EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

NALAIYATHIRAN PROJECT BASED LEARNING

PROJECT FOR INNOVATION,

EMPLOYNMENT And ENTERPRENEURSHIP

A PROJECT REPORT

Submitted

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1. INTRODUCTION

1. INTRODUCTION

1.1 Overview Project

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 (CO_2) 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.

A research study shows an automatic fire detection can be divided into three groups: aerial, ground and borne detection. The ground-based systems use several staring black and white video cameras are used in fire detection which detect the smoke and compares it with the natural smoke. The main benefit of using this system is high temporal resolution and spatial resolution. So that, the detection is easier.2But these mechanisms still have some drawbacks in detecting the early stage of the fire so that, it is highly important to introduce a system to detect the fire early as possible.

Moreover, information regarding the seat of the hearth is invaluable for the rapid deployment of fire- fighters. Therefore, early detection, containment at the primary stages and extinguishment of a fireplace before it spreads are crucial for wildfire Management

1.2 Purpose

Forest fires as of late have been annihilating both for normal biological system, biodiversity and woodland economy. With expanding populace weight

and change in worldwide atmosphere situation, there is an expansion in level of fires that are a significant reason for declining Indian woodlands. As indicated by woodland study report of India, 50 % of backwoods regions in nation are fire inclined (going from 50 to 90 % in certain conditions of nation). Around 6 % of the woods are inclined to extreme fire harms. The reason for this planned framework is to manufacture a dependable fire location framework so as to know dynamic status of backwoods temperature in specific conditions. It is about the sensors and dynamic checking framework to dodge a significant fire and genuine harm to woods.

2. LITERATURE SURVEY

2.1Existing problem

The existing system for detecting fire are smoke alarms and heat alarms. The main disadvantage of the smoke sensor alarm and heat sensor alarms are that just one module is not enough to monitor all the potential fire prone places. The only way to prevent fire is to cautious at the time. Even if they are installed in every nook and corner, it just is not sufficient for an efficient output

consistently. As the number of smoke sensor requirement increase the cost will also increase to its multiple. The proposed system can produce consistent and highly accurate alerts within seconds of accident of the fire. It reduces cost because only one software is enough to power the entire network of surveillance. Research is active on this field by data scientists and machine learning researchers. The real challenge is to minimize the error in detection of fire and sending alerts at the right time.The idea of this research is to fabricate a system through IoT sensors, which is arbitrarily spread in the forest and to make a self-sorted out powerful system between the sensors to cover all the enormous territories in the forest that will used to maintain a strategic distance from the fire harm whenever. The capacity of the sensor is to identify fire in the inclusion region between the time intermission of each 5-10 minutes. At the point when the fire is recognized the entirety of the sensor in the region will be dynamic and order to stop the normal assignment. The concept is to build early fire detector using Arduino which is connected with different IoT sensors. Putting all efforts to develop a smarter system by connecting it to a webpage and monitoring the developed system statistics controlled by the Arduino programming. The use of latest technology can help to prevent the catastrophic accidents in forests. The aim is to early detect the fireplace in forest by considering the several factor like smoke, temperature, humidity, flame and based on the data we get from this programming, the forest department will be able to take an appropriate decision and the rescue team will be able to arrive on time at exact location. Consider, if it is a large region and it produces more carbon monoxide than the ordinary vehicle traffic. Surveillance of the danger areas and an early detection of fireplace can appreciably shorten the response time and additionally decrease the practicable injury as nicely as the fee of firefighting. Known rule applies here: 1 minute – 1 cup of water, 2 minutes - 100 liters of water, 10 minutes - 1000 liters of water. The goal is to notice the fireplace as quicker as possible, its actual localization and early notification to the fire devices. When fire starts then the flammable texture may likewise issues fuel to the hearth focal spot. The spot at that point will expand and more extensive. The first phase of start is alluded as "surface fire‟ stage. This may feed on abutting bushes and the fire will turn into higher and transforming into "crown fire‟. Generally, at this stage the hearth transforms into wild and injury which end up being extreme that could stay for quite long time while depending on atmosphere

conditions and the territory. Forest fire detection using optimized solar–powered ZigBee wireless sensor networks- In this paper, they have developed system for Forest Fire Detection which overcomes the demerits of the Existing technologies of Forest Fire Detection. It can be ensured that the system developed can be implemented on a large scale with its promising results. The system is provided with low-power elements, higher versions of Zigbee, Maximum power point tracking Algorithm is used in order to make the system run for longer periods efficiently. Forest fires are a very serious problem in many countries, and global warming may contribute to make this problem worse. Experts agree that, in order to prevent these tragedies from happening, it is necessary to invest in new technologies and equipment that enable a multifaceted approach. This paper describes a WSN for early detection of forest fires. This network can be easily deployed at areas of special interest or risk. There are two types of nodes from the physical structure point of view: SNs, to collect data from the environment, and CNs, to gather data from the SNs and transmit the information to a Control Centre. The nodes also can be in different functioning modes. This enables a proper and seamless configuration of the network, provides redundancy, and ensures there will be full temporal and geographical coverage in the deployment zone. The information gathered is related not only to early detection purposes but also to environment monitoring to maximize the WSN usage. This environmental data can also be employed to firefighting preventive tasks such as vegetation modelling, microclimate studies, and propagation model parametrization.

2.2References

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2.3. Problem Statement Definition

1. In earlier times fires were detectedwith the help of watchingtowers or using satellite images.
2. Satellites collect images and send it to the monitoring authority which will decide by seeing images that it is a fire or not.
3. But this approachwas very slow as the fire may have spreadin the large areas and caused so much damage before the rescue team came.
4. 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.
5. 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.
6. 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.

7. 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:

8. There were mainly two problems in fire detection as discussed:

9. (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.

10. So, this problem was removed by using machine learning techniques by many researchers.

11. (b). Connection of nodes: Traditional systems used cables to connect alarm with the detectors.

12. Cable was mainlyof copper. But copper wire may be costly or it can suffer from fault in the mid-way.

13. So, this problem was removed using wireless sensor networks.

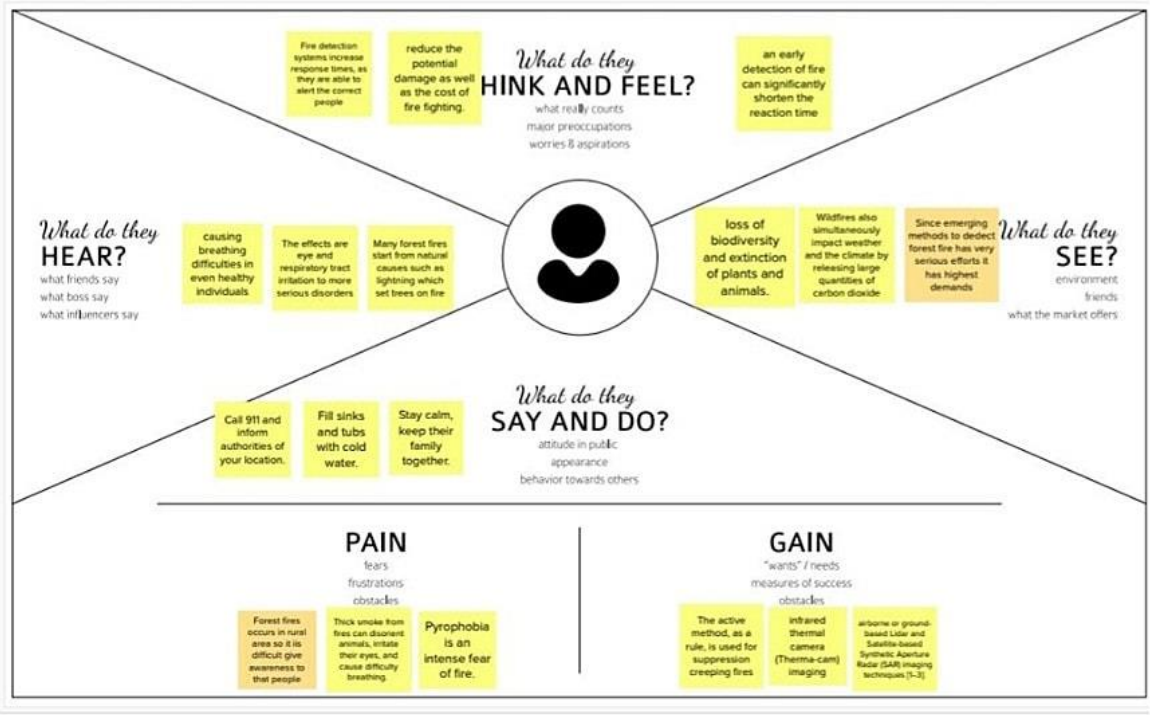
14. So, with the advancement in technology researchers find an efficient method to detect forest fire with the help of Wireless Sensor Network.

15. Fire can be identified by conveying sensor hubs in timberland regions by which they illuminate about fire.

16. 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.

3. IDEATION &PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation & Brainstorming

3.3 Proposed Solution

Problem Statement

A Large destructive fire that spread over a firestorm area of woodland is a Forest fire that causes loss of humungous amount of Property, Wildlife, Ecosystem and Economy. How to detect these types of fires at early stage and how to control them

Idea

1. Various techniques such as watchtowers, spotter planes, infrared, aerial patrols, and automatic detection systems to detect fire events.

2. Educate Everyone on Fire Risks and Safety.

3. Stay with outside fires until they are completely safe and dead out. Dispose of wood ashes in a metal bucket, soaking them with water before dumping them

4. Check weather and drought conditions.

5. Check conditions and regulations before you use fireworks or consider safe alternatives.

6. Check conditions and regulations before you use fireworks or consider safe alternatives.

Novelty

Sensor technology is an important tool in detecting forest fires by monitoring pressure, humidity, temperature, and chemical parameters. In particular, particulate, carbon dioxide (CO2), and carbon monoxide (CO) sensors are important for detecting wildfire smoke

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.

Forest fires occurs in rural area so it is difficult give awareness to that people

Thick smoke from fires can harm animals irritate their eyes and cause difficulty breathing.

Business Model

Remote sensing-based methods such as satellites, high-resolution static cameras fixed on the ground and unmanned aerial vehicles (UAVs).

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

ALTi Transition vertical take-off and landing fixed wing UAV and its ground control station

Scalability of the Solution

To further enhance the capability of their application, we recommend these

Features

Provides backup recovery of data

Provide better user interface for user.

3.4 Problem Solution Fit

Customer Segments

Forest officer

Local people

Hunters

Jobs-to-be-done/problems

Sensors are used to detect fires in forest. Continues monitoring is required to detect forest fire. Sensor set in the forest detect fires by sensing heat. Satellites are used for detecting and monitoring fires.

Triggers

Camp fires left unattended the burning of debris, equipment use and malfunction and negligently discarded cigarettes.

Available Solution

Satellites, Drones, Virtual Reality, Artificial intelligence are some of the techniques used for fire detection.

Behavior

The manner in which fuel ignites, flame develops and fires spreads.

Customer constraints

Sensors allow for detecting and monitoring of fires, transfer the information about the locations, temperature, of the forest fires through satellite. Satellite data is also critical for observing and monitoring smoke from the fires

Problem Root Cause

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, loss of valuable timber resources, ozone layer depletion, loss of livelihood for tribal people and poor people, increase in global warming.

You're Solution

We using sensor to detect fires. We should improve the quality of sensors for security. To further enhance the capability of their application backup and recovery of data technique can be used.

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Rules	Early detecting, signal transmitting, decision making
FR-4	External interface	The WUI is the zone of unoccupied land and human,

4.2 Non Functional requirement

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

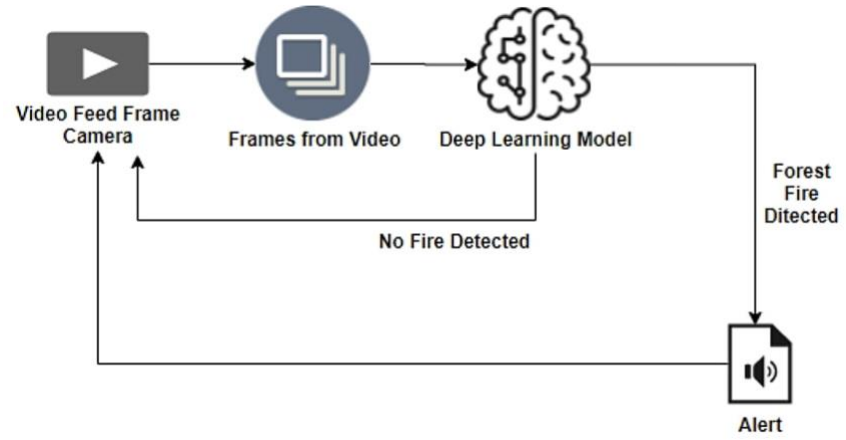
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Detection of forest fire and smoke in wet land areas is done through remote sensing based methods such as high resolution static cameras fixed on the ground .
NFR-2	**Security**	Forest fire detection should be done in a highly secured manner.
NFR-3	**Reliability**	Compared with traditional techniques wireless network technology is a very promising green technology for efficiency detect fires . Prediction should be accurate.
NFR-4	**Performance**	The forest fire detection system uses a transmitting location data alone. It takes very less time. It is more flexible.

5. PROJECT DESIGN

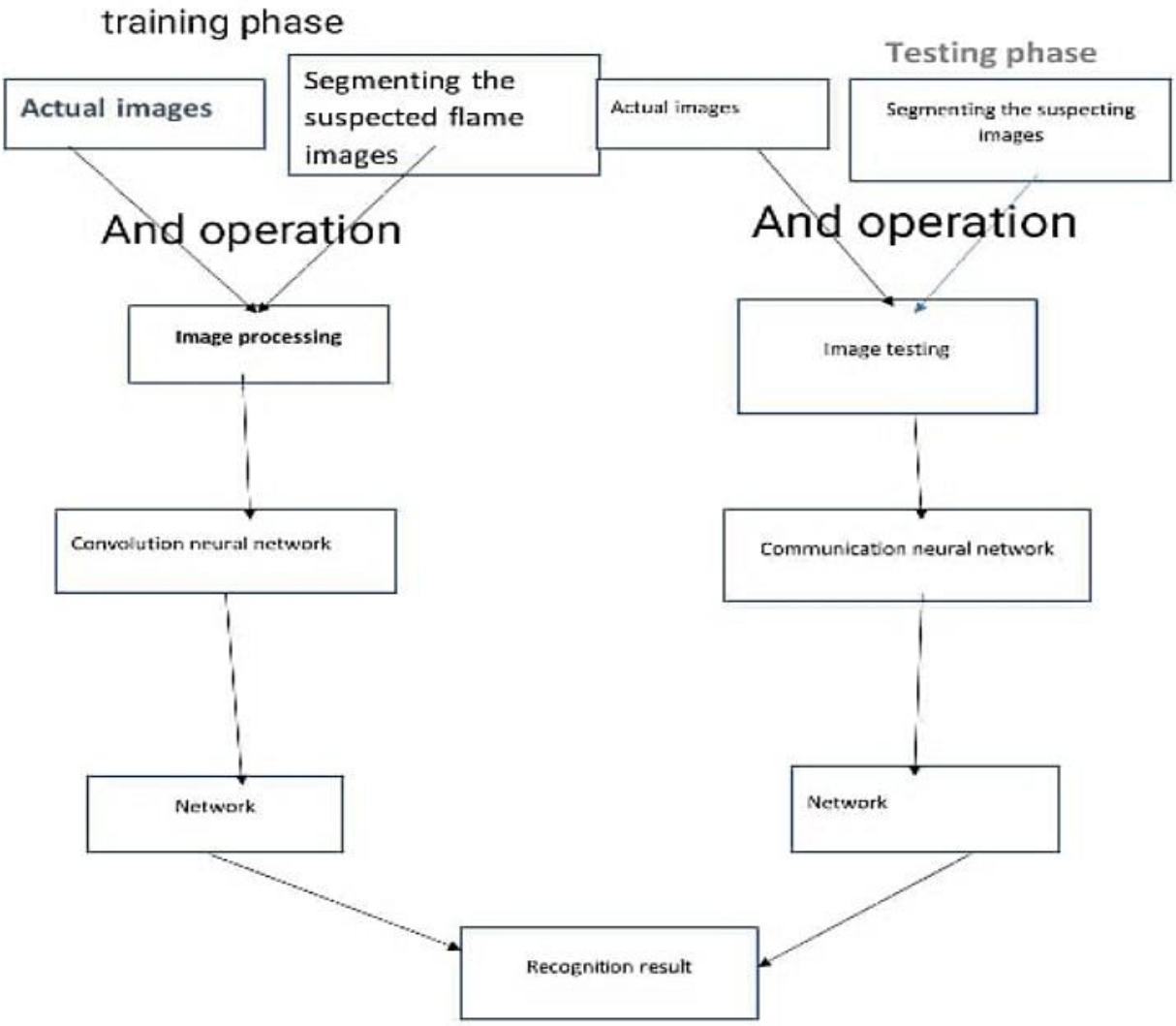
5.1 Data Flow Diagrams

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

Examples



- It is difficult to find fires in deep forest area.
- Since if it is difficult, we use ground based methods like camera or video based Approach to detect fires.
- Satellites are the important source for detecting forest fires.
- The various real-time forest fire detection and prediction approach, with the goal of informing the local fire authorities.
- If the fire is not detected, it will send the result to the frame camera. If the forest fire will detected the alert will go to the video feed frame camera.



5.2 Solution & Technical Architecture

Nowadays, forest fires are a serious threat to the environment and human life. The monitoring system for forest fires should be able to make a real-time monitoring of the target region and early detection of fire threats.Initially fire detected by the sensor that is fixed in the forest.

1. The signals transmitted to earth station.
2. The receiver signals transmitted to the fire detection centre f studies .It will be processed.

3. The alerts were given to state forest department.
4. The forest department immediately take the remedial measure for suppression and mitigation of forest fire.

5.3 User Stories

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

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Environmentalist	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 algorithm.	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 right output	High	Sprint-3

6. PROJECT PLANNING & 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	Neela Devi M Sneha A
Sprint-1		USN-2	As a user, I can register for the application through gmail,linkedin	1	High	Jini Kowshika G SharmilaVinoli M
Sprint-2	Login	USN-2	As a user,I can login by using valid user name and password.	2	High	Neela Devi M Sneha A Jini Kowshika G
Sprint-3	Dashboard	USN-3	As a user,I can view the garbage storage level.	2	Medium	Jini Kowshika G Sneha A Neela Devi 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	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 &SOLUTIONIN

7.1 Feature

import keras libraries

In [ ]:
```
import keras
```

Importing ImageDataGenerator from Keras

In [ ]:
```
from matplotlib import pyplot as plt
from keras.preprocessing.image import ImageDataGenerator
```

Defining the Parameters

In [ ]:
```
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)
```

Applying ImageDataGenerator functionality to train dataset

In [ ]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

In [ ]:
```
x_train=train_datagen.flow_from_directory('/content/drive/MyDrive/drive/dataset/Dataset/Dataset/train_set',target_size=(128,128),batch_size=32,class_m
```

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

Applying ImageDataGenerator functionality to test dataset

In [ ]:
```
x_test=test_datagen.flow_from_directory('/content/drive/MyDrive/drive/dataset/Dataset/Dataset/test_set',target_size=(128,128),batch_size=32,class_mode
```

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

Importing Model Building Libraries

In [10]:
```
#to define the linear Initialisation import sequential
from keras.models import Sequential
#to add layers import Dense
from keras.layers import Dense
#to create Convolutional 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')
```

```
[40]              metrics = ["accuracy"])

[41] r = model.fit(train_dataset, epochs = 5, validation_data = test_dataset)

     Epoch 1/5
     14/14 [==============================] - 23s 2s/step - loss: 0.5283 - accuracy: 0.7294 - val_loss: 0.1872 - val_accuracy: 0.9421
     Epoch 2/5
     14/14 [==============================] - 22s 2s/step - loss: 0.2845 - accuracy: 0.8647 - val_loss: 0.2339 - val_accuracy: 0.8926
     Epoch 3/5
     14/14 [==============================] - 23s 2s/step - loss: 0.1698 - accuracy: 0.9358 - val_loss: 0.0300 - val_accuracy: 1.0000
     Epoch 4/5
     14/14 [==============================] - 21s 1s/step - loss: 0.1655 - accuracy: 0.9404 - val_loss: 0.0394 - val_accuracy: 1.0000
     Epoch 5/5
     14/14 [==============================] - 22s 2s/step - loss: 0.1604 - accuracy: 0.9266 - val_loss: 0.0275 - val_accuracy: 1.0000

[42] predictions = model.predict(test_dataset)
     predictions = np.round(predictions)

     4/4 [==============================] - 5s 1s/step

[43] predictions
           [1.],
           [1.],
```

```
[33] 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)

[34] train_dataset = train.flow_from_directory("/content/drive/MyDrive/drive/dataset/Dataset/Dataset/train_set",
                                               target_size=(128,128),
                                               batch_size = 32,
                                               class_mode = 'binary')

     Found 436 images belonging to 2 classes.

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

     Found 121 images belonging to 2 classes.
```

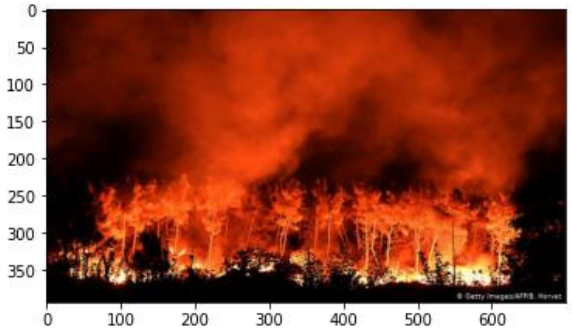
8.Testing

8.1.Test case

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

9. RESULTS

```
#import load model from keras.model
from keras.models import load_model
#import image from keras
from tensorflow.keras.preprocessing import image
import numpy as np
#import cv2
import cv2
#load the saved model
model=load_model('forest.h5')
img=image.load_img('/content/drive/MyDrive/drive/dataset/Dataset/Dataset/test_set/with fire/19464620_401.jpg')
x=image.img_to_array(img)
plt.imshow(img)
plt.show()
res=cv2.resize(x,dsize=(128,128),interpolation=cv2.INTER_CUBIC)
#expand the image shape
x=np.expand_dims(res,axis=0)
```



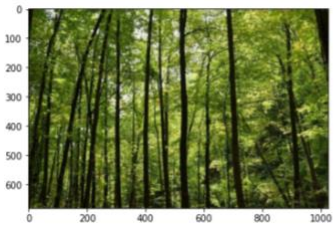

```
if pred==0:
  print('Forest fire')
  from twilio.rest import Client
  print('Forest fire')
  print("Fire detected")
  print("SMS Sent!")
elif pred==1:
  print('No Fire')
```

```
Forest fire
Forest fire
Fire detected
SMS Sent!
```

Predictions

In [19]:

```
#import load model from keras.model
from keras.models import load_model
#import image from keras
from tensorflow.keras.preprocessing import image
import numpy as np
#import cv2
import cv2
#load the saved model
model=load_model('forest.h5')
img=image.load_img('/content/drive/MyDrive/drive/dataset/Dataset/Dataset/test_set/forest/0.48007200_1530881924_final_forest.jpg')
x=image.img_to_array(img)
plt.imshow(img)
plt.show()
res=cv2.resize(x,dsize=(128,128),interpolation=cv2.INTER_CUBIC)
#expand the image shape
x=np.expand_dims(res,axis=0)
```




```
if pred==1:
  print('Forest fire')
  from twilio.rest import Client
  print('Forest fire')
  account_sid='ACd09c7dfa19678968748378895 3bc13024c09a'
  auth_token='e9b6b25a77c65fg33643746ge0ba0b755'
  client=Client(account_sid,auth_token)
  message=client.messages \
  .create(
      body='forest fire is detected,stay alert',
      #use twilio free number
      from_='+16075363954',
      #to number
      to='+917639764251')
  print(message.sid)
  print("Fire detected")
  print("SMS Sent!")
elif pred==0:
  print('No Fire')
```

```
No Fire
```

9.1 Performance Metrics

10. ADVANTAGES & DISADVANTAGES

Advantages

Fire clears out plants and trees to make more natural resources available to the habitat. Fewer trees mean more water becomes available for the remaining plants and animals that call the area their home. New grass and shrubs are food sources for a number of animals as well. A ground cover that comes back after a fire becomes a new micro-habitat. Everything is refreshed with a fire. The proposed system detects the forest fire at a faster rate compared to existing system. It has enhanced data collection feature. The major aspect is that it reduces false alarm and also has accuracy due to various sensors present. It minimizes the human effort as it works automatically. This is very affordable due to which can be easily accessed. The main objective of our project is to receive an alert message through an app to the respective user.

Disadvantages

The electrical interference diminishes the effectiveness of radio receiver. The main drawback is that it has less coverage range areas. Forest fires clear the underbrush away and encourage new growth, but there is a period of time between the fire and the new growth where the forest is vulnerable.

11. CONCLUSION

This type of system is the first of its kind to ensure no further damage is then to forests when there is fire breakout and immediately a message is sent to the user through the App. Immediate response or early warning to a fire breakout is mostly the only ways to avoid losses and environmental, cultural heritage damages to a great extent. Therefore the most important goals in fire surveillance are quick and reliable detection of fire. It is so much easier to suppress fire while it is in its early stages. Information about progress of fire is highly valuable for managing fire during all its stages. Based on this information the fire fighting staff can be guided on target to block fire before it reaches cultural heritage sites and to suppress it quickly by utilizing required fire fighting equipment and vehicles.

With further research and innovation, this project can be implemented in various forest areas so that we can save our forests and maintain great environment.

12. FUTURE SCOPE

This project is far from complete and there is a lot of room for improvement. Some of the improvements that can be made to this project are as follows:

- Additional pump can be added so that it automatically sends water when there is a fire breakout. Also industrial sensors can be used for better ranging and accuracy.
- This project has endless potential and can always be enhanced to become better. Implementing this concept in the real world will benefit several industries and reduce the workload on many workers, enhancing overall work efficiency.

DEMO LINK

https://www.youtube.com/watch?v=Nm8l8EYPhbg