SRI VENKATESWARA COLLEGE OF ENGINEERING

EMERGING METHODS OF EARLY DETECTION OF FOREST FIRES

TEAM ID: PNT2022TMID53546

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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S.NO	TABLE OF CONTENT

1.INTRODUCTION

1.1.PROJECT OVERVIEW

It is difficult to predict and detect forest fires in sparsely populated forest areas and it is more difficult when the prediction is done using ground-based models like cameras. Satellites can be an important source of data prior to and also during the fire due to their reliability and efficiency.The various real time forest fire detection and prediction approaches, results in the goal of informing the local fire authorities.

1.2.PURPOSE:

To detect the forest fire in the early stage.For the early detection of forest fire, the proposed model has an image recognition system method based on Deep learning model.

2.LITERATURE SURVEY

2.1.EXISTING METHOD:

S.NO	TITLE	AUTHOR
1	Video smoke based on accumulation and main motion orientation. Journal of image and graphics (Block motion algorithm)	Yuan F N, Zhang Y M, Liu S X.

- In this paper,smoke detection for the integration of features,they used a SVM(support vector machine),which classifies smoke and non-smoke pixels.
- There is variation in uneven density distribution and smoke contour irregularity in graph and system.

S.NO	TITLE	AUTHOR
2	Motion accumulation and translucence based model for video smoke detection. Journal of Data Acquisition and Processing.	Yuan F.

- In this used texture, the feature for smoke detection and it is based on GLCM (gray level cooccurence). The neural network is utilized to classify smoke and non-smoke pixels.
- There is no disadvantages because this algorithm is good and efficient to find the smoke.

S.NO	TITLE	AUTHOR
3	Autonomous Forest Fire Detection. Proc. Third Int'l Conf. Forest Fire (B&W Saptio temporal algorithm)	E.Den Breejen et al..

- In this paper the algorithm uses human judgement for updating the decision. It's four subalgorithms uses adaptive background subtraction to detect slowmoving objects, use of YUV color space for gray as a smoke color.
- In some situation human errors take place and in conclusion there are no other disadvantages.

S.NO	TITLE	AUTHOR
4	An early fire detection method based on image processing (Early fire-detection algorithm)	Chen, T.H., Wu,P.H. and Chiou, Y.C.

- This paper presents an early fire-alarm raising method based on video processing. The basic idea of the proposed fire-detection is to adopt a RGB (red,green,blue) model based chromatic and disorder measurement for extracting firepixels and smokepixels.
- The main disadvantage is the decision function of fire-pixels is mainly deduced by the intensity and saturation of R component.

S.NO	TITLE	AUTHOR
5	A fire-alarming method based on video processing. Proceeding of 2006 International	Huang, P.H., Su, J.Y. and Lu, Z.M.

	Conference on Intelligent Information Hiding and Multimedia Signal Processing, Pasadena. (Fire alarming algorithm based on RGB colour)	

- In this paper they used wavelet decomposition and optical flow method for smoke detection of wildfires. The algorithm is usefull for extracting many smoke features.
- In this paper, the main drawback is high computational cost.

2.2.REFERENCES:

1.Early detection of forest fire using deep learning.
https://ieeexplore.ieee.org/document/9293722

2.Deep Learning Applied Forest fire Detection.
https://ieeexplore.ieee.org/document/9408859

3.A Real-time Forest Fire Smoke detection System Using Deep Learning.
https://ijnaa.semnan.ac.ir/article_5899.html

4.Fire Detection Using Deep Learning.
https://journals.grdpublications.com/index.php/ijprse/article/view/141

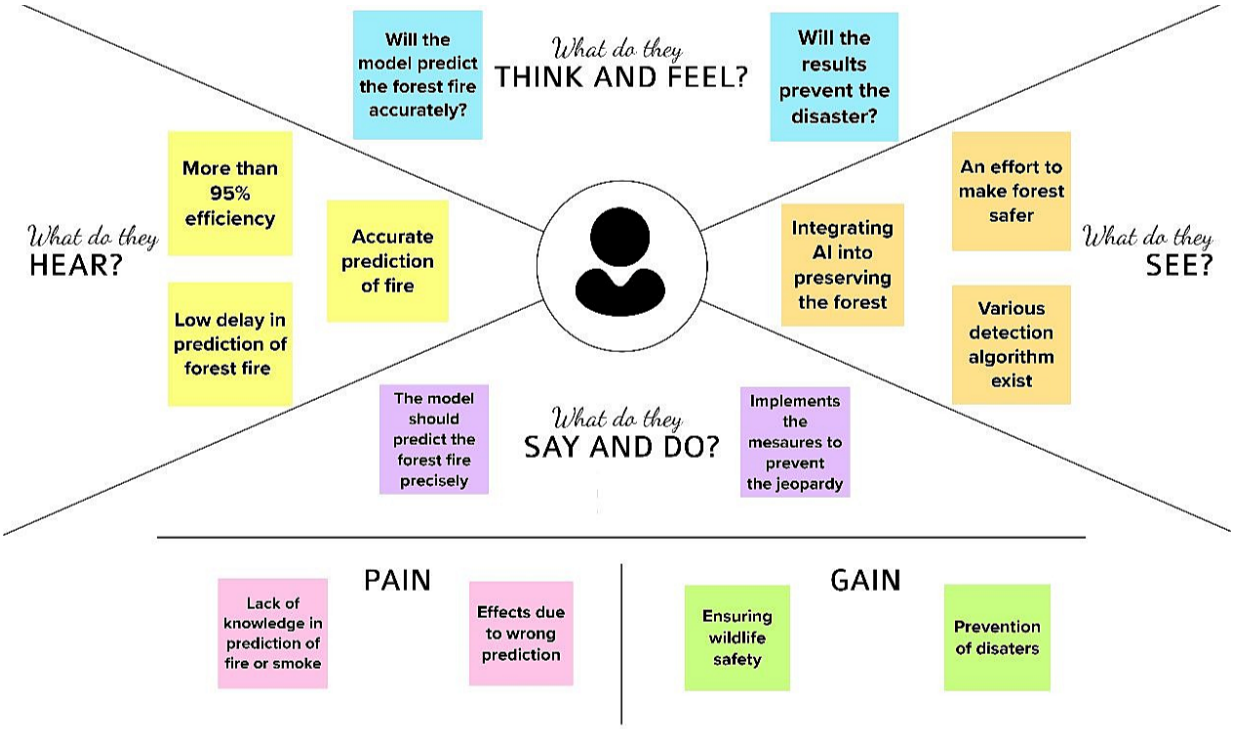
2.3.PROBLEM STATEMENT DEFINITION

Forest fires is a wide spread and critical factor in the earth's ecosystem. The most effective and vital solution is early detection fires to preserve natural resources and to protect living creatures.

Who does the problem affect?	People living in the forest.
When does the issue occurs?	When there is a climate change in the environment .
Where is the issue occurring?	The issue occurs when there is a difficulty to identify the forest fires.
What is the issue?	Forest fires are a major environmental issue,creating economic and ecological damage while endangering human lives.
Why is it important that we fix the problem?	By solving these issues,it can reduce the forest fire in the beginning stage,by alerting user and can save the ecosystem and human lives.

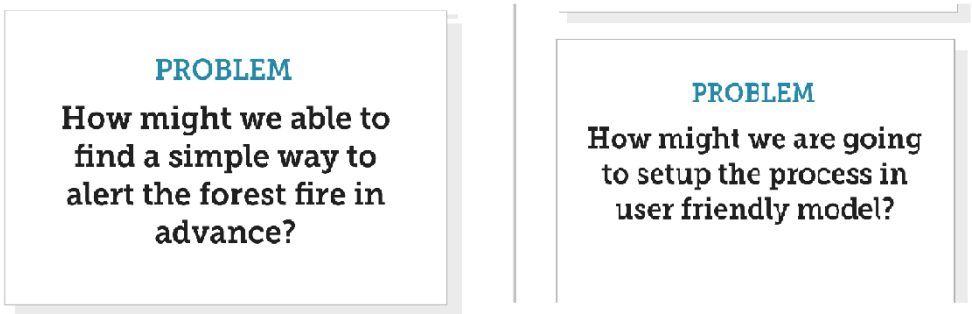
3.IDEATION & PROPOSED SOLUTION

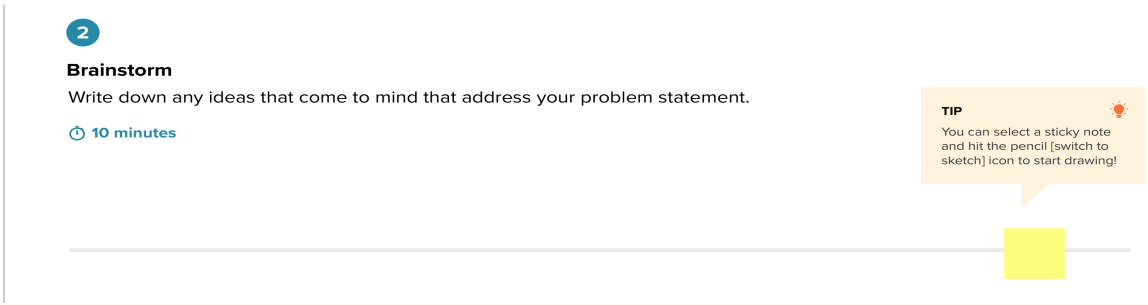
3.1.EMPATHY MAP CANVAS



3.2.IDEATION & BRAINSTORMING :

Problem Statements:





AANANT V

Used in real time prediction
High efficient algorithm
Input image analysis
More detailing about the algorithm and it's usage

CHARAN M

Accurate Prediction
Deployment of Artificial Intelligence
User friendly interface
Image data generation

GUHANESWAR S

Dynamic texter classification algorithm
Computer based fire detection
Video smoke and fire detection
Adaptive background subtraction

HARISHKUMAR GK

Input image analysis
Fractal encoding ideas to extract smoke region
Usage of ALEX-NET model and INCEPTION V3 model
Implementation of CNN

TOP 3 IDEAS

Implementation of CNN
Deployment of Artificial Intelligence
Video smoke and fire detection

3.3.PROPOSED SOLUTION:

Project Design Phase-I
Proposed Solution

Date	26 September 2022
Team ID	PNT2022TMID53546
Project Name	Emerging methods for early detection of forest fires.
Team Leader	V.Aanant
Team Mates	M.Charan , S.Guhaneshwar , G.K.Harish Kumar
Maximum Marks	2 Marks

Proposed Solution Template:

Project team shall fill the following information in the proposed solution template.

S.No.	Parameter	Description
1.	**Problem Statement (Problem to be solved)**	AI based Emerging methods for early detection of forest fires
2.	**Idea / Solution description**	Although progress has been made in the field of wildfire fighting in the last decades, there is still a need to strengthen the disaster response capacity, including early warning systems and improvements in real time exchange of data at all stages and levels of a forest monitoring scheme. Technological breakthroughs will be a key force driving change in wildland fire fighting.
3.	**Novelty / Uniqueness**	• Using real-time satellite data to detect and monitor forest fires (sending alerts to mobile devices), and understand fire patterns. • Low latency • This model is exclusively designed in such a way that even if a slight fire triggering factor is found the model detects it and informs the individual,which is way more efficient and safer.

4.	**Social Impact / Customer Satisfaction**	By detecting a fire quickly and accurately (i.e., by not sacrificing speed or causing false alarms) and providing early warning notification, a fire-detection system can limit the emission of toxic products created by combustion, as well as global-warming gasses produced by the fire itself. Detection and alarm systems are an important part of your overall fire protection process. Discovering fires early contributes to protecting wildlife , limiting ecosystem damage and prevents loss of flora and fauna .
5.	**Business Model (Revenue Model)**	The annual losses from forest fires in India for the entire country have been moderately estimated at Rs 440 crores (USS 107 million).To counter this , we use artificial intelligence based CNN model . The primary source of revenue for CNN is subscription fees. The revenue from subscription fees accounts for 50 per cent of its total revenue, whereas the other 50 per cent is held by advertising and ancillary revenue streams. Revenue model comprising subscriber and advertiser fees form the backbone of CNN

6.	**Scalability of the Solution**	Millions of hectares of forest are destroyed by fire every year. Areas destroyed by these fires are large and produce more carbon monoxide than the automobiles. Monitoring the potential risk areas and an early detection of fire can significantly shorten the reaction time and also reduce the potential damage as well as the cost of fire fighting. Its geographically scalable system keeps its usability and usefulness intact, regardless of the physical distance of resources and users.

4.REQUIREMENT ANALYSIS

4.1.FUNCTIONAL REQUIREMENTS:

FR No.	FunctionalRequirement(Epic)	SubRequirement(Story/Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN

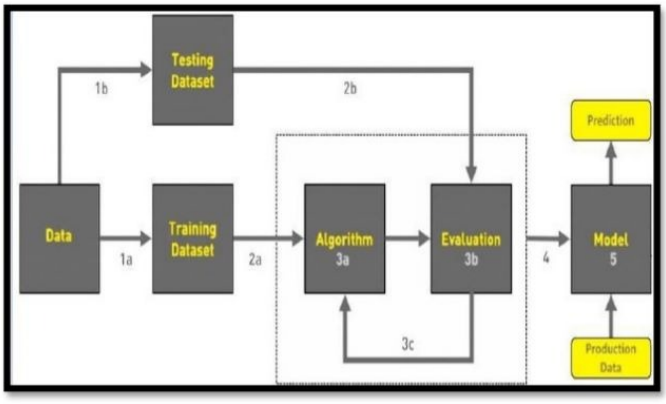
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Image recognition	The system shall be able to take real inputs of satellites images and determine whether image contains fire or not.
FR-4	Forest Monitoring	Forest are monitored 24/7 through
FR-5	Alert	The system will send notification to the user when fire is detected
FR-6	Detection	The system shall take training sets of fire and checks for fire or no fire or smoke
FR-7	Operating system	The system can run as a service on Windows .

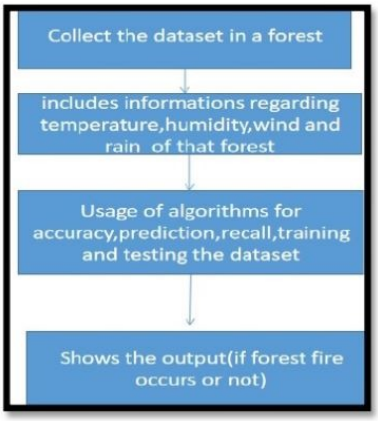
4.2.NON-FUNCTIONAL REQUIREMENTS

FR No.	**Non-FunctionalRequirement**	**Description**
NFR-1	**Usability**	Model is user friendly to use and very effective.
NFR-2	**Security**	More secure environment.
NFR-3	**Reliability**	Model is safe to install.
NFR-4	**Performance**	Model will achieve high accuracy.
NFR-5	**Availability**	Build model is available in all thetime
NFR-6	**Scalability**	Model can handle large amount of data and can easily adapt to every environment.
NFR-7	**Testability**	Putting in more training data into the model can Improve the accuracy level of the system.

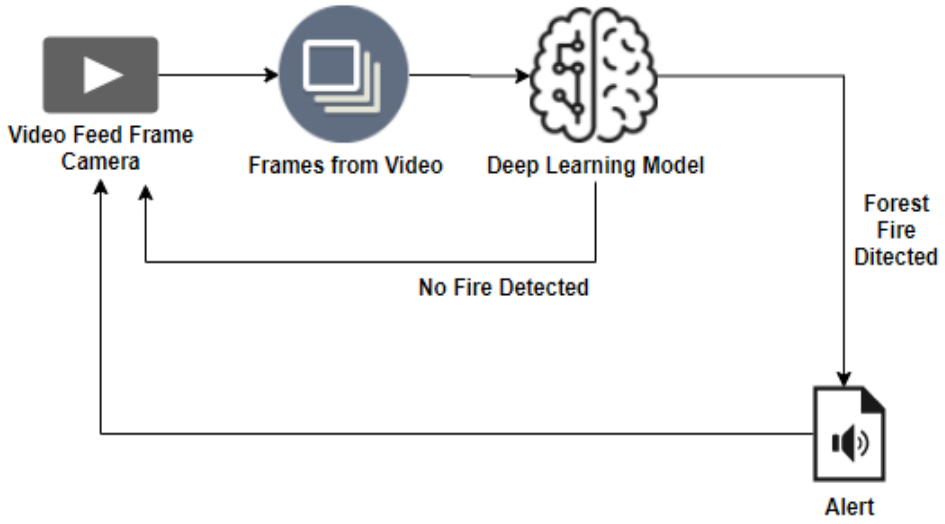
5.PROJECT DESIGN

5.1.DATA FLOW DIAGRAMS





5.2.SOLUTION AND TECHNICAL ARCHITECTURE



5.3.USER STORIES:

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 image feed frame camera.	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 algorithm	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 the accuracy of algorithm.	USN-5	Identify accuracy, precision, recall of each algorithm	These values are important for obtaining the right output	High	Sprint-3
	Display unit.	USN-6	Outputs from each algorithm are obtained	It is highly used to predict the effect and to take precautionary measures	High	Sprint-4

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	Download data set	USN-1	The data is downloaded from the Kaggle website and then the data set is classified into training and testing images.	10	High	All members
Sprint-1	Image pre-processing	USN-1	In Image processing technique the first step is usually importing the libraries that will be needed in the program. Import Keras library from that library and import the ImageDataGenerator Library to the Python script. The next step is definig the arguments for the ImageDataGenerator . Here 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. The next step is applying the ImageDataGenerator arguments to the train and test dataset.	10	High	All members

Sprint-2	Training image	USN-2	In this training phase the ImageDataGeneratorarguments is applied to the training images and the model is tested with several images and the model is saved.	20	High	All members
Sprint-3	Testing image	USN-3	In this testing phase the Image processing techniques is applied to the testing images and executed for prediction.	20	High	All members
Sprint-4	Evaluation metrics and accuracy	USN-4	In this phase the result, prediction, accuracy, and performance of the model are tested.		High	All members

MILESTONE & ACTIVITY LIST:

MILESTONE LIST

Milestone Name	Milestone Number	Description	Mandatory	
Project Objectives	M-01	We will be able to learn to prepare dataset, image processing, working with CNN layers, read images using OpenCV and CNN for computer vision AI	Yes	-
Project Flow	M-02	A project management process flowchart is a graphical aid, designed to visualize the sequence of steps to be followed throughout the project management process	Yes	
Pre-Requisites	M-03	To complete this project, we should have known following project such as Keras, TensorFlow, Python ,Anaconda, OpenCV, Flask, Scikit-learn etc.…	Yes	
Prior Knowledge	M-04	One should have knowledge on the Supervised Learning ,CNN and Regression Classification and Clustering, ANN	Yes	
Data collection	M-05	We can collect dataset from different open sources like kaggle.com, UCI machine learning etc.	Yes	
Image Preprocessing	M-06	Importing the ImageDataGenerator libraries, Define Parameters/Arguments for ImageDataGenerator class, Applying Image Data Generator Functionality to trainset and test set	Yes	
Model Building	M-07	Importing the model building libraries, Initializing the model, Adding CNN layers, Adding Dense layers, Configuring the learning Process, Train the model, Save the model, Predictions.	Yes	
Video Analysis	M-08	Opencv for video processing, creating an account in twilio service and sending alert message	Yes	
Train CNN model	M-09	Register for IBM Cloud and train Image Classification Model	Yes	
Ideation Phase	M-10	Prepare Literature Survey on the selected Project and Information Gathering, empathy map and ideation	Yes	
Project Design Phase-I	M-11	Prepare Proposed solution , problem-solution fit and Solution Architecture	Yes	
Project Design Phase-II	M-12	Prepare Customer journey ,functional requirements, Dataflow diagram and Technology Architecture	Yes	
Project Planning Phase	M-13	Prepare Milestone list , Activity list and Sprint Delivery Plan	Yes	
Project Development Phase	M-14	Project Development delivery of Sprint 1, Sprint 2, Sprint 3, Sprint 4	Yes	

ACTIVITY LIST

Activity Number	Activity	Sub Activity	Assigned To	Status
1.	PROJECT OBJECTIVES		All Members	Completed
2.	PROJECT FLOW		All Members	Completed
3.	PRE-REQUISITES		All Members	Completed
4.	DATA COLLECTION	4.1 Download the Dataset	All Members	Completed
5.	IMAGE PREPROCESSING	5.1 Import the ImageDataGenerator Library. 5.2 Define the Parameters/Arguments for ImageDataGenerator class. 5.3 Applying ImageDataGenerator Functionality to trainset and testset.	All Members	Completed
6.	MODEL BUILDING	6.1 Importing the model building libraries. 6.2 Initializing the model. 6.3 Adding CNN layers. 6.4 Adding dense layers. 6.5 Configuring the learning process. 6.6 Training the model. 6.7 Saving the model. 6.8 Predictions.	All members	Completed
7.	VIDEO ANALYSIS	7.1 OpenCV for video processing. 7.2 Creating an account in Twilio service 7.3 Sending alert message.	All Members	Completed
8.	TRAIN CNN MODEL ON IBM	8.1 Train image classification model. 8.2 Register for IBM cloud.	All Members	Completed
9.	IDEATION PHASE	9.1 Literature Survey. 9.2 Empathy map. 9.3 Ideation.	All Members	Completed
10.	PROJECT DESIGN PHASE – I	10.1 Proposed Solution. 10.2 Problem solution fit. 10.3 Solution Architecture.	All Members	Completed

11.	PROJECT DESIGN PHASE -II	11.1 Customer journey. 11.2 Functional requirement. 11.3 Data flow Diagrams. 11.4 Technology Architecture.	All Members	Completed
12.	PROJECT PLANNING PHASE	12.1 Prepare milestone and activity list. 12.2 Sprint delivery plan.	All Members	Completed
13.	PROJECT DEVELOPMENT PHASE	13.1 Project development-Delivery of Sprint-1. 13.2 Project development-Delivery of Sprint-2. 13.3 Project development-Delivery of Sprint-3. 13.4 Project development-Delivery of Sprint-4.	All Members	Completed

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 & SOLUTIONING

1.IMAGE DATA GENERATOR:

Keras ImageDataGenerator is used for getting the input of the original data and further, it makes the transformation of this data on a random basis and gives the output resultant containing only the data that is newly transformed. It does not add the data.

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

2.PARAMETERS

2.1.Rescale:

The ImageDataGenerator class can be used to rescale pixel values from the range of 0-255 to the range 0-1 preferred for neural network models. Scaling data to the range of 0-1 is traditionally referred to as normalization.

2.2.Shear Range:

Shear range means that the image will be distorted along an axis, mostly to create or rectify the perception angles. It's usually used to augment images so that computers can see how humans see things from different angles.

2.3.Rotation range:

ImageDataGenerator class allows you to randomly rotate images through any degree between 0 and 360 by providing an integer value in the rotation_range argument. When the image is rotated, some pixels will move outside the image and

leave an empty area that needs to be filled in.

2.4.Zoom Range:

The zoom augmentation method is used to zooming the image. This method randomly zooms the image either by zooming in or it adds some pixels aroundthe image to enlarge the image. This method uses the zoom_range argument of the ImageDataGenerator class. It can specify the percentage value of the zooms either in a float**,** range in the form of an array.

2.5.Horizontal Flip:

Horizontal flip basically flips both rows and columns horizontally. So for this, It have to pass the horizontal_flip=True argument in the ImageDataGenerator constructor.

3.CONVOLUTION NEURAL NETWORK:

A CNN is a kind of network architecture for deep learning algorithms and is specifically used for image recognition and tasks that involve the processing of pixel data. There are other types of neural networks in deep learning, but for identifying and recognizing objects, CNNs are the network architecture of choice. The layers used in the CNN is Convolutional ,maxpooling, and flatten layer.

3.1.Convolutional Layer:

A convolutional layer is the main building block of a CNN. It contains a set of filters (or kernels), parameters of which are to be learned throughout the training. The size of the filters is usually smaller than the actual image. Each filter convolves with the image

Convolution layer is used for a image processing to blur and sharpen images, but also to perform other operations.

```
from keras.layers import Convolution2D
```

3.2.Maxpooling Layer:

Max pooling is a pooling operation that selects the maximum element from the region of the feature map covered by the filter.

```
from keras.layers import MaxPooling2D
```

3.3.Flatten Layer:

Flattening is used to convert all the resultant 2-Dimensional arrays from pooled feature maps into a single long continuous linear vector. The flattened matrix is fed as input to the fully connected layer to classify the image.

```
from keras.layers import Flatten
```

4.DENSE LAYER:

Dense Layer is used to classify image based on output from convolutional layers.

8.TESTING

Purpose of Document:

The purpose of this document is to briefly explain the test coverage and open issues of the [Early detection of forest fire using Deep Learning] project at the time of the release to User Acceptance Testing (UAT).

Defect Analysis:

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

Resolution	Severity1	Severity2	Severity3	Severity4	Subtotal
By Design	5	1	1	1	8
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	7	2	4	10	23
Not Reproduced	0	0	0	0	0

Skipped	0	0	1	1	2
Won'tFix	0	3	2	1	6
Totals	15	9	11	14	49

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	5	0	0	5
Client Application	30	0	0	30
Security	2	0	0	2
Out source 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

9.1.PERFORMANCE METRICS:

S.No.	Parameter	Values
1.	Model Summary	As a threat of forest fire increases due to climate changes, the need for finding a detection system increases .The proposed Deep Learning-based model to predict early detection of forest fire. The Proposed model successfully classifies the images into fire and no fire, and sends an alert messages in case of fire. Thus, the Deep Learning algorithms proved their efficiency in detecting different objects.
2.	Accuracy	Training Accuracy - 98% Validation Accuracy - 95%

10.ADVANTAGES & DISADVANTAGES

ADVANTAGES:

1.Ability to cover areas at different altitudes and locations.

2.The results is quite accurate with the accuracy upto 95% .

3.Reliability - The model is very effective, inexpensive and easy to apply.

4.The model, it shows the 'fire' and 'no fire' images classified with high accuracy.

5.Video analysis of this model leads to low degree of misjudgment of fire detection.

DISADVANTAGES:

1.Individual learner is responsible for learning global information to avoid false

positives.
2.The limited learning and perception ability of individual learners is not sufficient to make them perform well in complex tasks.
3.Proper connectivity and maintenance will be a complex task.

11.CONCLUSION

As a threat of forest fire increases due to climate changes, the need for finding a detection system increase .The proposed Deep Learning-based model to predict the early detection of forest fire. The Proposed model successfully classifies the images into fire and no fire, and sends an alert messages in case of fire. Thus, the Deep Learning algorithm proved their efficiency in detecting the forest fire.

12.FUTURE SCOPE

1. Integrate live satellite data and process real time processing of the fires.
2. Enchance the time complexity of the detection of forest fires to improve the speed.
3. These accidents can be controlled to a greater extend.
4. Forest fire leads to destruction of excess of species, by using this technique it will save the life and environment.

13.APPENDIX

SOURCE CODE:

Our project source code link:

https://github.com/IBM-EPBL/IBM-Project-11128-1659269381/tree/main/Final%20Deliverables/Final%20Code

Our Github link:

https://github.com/IBM-EPBL/IBM-Project-11128-1659269381

DEMO VIDEO:

Demo video link:

https://github.com/IBM-EPBL/IBM-Project-11128-1659269381/blob/main/Final%20Deliverables/Project%20Demo/forest%20fire%20demo%20link.txt