EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

A PROJECT REPORT

Submitted by

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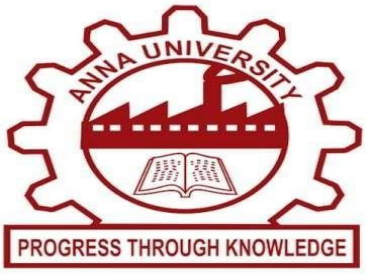
TEAM ID :PNT2022TMID52078

BACHELOR OF ENGINEERING *IN*

COMPUTER SCIENCE AND

ENGINEERING



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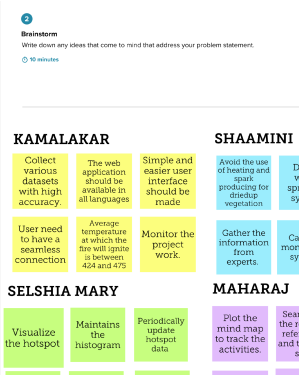
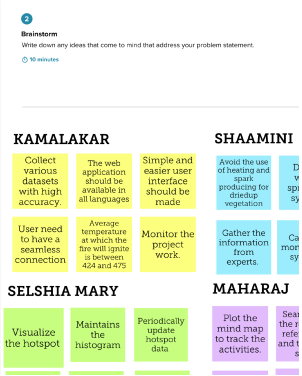
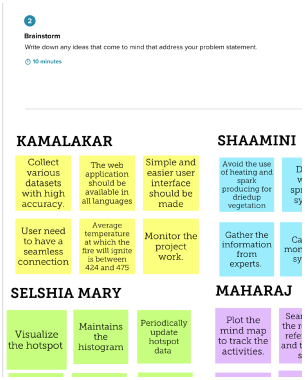






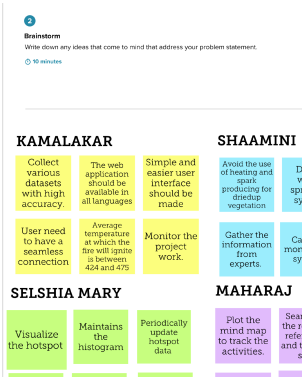
1.INTRODUCTION

1.1.PROJECT OVERVIEW

It is difficult to predict and detect forest firesin sparsely populated forest areas and it is more difficult if 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, with the goal of informing the local fire authorities.

1.2.PURPOSE:

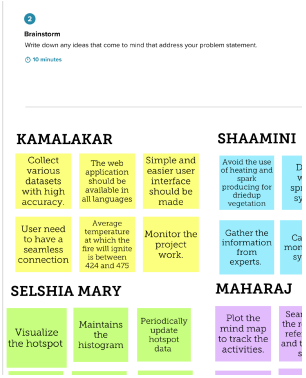
To detect the forest fire in the early stage.For the early detection of forest fire, we proposed an image recognition system method based on Deep learning model.



2.LITERATURE SURVEY

2.1.EXISTING METHOD:

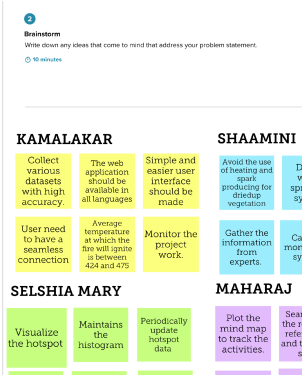
S.NO	AUTHOR	TITLE	NAME OF JOURNAL



1.	Medi RahuL, Karnekanti Shiva, SakethAttiliSanjeet and Nenavath Srinivas Naik.	Early Detection of Forest fire using Deep Learning.	2020.IEEE REGION10 Conference(TENCON),2020,pp. 11361140,doi:10.1109/tencon 50793.2020.9293722.

- The system involves pre-processing the image data and applying data augmentation such as shearing, flipping, etc.
- It uses models like VGG16 , ResNet50 , and DenseNet121 for the classification of images.
- The model initially divides the train and test sets in 80% and 20% and then sent to the pre-processing phase, where finally it is trained to classify them into two classes fire and non-fire.
- By using the optimal learning rate the proposed model was able to achieve a training set accuracy of 92.7% and an est set accuracy of 82.57%.

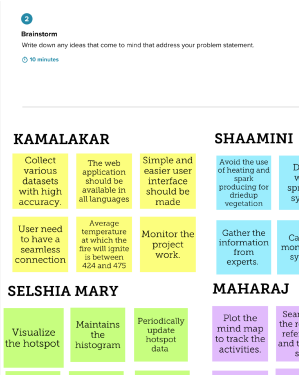
S.NO	**AUTHOR**	**TITLE**	**NAME OF JOURNAL**
2.	Byron Arteaga, Mauricio Diaz, Mario jajoa, University of Naino Pasto Columbia .	Deep Learning Applied forest Fire Detection.	2020 IEEE International Symposium on signal processing and information Technology(ISSPIT),2020,pp, 16,doi:10,1109/ISSPIT51521. 2020.9408859.



- The data processing was done through open source programming language Python, the cloud service Googlecollab, and deep learning algorithms using Pytorch's library.
- After the data augmentation and pre-processingof the training image, three types of transformation takes place cropping of the image, rotating of an image, and normalizing of the image.
- The classification of images is done by using the pre-trained models of ResNet and VGG pre-trained models.
- To validate the performance of each pre-trained model the k-fold method is used.
- The model obtained during the validationis sent to Raspberry to test its functionality.

S.NO	AUTHOR	TITLE	NAME OF JOURNAL
3.	Raghad k. Mohammed(Department of Basic sciences,college of Density, University Baghdad,Baghdad,Iraq).	A Real-time forest fire and Smoke detection System Using Deep Learning.	International Journal of Nonlinear Analysis and Application 13.1(2022):2053-2063.

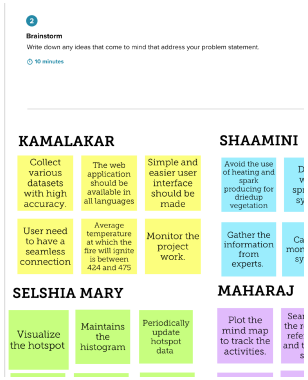
- The proposed framework aims to detect smoke and fire based on the images received from the video stream from the Raspberry Pi
- Pre-processing of image data.
- Image data augmentation (Scale, horizontal flip, and vertical flip).
- Pre-trainingng model imagenet dataset ->{inception-ResNet-V2}.



- By fine-tuning the above two steps we have to send that to the fully connected layer with softmax.
- we can view the model accuracy as instead.

S.NO	AUTHOR	TITLE	NAME OF JOURNAL
4.	Suhas.G ,Chetan Kumar,Abhishek.B.S, Digvijay Gowda.K.A, Prajwal.R . student of Department of Computer Science and Engineering, Maharaja Institute of Technology Mysore, Karnataka,India	Fire DetectionUsing Deep Learning.	International Journal of Progressive Research in ScienceAnd Engineeering Volume-1,Issue-5,August-2020.

- The model is divided into two parts
- a. Data collection and Pre-processing.
- b. Building fire detection model by transfer learning.
- The first step is to gather video frames and it should be divided into two classes fire and non-fire. The collected dataset is divided into train and test sets.
- The second step is to extract the video features of pre-trained models using Keras.
- We have used ResNet-50, Inception V3, and InceptionResNetV2 models to extract the features and various ML algorithms on the extracted features to detect fire in video frames.



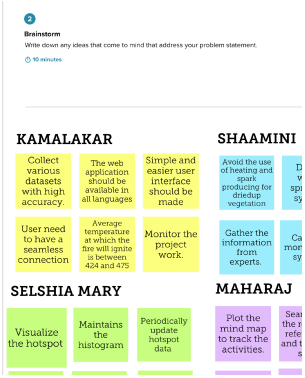
2.2.REFERENCES:

1.Early detection of forest fire - https://ieeexplore.ieee.org/document/9293722 using deep learning.
2.Deep Learning Applied -https://ieeexplore.ieee.org/document/9408859 Forest fire Detection.
3.A Real-time Forest Fire Smoke detection - https://ijnaa.semnan.ac.ir/article_5899.html System Using Deep Learning.
4.Fire Detection Using - https://journals.grdpublications.com/index.php/ijprse/article/view/141 Deep Learning.

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.

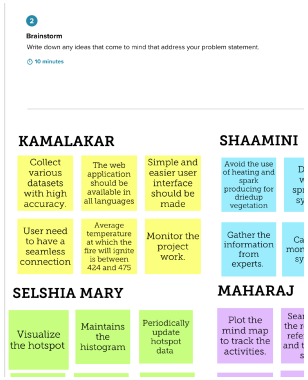
Who does the problem affect?	People living in the forest.
When does the issue occurs?	When there is a climate change in the environment .
Where is the issue occurring?	The issue occurs when there is a difficulty to identify the forest fires.
What is the issue?	Forest fires are a major environmental issue,creating economic and ecological damage while endangering human lives.

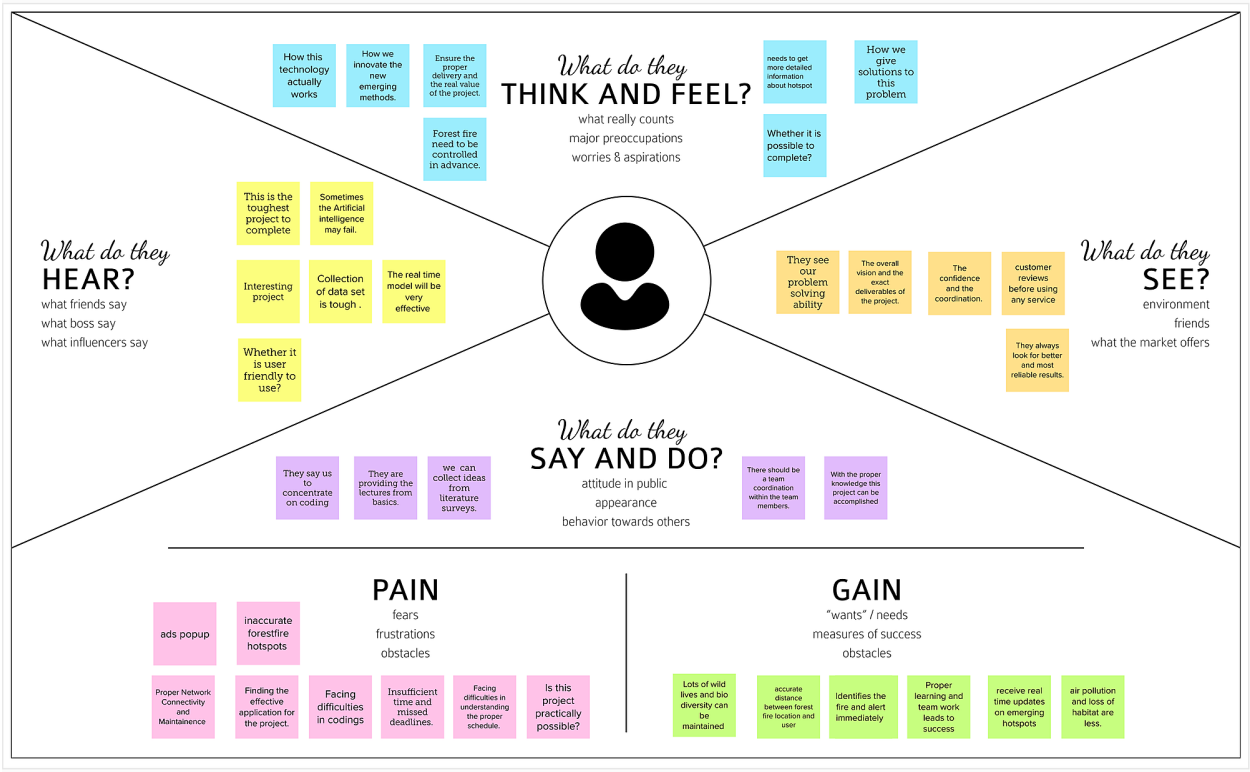


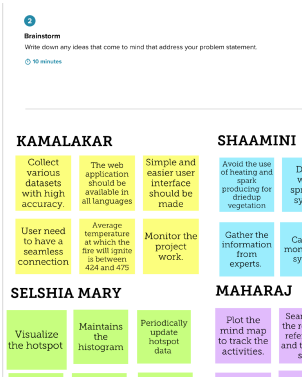
Why is it important that we fix the problem?	By solving these issues,it can reduce the forest fire in the beginning stage,by alerting user and can save the ecosystem and human lives.

3.IDEATION & PROPOSED SOLUTION

3.1.EMPATHY MAP CANVAS

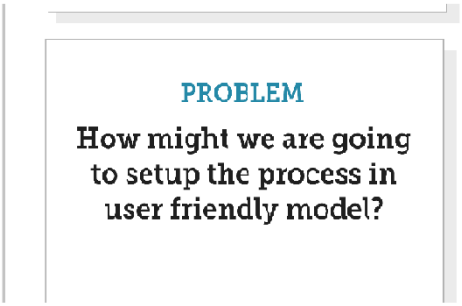

2
Brainstorm
Write down any ideas that come to mind that address your problem statement.
10 minutes
KAMALAKAR
Collect various datasets with high accuracy.
The web application should be available in all languages
Simple and easier user interface should be made
User need to have a seamless connection
Average temperature at which the fire will ignite is between 424 and 475
Monitor the project work.
SHAAMINI
Avoid the use of heating and spark producing for driedup vegetation
Gather the information from experts.
SELSHIA MARY
Visualize the hotspot
Maintains the histogram
Periodically update hotspot data
MAHARAJ
Plot the mind map to track the activities.

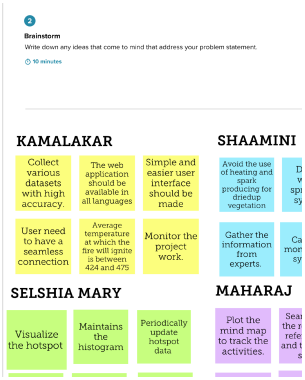

What do they
THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations
How this technology actually works
How we innovate the new emerging methods.
Ensure the proper delivery and the real value of the project.
Forest fire need to be controlled in advance.
needs to get more detailed information about hotspot
How we give solutions to this problem
Whether it is possible to complete?
What do they
HEAR?
what friends say
what boss say
what influencers say
This is the toughest project to complete
Sometimes the Artificial intelligence may fail.
Interesting project
Collection of data set is tough .
The real time model will be very effective
Whether it is user friendly to use?
What do they
SEE?
environment
friends
what the market offers
They see our problem solving ability
The overall vision and the exact deliverables of the project.
The confidence and the coordination.
customer reviews before using any service
They always look for better and most reliable results.
What do they
SAY AND DO?
attitude in public
appearance
behavior towards others
They say us to concentrate on coding
They are providing the lectures from basics.
we can collect ideas from literature surveys.
There should be a team coordination within the team members.
With the proper knowledge this project can be accomplished
PAIN
fears
frustrations
obstacles
ads popup
inaccurate forestfire hotspots
Proper Network Connectivity and Maintainence
Finding the effective application for the project.
Facing difficulties in codings
Insufficient time and missed deadlines.
Facing difficulties in understanding the proper schedule.
Is this project practically possible?
GAIN
"wants" / needs
measures of success
obstacles
Lots of wild lives and bio diversity can be maintained
accurate distance between forest fire location and user
Identifies the fire and alert immediately
Proper learning and team work leads to success
receive real time updates on emerging hotspots
air pollution and loss of habitat are less.



3.2.BRAINSTORMING :

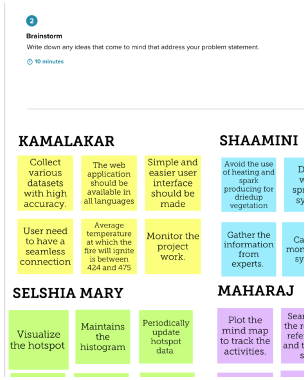
Problem Statements:





Brainstorm:

Group ideas: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Periodically update hotspot data
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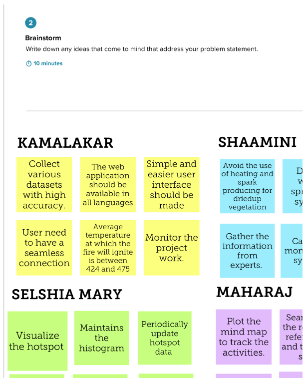
Plot the mind map to track the activities.

themes within your mural.
Collect various datasets with high accuracy.
Alert can be sent via alarm system and messages.
Alerts the user
Track down the monthly activities.
Plot the mind map to track the activities.
Gather the information from experts.
Periodically update hotspot data
Monitor the project work.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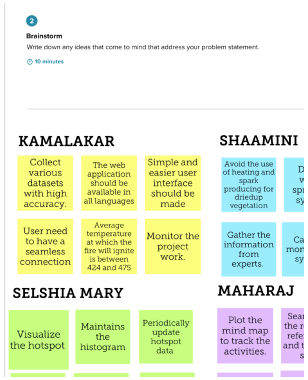
Priortize: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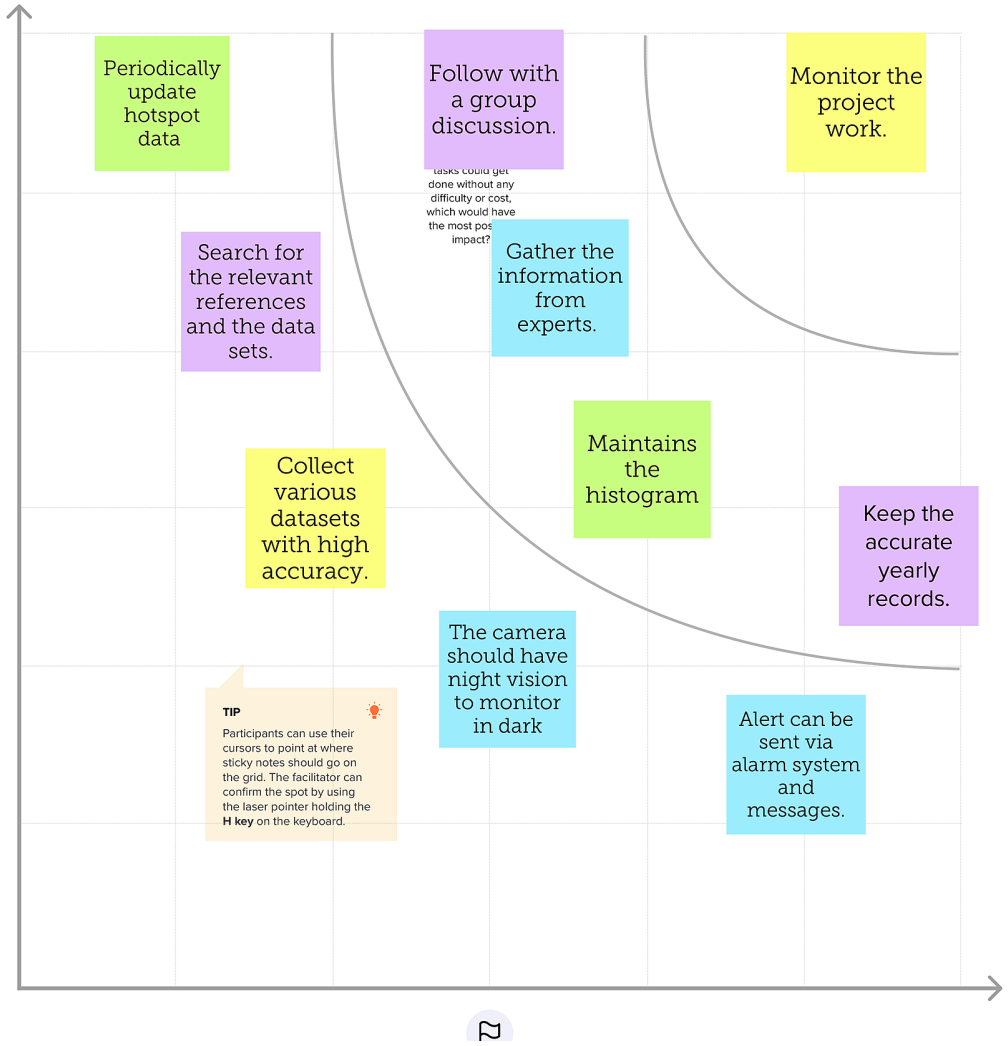
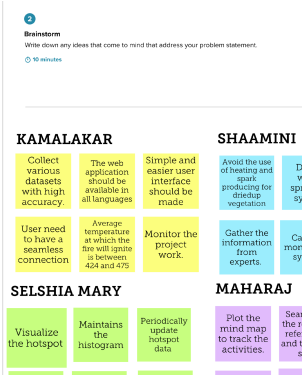
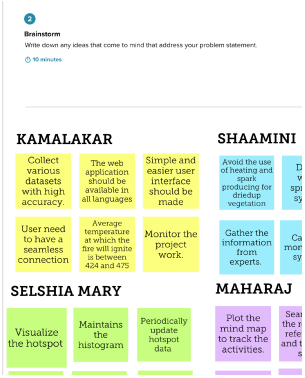

Periodically update hotspot data
Follow with a group discussion.
Monitor the project work.
done without any difficulty or cost, which would have the most pos impact?
Search for the relevant references and the data sets.
Gather the information from experts.
Maintains the histogram
Collect various datasets with high accuracy.
Keep the accurate yearly records.
The camera should have night vision to monitor in dark
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.
Alert can be sent via alarm system and messages.



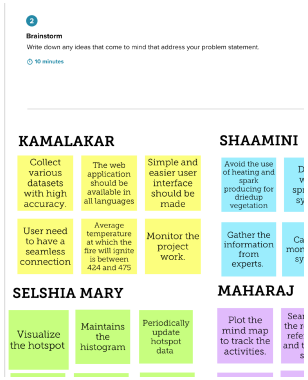
3.3.PROPOSED SOLUTION:

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	1.Forest fires are a major environmental issue, creating economic and ecological damage while endangering human lives. 2.It is difficult to predict and detect Forest Fire in a sparsely populated forest area. 3.So, it is necessary to detect the fire in an early stage to control it.
2.	Idea / Solution description	1.The model will detect forest fires automatically with the help of image processing using deep learning and with the use of satellite image data to observe, detect and report fire events.
3.	Novelty / Uniqueness	When the fire is detected, the station will get a notification via message and an alarm system will be activated automatically to alert the user.
4.	Social Impact / Customer Satisfaction	1.This can reduce the forest fire in the beginning stage, by alerting users. 2.The user can also use this as a surveillance 3.Camera to monitor the forest. Saving the most essential Forest cover.



5.	Business Model (Revenue Model)	1.This application will be available in a subscription-based model. 2.Supply chain, power & supply, Fire stations, and government by providing services.
6.	Scalability of the Solution	1.This application can monitor different places simultaneously and can detect fire accurately 2.This application can handle a large number of users and data simultaneously.

3.4.PROPOSED SOLUTION FIT:



Project Title:Early Detection of forest fire using deep learning **Project Design Phase-I Solution Fit Template** **Team ID:** PNT2022TMID49620

Define CS, fit into CC

1.CUSTOMER SERVICE CS

1.Tribal people and forest department officers living in forest.
2.Animals , birds and other living things in the forest.

6. CUSTOMER CONSTRAINTS CC

1.Solar power cameras can be used as a power source
2.Waterproof cameras.
3.Seamless connection.

5. AVAILABLE SOLUTIONS AS

1.Notification is sent via messages.
2.Fire alarm is activated to nearby stations.

Explore AS, differentiate

Focus on J&P,into BE, understand RC

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

1.Detecting small fire sparks in forest becomes difficult.
2.Camera should always be in motion

9. PROBLEM ROOT CAUSE RC

1.Special analysis system can be used.
2. Wireless mobile network via SIM can be used transfer alert message throughout areas.

7. BEHAVIOUR BE

1.Climate change should be monitored.
2.Hot areas should be monitored clearly.

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

Identify strong TR & EM

3. TRIGGERS TR

1.Correct detection.
2.Alarm alert
3.Follow correct algorithm

4. EMOTIONS: BEFORE / AFTER EM

BEFORE	AFTER
1.Unable to detect small sparks. 2.camera should always be in motion.	1.Able to detect small sparks. 2. 360 view of camera is used.

10. YOUR SOLUTION SL

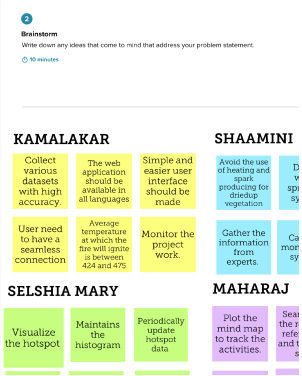
1.Mobile application can be developed for specific areas.
2.Forest can be monitored by several cameras.
3.This can be used in wild life sanctuaries.

8.CHANNELS of BEHAVIOUR CH

ONLINE
Connected direc1tly to the user via Internet.

OFFLINE
Alerts can be sent via Offline messages and an alarm system is activated.

Identify strong TR & EM



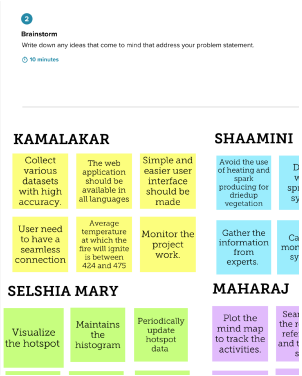
4.REQUIREMENT ANALYSIS

4.1.FUNCTIONAL REQUIREMENTS:

FR No.	FunctionalRequirement(Epic)	SubRequirement(Story/Sub-Task)
FR-1	UserRegistration	RegistrationthroughFormRegistration through Gmail RegistrationthroughLinkedIN
FR-2	UserConfirmation	ConfirmationviaEmail ConfirmationviaOTP
FR-3	Image recognition	The system shall be able to take real inputs of satellitesimagesanddeterminewhether imagecontainsfireornot.
FR-4	ForestMonitoring	Forestaremonitored24/7through
FR-5	Alert	Thesystemwillsend notificationtothe userwhen fireis detected
FR-6	Detection	Thesystem shalltaketrainingsetsoffireandchecks forfire ornofireorsmoke
FR-7	Operatingsystem	Thesystemcanrun as aserviceonWindows orLinuxoperatingsystem.

4.2.NON-FUNCTIONAL REQUIREMENTS

FR No.	Non-FunctionalRequirement	Description
NFR-1	**Usability**	Modelisuserfriendlyto use andveryeffective.

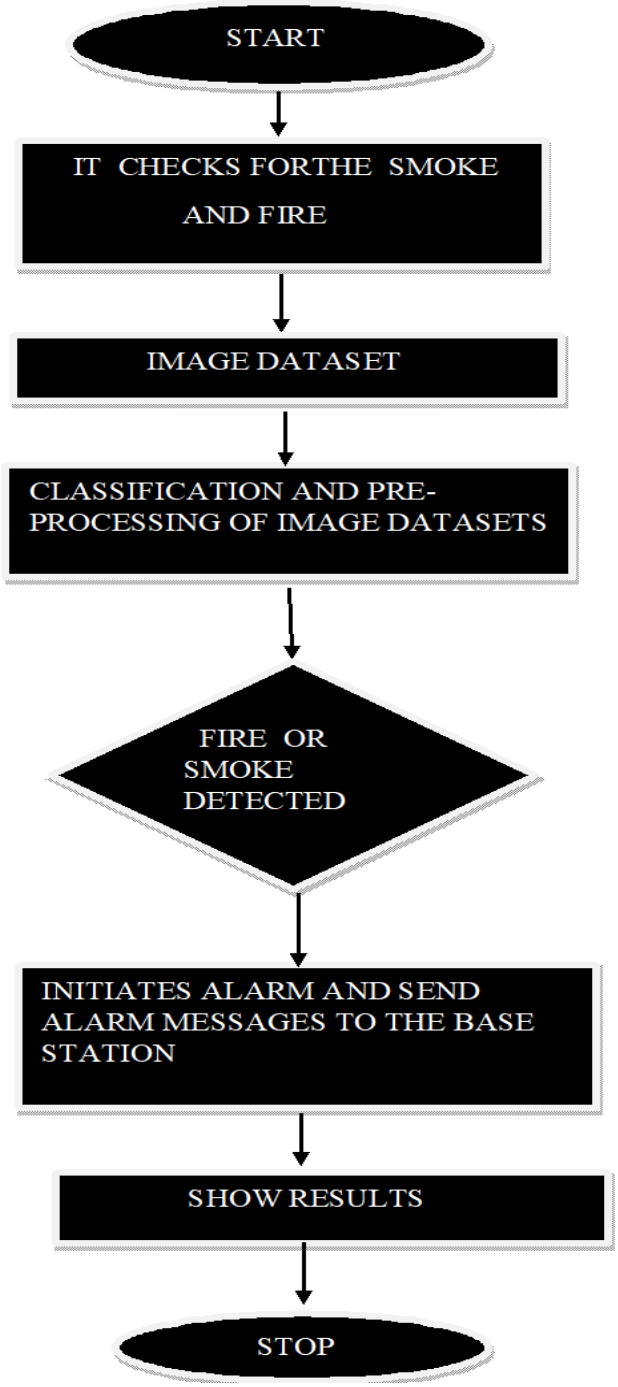


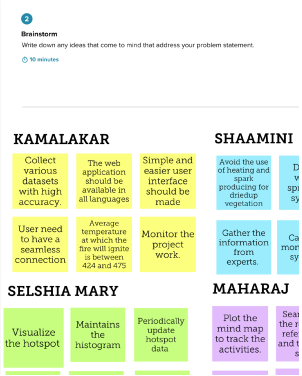
NFR-2	**Security**	More secureenvironment.
NFR-3	**Reliability**	Modelissafeto install.
NFR-4	**Performance**	Modelwill achievehighaccuracy.
NFR-5	**Availability**	Buildmodel is availableinallthetime
NFR-6	**Scalability**	Modelcanhandlelargeamountof dataandcan easily adapttoeveryenvironment.
NFR-7	**Testability**	Putting inmoretrainingdata intothemodelcan Improvethe accuracylevelofthesystem.

5.PROJECT DESIGN

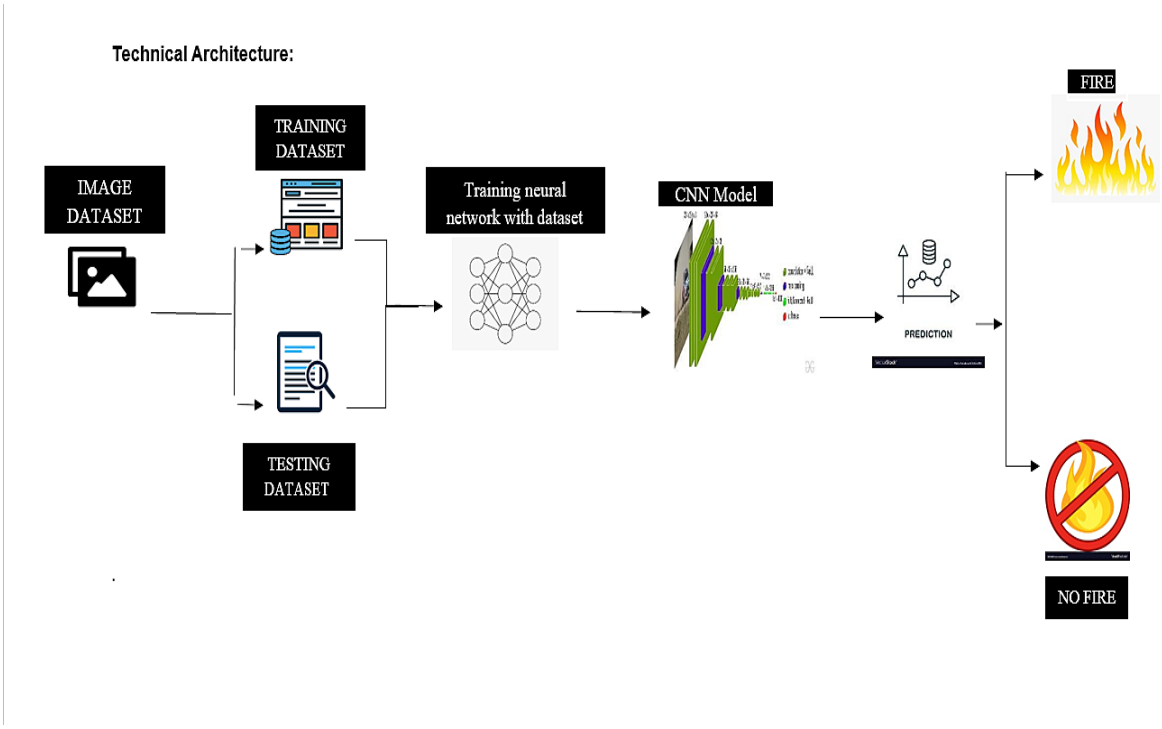
5.1.DATA FLOW DIAGRAMS:

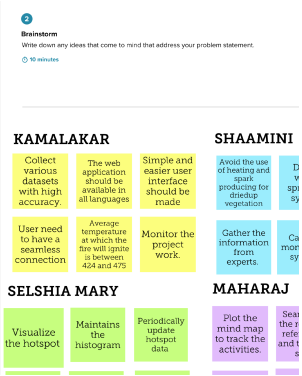

2
Brainstorm
Write down any ideas that come to mind that address your problem statement.
10 minutes
KAMALAKAR
Collect various datasets with high accuracy.
The web application should be available in all languages
Simple and easier user interface should be made
User need to have a seamless connection
Average temperature at which the fire will ignite is between 424 and 475
Monitor the project work.
SHAAMINI
Avoid the use of heating and spark producing for driedup vegetation
Gather the information from experts.
SELSHIA MARY
Visualize the hotspot
Maintains the histogram
Periodically update hotspot data
MAHARAJ
Plot the mind map to track the activities.


START
IT CHECKS FORTHE SMOKE AND FIRE
IMAGE DATASET
CLASSIFICATION AND PRE-PROCESSING OF IMAGE DATASETS
FIRE OR SMOKE DETECTED
INITIATES ALARM AND SEND ALARM MESSAGES TO THE BASE STATION
SHOW RESULTS
STOP



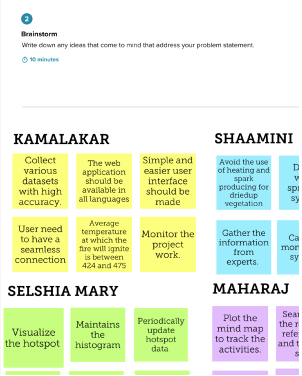
?5.2.SOLUTION AND TECHNICAL ARCHIETECTURE:





5.3.USER STORIES:

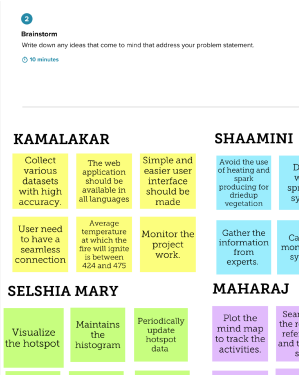
UserType	Functional Requirement(Epic)	User Story Number	UserStory/Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user,I can register for the application by entering my email, password, and confirming my password.	I can access my account/dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email on cel have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user , I can register for the application through Gmail		Medium	Sprint-1
	Login	USN-5	As a user,I can log into the application by entering email & password		High	Sprint-1
	Dashboard					



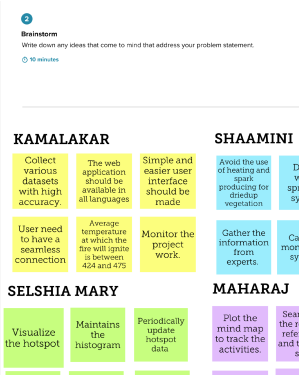
6.PROJECT PLANNING & SCHEDULING:

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	S. Kamalakar
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.	10	High	S. Kamalakar S. Shaamini C. Selshia Mary R. Maharaj



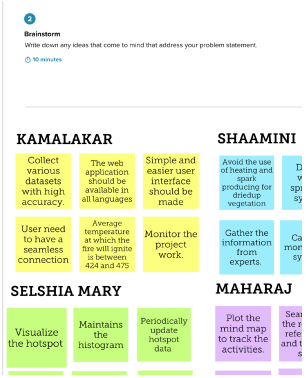
			Import Keras library from that library and import the ImageDataGenerator Library to your Python script. The next step is definig the arguments for the ImageDataGenerator . Here the arguments which we are given inside the image data generator class are, rescale, shear_range, rotation range of image, and zoom range that we can consider for images. The next step is applying the ImageDataGenerator arguments to the train and test dataset.			
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	S. Kamalakar S. Shaamini C. Selshia Mary R. Maharaj



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	S. Kamalakar S. Shaamini C. Selshia Mary R. Maharaj
Sprint-4	Evaluation metrics and accuracy	USN-4	In this phase the result, prediction, accuracy, and performance of the project are tested.	20	High	S. Kamalakar S. Shaamini C. Selshia Mary R. Maharaj

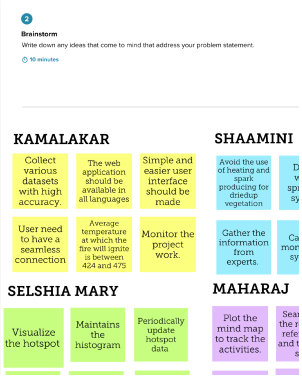
MILESTONE & ACTIVITY LIST:

Activity Number	**Activity Name**	**Detailed Activity Description**	**Task Assigned**	**Status**
1.1	Access Resources	Accesstheresources(courses)inproj ect dashboard.	All Members	COMPLETED
1.2	Rocket chat registration	Join the mentoring channel via platform& rocket-chat mobile app.	All Members	COMPLETED
1.3	Access workspace	Access the guided project workspace.	All Members	COMPLETED
1.4	IBM Cloud registration	Register on IBM Academic Initiative &Apply Feature code for IBM Cloud Credits.	All Members	COMPLETED
1.5	Project Repository Creation	Create GitHub account & collaboratewith Project Repository in project workspace.	All Members	COMPLETED
1.6	Environment Setup	Set-up the Laptop / Computers basedon the pre-requisites for each technology track.	All Members	COMPLETED



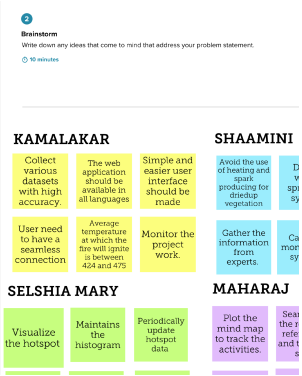
2.1	Literature survey	Literature survey on the selected project& Information Gathering.	All Member s	COMPLETED
2.2	Technology Training	Attend the technology trainings as perthe training Calendar.	All Members	COMPLETED
2.3	Empathy Map	Prepare EmpathyMapCanvasto capture the user Pains &Gains, Preparelistofproblemstatements	All Members	COMPLETED
2.4	Technology Training	Attend the technology trainings as perthe training Calendar.	All Members	COMPLETED
2.5	Brainstorming	List the ideas (at least 4 per each team member) by organizing the brainstorm session and prioritize the ideas	All Members	COMPLETED

2.6	Technology Training	Attend the technology trainings as perthe training Calendar.	All Members	COMPLETED
3.1	Proposed Solution Document	Prepare theproposedsolution document, which includes the novelty, feasibility of idea, business model, social impact, scalability of solution, etc.	All Members	COMPLETED
3.2	Technology Training	Attend the technology trainings as perthe training Calendar.	All Members	COMPLETED

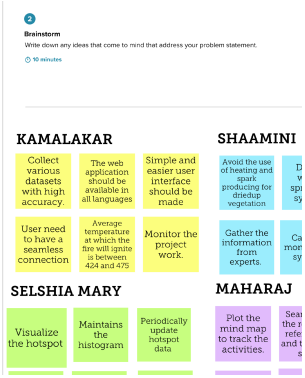


3.3	Problem - Solution fit & SolutionArchitecture	Prepare problem - solution fit document& Solution Architecture.	All Members	COMPLETED
3.4	Technology Training	Attend the technology trainings as per the training Calendar.	All Members	COMPLETED
4.1	Customer Journey Map	Prepare the customer journey maps to understand the user interactions & experiences with the application (entry to exit).	All Members	COMPLETED
4.2	Technology Training	Attend the technology trainings as perthe training Calendar.	All Members	COMPLETED
4.3	Functional Requirements& Data Flow Diagrams	Prepare theFunctionalRequirement Document &DataFlow Diagrams.	All Members	COMPLETED
4.4	Technology Architecture	Prepare Technology Architecture of the solution.	All Members	COMPLETED
4.5	Technology Training	Attend the technology trainings as per the training Calendar.	All Members	COMPLETED
5.1	Milestone&Activity List	Prepare Milestone & Activity List.	All Members	COMPLETED
5.2	Sprint Delivery Plan	Prepare Sprint Delivery Plan.	All Members	COMPLETED

6	Data Collection	Collect datasets from different open sources likekaggle.com, data.gov, UCI machine learningrepository, etc.	All Members	COMPLETED
7.1	Image Preprocessing	Importingthe ImageDataGenerator Library	All Members	COMPLETED

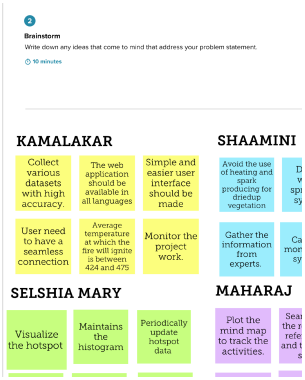


7.2	Image Preprocessing	Define the parameters/arguments for ImageDataGenerator class.	All Members	COMPLETED
7.3	Image Preprocessing	ApplyingImageDataGenerator functionality to trainset and test set.	All Members	COMPLETED
8.1	Model Building	Importing the model building libraries.	All Members	COMPLETED
8.2	Model Building	Initializing the model.	All Members	COMPLETED
8.3	Model Building	Adding CNN Layers.	All Members	COMPLETED
8.4	Model Building	Adding Dense Layers	All Members	COMPLETED
8.5	Model Building	Configuring the learning process	All Members	COMPLETED
8.6	Model Building	Training the Model	All Members	COMPLETED
8.7	Model Building	Save the model	All Members	COMPLETED
8.8	Model Building	Predictions	All Members	COMPLETED
9.1	Video Analysis	OpenCV for video processing.	All Members	COMPLETED
9.2	Video Analysis	Creating an account in Twilio service.	All Members	COMPLETED
9.3	Video Analysis	Sending alert message.	All Members	COMPLETED
10.1	Train CNN Model on IBM	Register for IBM Cloud	All Members	COMPLETED
10.2	Train CNN Model on IBM	Train Image Classification Model	All Members	COMPLETED

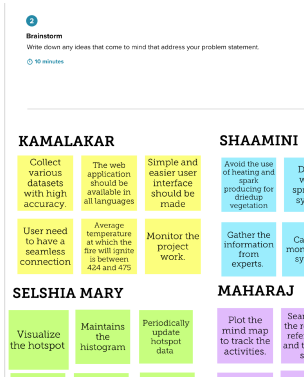


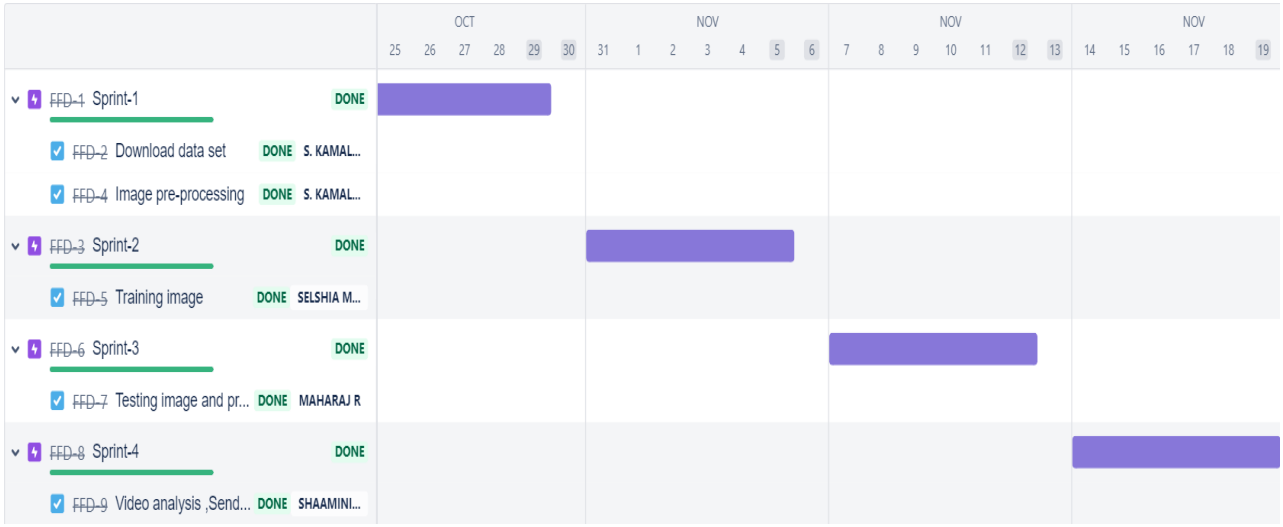
6.2.SPRINT DELIVERY SCHEDULE:

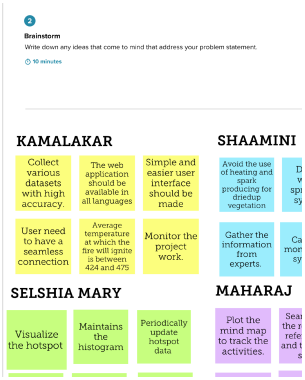
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022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



6.3.REPORTS FROM JIRA:


2
Brainstorm
Write down any ideas that come to mind that address your problem statement.
10 minutes
KAMALAKAR
Collect various datasets with high accuracy.
The web application should be available in all languages
Simple and easier user interface should be made
User need to have a seamless connection
Average temperature at which the fire will ignite is between 424 and 475
Monitor the project work.
SHAAMINI
Avoid the use of heating and spark producing for driedup vegetation
Gather the information from experts.
SELSHIA MARY
Visualize the hotspot
Maintains the histogram
Periodically update hotspot data
MAHARAJ
Plot the mind map to track the activities.


OCT
25 26 27 28 29 30
NOV
31 1 2 3 4 5 6
NOV
7 8 9 10 11 12 13
NOV
14 15 16 17 18 19
FFD-1 Sprint-1 DONE
FFD-2 Download data set DONE S. KAMAL...
FFD-4 Image pre-processing DONE S. KAMAL...
FFD-3 Sprint-2 DONE
FFD-5 Training image DONE SELSHIA M...
FFD-6 Sprint-3 DONE
FFD-7 Testing image and pr... DONE MAHARAJ R
FFD-8 Sprint-4 DONE
FFD-9 Video analysis ,Send... DONE SHAAMINI...



7.CODING & SOLUTIONING

7.1.FEATURE 1:

1.IMAGE DATA GENERATO

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.

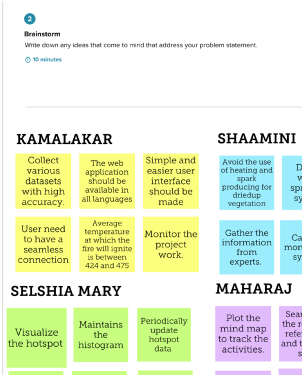
```
from keras.preprocessing.image import ImageDataGenerator
```

2.PARAMETRES

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:

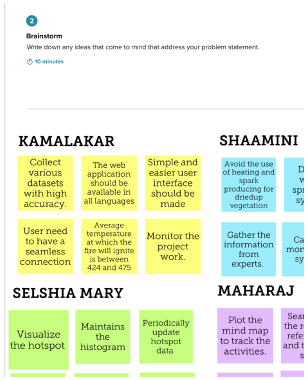
The zoom augmentation method is used to zooming the image. This method randomly zooms the image either by zooming in or it adds some pixels aroundthe image to enlarge the image. This method uses the zoom_range argument of the ImageDataGenerator class. We can specify the percentage value of the zooms 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, we 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 algorithm 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.

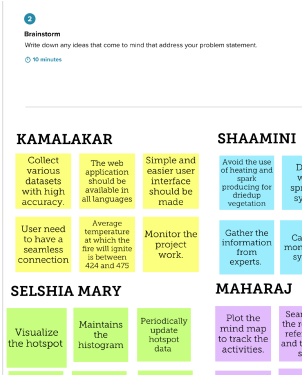
```
from keras.layers import MaxPooling2D
```

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.

7.2.FEATURE 2(CODE):

Importing Keras libraries

```
import keras
```

Importing ImageDataGenerator from Keras

```
from matplotlib import pyplot as plt
from keras.preprocessing.image import ImageDataGenerator
```

Defining the Parameters

```
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,shear_range=0.2,rotation_range=180,zoom_range=0.2,horizontal_flip=True)
```

Applying ImageDataGenerator functionality to train dataset

```
from google.colab import drive
drive.mount('/content/drive')

x_train=train_datagen.flow_from_directory('/content/drive/MyDrive/IBM PROJECT/dataset/DATA
```

SET/archive/Dataset/Dataset/train_set',target_size=(64,64),batch_size=32,class_mode='binary')

Applying ImageDataGenerator functionality to test dataset

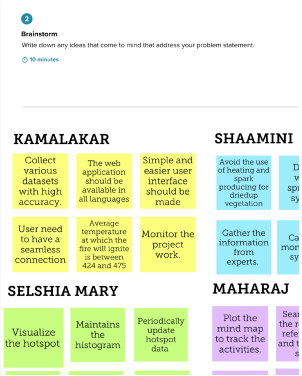
x_test=test_datagen.flow_from_directory('/content/drive/MyDrive/IBM PROJECT/dataset/DATA SET/archive/Dataset/Dataset/test_set',target_size=(64,64),batch_size=32,class_mode='binary')

Importing Model Building Libraries

```
#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')
```

Initializing the model

```
model = Sequential()
```



Adding CNN Layers

```
model.add(Convolution2D(32,(3,3),input_shape=(64,64,3),activation='relu'))
#add maxpooling layers
model.add(MaxPooling2D(pool_size=(2,2)))
#add faltten layer
model.add(Flatten())
```

Add Dense layers

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

configuring the learning process

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

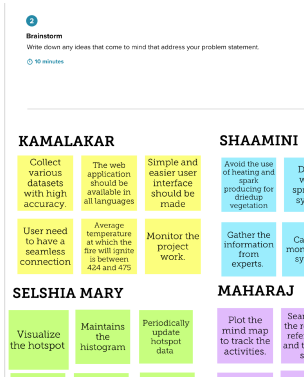
Training the model

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

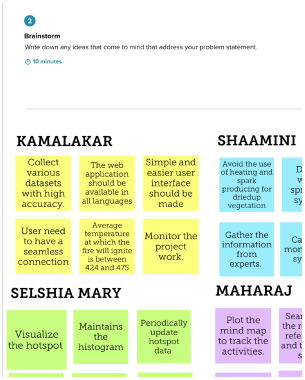
Save the model

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

Predictions




```
#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("/content/drive/MyDrive/IBM PROJECT/dataset/forest.h5")
img=image.load_img('/content/drive/MyDrive/IBM PROJECT/dataset/DATA SET/archive/Dataset/Dataset/test_set/with fire/FORESTFIRE (1).jpg')
x=image.img_to_array(img)
res=cv2.resize(x,dsize=(64,64),interpolation=cv2.INTER_CUBIC)
#expand the image shape
x=np.expand_dims(res,axis=0)

pred=model.predict(x)
pred = int(pred[0][0])
pred
int(pred)

pip install twilio

from twilio.rest import Client

if pred==0:
```

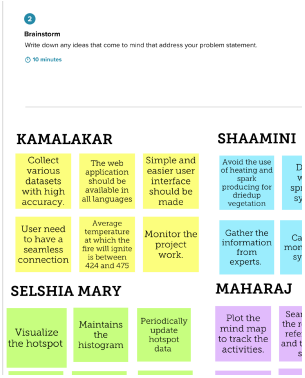



```
print('Forest fire')
account_sid='AC0f20fb7b8e71118fa14d874dc2384676'
auth_token='74902c8f190f5a4d288bbf5e3b48c84e'
client=Client(account_sid,auth_token)
message=client.messages \
.create(
    body='forest fire is detected,stay alert',
    #use twilio free number
    from_='+18608542959',
    #to number
    to='+916380889559')
print(message.sid)
print("Fire detected")
print("SMS Sent!")
elif pred==1:
print('No Fire')
```

Open cv for video processing

pip install twilio

```
 from logging import WARNING
#import opencv library
import cv2
#import numpy
import numpy as np
#import image function from keras
```



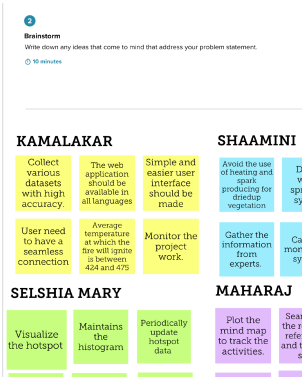

```
from keras.preprocessing import image
#import load_model from keras
from keras.models import load_model
#import client from twilio API
from twilio.rest import Client
#import playsound package
```

Creating An Account in Twilio Service

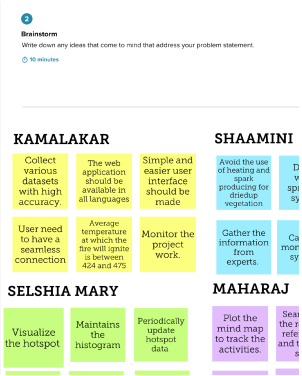
Sending Alert Message

```
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/IBM PROJECT/dataset/datasetvideo.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:

    cv2_imshow(frame)
    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/IBM PROJECT/dataset/forest.h5")
    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()



from twilio.rest import Client
if pred==0:
  print('Forest fire')
  from twilio.rest import Client
  account_sid='AC0f20fb7b8e71118fa14d874dc2384676'
  auth_token='74902c8f190f5a4d288bbf5e3b48c84e'
  client=Client(account_sid,auth_token)
  message=client.messages \
  .create(
      body='forest fire is detected,stay alert',
      #use twilio free number
      from_='+18608542959',
      #to number
      to='+916380889559')
  print(message.sid)
  print("Fire detected")
  print("SMS Sent!")
elif pred==1:
  print('No Fire')
```



8.TESTING

8.1.Test Cases:

8.2.User Acceptance Testing:

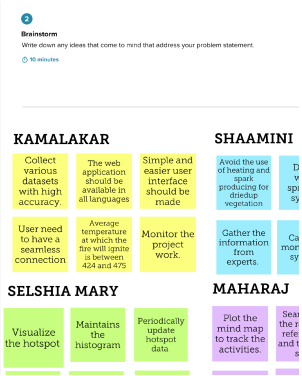
Purpose of Document:

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

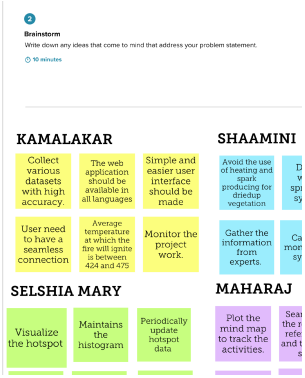


Skipped	0	0	1	1	2
Won'tFix	0	3	2	1	6
Totals	15	9	11	14	49

Test Case Analysis:

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

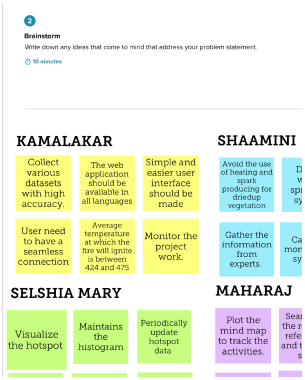
Section	Total Cases	Not Tested	Fail	Pass
Print Engine	5	0	0	5
Client Application	30	0	0	30
Security	2	0	0	2
Out source Shipping	3	0	0	3
Exception Reporting	9	0	0	9
Final Report Output	4	0	0	4
Version Control	2	0	0	2



9.RESULTS

9.1.PERFORMANCSE 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 increase .We proposed a Deep Learning-based model for 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 - 92% - 98% Validation Accuracy - 95%



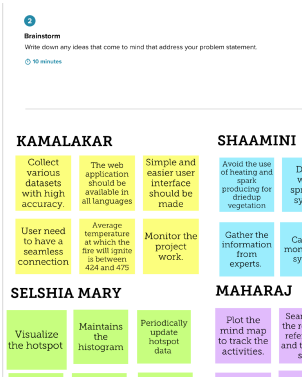
10.ADVANTAGES & DISADVANTAGES

ADVANTAGES:

1.Ability to cover areas at different altitudes and locations.
2.The results is quite accurate with the accuracy upto 92%
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:

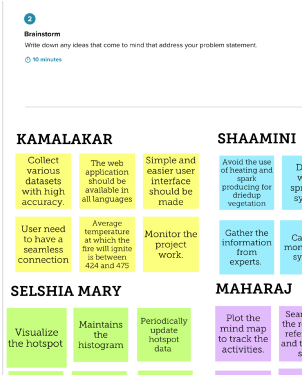
1.Individual learner is responsible for learning global information to avoid false positives.



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.

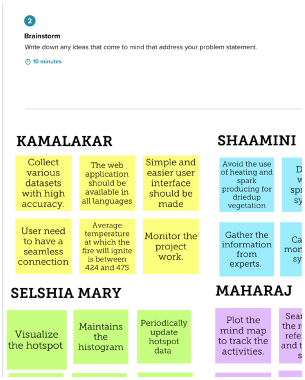
11.CONCLUSION

As a threat of forest fire increases due to climate changes, the need for finding a detection system increase .We proposed a Deep Learning-based model for 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.



12.FUTURE SCOPE

- Integrate live satellite data and process real time processing of the fires.
- Enchance the time complexity of the detection of forest fires to improve the speed.
- These accidents can be controlled to a greater extend.

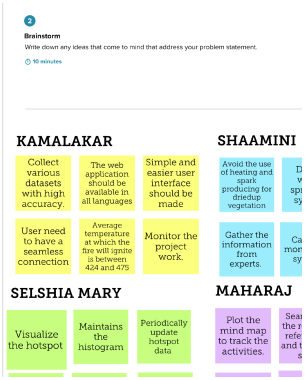


- Forest fire leads to destruction of excess of species, by using this technique we can save the life and environment.

13.APPENDIX

SOURCE CODE:

Our project source code link:
https://colab.research.google.com/drive/1LzoPeDCL4Mfo4n2lB_iR8HrNAY9IMXB3



Our Github link - https://github.com/IBM-EPBL/IBM-Project-42560-1660668190

DEMO VIDEO:

Demo video link - https://www.youtube.com/embed/tLLSVqQYB_A