EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

NALAIYA THIRAN PROJECT BASED LEARNING

On

PROFESSIONAL READINESS FOR INNOVATION, EMPLOYABILITY AND ENTREPRENEURSHIP

A PROJECT REPORT

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BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE AND ENGINEERING

HINDUSTHAN COLLEGE OF ENGINEERING AND TECHNOLOGY

Approved by AICTE, New Delhi, Accredited with 'A' Grade by NAAC

(An Autonomous Institution, Affiliated to Anna University, Chennai)

COIMBATORE – 641 032

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Certified that project report **"EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES"** is the bonafide work of **" G.GUNA SHEKAR, A.NAGA MAHESH, D.YAHOSHUVA, CHETHAN** who carried out the project work under my supervision.Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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Submitted for Project Viva-Voice conducted on …….

INTERNAL EXAMINER

EXTERNAL EXAMINER

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1. INTODUCTION

1.1 Project Overview

Forest fires have been and still are serious problem for the European Union and for all other countries in Europe. In the year 2000, the EU has established the European Forest Fire Information system (EFFIS) , which will soon become part of the European Emergency Management Service, maintained by the Copernicus Earth Observation Programme. This system provides valuable near real-time and also historical data on the forest fires in Europe, the Middle East and North Africa. Currently EFFIS is being used and supported with data by 25 EU member states and by numerous other countries. According to the annual report of EFFIS for 2016, more than 54 000 forest fires have occurred all around Europe and they have led to nearly 376 thousand hectares of burnt areas. If we compare these values to the average values from the EFFIS reports for the period 2006-2015, the number of forest fires have decreased by 13327 or by nearly 20%.

The most important factors in the fight against the forest fires include the earliest possible detection of the fire event, the proper categorization of the fire and fast response from the fire services. Several different types of forest fires are known, including ground fires, surface fires and crown/tree fires.

1.2 Purpose

Forest fires are a major environmental issue, creating economic and ecological damage while endangering human lives. There are typically about 100,000 wildfires in the United States every year. Over 9 million acres of land have been destroyed due to treacherous wildfires. It is difficult to predict and detect Forest Fire in a sparsely populated forest area and it is more difficult if the prediction is done using ground-based methods like Camera or Video-Based approach. Satellites can be an important source of data prior to and also during the Fire due to its reliability and efficiency. The various real-time forest fire detection and prediction approaches, with the goal of informing the local fire authorities.

2. Literature Survey

TREADITIONAL METHODS

Forest fire detection and prevention are real problems faced by a number of countries. Different methods have been stated for monitoring the emergence of fires.

A. Watch Towers

In earlier days, the forest fires were detected by manual observations with watch towers installed in the isolated areas of forest. Though this method was accurate, it was not preferred due to manual restrictions.

B. Satellite

Based Systems Earth orbiting satellites have been used for detection of forest fires. Unfortunately, these satellites can provide the images of regions of the earth's surface every two days which is a very long time for fire scanning. Also the weather conditions can affect the quality of satellite images.

C. Optical Sensors and Digital Camera

The use of optical sensors only provides a line of sight vision, where the vision can be blocked by high trees or hills. The Camera surveillance systems were also inefficient for forest fire detection because of short distance ranges.

D. Wireless Sensor Networks

The sensors sense physical as well as chemical parameters. The sensors can operate in a self-healing and self-organizing wireless networking environment. The major problem with this system is that there are high chances of false alarms due to lack of proper processing of the sensor data. In this paper, we propose a method which processes the sensor data to predict fire accurately. The sensor nodes are provided with Wi-Fi devices and tested on grassy areas to sense temperature, humidity, pressure and various other physical parameters and send this data back to the base station. At the base station, the data is processed by a machine learning agent to give alarm.

2.1 Existing problem

Problem statement Forest fires are a major environmental issue, creating economic and ecological damage while endangering human lives. There are typically about 100,000 wildfires in the United States every year. Over 9 million acres of land have been destroyed due to treacherous wildfires. It is difficult to predict and detect Forest Fire in a sparsely populated forest area and it is more difficult if the prediction is done using ground-based methods like Camera or Video-Based approach. Satellites can be an important source of data prior to and also during the Fire due to its reliability and

efficiency. The various real-time forest fire detection and prediction approaches, with the goal of informing the local fire authorities Literature survey TREADITIONAL METHODS Forest fire detection and prevention are real problems faced by a number of countries. Different methods have been stated for monitoring the emergence of fires. A. Watch Towers In earlier days, the forest fires were detected by manual observations with watch towers installed in the isolated areas of forest. Though this method was accurate, it was not preferred due to manual restrictions. B. Satellite Based Systems Earth orbiting satellites have been used for detection of forest fires. Unfortunately, these satellites can provide the images of regions of the earth's surface every two days which is a very long time for fire scanning. Also the weather conditions can affect the quality of satellite images. C. Optical Sensors and Digital Camera The use of optical sensors only provides a line of sight vision, where the vision can be blocked by high trees or hills. The Camera surveillance systems were also inefficient for forest fire detection because of short distance ranges. D. Wireless Sensor Networks The sensors sense physical as well as chemical parameters. The sensors can operate in a self-healing and self-organizing wireless networking environment. The major problem with this system is that there are high chances of false alarms due to lack of proper processing of the sensor data. In this paper, we propose a method which processes the sensor data to predict fire accurately. The sensor nodes are provided with Wi-Fi devices and tested on grassy areas to sense temperature, humidity, pressure and various other physical parameters and send this data back to the base station. At the base station, the data is processed by a machine learning agent to give alarm.

2.2 References

[1] Y. Huang and K. Boyle, Antennas, "From Theory to Practice.", West Sussex, United Kingdom: John Wiley & Sons Ltd, 2008.

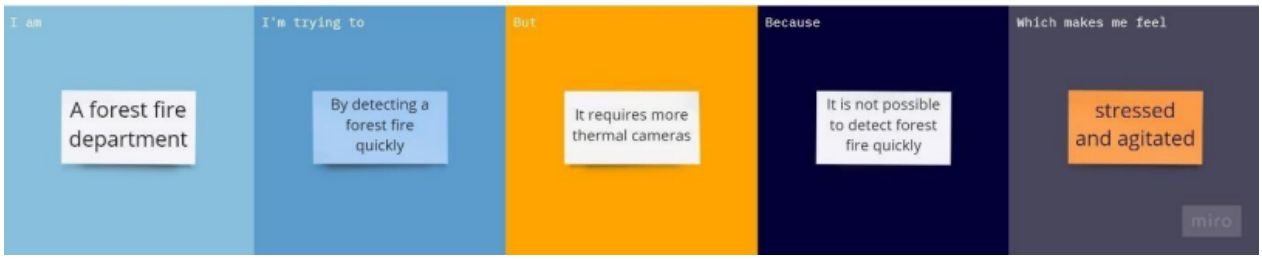
[2] AA Portable Power Corp, "Category : Li-Ion/Polymer Single Cells," 2019. [Online]. Available: https://www.batteryspace.com/liionsinglecell.aspx.

[3] C. A. Balanis, Antenna Theory, "Analysis and Design," Fourth Edition., Hoboken, New Jersey: John Wiley and Sons, Inc., 2016.

[4] J. Pike, "Understanding LoRa WAN Basics: A Non-Technical Explanation," 21 August 2017. [Online]. Available: https://metova.com/ understanding-lora-basics-a-non-technical-explanation/.

[5] "LoRaWAN, "What is it?"," November 2015. [Online]. Available: https://lora-alliance.org/sites/default/files/2018-04/what-is-lorawan.pdf.

2.3 Problem Statement Definition

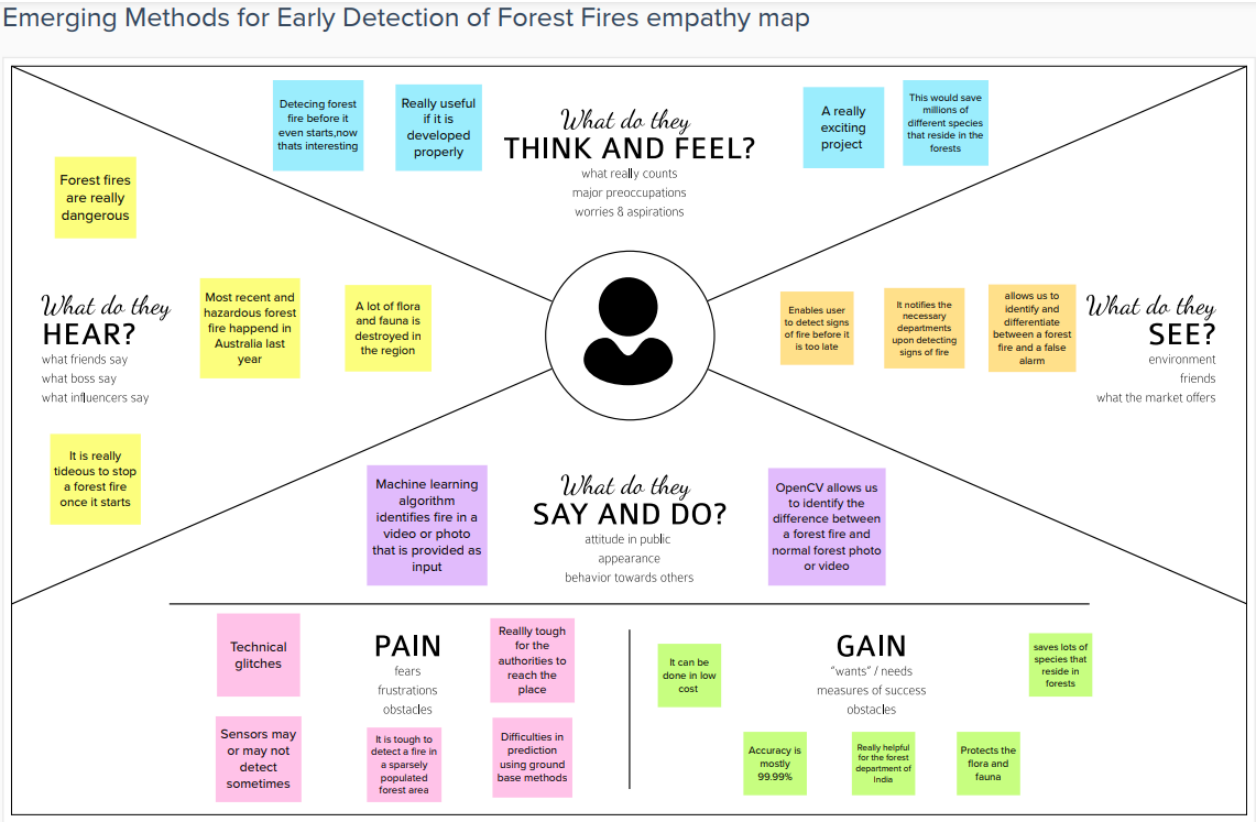


Problem Statement (PS):	A Large destructive fire that spread over a forest or area of woodland is a Forest fire that causes loss of humungous amount of Property, Wildlife, Ecosystem and Economy. The project is focused on creating a permanent solution for this problem. It consists of an integrated IoT based system to detect, monitor and solve the issue without any manual involvement. The system consists of regular monitoring of the forest area with the help of cloud computing and analysis of the root cause of the fire. The system uses the latest Microcontroller, Wi-Fi communication and precision sensors such that there is no error in this part. The system also provides a quick response system so the fire can be controlled at the earliest stage.
I am (USER)	A Forest fire department
I'm trying to	Frequently monitor fire and make sure to prevent them from getting destroyed .Analyze data from various thermal camera's.
But	Requires a lot of thermal cameras for monitoring

Because	It’s really hard to cover large boundaries and monitor them 24 hours a day
Which makes me feel	Stressed and agitated about the forests are burning fastly.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas



3.2 Ideation

Brainstorm & Idea Prioritization:

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

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

A **Team gathering**
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B **Set the goal**
Think about the problem you'll be focusing on solving in the brainstorming session.

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

Open article →

1

Define your problem statement

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

5 minutes

PROBLEM

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

Key rules of brainstorming

To run an smooth and productive session

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

4

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

Share the mural
Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

Export the mural
Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint
Define the components of a new idea or strategy.
Open the template

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template

Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.
Open the template

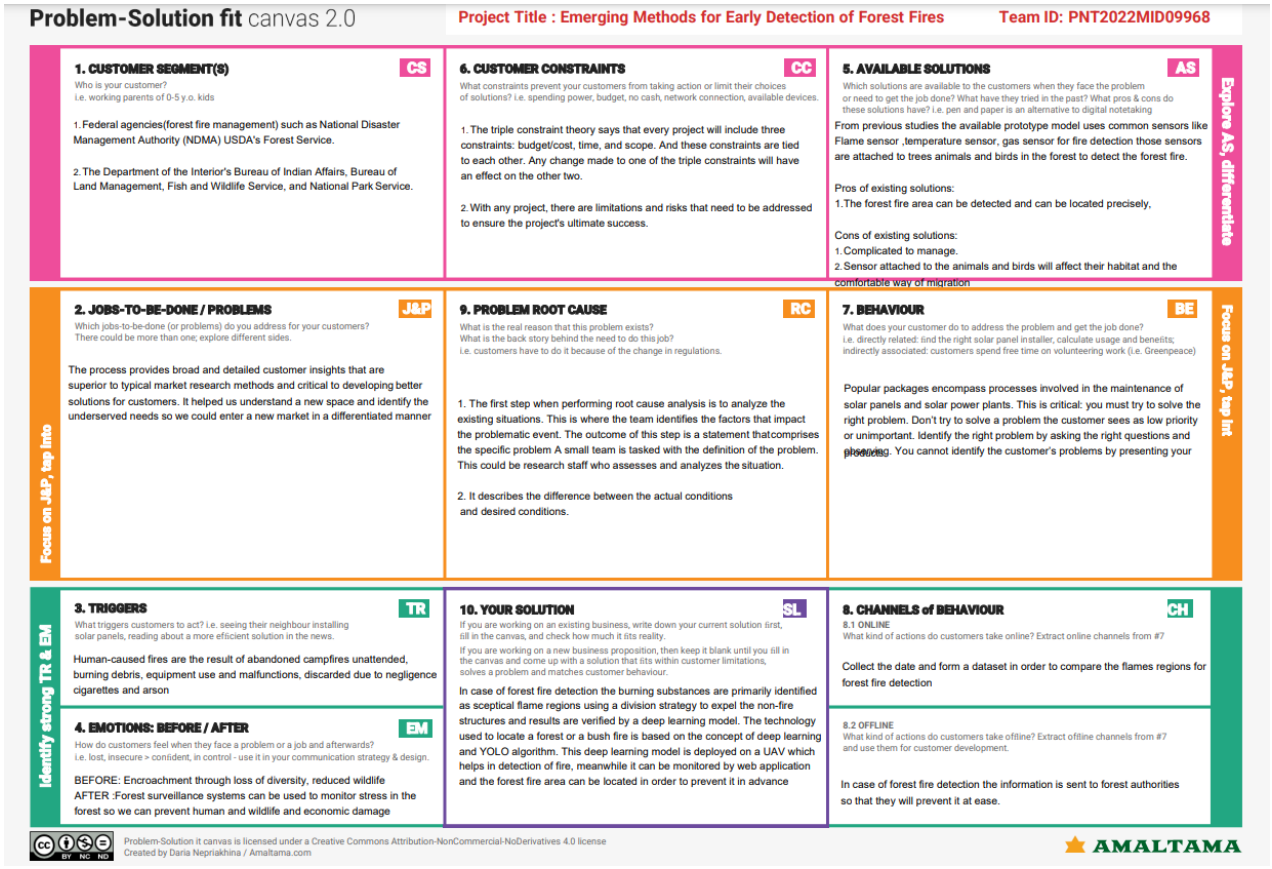
Share template feedback

3.3 Proposed Solution

S.No	Parameter	Description
1.	Proposed Statement (Problem to be solved)	**Statement:** To find emerging methods for early detection of forest fires using artificial intelligence. **Description:** This technology is to be implemented to locate a forest or a bush fire based on the concept of deep learning and YOLO algorithm. After detecting, authorities are to be alerted immediately to mitigate any damage
2.	Idea / Solution Description	1. In case of forest fire detection the burning substances are primarily identified as sceptical flame regions using a division strategy to expel the non-fire structures and results are verified by a deep learning model. 2. The technology used to locate a forest or a bush fire is based on the concept of deep learning and YOLO algorithm. This deep learning model is deployed on a UAV which help in detection of fire, meanwhile it can be monitored by web application in order to prevent it at advance

3.	Novelty / Uniqueness	1. Accurate and reliable recognition of sceptical flame regions by means of using YOLO v3 algorithm. 2. Unlike previous algorithms, the exact location of the origin of the forest fire is also detected and sent to the web-app
4.	Social Impact / Customer Satisfaction	1. Because of earlier prediction, loses of life, destruction of various environmental, geographical and essential resources can be avoided. 2. By detecting a fire quickly and accurately, this system can limit the emission of toxic products created by combustion, as well as globalwarming gases produced by the fire itself
5.	Business Model (Revenue Model)	1. The software platform to provide the fully autonomous processing of data received from the camera of UAV to obtain live feed in web App. 2. This can also be implemented as a mobile application where the services can be accessed on subscription basis
6.	Scalability of the solution	1. This application can be developed as the world wide surveillance system to monitor the several sections of different forests.. 2. Filtration of false positive result by comparing the dataset with the video feed obtained.

3.4 Problem Solution Fit



4. REQUIREMENT ANALYSIS

4.1 Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Reigstration	Registtation through Gmail.
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User Login	Login using credentials
FR-4	User Search	Search for info on forest fire occurence
FR-5	User Profile	User shall be given a live feed of the forest
FR-6	User Application	User is alerted if there is an forest fire occurrence in their suuroundings

4.2 Non-functional Requirements:

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

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Alerts according to the user location
NFR-2	**Security**	Instant live feed with alert of the siituation
NFR-3	**Reliability**	The predictions of the forest fire is 87% accurate
NFR-4	**Performance**	The feed and the alert message is an immediate action without a lag
NFR-5	**Availability**	The application gives alerts and live feeds 24/7
NFR-6	**Scalability**	Early detection and alerting users are done efficiently and in a faster means

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.

Example:

1. It is difficult to predict and detect Forest Fire in a sparsely populated forest area.

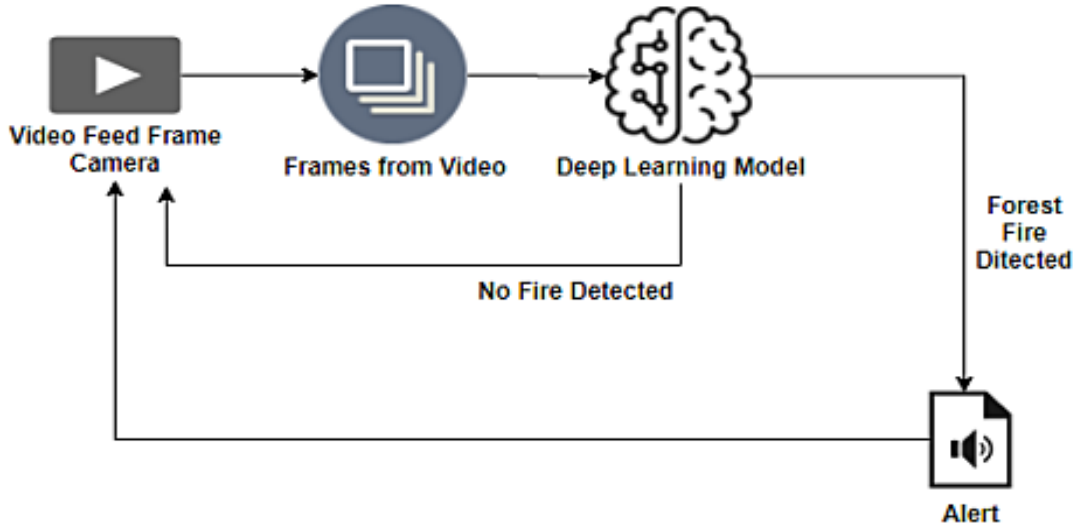
2. it is more difficult if the prediction is done using ground-based methods like Camera or Video-Based approach.

3. Satellites can be an important source of data prior to and also during the Fire due to its reliability and efficiency.

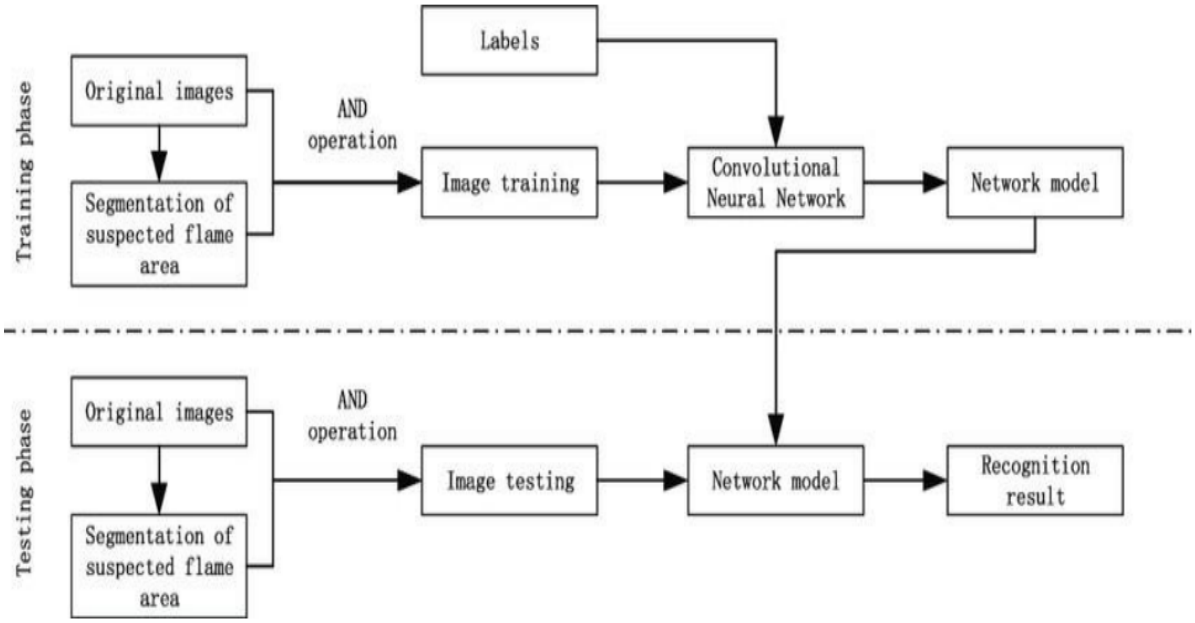
4. The various real-time forest fire detection and prediction approaches, with the goal of informing the local fire authorities.

5. 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.

FLOW


Video Feed Frame
Camera
Frames from Video
Deep Learning Model
Forest
Fire
Ditected
No Fire Detected
Alert

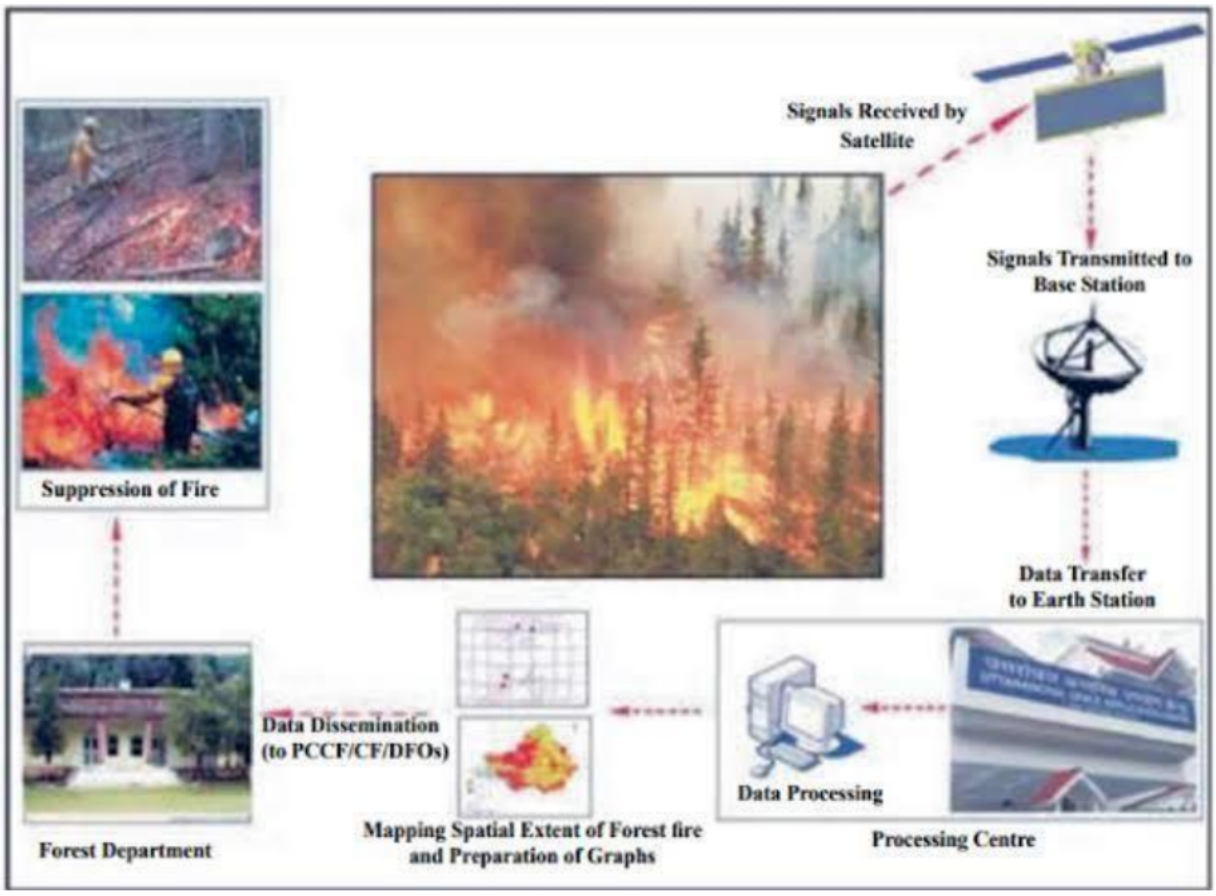
DFD:


Training phase
Original images
Segmentation of suspected flame area
AND operation
Labels
Image training
Convolutional Neural Network
Network model
Testing phase
Original images
Segmentation of suspected flame area
AND operation
Image testing
Network model
Recognition result

5.2 Solution Architecture

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to: • Find the best tech solution to solve existing business problems. • Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders. • Define features, development phases, and solution requirements. • Provide specifications according to which the solution is defined, managed, and delivered.

Solution Architecture Diagram:



Technical Architecture

Technical Architecture:

Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	The user interacts with the application.	Python
2.	Application Logic	The logic for performance of the process to execute the desired output	Python
3.	Database	(Pictures) Composite Data Types	MySQL
4.	Machine Learning Model	Purpose of Machine Learning Model	Object Recognition Model, CNN.
5.	Infrastructure (Server / Cloud)	Application Deployment on Local System / Cloud	Local, IBM cloud

Application Characteristics:

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	List the open-source frameworks used	OSINT framework
2.	Security Implementations	List all the security / access controls	OWSAP top10, SIEM

		implemented, use of firewalls etc.	
3.	Scalable Architecture	Justify the scalability of architecture (3 – tier, Micro-services)	HTTP overview implementation
4.	Availability	Justify the availability of application (e.g. use of load balancers, distributed servers etc.)	Round robin load balancing
5.	Performance	Design consideration for the performance of the application (number of requests per sec, use of Cache, use of CDN's) etc.	Secure cookie implementation

5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story I 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 wrona	High	Sprint-1
		USN-2	Identify algorithms that can be used for prediction	To collect the algorithm to identify the accuracy level of each algorithms	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 riaht output	High	Sprint-3
	Display Results	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	User input	USN-1	As a user, I can input the particular URL in the required field and waiting for validation.	2	High	Guna,Mahesh, Yahoushuva, Chethan
Sprint-1	Feature extraction	USN-1	Here system can extract feature using heuristic and visual similarity approach	1	High	Guna,Mahesh, Yahoushuva, Chethan
Sprint-1	Prediction	USN-1	Here the Model will predict the URL websites using Machine Learning algorithms	2	High	Guna,Mahesh, Yahoushuva, Chethan
Sprint-1	Classifier	USN-1	Here it will send all the model output to classifier in order to produce final result	2	High	Guna,Mahesh, Yahoushuva, Chethan

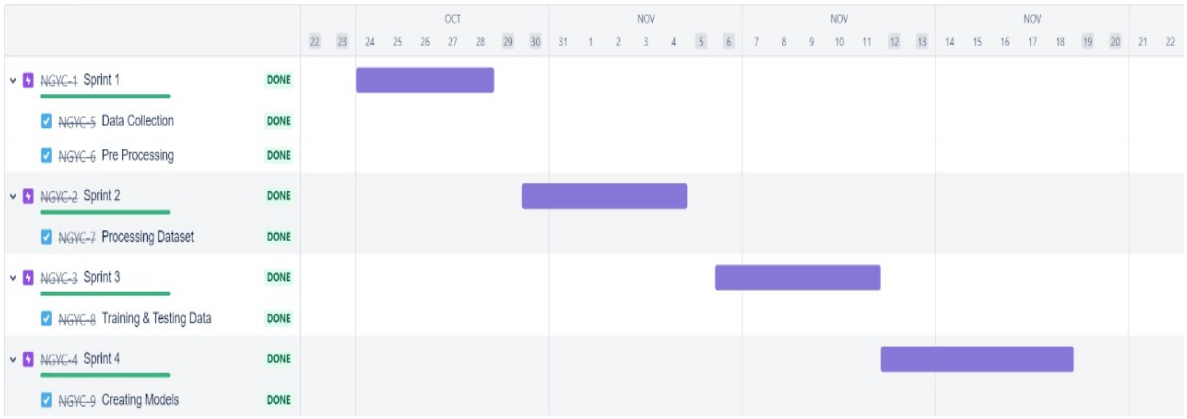
Sprint-1	Announcement	USN-1	Displays whether website is a legal site or a phishing site.	1	High	Guna,Mahesh, Yahoushuva,Chethan
Sprint-2	Bugs	USN-2	As a user, I can report bugs in the application	1	Medium	Guna,Mahesh, Yahoushuva,Chethan
Sprint-2	Feedback	USN-3	As a user, I can send feedback about the application and opinions for improvement	1	Low	Guna,Mahesh, Yahoushuva,Chethan
Sprint-3	Tips	USN-4	Here cyber security tips are provided for the Customers/Users	1	Low	Guna,Mahesh, Yahoushuva,Chethan

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	12 Nov 2022	20	12 Nov 2022

			2022			
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.3 Reports from JIRA



7. CODING & SOLUTIONING

7.1 Feature 1

```
# Linear Regression Model
model = LinearRegression()
model.fit(X_train, y_train)

# Predictions
predictions = model.predict(X_test)

# Scores
print ("Mean Squared Error : ", mean_squared_error(y_test, predictions))
print ("r2 Score : ", r2_score(y_test, predictions))
```

Linear regression predicts the dependent value (y) according to the independent variable (x). The output here is the dependent value, and the input is the independent value.

7.2 Feature 2

In [16]:
```
#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')
```

In [17]:
```
model = Sequential()
```

In [18]:
```
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())
```

In [19]:
```
#add hidden layers
model.add(Dense(150,activation='relu'))
#add output layer
model.add(Dense(1,activation='sigmoid'))
```

In [20]:
```
model.compile(loss='binary_crossentropy',optimizer="adam",metrics=["accuracy"])
```

In [21]:
```
model.fit_generator(x_train,steps_per_epoch=14,epochs=5,validation_data=x_test,validation_steps=20)
```

```
Epoch 1/5
14/14 [==============================] - ETA: 0s - loss: 0.8227 - accuracy: 0.6537WARNING:tensorflow:Your input ran out of data; interrupting training. Make sure that your dataset or generator can generate at least `steps_per_epoch * epochs` batches (in this case, 20 batches). You may need to use the repeat() function when building your dataset.
14/14 [==============================] - 23s 2s/step - loss: 0.8227 - accuracy: 0.6537 - val_loss: 0.2765 - val_accuracy: 0.9256
Epoch 2/5
14/14 [==============================] - 15s 1s/step - loss: 0.2791 - accuracy: 0.8761
Epoch 3/5
14/14 [==============================] - 15s 1s/step - loss: 0.2204 - accuracy: 0.9243
Epoch 4/5
14/14 [==============================] - 15s 1s/step - loss: 0.2018 - accuracy: 0.9197
Epoch 5/5
14/14 [==============================] - 15s 1s/step - loss: 0.1995 - accuracy: 0.9128
```

Out[21]:
```
<keras.callbacks.History at 0x7f7922f642b0>
```

In [22]:
```
model.save("forest.h5")
```

In [23]:
```
!tar -zcvf image-classification_new.tgz forest.h5
```

```
forest.h5
```

In [24]:
```
ls  -1
```

```
Dataset/
forest.h5
image-classification_new.tgz
```

In [26]:
```
from ibm_watson_machine_learning import APIClient
wml_credentilas = {
                   "url":"https://us-south.ml.cloud.ibm.com",
                   "apikey":"EaR3aCur9IAUaH1UBaPdk7Xyy8ndwd0kTuq_hoBc-eeV"
}
client = APIClient(wml_credentilas)
```

In [27]:
```
def guid_from_space_name(client, space_name):
    space = client.spaces.get_details()
    return(next(item for item in space['resources'] if item['entity']["name"] == space_name)['metadata']['id'])
```

In [30]:
```
space_uid = guid_from_space_name(client, 'image_deployment')
print("Space UID = " + space_uid)
```

```
Space UID = 9b378920-7f2a-4205-b263-7316f53b47bb
```

In [31]:
```
client.set.default_space(space_uid)
```

Out[31]:
```
'SUCCESS'
```

In [33]:
```
software_spec_uid = client.software_specifications.get_uid_by_name("tensorflow_rt22.1-py3.9")
software_spec_uid
```

Out[33]: 'acd9c798-6974-5d2f-a657-ce06e986df4d'

In [34]:
```
model_details = client.repository.store_model(model='image-classification_new.tgz',meta_props={
client.repository.ModelMetaNames.NAME:'CNN',
client.repository.ModelMetaNames.TYPE:"tensorflow_rt22.1",
client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:software_spec_uid}
                                                    )
model_id = client.repository.get_model_uid(model_details)
```

```
This method is deprecated, please use get_model_id()
```

In [35]:
```
model_id
```

Out[35]: '27c82d94-ca58-4755-8019-8935f87131c5'

In [36]:
```
#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('/home/wsuser/work/Dataset/test_set/with fire/forest_fire_2268729_1280.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)
```

In [37]:
```
pred=model.predict(x)
pred = int(pred[0][0])
pred
int(pred)
```

Out[37]: 1

In [38]:
```
if pred==1:
  print('Forest fire')
elif pred==0:
  print('No Fire')
```

```
Forest fire
```

Despite the power and resource complexity of CNNs, they provide in-depth results. At the root of it all, it is just recognizing patterns and details that are so minute and inconspicuous that it goes unnoticed to the human eye. But when it comes to understanding the contents of an image it fails.

8. TESTING

8.1 Test Cases

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	7	0	0	7
Client Application	51	0	0	51
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	9	0	0	9

8.2 User Acceptance Testing

1. Purpose of Document

The purpose of this document is to briefly explain the test coverage and open issuesof the project at the time of the release to User Acceptance Testing (UAT).

2. Defect Analysis

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

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	4	3	2	4	13
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	9	2	4	11	26
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	16	13	13	18	60

9. RESULTS

9.1 Performance Metrics

```
In [53]: model.fit_generator(x_train,steps_per_epoch=14,epochs=5,validation_data=x_test,validation_steps=20)
```

```
Epoch 1/5
14/14 [==============================] - ETA: 0s - loss: 0.5695 - accuracy: 0.7385WARNING:tensorflow:Your input ran out of data; interrupting training. Make sure that your dataset or generator can generate at least `steps_per_epoch * epochs` batches (in this case, 20 batches). You may need to use the repeat() function when building your dataset.
14/14 [==============================] - 22s 2s/step - loss: 0.5695 - accuracy: 0.7385 - val_loss: 0.1652 - val_accuracy: 0.9256
Epoch 2/5
14/14 [==============================] - 15s 1s/step - loss: 0.2985 - accuracy: 0.8440
Epoch 3/5
14/14 [==============================] - 15s 1s/step - loss: 0.1910 - accuracy: 0.9174
Epoch 4/5
14/14 [==============================] - 15s 1s/step - loss: 0.1883 - accuracy: 0.9083
Epoch 5/5
14/14 [==============================] - 15s 1s/step - loss: 0.1803 - accuracy: 0.9243
```

10. ADVANTAGES & DISADVANTAGES

ADVANTAGES

Early detection of forest fire-accidents can save innumerable lives along with saving properties from permanent infrastructure damage and the consequent natural losses.In order to achieve high accuracy and robustness in dense urban areas, detection through local surveillance is necessary and also effective.

DISADVANTAGES

Traditional opto-electronic fire detection systems have major disadvantages: Requirement of separate and often redundant systems, fault-prone hardware systems, regular maintenance, false alarms and so on. Usage of sensors in hot, dusty industrial conditions is also not possible.

11. CONCLUSION

Forest fires can be devastating, burning houses, animal habitats, and wood while polluting the air with potentially toxic pollutants. Fire also releases carbon dioxide into the environment.To avoid the uncontrolled broad spreading of forest fires, it is vital to identify wildfires in an earlier stage and control their propagation. It is necessary to mobilize appropriate fire apparatus and qualified operating people as rapidly as possible to the source of the fire. In conclusion, this literature review has found that deep learning-based classifiers are more accurate than traditional methods, and object detection was the most commonly used technique for forest fire detection.

12. FUTURE SCOPE

The application can be enhanced by training the model with a larger dataset consisting of fires at various stages and dimensions. With higher GPU memory,we could use two deep learning models for feature extraction, whose output feature vectors are concatenated and classified to offer more robustness. An R-CNN model can be used to implement fire localization along with classification. We can also expect better deep learning architectures to emerge in the future,offering better feature extraction.The application will also offer a considerably better performance when run on machines having better processing power compared to existing one of which it has been developed.

13. APPENDIX

13.1 Source Code

INDEX.PHP

```
<?php
 session_start(); if
(isset($_SESSION['SESSION_EMAIL'])) {
 header("Location: welcome.php");
die();
 }
 include 'config.php';
 $msg = "";
 if (isset($_GET['verification'])) {
 if (mysqli_num_rows(mysqli_query($conn, "SELECT * FROM users WHERE
code='{$_GET['verification']}'")) > 0) {
 $query = mysqli_query($conn, "UPDATE users SET code=" WHERE
code='{$_GET['verification']}'");

 if ($query) {
 $msg = "<div class='alert alert-success'>Account verification has been successfully
completed.</div>";
 }
 } else {
 header("Location: index.php");
 }
 }
```

```
 if (isset($_POST['submit'])) {
 $email = mysqli_real_escape_string($conn, $_POST['email']);
 $password = mysqli_real_escape_string($conn, md5($_POST['password']));
 $sql = "SELECT * FROM users WHERE email='{$email}' AND password='{$password}'";
 $result = mysqli_query($conn, $sql);
 if (mysqli_num_rows($result) === 1) {
$row = mysqli_fetch_assoc($result);
 if (empty($row['code'])) {
 $_SESSION['SESSION_EMAIL'] = $email;
 header("Location: welcome.php");
 } else {
 $msg = "<div class='alert alert-info'>First verify your account and try again.</div>";
 }
 } else {
 $msg = "<div class='alert alert-danger'>Email or password do not match.</div>";
 }
 }
?>
<!DOCTYPE html>
<html lang="zxx">
<head>
 <title>Forest fire detection</title>
 <!-- Meta tag Keywords -->
 <meta name="viewport" content="width=device-width, initial-scale=1">
 <meta charset="UTF-8" />
<meta name="keywords"
content="Login Form" /> <!--
```

```
//Meta tag Keywords -->
 <link href="//fonts.googleapis.com/css2?family=Poppins:wght@300;400;500;600&display=swap"
rel="stylesheet">
 <!--/Style-CSS -->
 <link rel="stylesheet" href="css/style.css" type="text/css" media="all" /> <!--//StyleCSS -->
 <script src="https://kit.fontawesome.com/af562a2a63.js" crossorigin="anonymous"></script>
</head>
<body>
 <!-- form section start -->
 <section class="w3l-mockup-form">
 <div class="container">
 <!-- /form -->
 <div class="workinghny-form-grid">
 <div class="main-mockup">
 <div class="alert-close">
 <span class="fa fa-close"></span>
 </div>
 <div class="w3l_form align-self">
 <div class="left_grid_info">
 <img src="login1.jpeg" alt="">
 </div>
 </div>
 <div class="content-wthree">
 <h2>Login Now</h2>

 <?php echo $msg; ?>
 <form action="" method="post">
```

```
 <input type="email" class="email" name="email" placeholder="Enter Your Email"
required>
 <input type="password" class="password" name="password" placeholder="Enter
Your Password" style="margin-bottom: 2px;" required>
 <p><a href="forgot-password.php" style="margin-bottom: 15px; display: block;
textalign: right;">Forgot Password?</a></p>
 <button name="submit" name="submit" class="btn" type="submit">Login</button>
 </form>
 <div class="social-icons">
 <p>Create Account! <a href="register.php">Register</a>.</p>
 </div>
 </div>
 </div>
 </div>
 <!-- //form -->
 </div>
 </section>
 <!-- //form section start -->
 <script src="js/jquery.min.js"></script>
 <script>
 $(document).ready(function (c) {
 $('.alert-close').on('click', function (c) {
 $('.main-mockup').fadeOut('slow', function (c) {
 $('.main-mockup').remove();
 });
 });
 });
```

```
 </script>
</body>
</html>
```

REGISTER.PHP

```
<?php
 //Import PHPMailer classes into the global namespace
 //These must be at the top of your script, not inside a function
use PHPMailer\PHPMailer\PHPMailer; use
PHPMailer\PHPMailer\SMTP; use
PHPMailer\PHPMailer\Exception;
 session_start(); if
(isset($_SESSION['SESSION_EMAIL'])) {
header("Location: welcome.php");
 die();
 }
 //Load Composer's autoloader
require 'vendor/autoload.php';
 include 'config.php';
 $msg = "";
 if (isset($_POST['submit'])) {
 $name = mysqli_real_escape_string($conn, $_POST['name']);
 $email = mysqli_real_escape_string($conn, $_POST['email']);
 $password = mysqli_real_escape_string($conn, md5($_POST['password']));
 $confirm_password = mysqli_real_escape_string($conn, md5($_POST['confirm-password']));
$code = mysqli_real_escape_string($conn, md5(rand()));
 if (mysqli_num_rows(mysqli_query($conn, "SELECT * FROM users WHERE email='{$email}'")) >
0)
```

```
{
 $msg = "<div class='alert alert-danger'>{$email} - This email address has been already
exists.</div>";
 } else {
 if ($password === $confirm_password) {
 $sql = "INSERT INTO users (name, email, password, code) VALUES ('{$name}', '{$email}',
'{$password}', '{$code}')";
 $result = mysqli_query($conn, $sql);
 if ($result) { echo "<div
style='display: none;'>";
 //Create an instance; passing `true` enables exceptions
$mail = new PHPMailer(true);
 try {
 //Server settings
 $mail->SMTPDebug = SMTP::DEBUG_SERVER; //Enable verbose debug
output
 $mail->isSMTP(); //Send using SMTP
 $mail->Host = 'smtp.gmail.com'; //Set the SMTP server to send through
 $mail->SMTPAuth = true; //Enable SMTP authentication
 $mail->Username = 'forestfiredetection13@gmail.com
'; //SMTP username
 $mail->Password = 'nolubeunltmkypfl'; //SMTP password
 $mail->SMTPSecure = PHPMailer::ENCRYPTION_SMTPS; //Enable implicit TLS
encryption
 $mail->Port = 465; //TCP port to connect to; use 587 if you have
set `SMTPSecure = PHPMailer::ENCRYPTION_STARTTLS`
 //Recipients
```

```
 $mail->setFrom('smartroadsafety247@gmail.com'); $mail-
>addAddress($email);
 //Content
 $mail->isHTML(true); //Set email format to HTML
 $mail->Subject = 'forestfiredetection13 register form';
 $mail->Body = ' click here to login <b><a
href="http://localhost/login/?verification='.$code.'">
http://localhost/login/?verification='.$code.'</a></b>';
 $mail->send();
echo 'Message has been sent';
 } catch (Exception $e) { echo "Message could not be
sent. Mailer Error: {$mail->ErrorInfo}";
 }
 echo "</div>";
 $msg = "<div class='alert alert-info'>We've send a verification link on your email
address.</div>";
 } else {
 $msg = "<div class='alert alert-danger'>Something wrong went.</div>";
 }
 } else {
 $msg = "<div class='alert alert-danger'>Password and Confirm Password do not
match</div>";
 }
 }
 }
?>
<!DOCTYPE html>
```

```
<html lang="zxx">
<head>
 <title>Forest fire detection</title>
 <!-- Meta tag Keywords -->
 <meta name="viewport" content="width=device-width, initial-scale=1">
 <meta charset="UTF-8" />
<meta name="keywords"
content="Login Form" />
 <!-- //Meta tag Keywords -->
 <link href="//fonts.googleapis.com/css2?family=Poppins:wght@300;400;500;600&display=swap"
rel="stylesheet">
 <!--/Style-CSS -->
 <link rel="stylesheet" href="css/style.css" type="text/css" media="all" /> <!--//StyleCSS -->
 <script src="https://kit.fontawesome.com/af562a2a63.js" crossorigin="anonymous"></script>
</head>
<body>
 <!-- form section start -->
 <section class="w3l-mockup-form">
 <div class="container">
 <!-- /form -->
 <div class="workinghny-form-grid">
 <div class="main-mockup">
 <div class="alert-close">
 <span class="fa fa-close"></span>
 </div>
 <div class="w3l_form align-self">
 <div class="left_grid_info">
```

```
<img src="reg1.jpeg" alt="">
</div>
</div>
<div class="content-wthree">
<h2>Register Now</h2>

<?php echo $msg; ?>
<form action="" method="post">
<input type="text" class="name" name="name" placeholder="Enter Your Name"
value="<?php if (isset($_POST['submit'])) { echo $name; } ?>" required>
<input type="email" class="email" name="email" placeholder="Enter Your Email"
value="<?php if (isset($_POST['submit'])) { echo $email; } ?>" required>
<input type="password" class="password" name="password" placeholder="Enter
Your Password" required>
<input type="password" class="confirm-password" name="confirm-password"
placeholder="Enter Your Confirm Password" required>
<button name="submit" class="btn" type="submit">Register</button>
</form>
<div class="social-icons">
<p>Have an account! <a href="index.php">Login</a>.</p>
</div>
</div>
</div>
</div>
<!-- //form -->
</div>
</section>
```

```
<!-- //form section start -->
<script src="js/jquery.min.js"></script>
<script>
$(document).ready(function (c) {
$('.alert-close').on('click', function (c) {
$('.main-mockup').fadeOut('slow', function (c) {
$('.main-mockup').remove();
});
});
});
</script>
</body>
</html>
```

WELCOME.PHP

```
<?php
session_start(); if
(!isset($_SESSION['SESSION_EMAIL'])) {
header("Location: index.php");
die();
}
include 'config.php';
$query = mysqli_query($conn, "SELECT * FROM users WHERE
email='{$_SESSION['SESSION_EMAIL']}'");
if (mysqli_num_rows($query) > 0) {
$row = mysqli_fetch_assoc($query);
echo "Welcome " . $row['name'] . " <a href='logout.php'>Logout</a>";
}
```

?>

FORGET PWD.PHP

```
<?php
session_start(); if
(isset($_SESSION['SESSION_EMAIL'])) {
header("Location: welcome.php");
 die();
}
//Import PHPMailer classes into the global namespace
//These must be at the top of your script, not inside a function
use PHPMailer\PHPMailer\PHPMailer; use
PHPMailer\PHPMailer\SMTP; use
PHPMailer\PHPMailer\Exception;
//Load Composer's autoloader require
'vendor/autoload.php';
include 'config.php';
$msg = "";
if (isset($_POST['submit'])) {
 $email = mysqli_real_escape_string($conn, $_POST['email']);
 $code = mysqli_real_escape_string($conn, md5(rand()));
 if (mysqli_num_rows(mysqli_query($conn, "SELECT * FROM users WHERE email='{$email}'")) >
0) {
 $query = mysqli_query($conn, "UPDATE users SET code='{$code}' WHERE email='{$email}'");
 if ($query) { echo "<div
style='display: none;'>";
 //Create an instance; passing `true` enables exceptions
 $mail = new PHPMailer(true);
```

```
try {
//Server settings
$mail->SMTPDebug = SMTP::DEBUG_SERVER; //Enable verbose debug output
$mail->isSMTP(); //Send using SMTP
$mail->Host = 'smtp.gmail.com'; //Set the SMTP server to send through
$mail->SMTPAuth = true; //Enable SMTP authentication
$mail->Username = 'forestfiredetection13@gmail.com'; //SMTP username
$mail->Password = 'nolubeunltmkypfl'; //SMTP password
$mail->SMTPSecure = PHPMailer::ENCRYPTION_SMTPS; //Enable implicit TLS
encryption
$mail->Port = 465; //TCP port to connect to; use 587 if you have set
`SMTPSecure = PHPMailer::ENCRYPTION_STARTTLS`
//Recipients
$mail->setFrom('forestfiredetection13@gmail.com');
$mail->addAddress($email);
//Content
$mail->isHTML(true); //Set email format to HTML
$mail->Subject = 'smartroadsafety247 reset password';
$mail->Body = 'reset link <b><a
href="http://localhost/login/changepassword.php?reset='.$code.'">http://localhost/login/changepas
sword.php?reset='.$code.'</a></b>';
$mail->send(); echo
'Message has been sent';
} catch (Exception $e) { echo "Message could not be sent.
Mailer Error: {$mail->ErrorInfo}";
}
echo "</div>";
```

```
 $msg = "<div class='alert alert-info'>We've send a verification link on your email
address.</div>";
 }
 } else {
 $msg = "<div class='alert alert-danger'>$email - This email address do not found.</div>";
 }
}
?>
<!DOCTYPE html>
<html lang="zxx">
<head>
 <title>Forest fire detection</title>
 <!-- Meta tag Keywords -->
 <meta name="viewport" content="width=device-width, initial-scale=1">
 <meta charset="UTF-8" />
<meta name="keywords"
content="Login Form" />
 <!-- //Meta tag Keywords -->
 <link href="//fonts.googleapis.com/css2?family=Poppins:wght@300;400;500;600&display=swap"
rel="stylesheet">
 <!--/Style-CSS -->
 <link rel="stylesheet" href="css/style.css" type="text/css" media="all" /> <!--//StyleCSS -->
 <script src="https://kit.fontawesome.com/af562a2a63.js" crossorigin="anonymous"></script>
</head>
<body>
 <!-- form section start -->
 <section class="w3l-mockup-form">
```

```
<div class="container">
<!-- /form -->
<div class="workinghny-form-grid">
<div class="main-mockup">
<div class="alert-close">
<span class="fa fa-close"></span>
</div>
<div class="w3l_form align-self">
<div class="left_grid_info">
<img src="fog1.jpeg" alt="">
</div>
</div>
<div class="content-wthree">
<h2>Forgot Password</h2>

<?php echo $msg; ?>
<form action="" method="post">
<input type="email" class="email" name="email" placeholder="Enter Your Email"
required>
<button name="submit" class="btn" type="submit">Send Reset Link</button>
</form>
<div class="social-icons">
<p>Back to! <a href="index.php">Login</a>.</p>
</div>
</div>
</div>
</div>
```

```
<!-- //form -->
</div>
</section>
<!-- //form section start -->
<script src="js/jquery.min.js"></script>
<script>
$(document).ready(function (c) {
$('.alert-close').on('click', function (c) {
$('.main-mockup').fadeOut('slow', function (c) {
$('.main-mockup').remove();
});
});
});
</script>
</body>
</html>
```

LOGOUT.PHP

```
<?php
session_start(); session_unset();
session_destroy();
header("Location: index.php");
```

13.2 GitHub & Project Demo Link

https://github.com/IBM-EPBL/IBM-Project-34665-1660256754

https://youtu.be/6L84NAULtcY