EMERGING METHOD FOR EARLY DETECTION OF FOREST FIRE

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CHAPTER-1

Introduction:

Forests are the protectors of earth's ecological balance. Forest fires can potentially result in a great number of environmental disasters causing vast economic and ecological losses as well as endangering human lives. In order to preserve natural resources and protect human safety and properties, forest fire monitoring and detection have become a significant solution, which attract an increasing interest around the world. Especially, the growth number of large scale worldwide forest fires has made automatic fire detection as an important technique for the early fire alarm. Unfortunately, the forest fire is usually observed when it has already spread over a large area of forest, making fire control and stoppage is very difficult and impossible. The result is devastating loss and irreparable damage to the environment and atmosphere (30% of carbon dioxide (CO2) in the atmosphere comes from forest fires), in addition to irreparable weaken the ecology.

Among other dreadful consequences of forest fires are long-term.

1.1 Project Overview

Forest are considered as one of the most important and indispensable resources. The common hazards in forest are forest fire. It causes great harm to the forest and result a very serious economic loss. In order to prevent the natural resources and human safety and property. Early detection in forest fire can be significant impact on the control of forest fire. Many forest fire detection techniques have been proposed by different researchers. There are so many techniques to detect the occurrence of forest fire. A fire detection method for the application of UAV-based forest fire surveillance using IR camera. This approach improves the accuracy and reliability of forest fire detection. This paper presents a literature study on forest fire detection.

1.2 Purpose:

Forests are the reason for most of the earth's terrestrial biodiversity. Forest is an ecosystem that provides food, shelter to 80% of the living beings on the earth. Most of the time homo sapiens have existed, spent their lives in the forest. They play a crucial role in weather, atmosphere, rains and other various ecological factors important for the existence of terrestrial life. Forests are the largest terrestrial storehouse of carbon (and thus fuel). They are still home to many indigenous tribes. Around 60 million people are from various indigenous tribes around the globe. The area covered by forests has been shrinking due to deforestation. Forest fire is another threat to forests.

CHAPTER-2

LITERATURE SURVEY

2.1 Existing problem:

- The first technique is human observation towers, but this technique is inaccurate and inefficient.
- Optical systems were used in many countries, and they also proved inefficiency due to camera manual installation and line of sight and night images problems.
- Satellite scanning is mainly done by two satellites: the Advance Very High Resolution Radiometer (AVHRR), launched in 1998, and the moderate resolution imaging
- Spectroradiometer (MODIS), launched in 1999. A full scanning for the Earth requires 2 days, which is considered long delay to detect the fire. Satellite images quality is related to weather conditions.
- Finally, WSN started to be considered as a partial solution, where this kind of technology is used together with other technologies such as IP cameras, weather databases and fuel databases.

2. References:

- Official webpage of the European Smart crop protection System at :http://effis.jrc.ec.europa.eu/
- Official webpage of the Copernicus Earth Observation Programmeat: http://www.copernicus.eu
- Forest Fires in Europe, Middle East and North Africa 2016, JRC Science for policy report, BN 978-92-79-71292- 0, ISSN 1831-9424, doi:10.2760/17690, availabe at: http://effis.jrc.ec.europa.eu/media/cms_page_media/40/Smart_Crop_in_Europe_Middle_east_and_North_Africa_2016_final_pdf_JZU7He L pd

2.3 Problem Statement Definition:

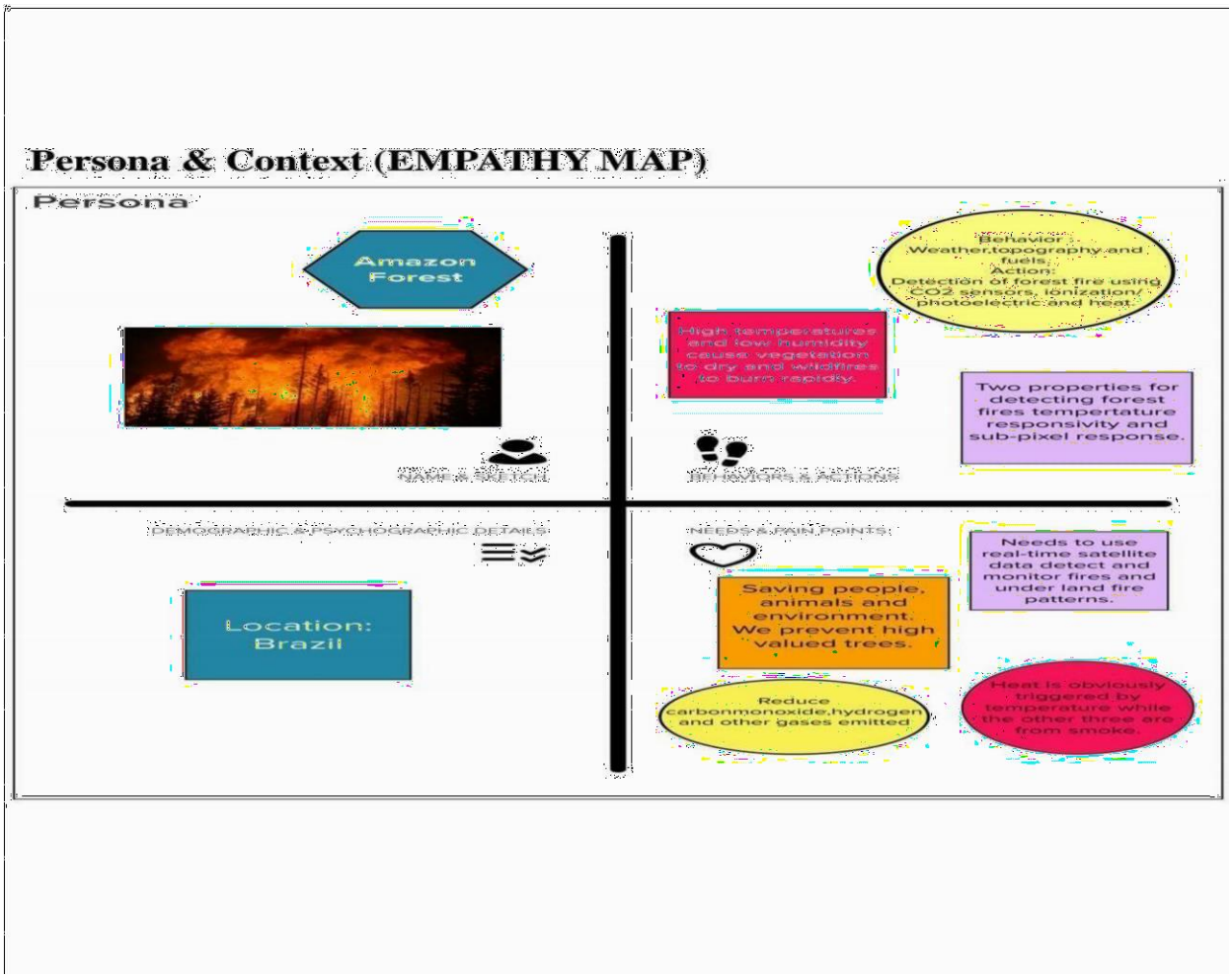
This problem is difficult to predict and detect Forest Fire in a sparsely populated forest area and it is more difficult if the prediction is done using ground-based methods like Camera of Video-Based approach. Satellites can be an important source of data prior to and also during the Fire due to its reliability and efficiency.Forest fire cause lots of damage, some of them are loss of wildlife habitat, extinction of plants and animals,destroys the nutrient rich top soil, reduction in forest cover, loss of valuable timber resources, ozone layer depletion, loss of livelihood for tribal people, poor people, increase in globalwarming.

CHAPTER-3

IDEATION AND PROPOSED SOLUTION

3.1 Empathy Map Canvas:

An empathy map is a collaborative tool teams can use to gain a deeper insight into their customers. Much like a user persons, an empathy map can represent a group of users, such as a customer segment.

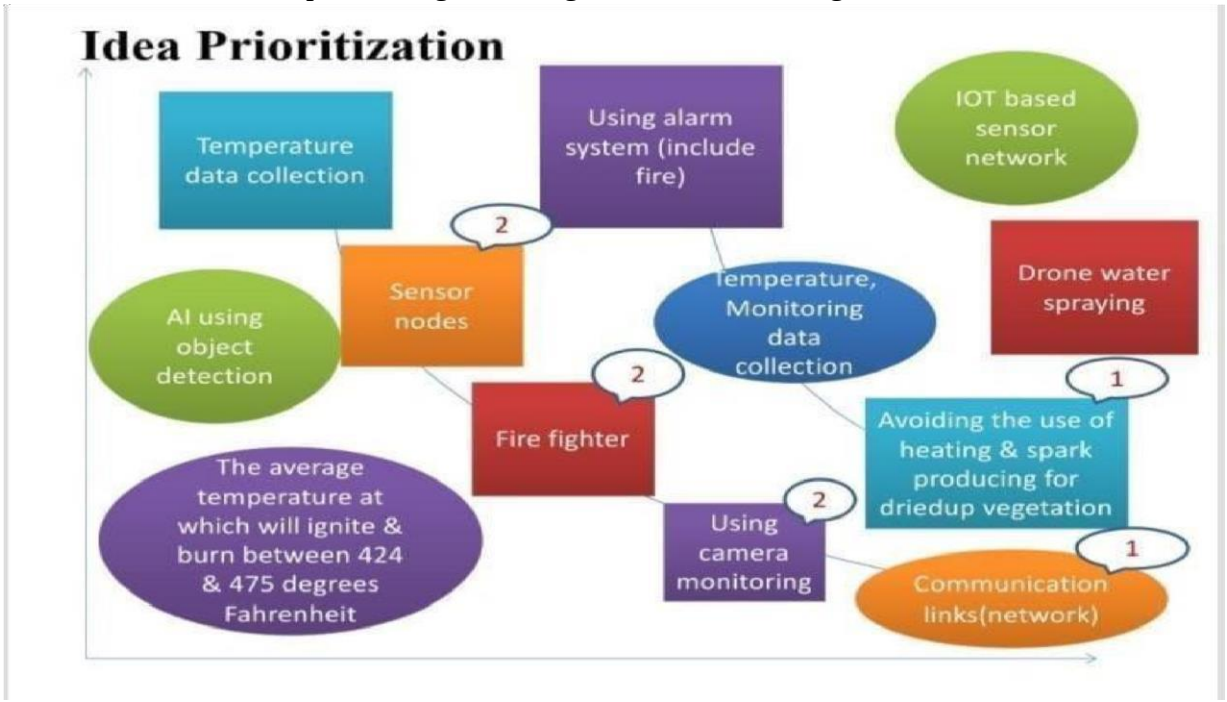


3.2 Big Ideas:

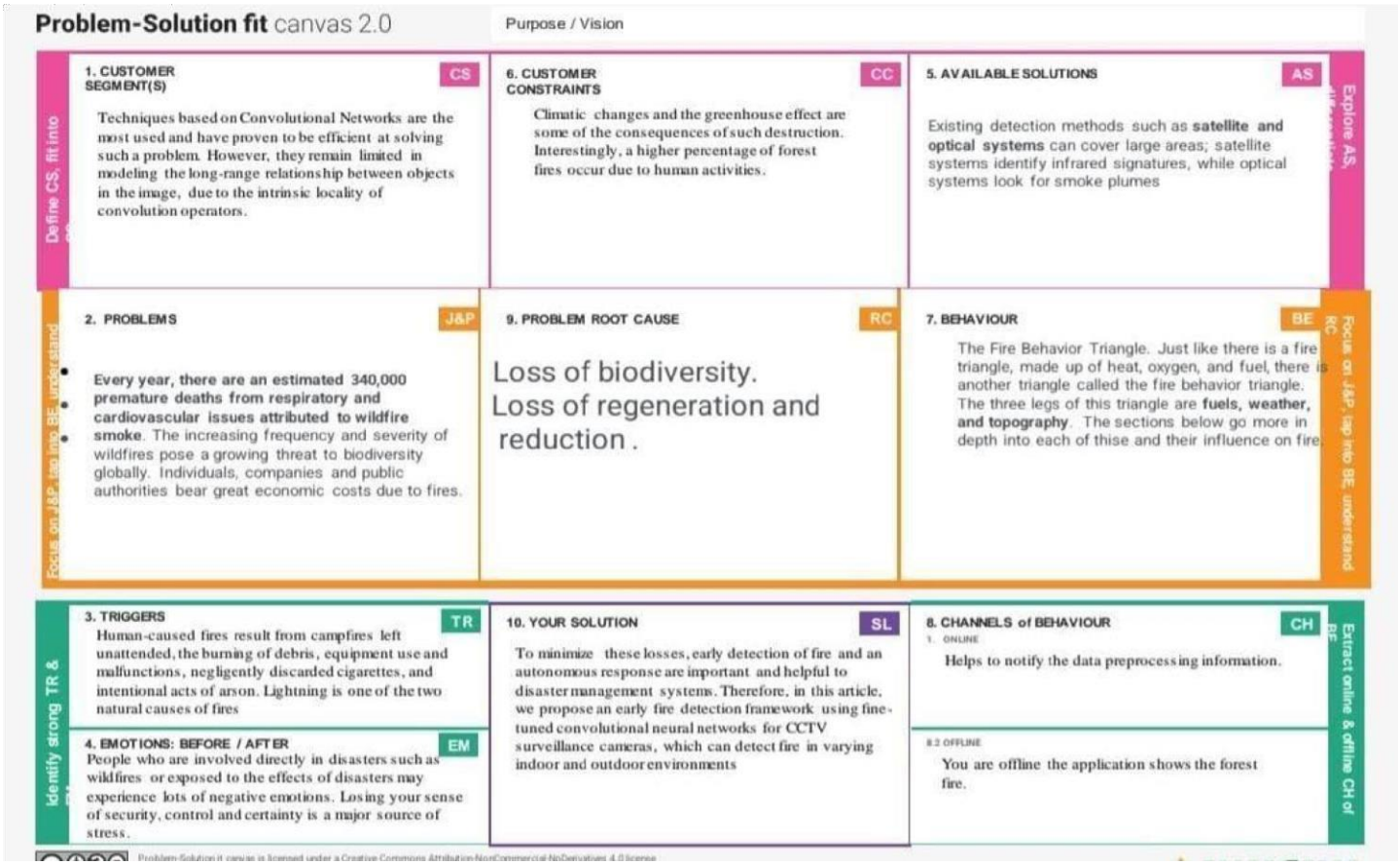
It consists of all the ideas of instruments and equipments that we are going to implement in this project.

3.3 Idea Prioritization:

It deals with the prioritizing of the big ideas in order of highest to lowest likes.



3.4 Problem Solution Fit :



3.5 Proposed Solution:

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 fire fighters valuable time to extinguish the fire before it spreads out of control. Sensing solutions from Bosch Sensor tec 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 fight against the forest fires include the earliest possible detection of the fire event , the proper categorisation 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 . Each of these types of forest fires is specific and the proper counteractions against it must be considered and 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 India for the entire country have been moderately estimated at Rs 440 crores (US$ 107 million).
6.	**Scalability of the Solution**	Aerial-based systems gained recently a lot of attention due to the rapid development of UAV technology. Such systems provide a broader and more accurate perception of the fire, even in regions that are inaccessible or considered too dangerous for firefighting crews. In addition, UAVs can cover wider areas and are flexible, in the sense that they monitor different areas, as needed

CHAPTER-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 registration	Registration through Form Registration through Wildfire Portal.
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Data Prediction	Scientists create computer models to predict wildfire potential under a range of potential climate futures. Using different projections of temperature and precipitation, scientists predict where and when wildfires are most likely to occur.
FR-4	Using Sensor	This Bosch environment sensors installed in the forest fire detection system using artificial intelligence deployed as early wildfire warming tool

4.2 Non-Functional Requirements

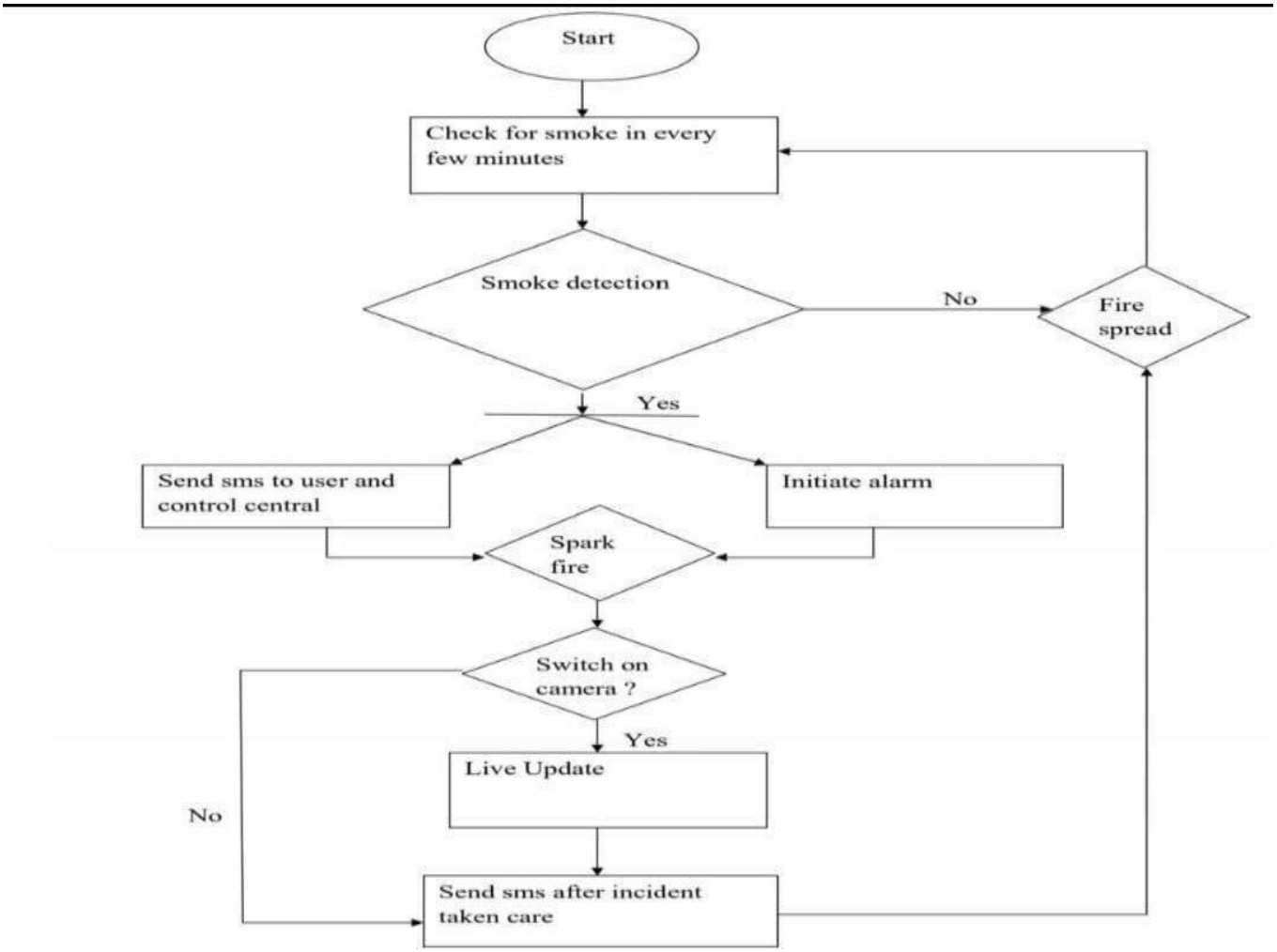
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Many methods have been proposed to detect forest fires, such as camera-based systems, WSN-based systems, and machine learning application-based systems, with both positive and negative aspects and performance figures of detection.
NFR-2	**Security**	We have designed this project to secure the forest from wild fires.
NFR-3	**Reliability**	It has achieved 1.24 seconds of classification time with an accuracy of 91% and F1 score of 0.91.
NFR-4	**Performance**	In the event of a fire, the primary objective of using drones is to gather situational awareness, which can be used to direct the efforts of the firefighters in locating and controlling hot spots. Just like urban fires, forest fires to require monitoring so that firefighters know what they are dealing with.
NFR-5	**Availability**	Forest fires (wildfires) are common hazards in forests, particularly in remote or unmanaged areas. It is possible to detect forest fires, elevated CO2, and temperature levels using AI.
NFR-6	**Scalability**	A widely used measure of fire intensity is firelineintensity, which is the rate of heat transfer per unitlength of the fire line (measured in kW m−1) and represents the radiant energy release in the flaming front.

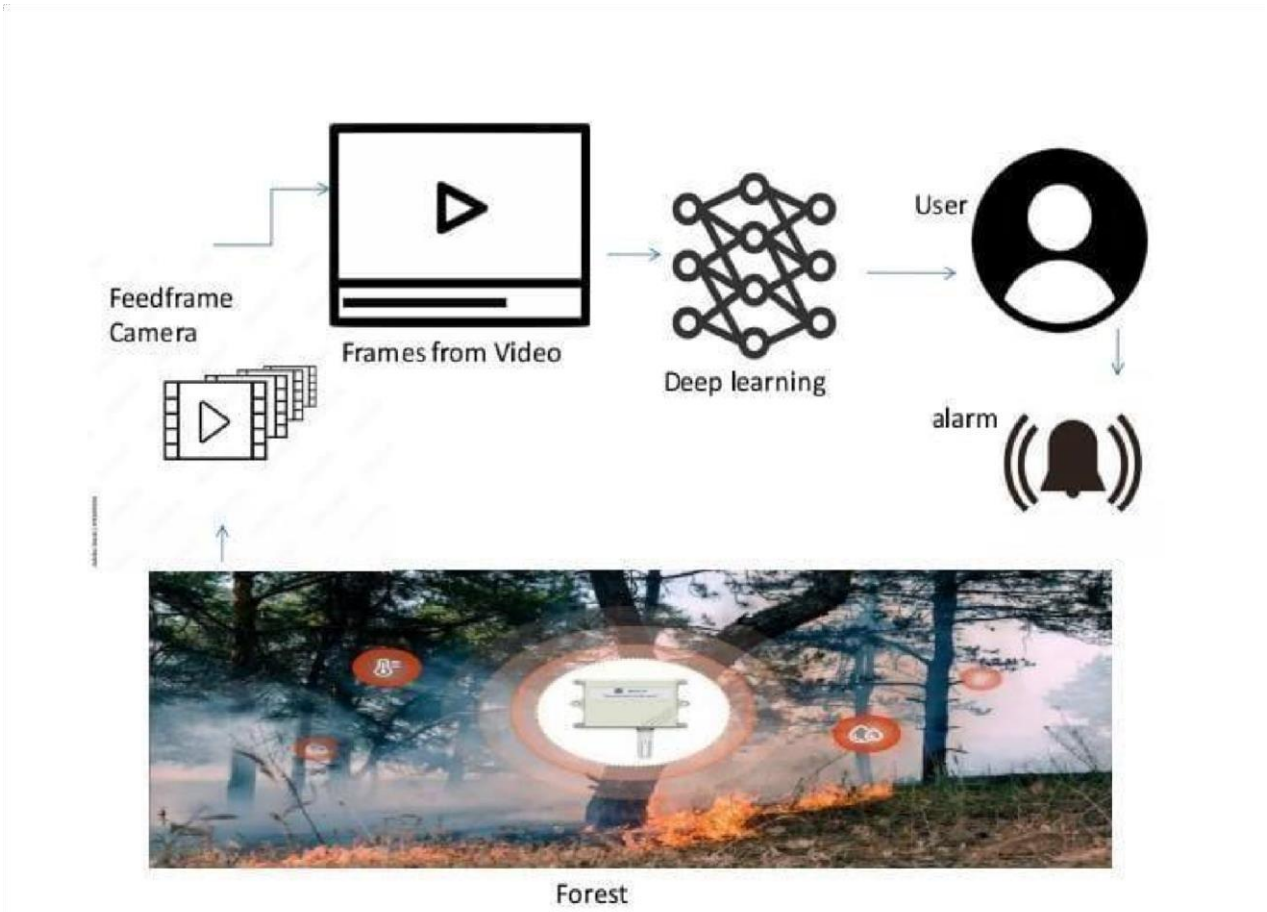
CHAPTER-5

PROJECT DESIGN

5.1 Data Flow Diagram:



5.2 Solution & Technical Architecture:



5.3 Customer Journey Map:

User journey

by the Design Team of Accenture Interactive

People 2 - 9 | Time 30 min | Difficulty Beginner

Creating a user journey is a quick way to help you and your team gain a deeper understanding of who you're designing for, aka the stakeholder in your project. The information you add here should be representative of the observations and research you've done about your users.

	Ignition	Growth	Fully developed	Decay
Phases				
Steps	A source of ignition is anything that has the potential to start a fire . E.g. a naked flame or a faulty electrical appliance .	consumers have accepted the product in the market and customers are beginning to truly buy in , market for the product is expanding and competition begins developing .	Fire has spread over much if not all the available fuel . Temperatures reach their peak . Resulting in heat damage . Oxygen is consumed rapidly .	Usually the longest stage of a fire. They characterized a significant decrease in oxygen or fuel . Putting an end to the fire .
Feelings What your user might be thinking and feeling at the moment	More precise It control spark timing It improve engine efficiency It improve efficiency and performance	The major factor that influence the fire growth are fuel arrangement ceiling height, length/width ratio, room insulation, size and location of openings, heating- ventilation-air conditioning operation.	Fire removes low-growing underbrush. Cleans the forest floor of debris. Opens it up to sunlight. Nourishes the soil	They kill harmful insects They clear away diseased trees They make way for new trees The ashes add nutrients to the soil
Pain points	No matter the cause , wildfires still require three key components to ignite and eventually spread : fuel , heat and oxygen . These components are commonly referred to as the fire triangle	Wildfires can disrupt transportation, communications, power and gas services, and water supply. They also lead to a deterioration of the air quality, and loss of property, crops, resources, animals and people	Human carelessness is the biggest factor contributing to wildfires	Fire detection systems has many limitations, such as the limited amount of energy, the energy required for data processing, the short range of communication and limited computations, the complexity of ML algorithms when executing on sensor nodes
Opportunities	Fire removes low Growing underbrush Cleans the forest floor of debris .	Opens it up to sunlight Nourishes the soil	Fire frequencies determine the over storey of coniferous composition Besides developing a natural space among the stands .	It plays a role in recycling nutrients from the ground – layer vegetation and litter to the over storey trees. Thereby counteracting the infertile substrates and arrested decay

Share your feedback

CHAPTER-6

PROJECT PLANNING PHASE

6.1 Sprint Planning, Schedule & Estimation

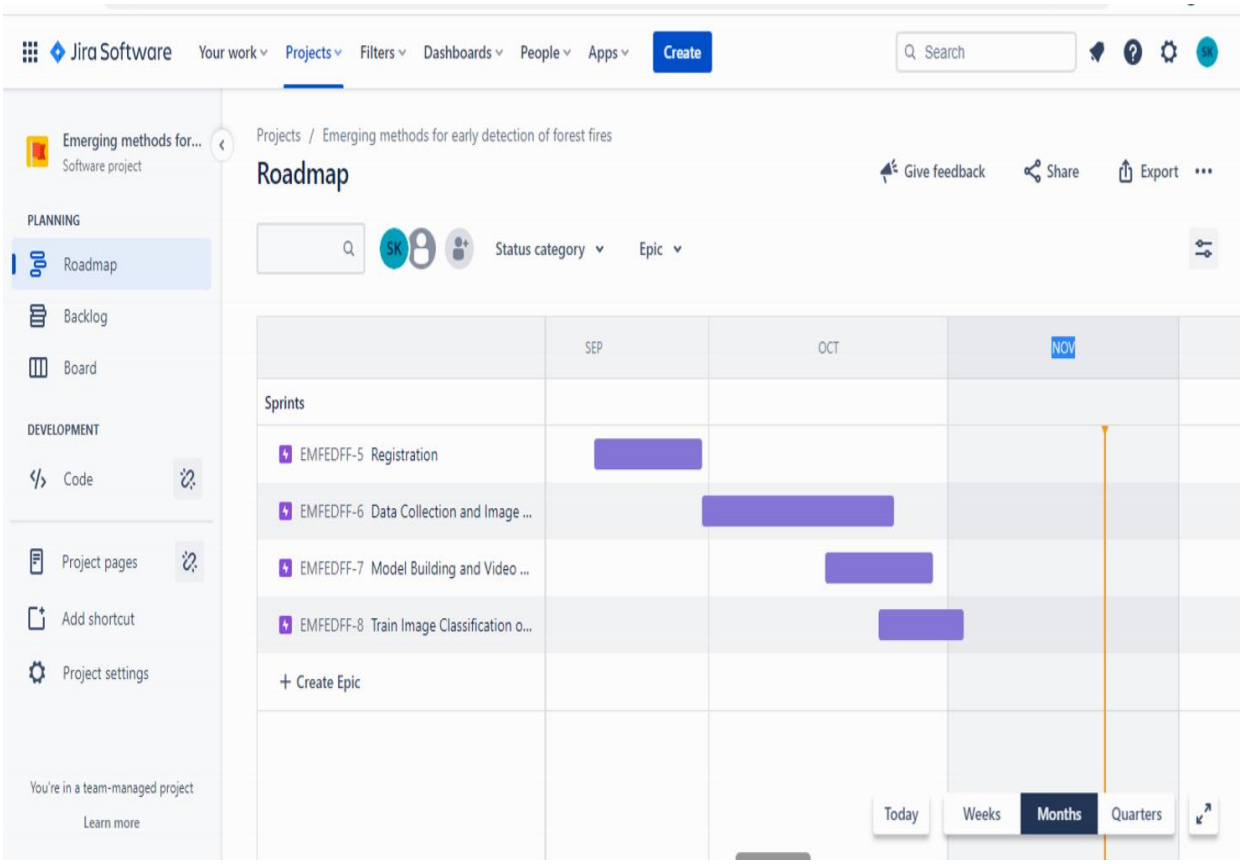
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority
Sprint-1	Registration	USN-1	For As an user, I can register application by entering my email, password, and confirming my password.	2	High
Sprint-1	User Confirmation	USN-2	As an user, I will receive confirmation email once I have registered for the application	1	Medium
Sprint-1	Login	USN-3	As an user, I can log into the application by entering email & password	2	High
Sprint-2	Data Collection	USN-1	Download the dataset used in Digital Naturalist –AI Enabled tools for Biodiversity Researchers	2	High
Sprint-2	Image Preprocessing	USN-1	Improving the image data that suppresses unwilling distortions or enhances some image features important for further processing. although performing some geometric transformations of images like rotation, scaling, etc.	1	High

Sprint-3	Getting started with Convolutional Neural Network	USN-1	Neural network are integral for 2 teaching computers to think and learn by classifying information. similar to how we as humans learn. With neural networks, the software can learn to recognize images, for example. Machines can also make predictions and decisions with a high level of accuracy based on data inputs.	2	High
Sprint-3	Evaluation and model USN-1 saving	USN-1	well a model behaves after each 1 iteration of optimization. An accuracy metric is used to measure the algorithm's performance in an interpretable way. The accuracy of a model is usually determined after the model parameters and is calculated in the form of a percentage. Saving The Model get weights, set weights.	1	Medium
Sprint-4	Application Building	USN-2	After the model is built, we will be integrating it to a web application so that normal users can also use it. The users need to give the images of specie	1	High
Sprint-4	Train the Model on IBM	USN-3	Build Deep learning model and computer vision Using the IBM cloud.	2	High

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	4 Days	24 Oct 2022	27 Oct 2022	20	29 Oct 2022
Sprint-2	20	5 Days	28 Oct 2022	01 Nov 2022	20	04 Nov 2022
Sprint-3	20	8 Days	02 Nov 2022	09 Nov 2022	20	11 Nov 2022
Sprint-4	20	9 Days	10 Nov 2022	18 Nov 2022	20	19 Nov 2022

6.3 Reports From JIRA :



CHAPTER-7

CODING AND SOLUTION

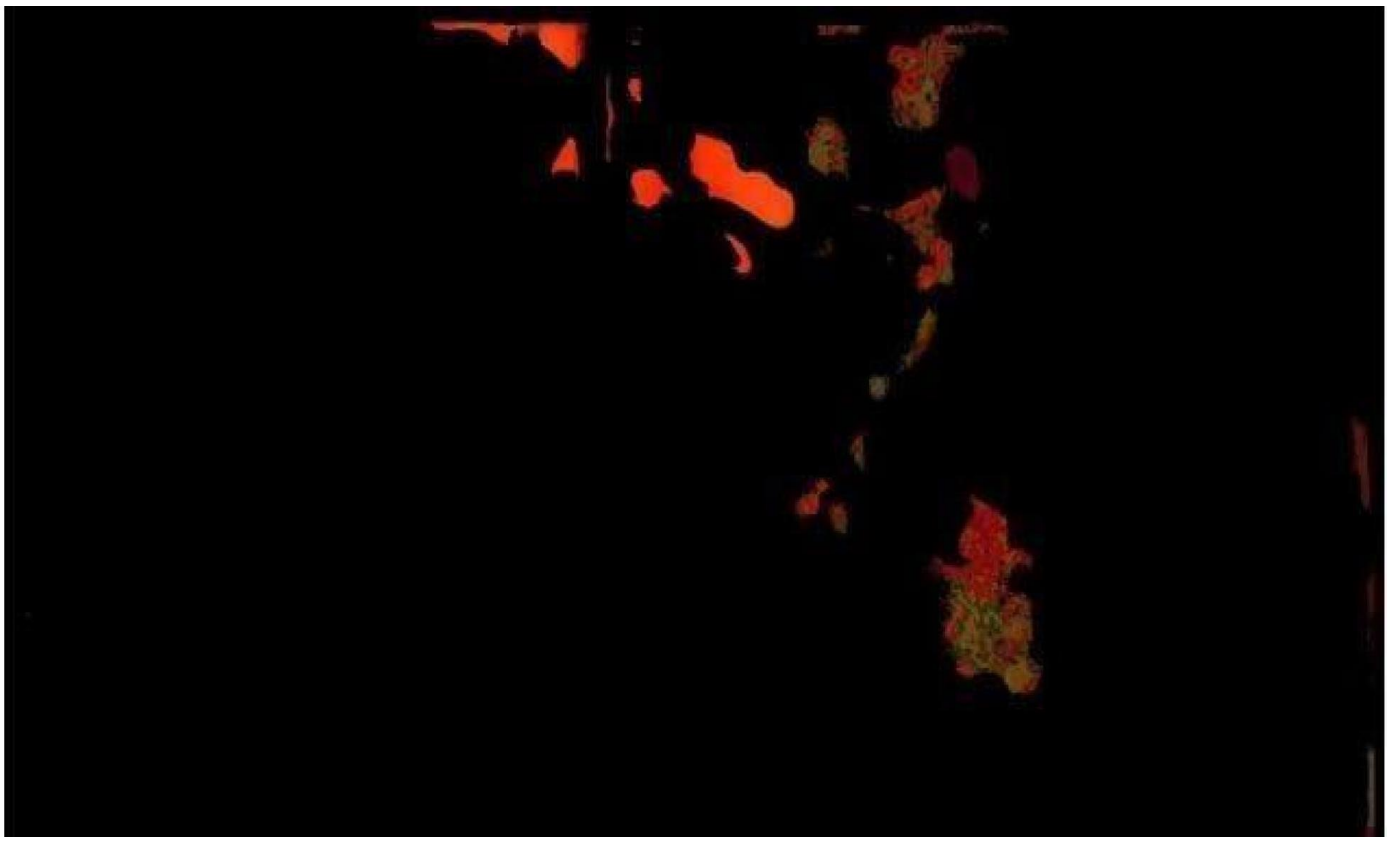
7.1 Feature:

OpenCv for video processing:

```
import cv2
import numpy
as np

#import smtp lib
#import playsound
#import threading
Alarm_Status = False
Email_Status = False
Fire_Reported = 0
#def play_alarm_sound_function():
#while True:
#playsound.playsound('alarm-sound.mp3',True#def send_mail_function():
 #recipientEmail = "reenu8602@gmail.com"
 # recipientEmail = recipientEmail.lower()
  # try:
 #server = smtplib.SMTP('smtp.gmail.com', 587)
 #server.ehlo()
 #server.starttls()
 #!server.login("swethathanam52@gmail.com", 'swethaanu3')
 #server.sendmail('reenu8602@gmail.com)', recipientEmail,
 "Warning A  Fire Accident has been reported on ABC ")
 #print("sent to {}".format(recipientEmail))
 # server.close()
 # except Exception as e:
```

```
# print(e) video = cv2.VideoCapture("video.mp4") # If you want to use webcam use Index like 0,1.
while True:
(grabbed, frame)=video.read() if not grabbed: break frame = cv2.resize(frame, (960, 540)) blur = cv2.GaussianBlur(frame, (21, 21), 0) hsv = cv2.cvtColor
(blur, cv2.COLOR_BGR2HSV)
lower = [18, 50, 50] upper = [35, 255, 255] lower = np.array(lower, dtype="uint8") upper = np.array(upper, dtype="uint8") mask = cv2.inRange(hsv, lower, upper) output = cv2.bitwise_and (frame, hsv, mask=mask) no_red = cv2.countNonZero(mask) if int(no_red) > 15000:
Fire_Reported = Fire_Reported + 1 cv2.imshow("output", output) if Fire_Reported>= 1: if Alarm_Status == False:

#threading.Thread(target=play_alarm_sound_function).start()
Alarm_Status = True if Email_Status ==False:
#threading.Thread(target=send_mail_function).start()
Email_Status = True if cv2.waitKey(1) & 0xFF == ord('q'): break cv2.destroyAllWindows()
video.release()
```

OUTPUT :



Creating an account in Twilio Services:

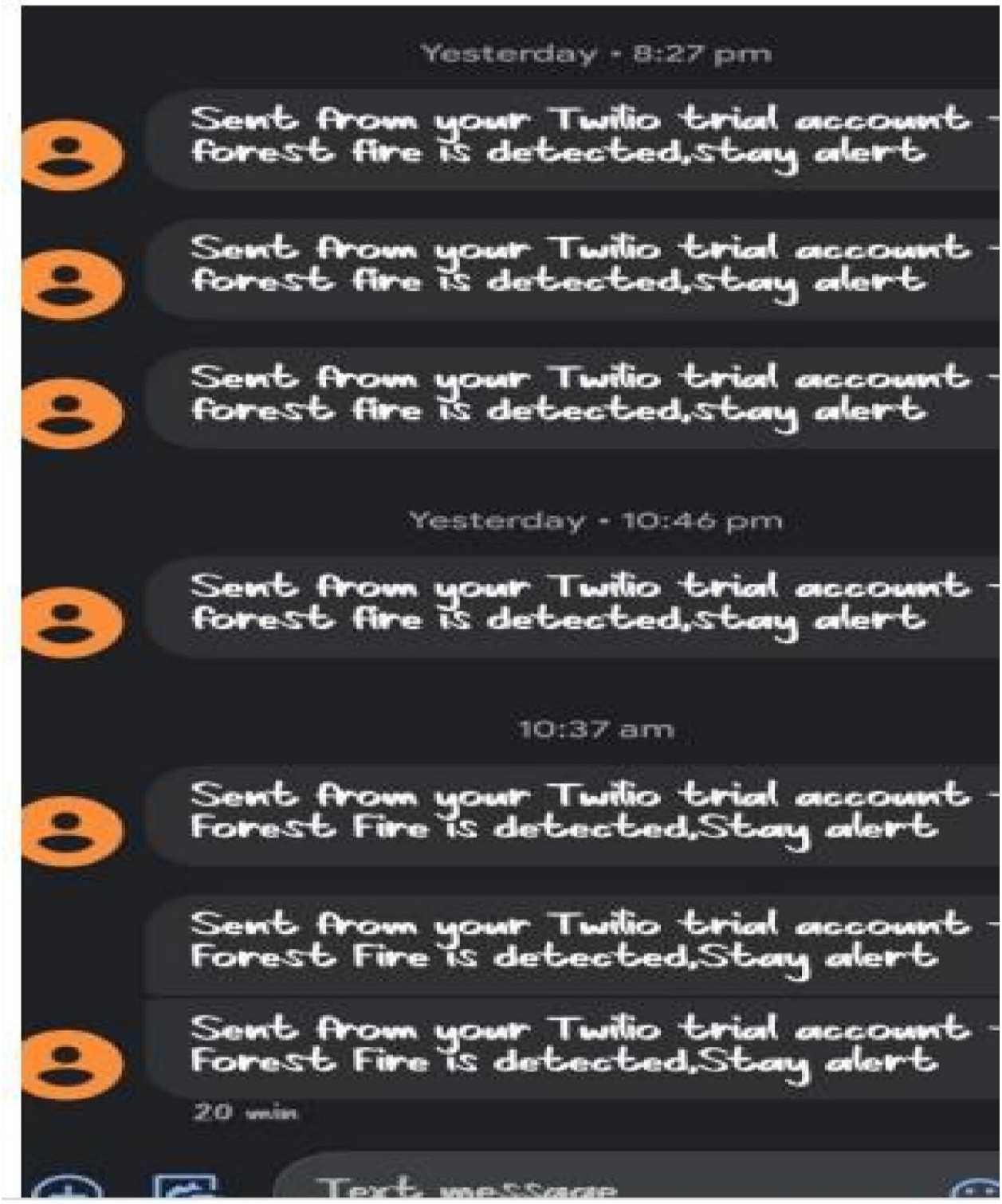
```
from twilio.rest import Client
account_sid='AC9496860c13d1e2959a984c6744e6e513'
auth_token = 'c5d994417543434 92a6d9046e614c4cb'
client = Client(account_sid, auth_token)
myMessage = client.messages.create(body = 'Forest Fire is detected,Stay alert' ,
from_=' +12183046916',
to = ' +918680875090')
 print(message.sid)
print("Fire detected")
print("SMS Sent!")   Sending
```

Alert Message:

```
import cv2

import numpy as np

 from  keras.preprocessing

import image from keras.models

import load_model from twilio.rest

import Client from playsound

import playsound model = load_model(r'forestfire13.h5') video = cv2.VideoCpature(0)

 name = ['forest','with fire']

while(1): success,frame = video.read() cv2.imwrite("img.jpg",frame)  img
= image.load_image("image.jpg",target_size = (64,64))    x =
image.img_to_array(img)    x = np.expand_dims(x,axis = 0) pred =
model.predict_classes(x)    p = pred[0] print(pred)
cv2.putText(frame,"predictedclass="+str(name[p]),(100,100),
cv2.FONT_HERSHEY_SIMPLEX,1,(0,0,0),1)  pred =

model.predict_classes(x)    if pred[0]==1:account_sid =
'AC9496860c13d1e2959a984c6744e6e513'auth_token =
'c5d99441754343492a6d9046e614c4cb'    client = Client(account_sid,
auth_token)   myMessage = client.messages.create(   body='Forest Fire is
detected,Stay alert',from_='+12183046916', to='+918680875090')
print(message.sid)   print("Fire detected")   print("SMS Sent!")
playsound(r")    else:

 print("NODanger")
cv2.imshow("image",frame)
```

if cv2.waitKey(1) & 0xFF == ord('a'): break video.release() cv2.destroyAllWindows()

MESSAGE OUTPUT:



CHAPTER-8

TESTING

Test cases

				Date	21-Nov-22							
				Team ID	PNT2022TMID49492							
				Project Name	Emerging methods for early detection of forest fires							
				Maximum Marks	4 marks							
Test case ID	Feature Type	Component	Test Scenario	Pre-Requisite	Steps To Execute	Test Data	Expected Result	Actual Result	Status	Comments	TC for Automation(Y/N)	BUG ID	Executed By
HomePage_TC_001	Functional	Home Page	Verify user is able to see the home page or not.		1. Enter URL and click go 2. verify whether the user is able to see the home page.	Enter URL and click go	User able to see the home page	Working as expected	Pass	Nil	N	-	Sweta K
HomePage_TC_002	UI	Home Page	Verify the UI elements in Home Page		1. Enter URL and click go 2. Verify the UI elements in Home Page.	Enter URL and click go	Application should showbelow UI element:	Working as expected	pass	Nil	N	-	Naveen M
RegisterPage_TC_003	Functional	RegisterPage	AIRegister page is able to will Input the user data.		1. Enter URL and click go 2. Verify the UI elements in Home Page 3 Click the signin button	Click in sign up home page	Application should show 'Incorrect email or password ' validation message.	Working as expected	pass	Nil	N		Keerthiga G
LoginpageTC_004	Functional	login page	Verify user is able to redirect to detect page or not.		1. Enter URL and click go 2.Click on detect button 3. Verify whether the user to redirect to detect page or not.	Click in sign in home page	Application should show 'Incorrect email or password' validation message.	Working as expected	pass	Nil	N	-	Sangeetha M
PredictPage_TC_005	UI	Predict page	Verify the UI elements in Predict Page		1. Enter URL and click go 2. Verify the UI elements in Predict Page.	Click the predict button and redirect to predict page	Application should showbelow UI elements: Dropdown List , detect button.	Working as expected	pass	Nil	N	-	Keerthiga G, Sangeetha M
PredictPage_TC_006	Functional	Predict page	Verify user is able to select the dropdown value or not.		1.Enter URL and click go 2.Click on detect button 3. Verify whether the user to redirect to detect page or not. 4. Verify user is able to select the dropdown value or not	Fire predicted or not	Application should shows detecting video	Working as expected	pass	Nil	N	-	Sweta K, Naveen M
PredictPage_TC_007	Functional	Predict page	Verify the video		1.Enter URL and click go 2.Click on Predict button 3. Verify whether the user to redirect to predict page or not. 4. Verify user is able to select the dropdown value or not 5.Verify the video	Predicting the video	Application should shows the uploaded video	Working as expected	pass	Nil	N	-	Sweta K, Naveen M
PredictPage_TC_008	Functional	Predict page	Verify whether the forest fire is predicted or not		1.Enter URL and click go 2.Click on Predict button 3. Verify whether the user to redirect to predict page or not. 4.Verify user is able to select the dropdown value or not. 5. Verify whether the video is predicted correctly or not	Click the Detect Button	Application shows the predicted output	Working as expected	pass	Nil	N	-	Sweta K Naveen M Keerthiga G Sangeetha M

User Acceptance Testing:

1. Purpose of Document:

The purpose of this document is to briefly explain the test coverage and open issues of the Emerging Methods for Early Forest Fire Detection Project at the time of the release to User Acceptance Testing (UAT).

2. Defect Analysis:

This report shows the 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	1	0	0	0	1
Duplicate	0	0	0	0	0
Extemal	0	0	0	0	0
Fixed	0	0	0	0	0
Not Reproduced	0	2	0	0	2
Skipped	0	0	0	0	0
Won't Fix	0	0	0	0	0
Totals	1	2	0	0	3

3. Test Case Analysis:

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

Section	Total Cases	Not Tested	Fail	Pass
Performance	5	0	0	5
UI	1	0	0	1
Security	3	0	0	3

CHAPTER -9

RESULTS

9.1 Performance Metrics

Model Summary

```
In [37]: model.summary()

Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 126, 126, 32)      896
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 63, 63, 32)        0
_________________________________________________________________
flatten (Flatten)            (None, 127008)            0
=================================================================
Total params: 896
Trainable params: 896
Non-trainable params: 0
_________________________________________________________________
```

Accuracy :

```
In [33]: model.fit_generator(x_train,steps_per_epoch=len(x_train),validation_data=x_test,validation_steps=len(x_test),epochs=10)

/opt/conda/envs/Python-3.9/lib/python3.9/site-packages/tensorflow/python/keras/engine/training.py:1940: UserWarning: `Model.fit_generator` is deprecated and will be removed in a future version. Please use `Model.fit`, which supports generators.
  warnings.warn('`Model.fit_generator` is deprecated and '
Epoch 1/10
77/77 [==============================] - 58s 741ms/step - loss: 0.9698 - accuracy: 0.8657 - val_loss: 0.5529 - val_accuracy: 0.8971
Epoch 2/10
77/77 [==============================] - 55s 717ms/step - loss: 0.1668 - accuracy: 0.9383 - val_loss: 0.3615 - val_accuracy: 0.8824
Epoch 3/10
77/77 [==============================] - 56s 722ms/step - loss: 0.1439 - accuracy: 0.9520 - val_loss: 0.3120 - val_accuracy: 0.8971
Epoch 4/10
77/77 [==============================] - 57s 736ms/step - loss: 0.1347 - accuracy: 0.9509 - val_loss: 0.3402 - val_accuracy: 0.9118
Epoch 5/10
77/77 [==============================] - 58s 755ms/step - loss: 0.1265 - accuracy: 0.9552 - val_loss: 0.3401 - val_accuracy: 0.9412
Epoch 6/10
77/77 [==============================] - 54s 700ms/step - loss: 0.1274 - accuracy: 0.9552 - val_loss: 0.3368 - val_accuracy: 0.8971
Epoch 7/10
77/77 [==============================] - 53s 686ms/step - loss: 0.0914 - accuracy: 0.9678 - val_loss: 0.4035 - val_accuracy: 0.9118
Epoch 8/10
77/77 [==============================] - 53s 696ms/step - loss: 0.1096 - accuracy: 0.9607 - val_loss: 0.3181 - val_accuracy: 0.9265
Epoch 9/10
77/77 [==============================] - 54s 699ms/step - loss: 0.0759 - accuracy: 0.9743 - val_loss: 0.3875 - val_accuracy: 0.9118
Epoch 10/10
77/77 [==============================] - 56s 726ms/step - loss: 0.1005 - accuracy: 0.9651 - val_loss: 0.3555 - val_accuracy: 0.9265
Out[33]:
```

CHAPTER-10

ADVANTAGES & DISADVANTAGES

10.1 ADVANTAGE:

- Cleaning the Forest Floor. Fire removes low-growing underbrush, cleans the forest floor of debris, opens it up to sunlight, and nourishes the soil.
- Proposed methods are very convenient and can easily detect.
- More dynamic and wider detection as compared to fixed sensors.
- Reduction in cost.

2. DISADVANTAGE:

- Forest fires can create health problems for people.
- Forest fires can trigger mudslides, landslides, and other forms of erosion
- Forest fires under control can still burn other structures
- The cutting down of forests leads to a loss in biodiversity

.

CHAPTER-11

CONCLUSTION

The recent improved processing capabilities of smart devices have shown promising results in surveillance systems for identification of different abnormal events i.e., fire, accidents, and other emergencies. Fire is one of the dangerous events which can result in great losses if it is not controlled on time. This necessitates the importance of developing early fire detection systems. Therefore, in this research article, we propose a cost-effective fire detection CNN architecture for forest architecture. Translations and content mining

are permitted for academic research only. Although, this work improved the flame detection accuracy, yet the number of false alarms is still high and further research is required in this direction. In addition, the current flame detection frameworks can be intelligently tuned for detection of fire. This will enable the video surveillance systems on forest to handle more complex situations in real-world.

CHAPTER-12

FUTURE SCOPE

- ✓ Integrate live satellite data and process real time processing of the fires.
- ✓ Enhance the time complexity of the detection of fires to improve the speed.
- ✓ Low cost implementation of an automatic system in small scale industries is possible.
- ✓ Higher efficiency attainable with the implementation of much more sophisticated algorithm.
- ✓ Large scale production can utilize computers with greater processing speed and efficiency.

CHAPTER-13

APPENDIX

Github : https://bit.ly/3XpR6xw

Demo Link : http://bitly.ws/wZgt