Project Report On

Emerging Methods For Early Detection of Forest Fires

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ABSTRACT

Forest fires are occurring throughout the year with an increasing intensity in the summer and autumn periods. These events are mainly caused by the actions of humans, but different nature and environmental phenomena,likelightning strikes or spontaneous combustion of dried leafs or sawdust, can also be credited for their occurrence. Regardless of the reasons for the ignition of the forest fires, they usually cause devastating damage to both nature and humans. Forest fires are also considered as a main contributor to the air pollution, due to the fact that during every fire huge amounts of gases and particle mater are released in the atmosphere.To fight forest fires, different solutions were employed throughout the years. They ware primary aimedat the early detection of the fires. The simplest of these solutions is the establishment of a network of observation posts – both cheap and easy to accomplish,but also time-consuming for the involved people. The constant evolution of the information and communication technologies has led to the introduction of a new generation of solutions for early detection and even prevention of forest fires. ICT-based networks of cameras and sensors and even satellite based solutions were developed and used in the last decades. These solutions have greatly decreased the direct involvement of humans in the forest fire detection process, but have also proven to be expensive and hard to maintain.

1.INTRODUCTION

1.1 PROJECT OVERVIEW

In this paper we will discuss and present two different emerging solutions for early detection of forest fires. The first of these solutionsinvolves the use of unmanned aerial vehicles(UAVs) with specialized cameras. Several different scenarios for the possible use of the drones for forest fire detection will be presented and analysed, including a solution with the use of a combination between a fixed-wind and a rotary-wing UAVs.In the next chapter of the paper, we will present and discuss the possibilities for development of systems for early forest fire detection using LoRaWAN sensor networks and we will analyse and present some of the hardware and software components for the realisation of such sensor networks.The paper will also provide another point-of-view, which will present the involvement of students in the development and in the use of both systems and we will analyse the advantages and the benefits, which the students will gain from their work on and with these solutions.

1.2 PURPOSE

Detection of forest fire and smoke in wildland areas is done through remote sensing-based methods such as satellites, high-resolution static cameras fixed on the ground, and unmanned aerial vehicles (UAVs). Optical/thermal cameras deployed on the observationtowers together with the other sensors such as smoke, temperature, and humidity sensors might detect the hazards in theclosed environment rather than in the open environment as these sensors need vicinity to the fire or smoke. Information obtained through these sensors is not appropriate. Distance covered by these methods could be limited, and to cover a large area,more sensors have to be deployed that might incur expenses. Through the deployment of UAV, large areascould be covered, and the images with high spatial and temporal resolutions could be captured properly. The operational cost is very low when compared with the other methods.

2. LITERATURE REVIEW

2.1 EXISTING PROBLEM

2.1.1. TITLE: Generic model for fire and smoke detection without the use of sensors, 2007

AUTHOR NAME: Celik

Fuzzy based approach is used in this system. Color models such as YCbCr, HSV are used for fire and smoke detection. The fire is detected using YCbCr color model samples because it distinguishes luminance and chrominance. Y, Cb, Cr color channels are separated from RGB input image. A pixel is more likely a fire pixel if intensity of Y channel is greater than channel Cb and Cr.

2.1.2. TITLE: Fire detection method based on probabilistic method and classification, 2008

AUTHOR NAME: Paulo Vinicius Koerich Borges

Computer vision based approach is used in this approach. Though this approach is used surveillance it is also used to automatic video classification for retrieval of fire catastrophes in databases of newscast content.There are large variations in fire and background characteristics depending on the video instance. The proposed method observes the frame-to-frame changes of low-level features describing potential fire regions. These features include color, area size, surface coarseness, boundary roughness, and skewness within estimated fire regions. Bayes classifier is used for fire recognition. In addition, apriori knowledge of fire events captured in videos is used to significantly improve the results. The fire region is usually located in the center of each frame. This fact is used to model the probability of occurrence of fire.

2.1.3. TITLE: Computer vision approach for fire-flame detection is used to detect fire at an early stage , 2015

AUTHOR NAME: Dimitropoulos

Initially, background subtraction and color analysis is used to define candidate fire regions in a frame and this approach is a non-parametric
model. Following this, the fire behavior is modeled by employing various Spatiotemporal features such as color probability, flickering, spatial and spatiotemporal energy. After flame modeling the dynamic texture analysis is applied in each candidate region using Linear Dynamical Systems, Histogram and Mediods. LDS is used to increase the robustness of the algorithm by analyzing temporal evolution of pixel intensities. Pre-processing is done after this to filter non-candidate regions. Spatiotemporal analysis is done to increase the reliability of the algorithm. The consistency of each candidate fire region is estimated to determine the existence of fire in neighboring blocks from the current and previous video frames. Finally, a two-class SVM classifier is used to classify the fire and no fire regions.

2.1.4. TITLE: Method to detect fire based on Wavelet Transform, 2018

AUTHOR NAME: R.Gonzalez

Stationary Wavelet Transform is used to detect Region of Interest. This method involves three steps preprocessing, SWT, histogram analysis. In preprocessing unwanted distortions are removed and image is resized and transformation of resized image is performed. High frequencies of an image are eliminated using SWT and the reconstruction of image is done by inverse SWT. Image indexation is performed to group the intensity colors that are closed to each other. Histogram analysis is used to determine the various levels of indexation. After analysis a comparison is made with non-smoke frame and non-smoke images are eliminated. These three are combined and fire is detected.

2.1.5. TITLE: Fire detection system based on Neural Network , 2011

AUTHOR NAME: Cheng

Neural network is used in detection information for temperature, CO
concentration, and smoke density to determine probability of three representative fire conditions. RBF neuron structure is used, the information regarding temperature, CO concentration, and smoke density are collected and data fusion is used to generate fire signal decision.The detectors have continuous analog outputs, when detection limit is exceeded the hardware circuit sends a local fire indication to fusion center, this force the system detectors to generate final decision. Single-sensor detector is used to generate the final decision.

2.2 REFERENCES

- Kosmas Dimitropoulos, Panagiotis Barmpoutis, and Nikos Grammalidis (2015). Spatio Temporal Flame Modeling and Dynamic Texture Analysis for automatic video-based fire detection, IEEE transactions on circuits and systems for video technology, vol. 25, no. 2.

- Turgay Celik, Huseyin Ozkaramanl, and Hassan Demirel (2007). Fire and Smoke detection without Sensors: Image Processing based approach.15th European signal processing conference (eusipco 2007), Poznan, Poland, September 3-7.

- CHENG Caixia, SUN Fuchun, ZHOU Xinquan (2011). One Fire Detection Method Using Neural Networks, Tsinghua Science and Technology, ISSN 1007-0214 05/17 31-35Volume 16, Number 1.

- Paulo Vinicius Koerich Borges (2010). A Probabilistic Approach for Vision- Based Fire Detection in Videos, IEEE transactions on circuits and systems for video technology, vol. 20, no. 5.

- Rafael C. Gonzalez and Richard E. Woods. Digital Image Processing. Pearson publication, Third Edition

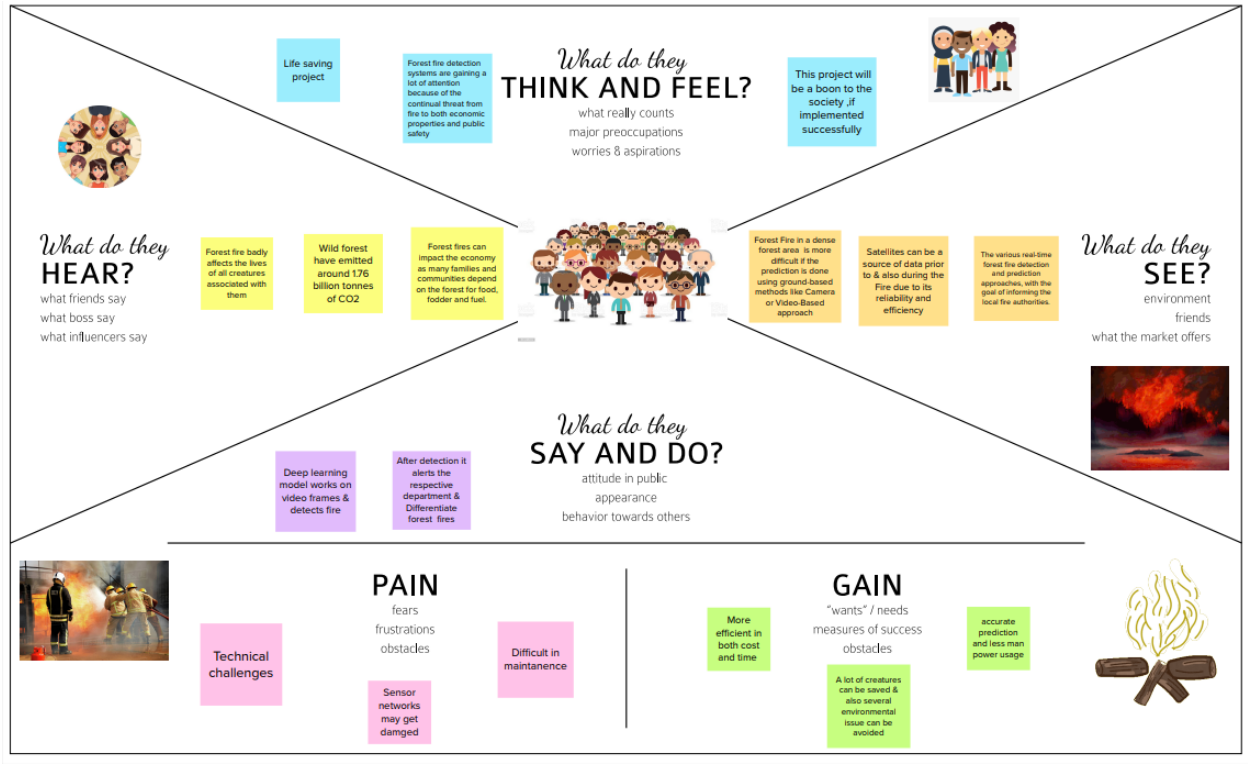
2.3 PROBLEM STATEMENT DEFINITION

Prevention, prediction, forecasting and post-incident damage assessment are key com ponents of the fight against forest fires; however, this work will focus essentially on detection and ongoing incident damage assessment. In particular, the methods exploit- ing neural networks will be given special attention since these families of algorithms have been known to show state-of-the-art performances at many tasks including detec tion and assessment. To detect and assess forest fires efficiently, multiple methods that leverage machine learning have been suggested in the past few years. They can first be distinguished in terms of the infrastructure that enables them to gather data to their predictions on many of satellite like 98,51,54,60,24,111,104,68,6,95,63,2,62,112 Unmanned Aerial Vehicle (UAV), 19,57,25 closed-circuit television (CCTV)118,116,4 or Wireless Sensor Net- work (WSN). 1,5,90,79,7,45,46,26,115,85 Each of them has its own strengths and weak nesses which will be reviewed .

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

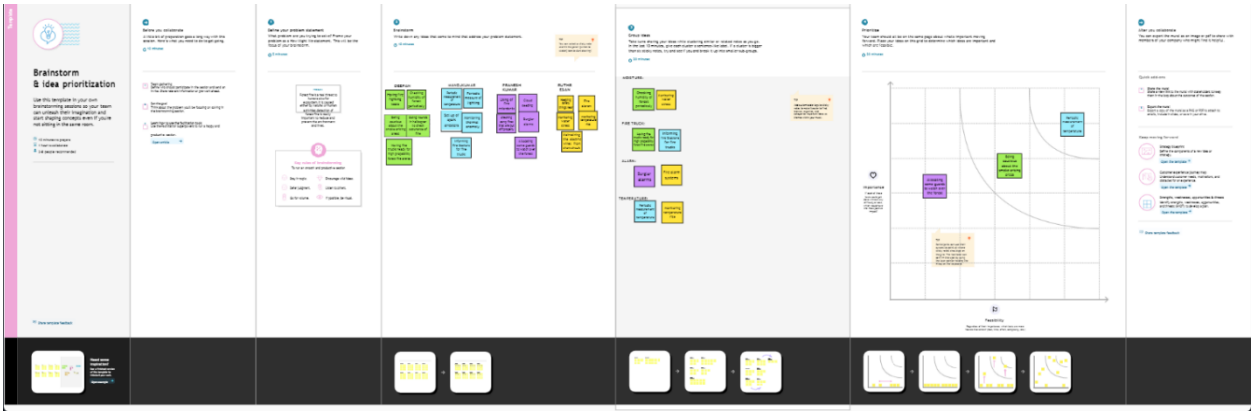
An empathy map is a collaborative visualization used to articulate what we know about a particular type of user. It externalizes knowledge about users in order to 1) create a shared understanding of user needs, and 2) aid in decision making.
Traditional empathy maps are split into 4 quadrants (Says, Thinks, Does, and Feels), with the user or persona in the middle. Empathy maps provide a glance into who a user is as a whole and are not chronological or sequential.



3.2 Ideation & Brainstroming

Brainstorming is a method design teams use to generate ideas to solve clearly defined design problems. In controlled conditions and a free-thinking environment, teams approach a problem by such means as “How Might We” questions. They produce a vast array of ideas and draw links between them to find potential solutions.

Everyone in a design team should have a clear definition of the target problem. They typically gather for a brainstorming session in a room with a large board/wall for pictures/Post-Its. A good mix of participants will expand the experience pool and therefore broaden the idea space.



3.3 Proposed solution

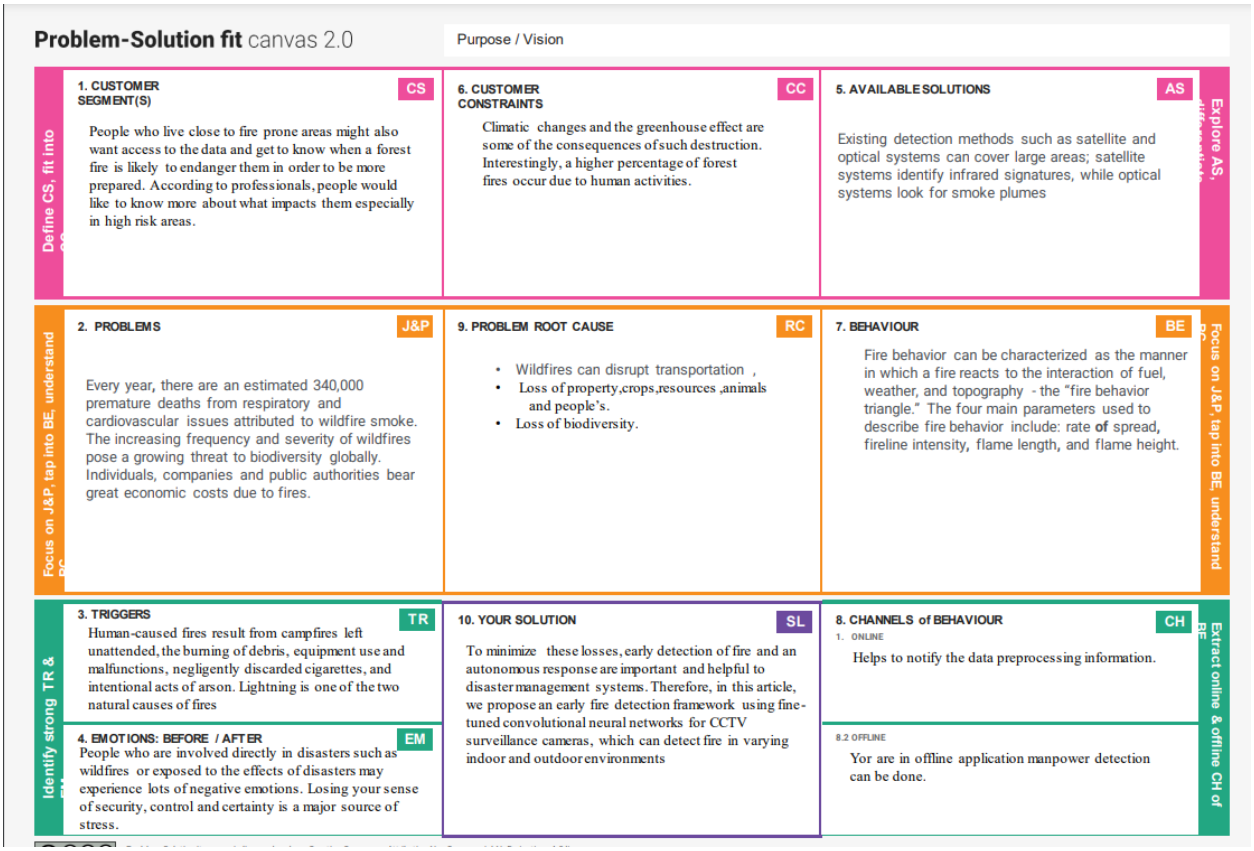
Proposed Solution means the technical solution to be provided by the Implementation agency in response to the requirements and the objectives of the Project.Proposed Solution means the Proposed System with modifications that meet the Agency's requirements as set forth in this RFP.Proposed Solution means the combination of software, hardware, other products or equipment, and any and all services (including any installation, implementation, training, maintenance and support services) necessary to implement the solution described by Vendor in its Proposal.

S.No.	Parameter	Description
1.	**Problem Statement (Problem to be solved)**	AI based Emerging methods for early detection of forest fires
2.	**Idea / Solution description**	A solution is needed that detects fires early by detecting smoke, hydrogen and other gases released by pyrolysis in the early stages of a wildfire, buying firefighters valuable time to extinguish the fire before it spreads out of control. Sensing solutions from Bosch Sensortec can help to reduce wildfires.
3.	**Novelty / Uniqueness**	Remote sensing Machine learning Wildfire prediction Data mining using **Artificial intelligence**
4.	**Social Impact / Customer Satisfaction**	The most important factors in the fightagainst the forest fires include the earliestpossible detection of the fire event , theproper categorisation of the fire and fastresponse from the fire services . Severaldifferent types of forest fires are known , including ground fires , surface fires andcrown / tree fires . Each of these types offorest fires is specific and the propercounteractions against it must be consideredand implemented to successfully fight it .Over the years the detection of forest fires has been conducted in different ways ,ranging from the use of forest outposts to fully automated solutions .

5.	**Business Model (Revenue Model)**	The annual losses from forest fires in Indiafor the entire country have been moderately estimated at Rs 440 crores (US$ 107

3.4 Problem Solution Fit

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem.



4. REQUIREMENT ANALYSIS

4.1 Functional requirement

Functional requirements may involve calculations, technical details, data manipulation and processing, and other specific functionality that define what a system is supposed to accomplish. Behavioral requirements describe all the cases where thesystem uses the functional requirements, these are captured in use cases.

FR No.	**Functional Requirement (Epic)**	**Sub Requirement (Story / Sub-Task)**
FR-1	User Registration	Registration through Form Registration th rough Gmail Registration through LinkedIN
FR-2	Image capture	Capture image of forest Check the forest if fired
FR-3	Image Processing	Upload the forestimage Start detection
FR-4	Forest fire prediction	Identify the parameters to be considered for the identification of forest fire
FR-5	Fire descrption	Show the recommended rescue measur es for the forest fire
FR-6	Providing dataset	Training dataset Testing dataset
FR-7	Adding dataset	Forest fire dataset

FR-8	Updated Native Language options	Language can be changed according to the user wish

4.2 Non-Functional requirements

In systems engineering and requirements engineering, a non-functional requirement (NFR) is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviours.

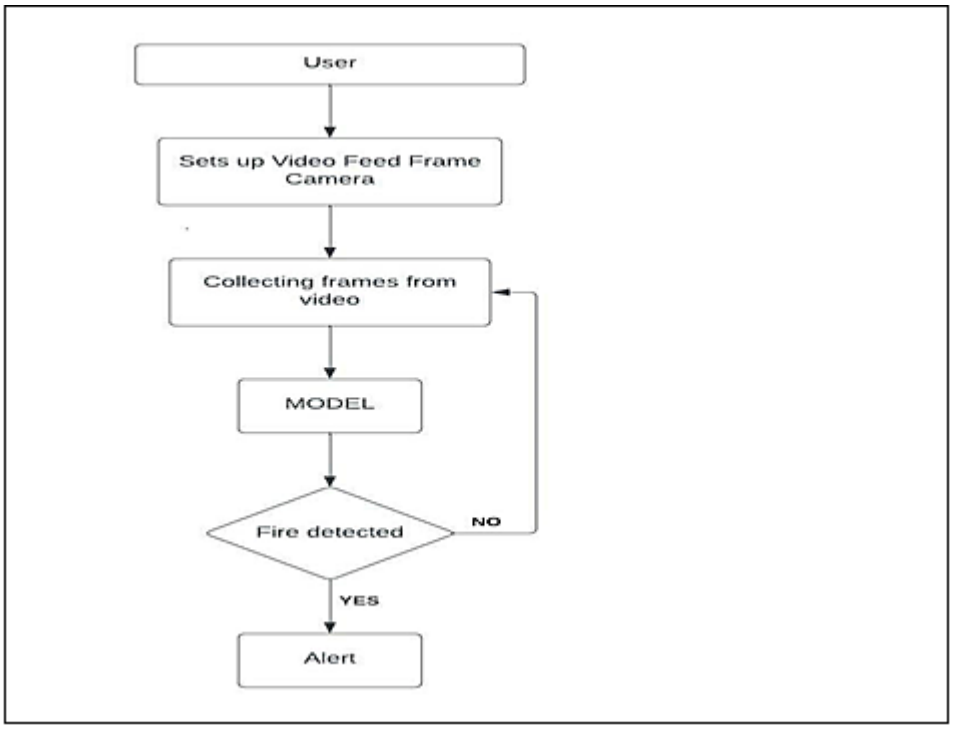
FR No.	**Non-Functional Requirement**	**Description**
NFR-1	**Usability**	Forest fire dataset can be used for detection of all kind of forest's dataset can be reusable datasets can be prepared according to the leaf
NFR-2	**Security**	User information and forest data are secured The algorithm used are moresecure
NFR-3	**Reliability**	The fore fireis more The dataset and image captureing performsconsistenly well

NFR-4	**Performance**	Forest fire defines once the fire is detected Performs wellaccordingly t o the quality of forest fire
NFR-5	**Availability**	Forest fire willused again fordetection

5. PROJECT DESIGN

5.1 Data Flow Diagrams

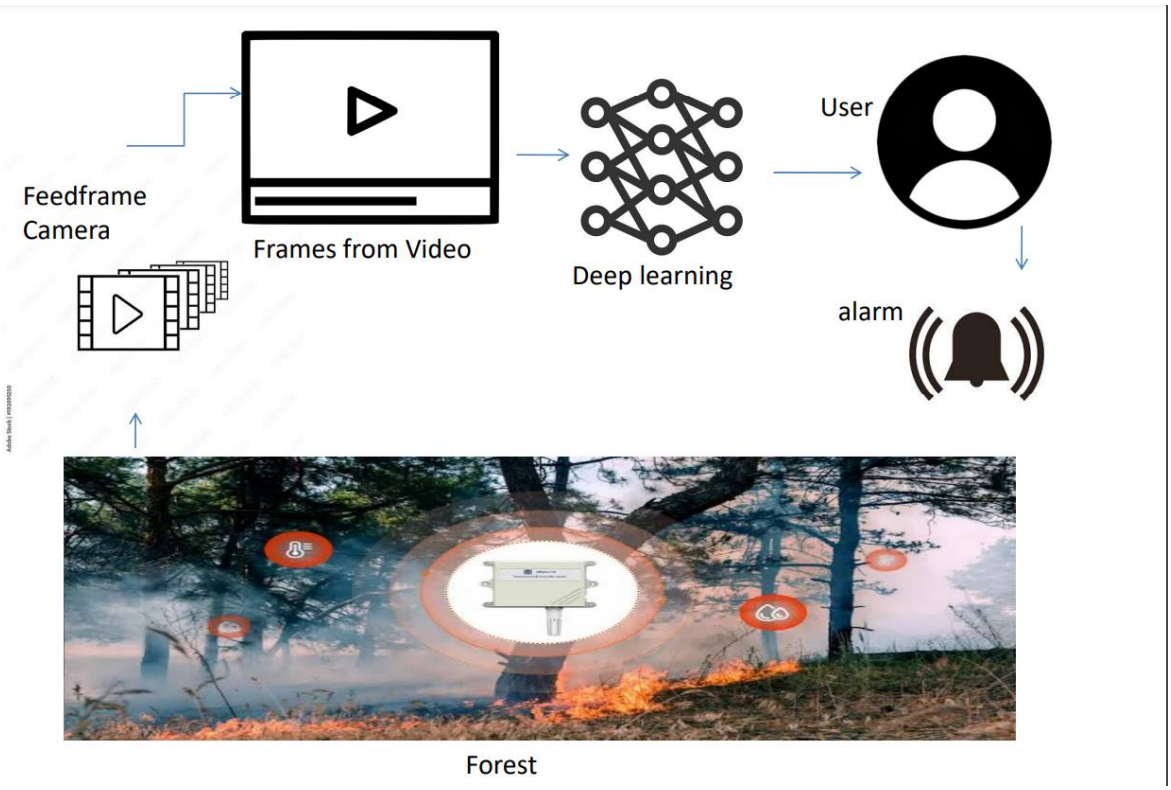
A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



5.2 Solution & Technical Architecture

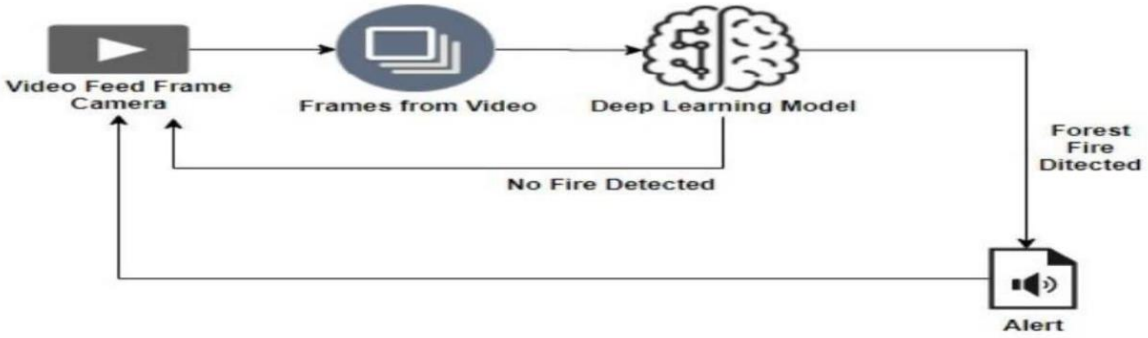
Solution Architecture:

A solution architecture (SA) is an architectural description of a specific solution. SAs combine guidance from different enterprise architecture viewpoints (business, information and technical), as well as from the enterprise solution architecture (ESA).



Technical Architecture:

Technical Architecture (TA) is a form of IT architecture that is used to design computer systems. It involves the development of a technical blueprint with regard to the arrangement, interaction, and interdependence of all elements so that systemrelevant requirements are met.



5.3 User Stories

A user story is an informal, general explanation of a software feature written from the perspective of the end user or customer. The purpose of a user story is to articulate how a piece of work will deliver a particular value back to the customer.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user,I can register for the application byentering my email, password, and confirmingmy password.	I can access my account /dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation emailonce I have registered for the application	I canreceive confirmationemail& click confirm	High	Sprint-1
		USN-3	As a user, I can register for the applicationthrough Facebook	I can register & access thedashboard with Facebook Login	high	Sprint-2
		USN-4	As a user, I can register for the applicationthrough Gmail		Low	Sprint-1
	Login	USN-1	As a user, I can log into the application byenteri	They can access the details a	High	Sprin

			ng email & password	nd dashboar d		t- 1
Custom er (Web user)	Regist ration	USN-3	Login into executive portal to hel p the user	Help in accessing the moment and the aces s	Hi g h	S pr in t- 1
Custo mer Ca reExec utive	Help d ashbo ard	USN-2	Can provide the necessary details of help through desired way like emails,mo biles andSMS		M e di u m	S pr in t- 1
Administ rator	U se r a c c o u nt c o nt ro l	USN-4	The person who is responsible for the websitecontr ol and otherman agement	Provides supp ortto forestfire predection	Hi g h	S pr in t- 1

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

In Scrum Projects, Estimation is done by the entire team during Sprint Planning Meeting. The objective of the Estimation would be to consider the User Stories for the Sprint by Priority and by the Ability of the team to deliver during the Time Box of the sprint.

Sprint	FunctionalRequirement(Epic)	UserStory Number	UserStory/Task	StoryPoints	Priority	TeamMembers
Sprint-1	Datacollectionandp repocessing	USN-1	Collectingthedorestfiredataset	2	High	Deepan Pranesh kumar
Sprint-1		USN-2	Labellingthedatasetaccordingtoclass	1	High	Manojkumar Ruthresan
Sprint-1		USN-3	Someoftheforestfireis labeledaccordingly	2	Low	Ruthresan
Sprint-1		USN-4	Datasetwillcontainforestfireprediction	Qsz1z	Medium	Pranesh kumar
Sprint-1	Preprocessing	USN-5	Topreparerawdatain aformatthatthenetwork canaccept	1	High	ManojkumarDeepan Ruthresan
Sprint-1		USN-6	Scalingisusedformakingdatapointsgeneralized	1	Low	Deepan
Sprint-1		USN-7	Shear range imagewill be disorted along anaxis,mostlytocreateorrectifythepercepti onangle	3	High	Pranesh kumarManojkumar
Sprint-1		USN-8	Zoomaugmentationwillrandomlyzoomtheimageand adds newpixelsfortheimage	2	Medium	Ruthresan Pranesh kumar
Sprint-1		USN-9	Flippingtheentirepixellsofanimage	1	Low	Manojkumar
Sprint-2	Training,Testingand Creating amodel	USN-10	Start initialthemodel	2	Medium	Deepan Ruthresan
Sprint-2		USN-11	Addingdifferencelayersofcnn	1	High	ManojkumarDeepan Ruthresan Pranesh kumar

Sprint	FunctionalRequirement(Epic)	UserStory Number	UserStory/Task	StoryPoints	Priority	TeamMembers
Sprint-2		USN-12	Creatingcompilingwithadamoptimizer	4	Medium	Pranesh kumarRuthresan
Sprint-2		USN-13	Creatingmetrics	3	Low	Manojkumar
Sprint-2		USN-14	Trainthedatawith20 epoch	1	Medium	Deepan Manojkumar
Sprint-2		USN-15	Testingthemodel	5	High	Pranesh kumarManojkumar Deepan Ruthresan
Sprint-2		USN-16	Savethemodel	2	Medium	Pranesh kumarRuthresan
Sprint-2	Flaskandframe workdesign	USN-17	Creatingbackendframeworkwithflask	4	Low	Manojkumar
Sprint-3		USN-18	Importingthemodelfile	3	High	Deepan Manojkumar
Sprint-3		USN-19	Serverstartup,requestandserviceinaloop	1	Medium	Ruthresan Pranesh kumar
Sprint-3	Frontend webapplicationdevelopement	USN-20	Creatingahtmltemplatewithcssfile	2	Low	Pranesh kumar
Sprint-3		USN-21	Usercanimportforestfirein webpage	5	Medium	Manojkumar
Sprint-4		USN-22	Predictingwhereisfireoccurredforthegiveninp ut	4	High	Deepan Manojkumar
Sprint-4		USN-23	Usercanclassify asforestfiredornot	3	Low	Pranesh kumar
Sprint-4		USN-24	Alerttheadminaboutthepredectionwithhegmail	2	Medium	Ruthresan Manojkumar

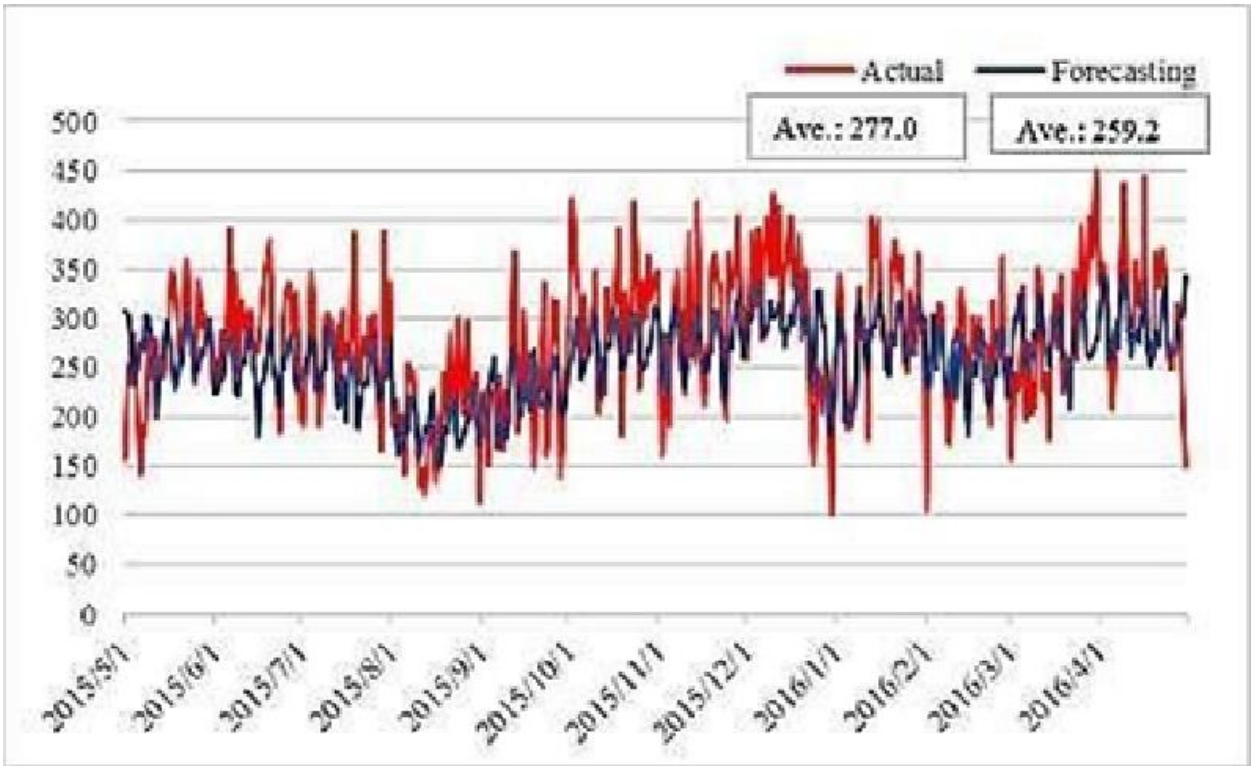
6.2 Sprint Delivery Schedule

A sprint schedule is a document that outlines sprint planning from end to end. It's one of the first steps in the agile sprint planning process—and something that requires adequate research, planning, and communication.

Sprint	Total StoryPoints	Duration	SprintStartDate	SprintEndDate(Planned)	Story PointsCompleted (asonPlannedEndDate)	SprintReleaseDate(Actual)
Sprint-1	20	6Days	24Oct2022	29Oct2022	20	29Oct2022
Sprint-2	20	6Days	31Oct2022	05Nov2022	20	3Nov2022
Sprint-3	20	6Days	07Nov2022	12Nov2022	20	10Nov2022
Sprint-4	20	6Days	14Nov2022	19Nov2022	20	17Nov2022

6.3 Reports From JIRA

Jira helps teams plan, assign, track, report, and manage work and brings teams together for everything from agile software development and customer support to startups and enterprises. Software teams build better with Jira Software, the #1 tool for agile teams.



7. CODING & SOLUTIONING

```
import cv2
import numpy as np
from tensorflow.keras.preprocessing import image
from tensorflow.keras.models import load_model
from twilio.rest import Client
from playsound import playsound
from decouple import config


message_sent = False

model = load_model("./model.h5")

video = cv2.VideoCapture("fire.mp4")

name = ["No fire", "Fire Detected"]


def send_message():
    account_sid = config("ACCOUNT_SID")
    auth_token = config("AUTH_TOKEN")

    client = Client(account_sid, auth_token)
    message = client.messages.create(
        body="Forest Fire detected , Stay safe!!!",
        from_=config("FROM"),
        to=config("TO")
    )
    print(message.sid)
    print("Fire Detected")
    print("SMS Sent!")

playsound("./beep.mp3")
```

```
while True:
    success, frame = video.read()
    cv2.imwrite("image.jpg", frame)
    img = image.load_img("image.jpg", target_size=(128, 128))
    x = image.img_to_array(img)
    x = np.expand_dims(x, axis=0)
    pred = model.predict(x)
    p = int(pred[0][0])
    cv2.putText(frame, str(name[p]), (100, 100), cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 0), 1)

    if p == 1:
        if not message_sent:
            send_message()
            message_sent = True
        print("Fire Detected , stay safe!!!")
    else:
        print("No Fire Detected")

    cv2.imshow("Image", frame)

    if cv2.waitKey(1) & 0xFF == ord('x'):
        break

video.release()
cv2.destroyAllWindows()
```

8. TESTING

8.1 Test Cases

A test case includes information such as test steps, expected results and data while a test scenario only includes the functionality to be tested.

Component	Test Scenario	Steps To Execute	Test Data	Expected Result	Actual Result	Status	BUG ID	Executed By
Page	Check if user can upload their file	The sensor senses the fire	Sample 1.png	The input image should be uploaded to the application successfully	Working as expected	PASS		DEEPAN
Page	Check if user cannot upload unsupported files	1) The sensor senses the fire 2)checks with the pre-uploads images	installer.exe	The application should not allow user to select anon image file	User is able to upload any file	FAIL	BUG_HP_002	MANOJ KUMAR
Page	Checks whether the page redirects to the result page to the given output	1) The sensor senses the fire 2)checks with the pre-uploaded images 3)checks if there is fire detection	Sample 1.png	The page should redirect to the results page	Working as expected	PASS		MANOJ KUMAR
Backend	Checks if all the routes are working properly	1) The sensor senses the fire 2)checks with the pre-uploaded images 3)checks if there is fire detection	Sample 1.png	All the routes should properly work	Working as expected	PASS		RUTH ERSAN
Model	Check whether the model can handle various image sizes	1) Open the page in a specific device 2) Upload the input image 3) Repeat the above steps with different input	Sample 1.png Sample 1 XS.png Sample 1 XL.png	The model should rescale the image and predict the results	Working as expected	PASS		PRANESH KUMAR
Model	Check if the model predicts the digit	1) Open the page 2) Select the input images	Sample 1.png	The model should predict the number	Working as expected	PASS		DEEPAN
Model	Check if the model can handle complex input image	1) Open the page 2) Select the input images 3) Check the results	Complex Sample.png	The model should predict the number in the compex image	The model fails to identify the digit since the model is not built to handle such data	FAIL	BUG_M_001	RUTHER SAN
Result Page	Verify the elements	1) Open the page 2) Select the input image 3) Check if all the UI elements are displayed properly	Sample 1.png	The Result page must be displayed properly	Working as expected	PASS		PRANESH KUMAR
Result Page	Check if that image is displ ayed	1) Open the page 2) Select the input image	Sample 1.png	The input image should be displ	The size of the input image exceeds the	FAIL	BUG_RP_001	DEEPAN

8.2 User Acceptance Testing

User Acceptance Testing (UAT), which is performed on most UIT projects, sometimes called beta testing or end-user testing, is a phase of software development in which the software is tested in the "real world" by the intended audience or business representative.

8.2.1 DEFECT ANALYSIS

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Total
By Design	1	1	1	0	3
Duplicate	0	0	0	0	0
External	0	0	2	0	2
Fixed	3	1	0	1	5
Not Reproduced	0	0	0	1	1
Skipped	1	0	1	0	2
Won’t Fix	1	0	0	0	1
Total	6	3	4	3	14

8.2.2 TEST CASE ANALYSIS

Section	TotalCases	Not Tested	Fail	Pass
Client Application	10	0	2	8
Security	3	0	2	2
Performance	2	0	1	1
Exception Reporting	3	0	0	3

9. RESULTS

9.1 PERFORMANCE METRICS

Performance testing is the practice of evaluating how a system performs in terms of responsiveness and stability under a particular workload. Performance tests are typically executed to examine speed, robustness, reliability, and application size.

10. ADVANTAGES & DISADVANTAGES

10.1 ADVANTAGES

The proposed system detects the forest fire at a faster rate compared to existing system. It has enhanced data collection feature. The major aspect is that it reduces false alarm and also has accuracy due to various sensors present. It minimizes the human effort as it works automatically. This is very affordable due to which can be easilyaccessed. The main objective of our project is to receive an alert message throughan app to the respective user.

10.2 DISADVANTAGES

The electrical interference diminishes the effectiveness of radio receiver. The main drawback is that it has less coverage rangeareas.

11. APPLICATIONS

An application for forest fire detection has been developed as apart of ther research work.the application and its components are described as Proposed Environment, Component Overview and Discussions.

12. CONCLUSION

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

13. FUTURE SCOPE

This project is far from completeand there is a lot of room for improveme nt. Some of theimprovements that can be made to this project are as follows:

Additional pump can be added so that it automatically sends water when there is a fire breakout. Also industrial sensors can be used for better rangingand accuracy.

This project has endless potentialand can always be enhancedto become better.Implementing this concept in the real world will benefit several industries and reduce the workload on many workers,enhancing overall work efficiency.

14. APPENDIX

SOURCE CODE

```
import keras
import tensorflow

from tensorflow.keras.preprocessing.image import
ImageDataGenerator
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)
x_train = train_datagen.flow_from_directory(r'./Dataset/train_set/',
                                            target_size=(128, 128),
                                            batch_size=32,
                                            class_mode='binary')
x_test = train_datagen.flow_from_directory(r'./Dataset/test_set/',
                                           target_size=(128, 128),
                                           batch_size=32,
                                           class_mode='binary')
```

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Convolution2D, MaxPooling2D, Flatten

model = Sequential()
model.add(Convolution2D(32, (3,3), input_shape=(128, 128, 3), activation="relu"))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Flatten())
model.add(Dense(150,activation="relu"))
model.add(Dense(1, activation="sigmoid"))

model.compile(loss="binary_crossentropy",
              optimizer="adam",
              metrics=["accuracy"])
model.fit(x_train, steps_per_epoch=14, epochs=10, validation_data=x_test, validation_steps=4)
```

Save the model

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

Prediction

```
from tensorflow.keras.models import load_model
from tensorflow.keras.preprocessing import image
import numpy as np
import cv2
model = load_model("model.h5")
```

Reviewing the model

```
img = image.load_img("forest-fire.jpg")
x = image.img_to_array(img)
res = cv2.resize(x, dsize=(128, 128),
interpolation=cv2.INTER_CUBIC)
x = np.expand_dims(res, axis=0)
pred = model.predict(x)
pred = int(pred[0][0])
pred
```

```
import cv2
import numpy as np
from tensorflow.keras.preprocessing import image
from tensorflow.keras.models import load_model
from twilio.rest import Client
from playsound import playsound
from decouple import config
```

```
message_sent = False

model = load_model("./model.h5")

video = cv2.VideoCapture("fire.mp4")

name = ["No fire", "Fire Detected"]


def send_message():
    account_sid = config("ACCOUNT_SID")
    auth_token = config("AUTH_TOKEN")

    client = Client(account_sid, auth_token)
    message = client.messages.create(
        body="Forest Fire detected , Stay safe!!!",
        from_=config("FROM"),
        to=config("TO")
    )
    print(message.sid)
    print("Fire Detected")
    print("SMS Sent!")

playsound("./beep.mp3")
```

```
 while True:
    success, frame = video.read()
    cv2.imwrite("image.jpg", frame)
    img = image.load_img("image.jpg", target_size=(128, 128))
    x = image.img_to_array(img)
    x = np.expand_dims(x, axis=0)
    pred = model.predict(x)
    p = int(pred[0][0])
    cv2.putText(frame, str(name[p]), (100, 100),
cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 0), 1)


    if p == 1:
        if not message_sent:
            send_message()
            message_sent = True
        print("Fire Detected , stay safe!!!")
    else:
        print("No Fire Detected")


    cv2.imshow("Image", frame)


    if cv2.waitKey(1) & 0xFF == ord('x'):
        break
```

```
video.release()
cv2.destroyAllWindows()
```

Login.html

```
<!DOCTYPE html>
<html>
   <head>
      <style>
         body{
            background: url(429865.jpg);
            background-repeat: no-repeat;
            background-size: 100% 200%;
         }
         #fp{
          text-decoration: none;
         padding-left: 1rem;
         }
         #lgn{
          text-decoration: none;

         }
         .wholeform{
```

```
    height: 20rem;
    width: 16rem;
    border: 2.5px solid rgb(246, 60, 199);
    border-radius: 1.5rem;
    box-shadow: 1px 3px 5px 2px rgba(13,12,13,1);
    transform: translateX(40rem);
    margin-top: 10rem;
   }
   .subform{
 transform: translateX(3rem);
    margin-top: 2rem;
   }
   .bn{

    padding-left: 3rem;
}
.hd{
     transform: translateX(1.5rem);
    font-family: Verdana, Geneva, Tahoma, sans-serif;
}
</style>
<title>
    IBM Demo
</title>
```

```
    </head>
    <body>
        <div class="wholeform">
            <div class="subform">
                <div class="hd"> <h1>LOGIN</h1></div>
        <label for="">Email <br> <br>
        <input type="text" placeholder="Enter you Email"> <br><br>
        </label>
        <label for="">Password <br> <br>
        <input type="text" placeholder="Enter you Password">
        </label> <br> <br>
        <a href="" id="fp">Forgot Password?</a> <br> <br>
        <div class="bn"><button><a href="./Home page.html"
id="lgn">Login</a></button></div>
    </div>


    </div>
    </body>
</html>
```

Home.html

```
<!DOCTYPE html>
<html>
```

```
<head>
  <style>
   body{

        background: url(28090120_web1_FOREST.jpg);
        background-repeat: no-repeat;
        background-size: 100% 200%;
   }

   a{
      text-decoration: none;
       padding-right: 3rem;
       padding-top: 1.5rem;

   }
   .ma{
      display: flex;
      justify-content: space-between;
   }
   h1{
      font-size: 30px;
      transform: translateX(20rem);
   }
   .center{
```

```
        display: flex;
        justify-content: center;
        align-items: center;
        height: 200px;
        width: 300px;
        border: 3px solid rgb(214, 26, 26);
        border-radius: 1.5rem;
        box-shadow: 1px 3px 5px 2px rgba(13,12,13,1);
        transform: translateX(40rem);
        margin-top: 10rem;
    }
   </style>

</head>
<body>
    <div class="ma">
    <h1>
        EMERGING METHODS FOR DETECTION OF FOREST FIRES
    </h1>

    <div class="Pre"><button><a href="Predict.html"
id="lgn">Predict</a></button></div>
</div>

<div class="center"> <p>Fire Destruction is one man's job<br>Fire
prevention is everybody's job.</div>
```

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

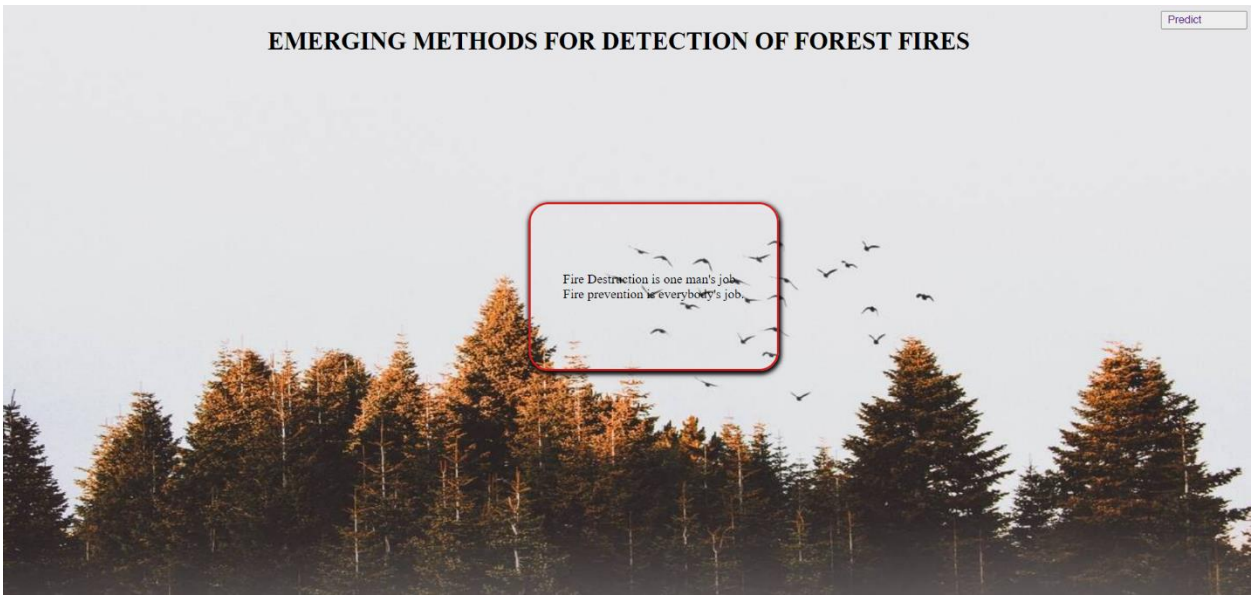
Predict.html

```
<!DOCTYPE html>
<html >
<head>
   <style>
   body{

      background: url(forest-fire-4k-yf-1920x1080.jpg);
      background-repeat: no-repeat;
      background-size: 100% 150%;

}



   #lgn{
      text-decoration: none;
   }

   .center1{
```

```
    display: flex;
    justify-content: center;
    align-items: center;
    height: 200px;
    width: 300px;
    border: 3px solid rgb(0, 225, 60);
    border-radius: 1.5rem;
    box-shadow: 1px 3px 5px 2px rgb(6, 6, 6);
    transform: translateX(40rem);
    margin-top: 8rem;
}
.center2{
    display: flex;
    justify-content: center;
    align-items: center;
    height: 200px;
    width: 300px;
    border: 3px solid rgb(4, 241, 52);
    border-radius: 1.5rem;
    box-shadow: 1px 3px 5px 2px rgb(0, 0, 0);
    transform: translateX(40rem);
    margin-top: 5rem;
}
```

```
</style>

</head>
<body>

   <div class="ba">
      </div>

      <div class="center1"><p>Cemara</p></div>
      <div class="center2"><p>Video</p></div>


</body>
</html>
```

OUTPUT SCREENSHOTS



GITHUB LINK: https://github.com/IBM-EPBL/IBM-Project-9982-1659087836