984, Beograd, 1984.

[2] S. Živanović: "Risk factors for forest fires", Bezbednost, Beograd, Vol 52, iss. 2, 2010, pp. 179-190.

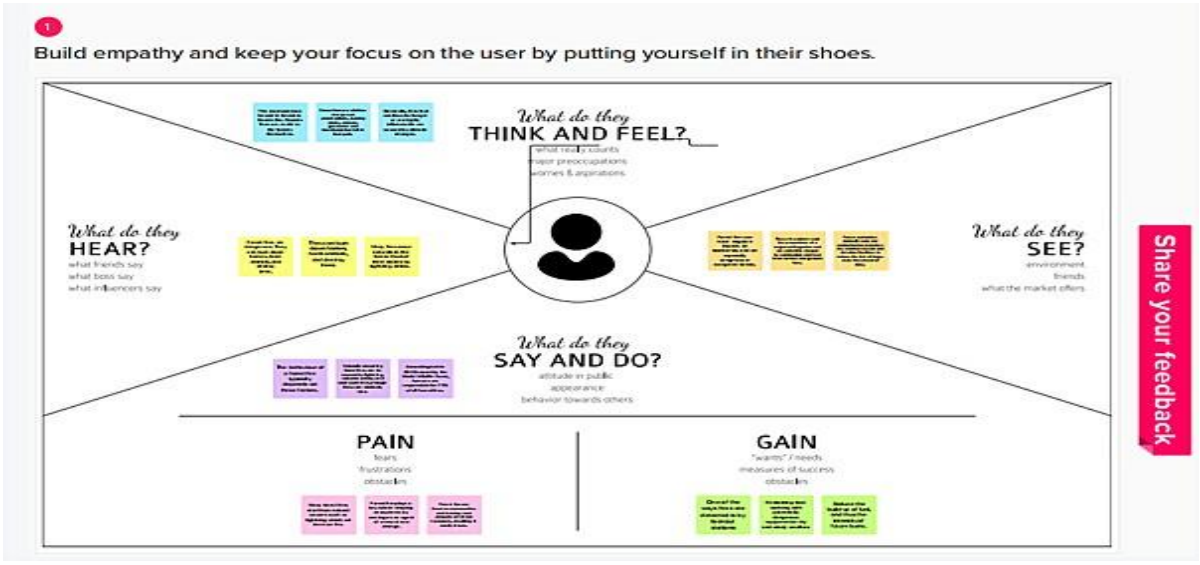
[3] S. Živanović: "Modelovanje pravca širenja šumskog požara u cilju predikcije", NBP-Journal of Criminalistics and Law, Beograd, Vol 17 No 2, 2012 pp. 163-171.

2.3 Problem Statement Definition:

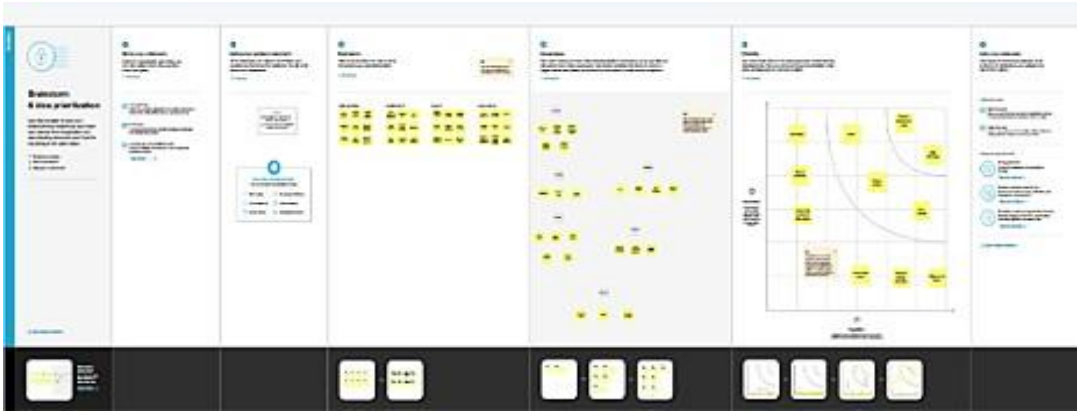
A Large destructive fire that spread over a forest or area of woodland which leads to damage in Wildlife, humans, property and Environment. The major Causes Are Lightning. Sparks from Rock falls. Volcanic Eruption or any other manual Ignition from the Humans on purpose which leads to the following disadvantages: A forest fire sets up the potential for soil erosion to occur, Forest fires always bring death to life of humans and animals, Uncontrolled fires can cause localized air pollution, Homes can be destroyed without compensation.

3. IDEATION AND PROPOSED SOLUTION

3.1 Empathy Map Canvas:



3.2 Ideation And Brainstorming:



3.3 Proposed Solution:

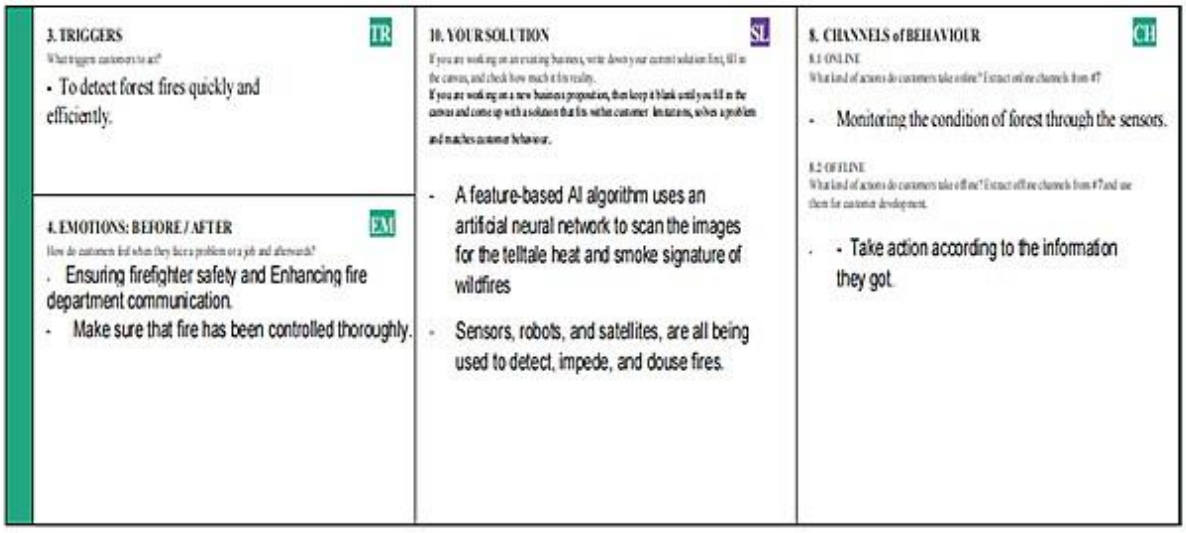
S.No	Parameter	Description
1.	Problem Statement	The most common hazard in forests is forests fire. Forests fires are as old as the forests themselves. They pose a threat not only to the forest wealth but also to the entire regime to fauna and flora seriously disturbing the biodiversity and the ecology and environment of a region.
2.	Idea	1. Check weather and drought condition 2. Carefully dispose of smoking materials. 3. Avoid any activities that involve fire or sparks when it's hot, dry and windy. 4. High temperatures raise the flammability of dry grass, leaves, trunks, or pine tar 5. Wildland fire managers must constantly assess the threat of human-caused fire to wildlands and the threat of wildland fires to humans. 6. Human-caused fires result from campfires left unattended, the burning of debris, equipment use and malfunctions, negligently discarded cigarettes, and intentional acts of

		arson.

3.	Novelty	Forest fires (wildfires) are common hazards in forests, particularly in remote or unmanaged areas. It is possible to detect forest fires, elevated CO2, and temperature levels using Internet of Things (IoT) sensors. You can deploy IoT, satellite and solar sensors in remote areas without the need for internet, cellular/mobile or mains power.
4.	Social Impact	Blocked roads and railway lines, electricity, mobile and land telephone lines cut, destruction of homes and industries, and the way of life of many communities are annual news stories and the balance of the catastrophe caused by fire results in a wealth of articles, editorials and communications. A search in the newspaper archives reveals shocking figures, which we offer here to illustrate the magnitude of a problem which is now unsustainable and to which the managers and politicians responsible have

		become accustomed.
5.	Business Model	To support the entrepreneurial process, the business plan is of key importance. The business plan is a written document that describes all the relevant external and internal elements involved in starting a new venture. It is an integration of functional plans such as marketing, finance, manufacturing and human resources .
6.	Scalability of the Solution	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.

3.4 Problem Solution fit:



4. REQUIREMENT ANALYSIS

4.1 Functional requirement:

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	ASTER	It provide high-resolution images
FR-2	CERES	Its purpose is to measure Earth's radiation budget and atmospheric radiation
FR-3	MISR	It is created to multiple angle observation.
FR-4	MODIS	It was designed to measure high-priority atmospheric, land surface features on a global basis

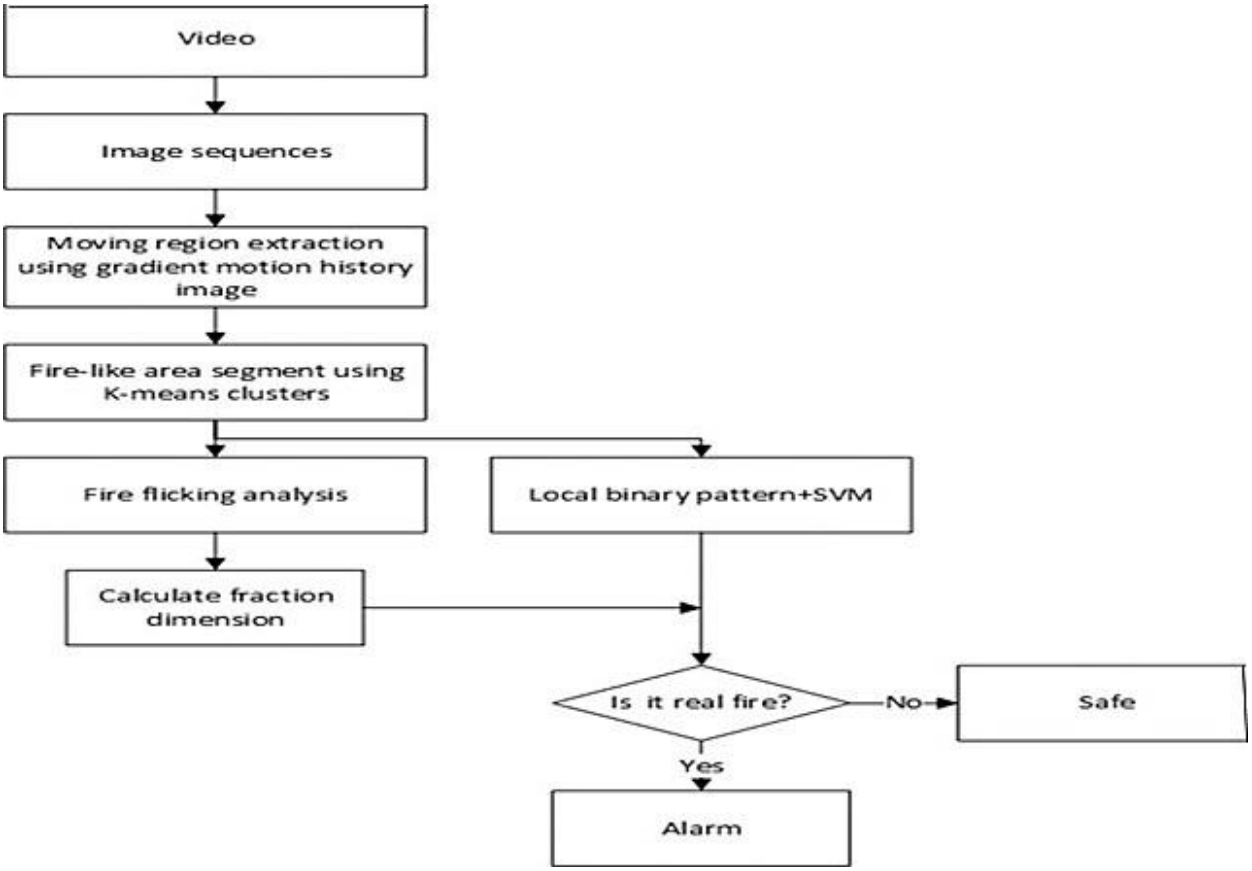
4.2 Non-Functional requirements:

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	It takes simultaneous measurements of Earth's atmosphere, land to understand how Earth is changing.
NFR-2	**Security**	It shut down all non-essential system.
NFR-3	**Reliability**	The proposed method has high operating efficiency.

NFR-4	**Performance**	The performance of the proposed system is better, so it can be considered suitable for forest fire monitoring.
NFR-5	**Availability**	It is rapidly growing and will continue to expand in the future.
NFR-6	**Scalability**	It is a highly dynamic system that can readily adapt and grow in strength and utility.

5.PROJECT DESIGN

5.1.DATA FLOW DIAGRAMS:

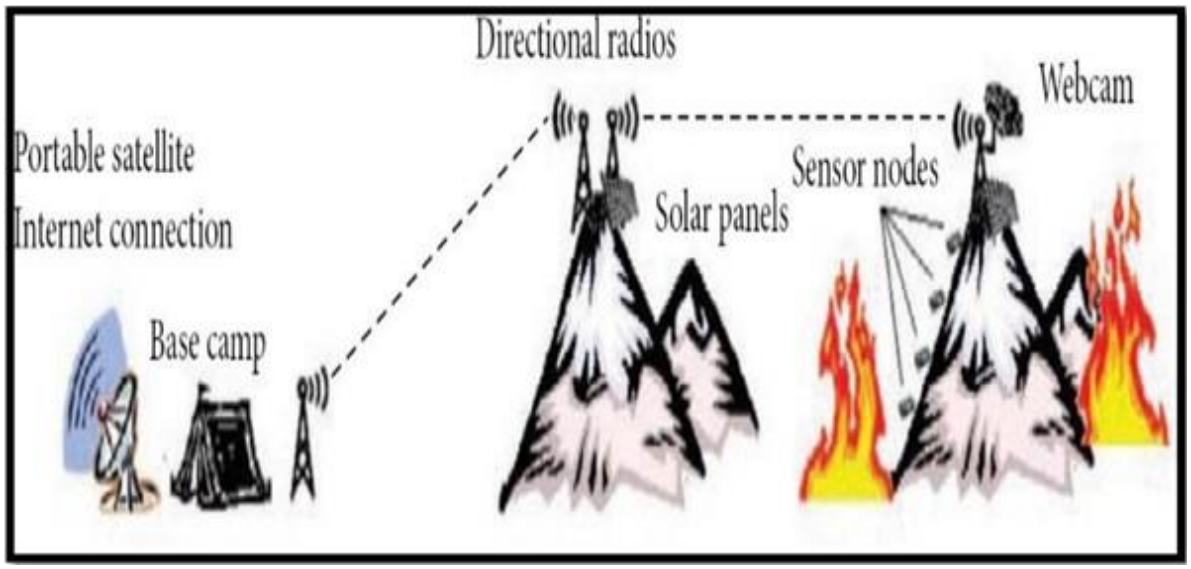


5.2 Solution And Technical Architecture:

Forests are part of the important Resources for human survival and social development that protect the balance of the earth ecosystem. These fires are the most uncontrollable disasters to forest resources and the human environment condition. Now there are many methods used for providing fire detection to forest.

- There are many existing systems like Satellite Systems, CCD CAMERAS, wired system and Bluetooth technology. These system provides a complete image of the earth.
- Forest fire monitoring by remote sensing can be achieved through the use of polar orbiting and geostationary satellites.
- The system is being detected the level of temperature, Smoke by using the sensors.
- These systems are efficient for detecting fire in very short duration.
- The industrial application of wireless sensor networks are in digital transmission to monitor temperature and humidity in the forest in a more timely and precise way.

Real Time Monitoring of Forest Fires



5.3 User Stories:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer(Mobile user, Web user)	Antennas	USN-1	As a user, I can know how antennas works.	It receives signals uplinked from various sources on earth.	High	Sprint-1
	Transponders	USN-2	As a user, I can know what it transmits.	It transfers the received signals.	Medium	Sprint-2
	Power system	USN-3	As a user, I can know that electrical power system is being used.	It pumps electrical energy to the various parts of the satellite.	Medium	Sprint-3
	Propulsion system	USN-4	As a user, I can know how it changes the velocity.	Its function is to produce thrust which makes the rocket move.	High	Sprint-4

6.PROJECT PLANNING AND SCHEDULING

6.1 Sprint Planning & Estimation:

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.	2	High	Akali Asmi Mol A Anusri V
Sprint-1		USN-2	As a user, I can register for the application through gmail,linkedin	1	High	Amala Bensit M Annie J Alex B
Sprint-2	Login	USN-2	As a user,I can login by using valid user name and password.	2	High	Akali Asmi Mol A Anusri V Amala Bensit M

Sprint-3	Dashboard	USN-3	As a user,I can view the garbage storage level.	2	Medium	Amala Bensit M Anusri V Akali Asmi Mol A
Sprint-4	Blynk-App	USN-4	Blynk Server is responsible for all the communicatio ns between the smartphone and hardware.	2	High	Annie J Alex B Anusri V Amala Bensit M

6.2 Sprint Delivery Schedule:

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	18 Nov 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	18 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	18 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	18 Nov 2022

7.CODING AND SOLUTIONING

7.1 Feature 1:

1. **Importing The ImageDataGenerator Library:**

Import Keras library from that library import the ImageDataGenerator Library to your Python script

2. **Define The Parameters For ImageDataGenerator Class:**

The arguments which we are given inside the image data generator class are, rescale, shear range, rotation range of image, and zoom range that we can consider for images, etc.

3. **Importing The Model Building Libraries:**

Import the libraries that are required to initialize the neural network layer, create and add different layers to the neural network model.

4. **Initializing The Model:**

Keras has 2 ways to define a neural network:

- Sequential
- Function API

The Sequential class is used to define linear initializations of network layers which then, collectively, constitute a model. In our example below, we will use the Sequential constructor to create a model, which will then have layers added to it

using the add () method.

5. **Adding CNN Layers:**

We will be adding three layers for CNN

- Convolution layer
- Pooling layer
- Flattening layer

6. **Adding Convolutional Layer:**

The convolutional layer is the first and core layer of CNN. It is one of the building blocks of a CNN and is used for extracting important features from the image.In the Convolution operation, the input image will be convolved with the feature detector/filters to get a feature map. The important role of the feature detector is to extract the features from the image.

7. **Adding Pooling Layer:**

Max Pooling selects the maximum element from the region of the feature map covered by the filter. Thus, the output after max-pooling layer would be a feature map containing the most prominent features of the previous feature map.

After the convolution layer, a pooling layer is added. Max pooling layer can be added using MaxPooling2D class. It takes the pool size as a parameter.

8. **Adding Flatten Layer:**

Now the pooled feature map from the pooling layer will be converted into one single dimension matrix or map, where each pixel in one single column, nothing but flattening. The flattening layer converts the multi-dimension matrix to one single dimension layer.

9. **Adding Dense Layers:**

The name suggests that layers are fully connected (dense) by the neurons in a network layer. Each neuron in a layer receives input from all the neurons present in the previous layer. Dense is used to add the layers.

7.2 FEATURE 2:

Code:

Importing Keras libraries

```
import keras
```

Importing The ImageDataGenerator Library

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

Define the parameters/arguments for ImageDataGenerator class

```
train_datagen=ImageDataGenerator(rescale=1./255,shear_range=0.2,rotation_range=180,zoom_range=0.2,horizontal_flip=True)
```

```
test_datagen=ImageDataGenerator(rescale=1./255)
```

Mounting Drive

```
from google.colab import drive

drive.mount('/content/drive')
```

Applying ImageDataGenerator functionality to trainset

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

Applying ImageDataGenerator functionality to testset

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

Importing The Model Building Libraries

```
#To define linear initialisation import sequenial
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 convolution layer
model.add(Convolution2D(32,(3,3),input_shape=(128,128,3),activation='relu'))

add flatten layer
model.add(Flatten())

Add Dense layers

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

configure the learning process
model.compile(loss='binary_crossentropy',optimizer="adam",metrics=["accuracy"
])

Training the model

model.fit_generator(x_train,steps_per_epoch=14,epochs=10,validation_data=x_tes
t,validation_steps=4)

Save the model

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

Predictions

```
from keras.models import load_model
from tensorflow.keras.preprocessing import image
import numpy as np
import cv2
model = load_model("forest1.h5")
img=image.load_img('/content/drive/MyDrive/Dataset/Dataset/Dataset/test_set/wi
th fire/GettyImages_482867948.0.jpg')
x=image.img_to_array(img)
res = cv2.resize(x, dsize=(128, 128), interpolation=cv2.INTER_CUBIC)
x=np.expand_dims(res,axis=0)
pred=model.predict(x)
pred
```

Open cv for video processing

```
from google.colab import drive
drive.mount('/content/drive')
from logging import WARNING
#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
import cv2
import numpy as np
from google.colab.patches import cv2_imshow
from matplotlib import pyplot as plt
import librosa
from tensorflow.keras.preprocessing import image
from keras.models import load_model
# Create a VideoCapture object and read from input file
# If the input is the camera, pass 0 instead of the video file name
cap = cv2.VideoCapture('/content/drive/MyDrive/forest fire video/pexels-arnav-kainthola-7543653.mp4')

# Check if camera opened successfully
if (cap.isOpened()== False):
  print("Error opening video stream or file")

# Read until video is completed
while(cap.isOpened()):
  # Capture frame-by-frame
  ret, frame = cap.read()
  if ret == True:
    x=image.img_to_array(frame)
    res=cv2.resize(x,dsize=(64,64),interpolation=cv2.INTER_CUBIC)
```

```
    #expand the image shape
    x=np.expand_dims(res,axis=0)
    model=load_model("/content/drive/MyDrive/forest h5/forest.h5")
    cv2_imshow(frame)
    pred=model.predict(x)
    pred = int(pred[0][0])
    pred
    int(pred)
    if pred==0:
      print('Forest fire')
      break
    else:
      print("no danger")
      break
  #When everything done, release the video capture object
cap.release()

# Closes all the frames
cv2.destroyAllWindows()
pip install pygobject
pip install twilio
```

Fire detected:

```
from twilio.rest import Client
from playsound import playsound
if pred==0:
  print('Forest fire')
  account_sid='AC34c4bee5e03df7bc7dba1eef29761275'
```

```
  auth_token='1fc522239435d0c251c1fd870d715295'
  client=Client(account_sid,auth_token)
  message=client.messages \
  .create(
      body='forest fire is not detected,stay alert',
      #use twilio free number
      from_='+19803934024',
      #to number
      to='+919962082226')
  print(message.sid)
print("no danger")
print("SMS Sent!")
elif pred==1:
  print('fire detected')
  print("SMS Sent!")
```

No fire:

```
from twilio.rest import Client
from playsound import playsound
if pred==0:
  print('Forest fire')
  account_sid='AC34c4bee5e03df7bc7dba1eef29761275'
  auth_token='1fc522239435d0c251c1fd870d715295'
  client=Client(account_sid,auth_token)
  message=client.messages \
  .create(
      body='forest fire is detected,stay alert',
      #use twilio free number
```

```
      from_='+19803934024',
      #to number
      to='+919962082226')
  print(message.sid)
print("Fire detected")
print("SMS Sent!")
elif  pred==1:
print('No danger')
```

8.TESTING

8.1 Test Cases:

A test case is a set of actions executed to verify a particular feature or functionality of your software application. A Test Case contains test steps, test data, precondition, postcondition developed for specific test scenario to verify any requirement.

Test Frame	Expected Output	Actual Output	Accuracy	Result
	Fire	Fire	62%	Pass
	No Fire	No Fire	100%	Pass

9. RESULTS

9.1 Performance Metrics:

It is the process of collecting, analyzing and/or reporting information regarding the performance of an individual, group, organization, system or component. Definitions of performance measurement tend to be predicated upon an assumption about why the performance is being measured.

10. ADVANTAGES AND DISADVANTAGES

10.1 ADVANTAGES:

The line of sight and the early stage of the fire process problem could be solved with the second type of sensors. A new technology called wireless sensor network (WSN) is nowadays receiving more attention and has started to be applied in forest fire detection. The wireless nodes integrate on the same printed circuit board, the sensors, the data processing, and the wireless transceiver and they all consume power from the same source batteries. Unlike cell phones, WSN do not have the capability of periodic recharging. The sensors are devices capable of sensing their environment and computing data. The sensors sense physical parameters such the temperature, pressure and humidity, as well as chemical parameters such as carbon monoxide, carbon dioxide, and nitrogen dioxide. There is no need to build towers or set up complicated communication links. They can be deployed anywhere even in inaccessible places.

10.2 DISADVANTAGES:

Forest fires can impact the economy as many families and communities depend on the forest for food, fodder and fuel. It burns down the small shrubs and grasses, leading to landslides and soil erosion. Burning of forests causes smoke and poisonous gas emissions that result in significant health issues in humans. Loss of trees can disrupt the climatic conditions and break down the carbon chain. Wildfires damage the habitat of animals, causing them to wander in cities. Many die in the fires, unable to escape. These fires destroy the vegetation, soil quality and overall flora and fauna.

11.CONCLUSION

This technology can provide real-time monitoring, where it can provide information at the ignition instance or at very small delays, depending on the node used in wake-up/sleep schedule. This technology works on short communication links fashion. As a result, more accurate information with less delay can be provided for the fire fighters.

Wireless sensor network technology normally deploys large number of small, low cost sensors fairly densely that can observe and influence the physical world around them by gathering physical information, transforming it into electrical signals, sending it to a remote location to do some analysis, and deploying the results in different applications. By this way there is no need to build towers or set up complicated communication links such as microwave and satellite. It can be deployed anywhere even in inaccessible places.

12.FUTURE SCOPE:

- This fire alert system is power efficient, low cost and low maintenance, and the equipment is durable and reliable.

- In future, we can install a wind sensor to the system which helps to determine the direction of the fire and the rate at which it will spread.

- Along with this we can implement an automatic fire extinguisher system. As soon as a sensor detects fire, extinguisher gets activated.

- GPS module can be added to the nodes to get the exact location of fire or smoke.

13.APPENDIX

13.1 GitHub & Project Demo Link:

https://www.youtube.com/watch?v=FBizL0gtDNs