EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

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NALAIYA THIRAN PROJECT BASED LEARNING ON PROFESSIONAL READLINESS FOR INNOVATION, EMPLOYNMENT AND ENTERPRENEURSHIP

PROJECT REPORT

Submitted By

PAVITHIRAN G	211519104109
SHARAN PADMANABHAN	211519104146
CHANDAR B	211519104029
ABINASH M	211519104005

TEAM ID	PNT2022TMID25867
INDUSTRY MENTOR	SHANTHI
FACULTY MENTOR	MALATHI V

BECHELOR OF ENGINEERING

COMPUTER SCIENCE AND ENGINEERING

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CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEW:

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 nine 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 before 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.

1.2 AIM & SCOPE OF THE PROJECT:

Throughout the year, there are forest fires; however, they are most severe in the summer and fall. Although diverse environmental and natural occurrences, such as lightning strikes or the spontaneous combustion of dried leaves or sawdust, can also be blamed for the occurrence of these catastrophes, human activity is the primary cause of them. No of what causes forest fires to start, they typically result in terrible harm to both humans and the environment. Due to the enormous quantities of gases and particles that are released into the atmosphere after each forest fire, they are also recognized as a major cause of air pollution. Over the years, various strategies have been used to fight forest fires. They primarily seek to find fires before they spread. The simplest of these solutions is the creation of a network of observation posts, which is time-consuming for those involved but also affordable and simple to complete. We are developing a system that employs technilogies like Deep Learning and Computer Vision to identify and inform about the onset of fire.

CHAPTER 2

LITERATURE STUDY

2.1 EXISTING SYSTEM:

S.NO:	TITLE OF THE PAPER	DETAILS OF THE PAPER	OBJECTIVES	METHODOLOGY USED	TAKE AWAY
1.	Early Forest Fire Detection using Drones and Artificial Intelligence.	Published on 2019	To detect forest fires, the proper categorization of fire and fast response from the fire fighting departments.	The fire detection is based on a platform that uses Unmanned Aerial Vehicles (UAVs) which constantly patrols over potentially threatened by fire areas. The UAVs utilize the benefits from Artificial Intelligence (AI).This allows to use computer vision methods for recognition and detection of smoke or fire, based on images or video input from the drone cameras.	From this journal, we use drone cameras and UAVs, because it patrols the forest always.
2.	A review on early forest fire detection system using optical remote sensing.	Published on 2018.	To fight forest fires occurring throughout the year with an increasing intensity in the summer and autumn periods.	Detection methods that use optical sensors or RGB cameras combine features that are related to the physical properties off lame and smoke, such as color, motion, spectral, spatial, temporal, and texture characteristics.	In this article, we use optical sensor networks, which are known for their long-range communication capabilities and are ideal for sensor and telemetry applications.
3.	Developing a real-time and automatic early warning system for forest fire.	Published on 2018.	To detect forest fires caused by climatic conditions and also caused by human.	The method using here is making use of stand-alone boxes which are deployed throughout the forest. Those boxes contain different sensors and a radio module to transmit data received from the sensors. Each sensor will be tested in individually and XBee modules are configured and paired using XCTU Software.	From this journal, we use software solutions which are used for implementing microcontroller kits and to simulate and designing circuit boards.

4.	Early Fire Detection System using wireless sensor networks.	Published on 2018.	To detect fires from huge cause of forests.	The hierarchical architecture of Wireless Sensor Networks is most efficient and extensible for dense networks which simplify the management of the forest as well as the communication and the localization of fire and sensors.	From this journal, we use cluster heads as landmark for the rest of sensor for localization in-order to define their GPS coordinates according to the cluster head’s coordinate.
5.	Automatic Early Forest fire Detection based Gaussian Mixture Model.	Published on 2018.	To avoid the huge damage of forest caused by fires.	Based on the slow spread of smoke, firstly a time delay parameter improves Gaussian mixture model for extracting candidate smoke regions. Then, two motion features of smoke, the rate of area change and motion style are used to select smoke regions from the candidate regions.	From this journal, we use Gaussian mixture model. Because it can reconstruct background with the advantages of small storage space, adaptive learning and good noise toleration.

2.2 REFERENCES:

1) Tanase, M.A.; Aponte, C.; Mermoz, S.; Bouvet, A.; Le Toan, T.; Heurich, M. Detection of wind throws and insect outbreaks by L-band SAR: A case study in the Bavarian Forest National Park. Remote Sens. Environ. 2018, 209, 700–71.

2) Bu, F.; Gharajeh, M.S. Intelligent and vision-based fire detection systems: A survey. Image Vis. Comput. 2019, 91, 103803.

3) Muhammad, K.; Ahmad, J.; Mehmood, I.; Rho, S.; Baik, S.W. Convolutional neural networks based fire detection in surveillance videos. IEEE Access 2018, 6, 18174–18183. [Cross Ref]

4) Shen, D.; Chen, X.; Nguyen, M.; Yan, W.Q. Flame detection using deep learning. In Proceedings of the 2018 4th International Conference on Control, Automation and Robotics (ICCAR), Auckland, New Zealand, 20–23 April 2018; pp. 416–420.

5) Wickramasinghe, C.; Wallace, L.; Reinke, K.; Jones, S. Inter-comparison of Himawari-8 AHIFSA with MODIS and VIIRS active fire products. Int. J. Dig. Earth 2018.

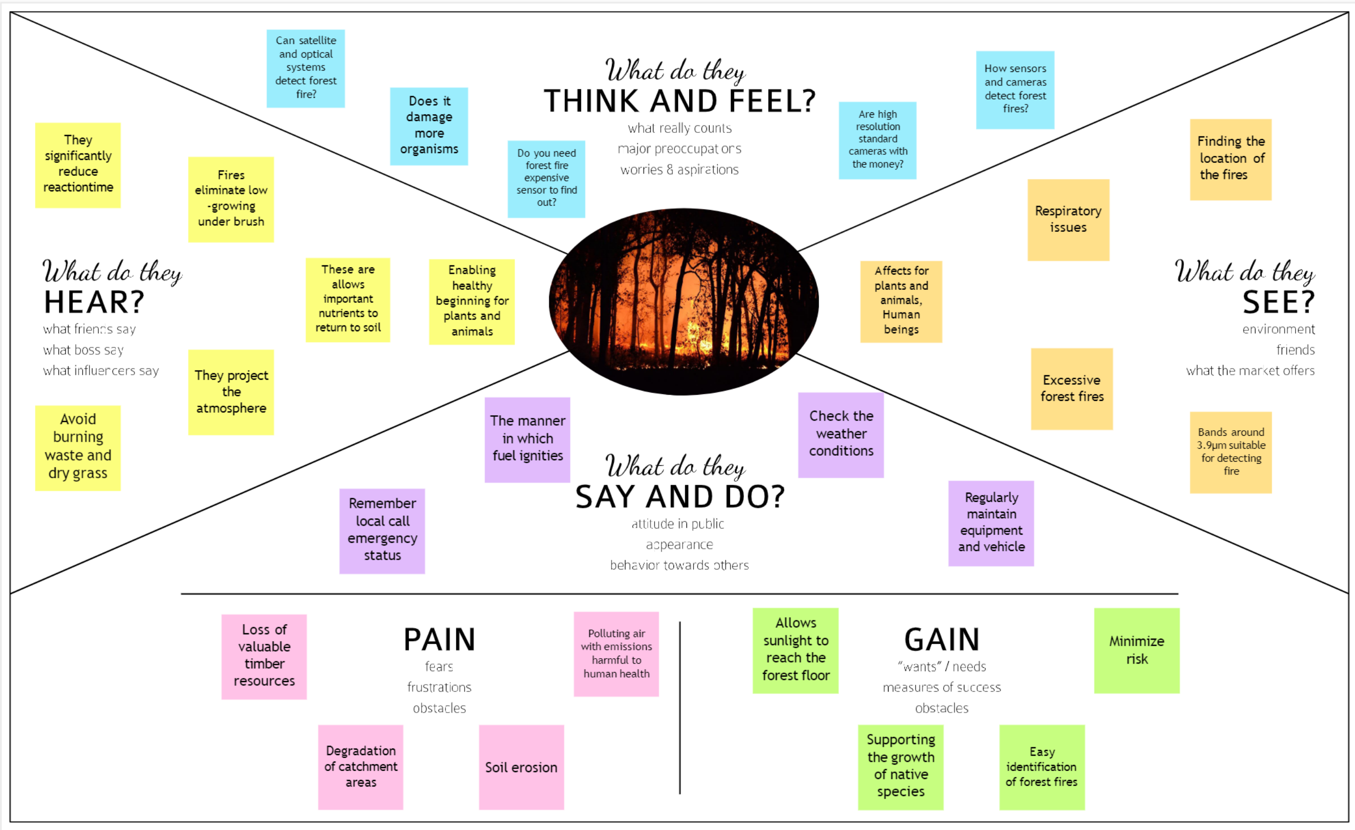
2.3 PROBLEM STATEMENT DEFINITION:

There are forest fires all year long, but the summer and fall are when they are most destructive. These calamities are mostly caused by human activity, despite a variety of environmental and natural events, such as lightning strikes or the spontaneous combustion of dried leaves or sawdust, can also be held responsible. No matter what starts a forest fire, it usually has severe consequences for both the ecosystem and people. Forest fires are also acknowledged as a significant contributor to air pollution due to the vast volumes of gases and particles that are discharged into the environment after each one. Different tactics have been employed over time to fight forest fires. They mostly look for flames to put out before they spread.

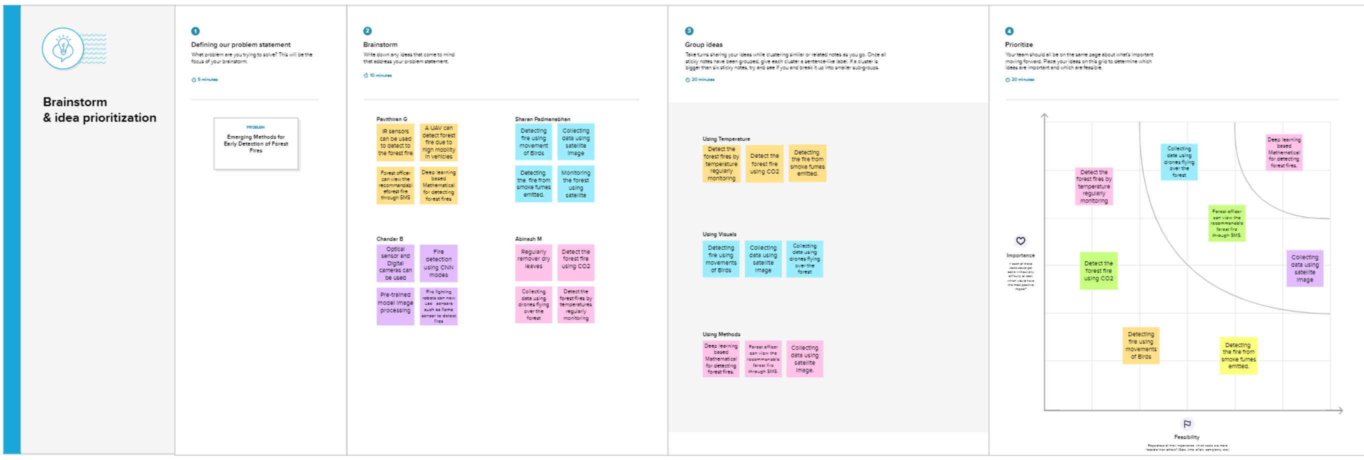
CHAPTER 3

IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS:



3.2 IDEATION & BRAINSTORMING:

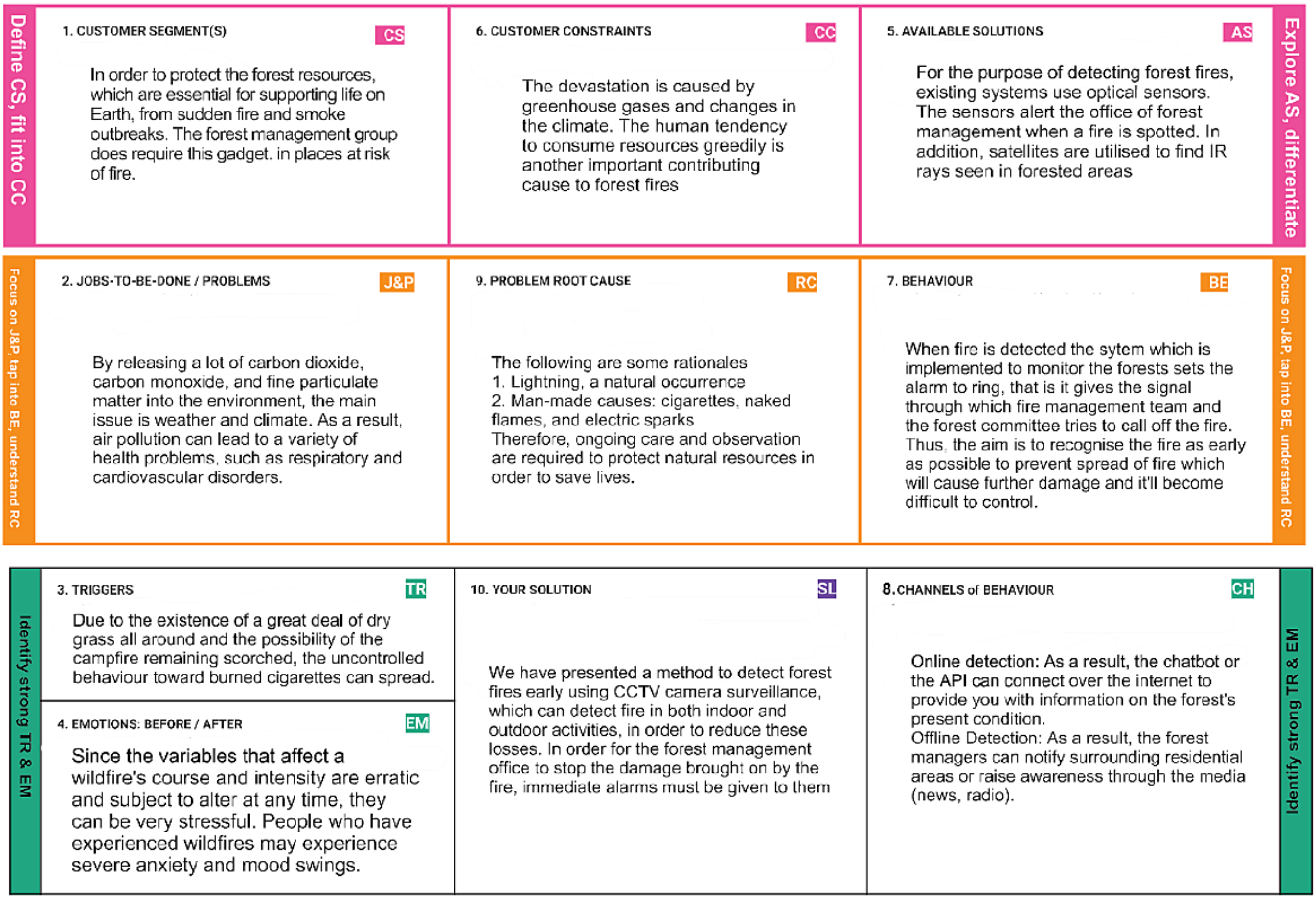


3.3 PROPOSED SOLUTION:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Forests are one of the main factors in balancing the ecology. Forestfires are one of the most worrisome natural disasters, destroying thousands of acres of forests and nearby urban zones, affecting plant, animals and human life. So, the fire detection is important in this scenario. Finding of the exact location of the fire and sending notification to the fire authorities soon afterthe occurrence of fire can make a positive impact.
2.	Idea / Solution description	Our solution aims at collecting the dataset to test and train the model. The damage and the cost for distinguish fire because of forest fire can be reduced when the fire detected early as possible. So, the fire detection is important in this scenario. Finding of the exact location of the fire and sending notification to the fire authorities soon after the occurrence of fire can make a positive impact. We have implemented a fire detection system to detect fire by capturing images. The system uses CNN (convolutional neural network), and image processing techniques.
3.	Novelty / Uniqueness	Real time computer program detect forest fire in earliest before it spread to larger area. Our proposed systemdepends on usingAI to make it cheaper and easier forthe forest management. Accuracy and timely prediction using AI, CNN and API made it possible.
4.	Social Impact/ Customer Satisfaction	The destroying homes, wildlife habitat and timber, and polluting the air with emissions harmful to human health. The proposed solutio fulfills the satisfaction requirements of the customer as it provides instant alerts on fire detection which helps the forestofficer to takeaction as soonas possible.
5.	Business Model (Revenue Model)	● A working model in which mini cameras continuously monitor the forest area and capture live images from satellites is a trained model that automatically detects fire or smoke. ● This proposed model can detect the exactlocation of the fire and can be activated by SMS. The fire officer can implement quickresponses and preventive measures.
6.	Scalability of the	1. The device should be compatible with a minimum of 4GB RAM and WINDOWS 10 (x64 bit) and 100

		GB ROM to support usage of various software like PYTHON 3.6.5. 2. Testing and training undergo using latest technology like KERAS, TENSORFLOW, NUMPY and PILLOW.

3.4 PROBLEM SOLUTION FIT:



CHAPTER 4

REQUIREMENTS ANALYSIS

4.1 FUNCTIONAL REQUIREMENTS:

- **HIGH PRIORITY:**

  a. The system shall take training sets of fire images and recognize whether there is a fire or the beginning of a fire (smoke) or if there is no fire.

  b. The system shall send a notification to the admin when it recognizes a fire in the image given.

  c. The system shall take real inputs of camera images and determine whether the image contains a fire or not.

  d. The system shall be able to take images with a variety of sizes and convert it to one fixed image to be used throughout the application.

  e. The system shall run as a service on either a Windows or Linux operating system.

  f. If the computer on which the system is running shuts down, the system service should start automatically when the computer restarts

- **MEDIUM PRIORITY:**

The system shall provide following facility that will allow web pages that the user is permitted to access. The system must support the following facility:

  a. Send alert message.

  b. Customer Data Management.

- **LOW PRIORITY:**

  a. The system shall allow the user's status to be stored for the next time he returns to the web site. This will save the user x minutes per visit by not having to re-enter already supplied data.

  b. The system shall provide information about event log of forest.

4.2 NON-FUNCTIONAL REQUIREMENTS:

- **RELIABILITY:**
  - The system shall be completely operational at least x% of the time.
  - Down time after a failure shall not exceed x hours.

- **USABILITY:**
  - Customer should be able to use the system in his job for x days.
  - A user who already knows what camera he is using should be able to connect and view that page in x seconds.

- **PERFORMANCE:**
  - The system should be able to support x simultaneous users.
  - The mean time to view a web page over a 56Kbps modem connection shall not exceed x seconds.

- **SECURITY:**
  - The system shall provide password protected access to web pages that are to be viewed only by users.

- **SUPPORTABILITY:**
  - The system should be able to accommodate many camera links.
  - The system web site shall be viewable from chrome or any browser.

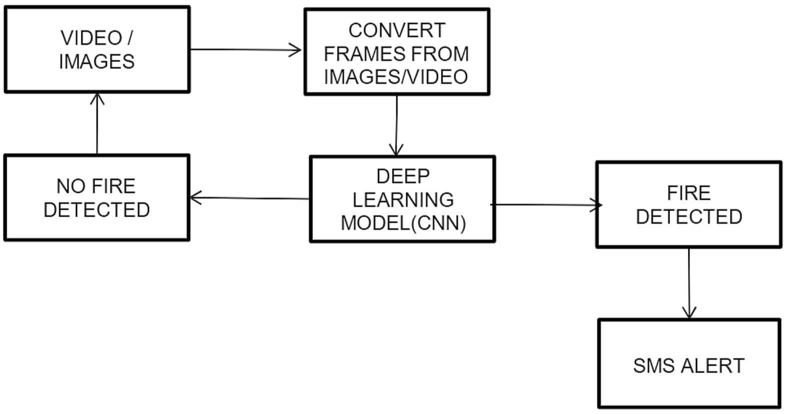
- **INTERFACES:**

  The system must interface with
  - The cloudant db for customer and customer log information
  - The acquired web site search engine.

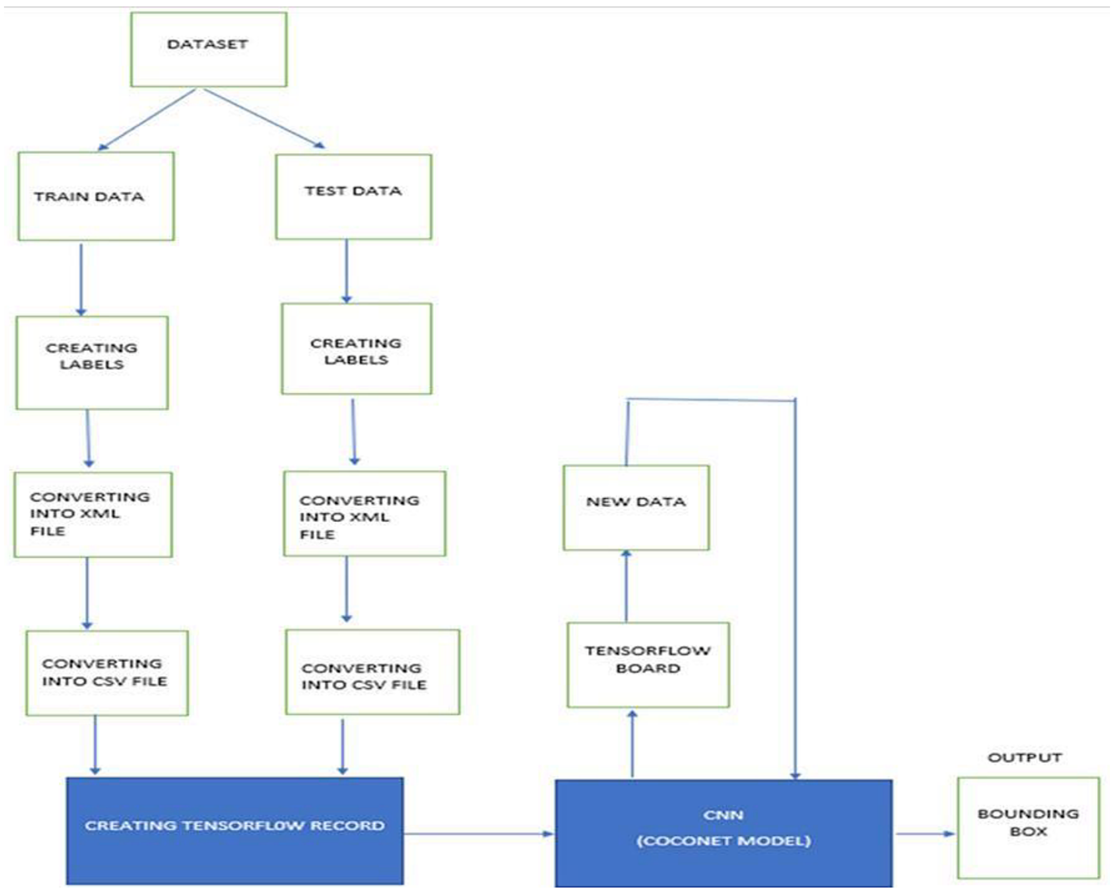
CHAPTER 5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAM:



5.2 SOLUTION & TECHNICAL ARCHITECTURE:



5.3 USER STORIES:

USER TYPE	FUNCTIONAL REQUIREMENTS	USER STORY / TASK	ACCEPTANCE CRITERIA	PRIORITY	RELEASE
Environ-mentalist	Collection of data	It is necessary for an animal rights activist to gather information about forestfires.	We must collect the correctdata.because of prediction.	High	Sprint-1
		Determine which algorithms can be used for prediction.	To gather the algorithms and determine each algorithm's accuracy .	Medium	Sprint-2
	Implementation of the Algorithm	Determine each algorithm's accuracy.	Accuracy of the algorithm is must to be calculated .	High	Sprint-2
		Assess the data set.	Data is preprocessing before the training.	High	Sprint-1
	Algorithm Accuracy Evaluation	Decide the precision, accuracy, as wellas recall of each algorithm.	Accuracy is importantto detectthe seviearityof fire	High	Sprint-3

CHAPTER 6

PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION:

SPRINT	FUNCTIONAL REQUIREMENTS	USER STORY / TASK	PRIORITY	TEAM MEMBERS
Sprint-1	Data Collection	Data collected by sensors aboard orbiting satellites, carried aboard aircraft, or installed on the ground provide a wealth of data thatcan be used to assessconditions before aburn and track the movement of awildfire innear real-time.	High	● Pavithiran G ● Sharan Padmanabhan ● Chandar B ● Abinash M
Sprint-1	Image Preprocessing	Image processing technique automatically detects forest fires around the world by using infrared (IR) images sourced from satellites and CNN used for image recognition and tasks that involve the processing of pixel data.	Medium	● Pavithiran G ● Sharan Padmanabhan ● Chandar B ● Abinash M
Sprint-2	Training And Testing	The model is trained for detecting the fire by training with real time work and the testing is done according the accuracy of the model.	High	● Pavithiran G ● Sharan Padmanabhan ● Chandar B ● Abinash M
Sprint-3	Reviewing The Model	The main task is to check that the model is efficient to work in real time to ensure there is no error in the model.	Medium	● Pavithiran G ● Sharan Padmanabhan ● Chandar B ● Abinash M
Sprint-4	Implementation	After completing every step, the model is implemented on the forest and the quickresponses is collected from forestorganization	High	● Pavithiran G ● Sharan Padmanabhan ● Chandar B ● Abinash M

6.2 SPRINT DELIVERY SCHEDULE:

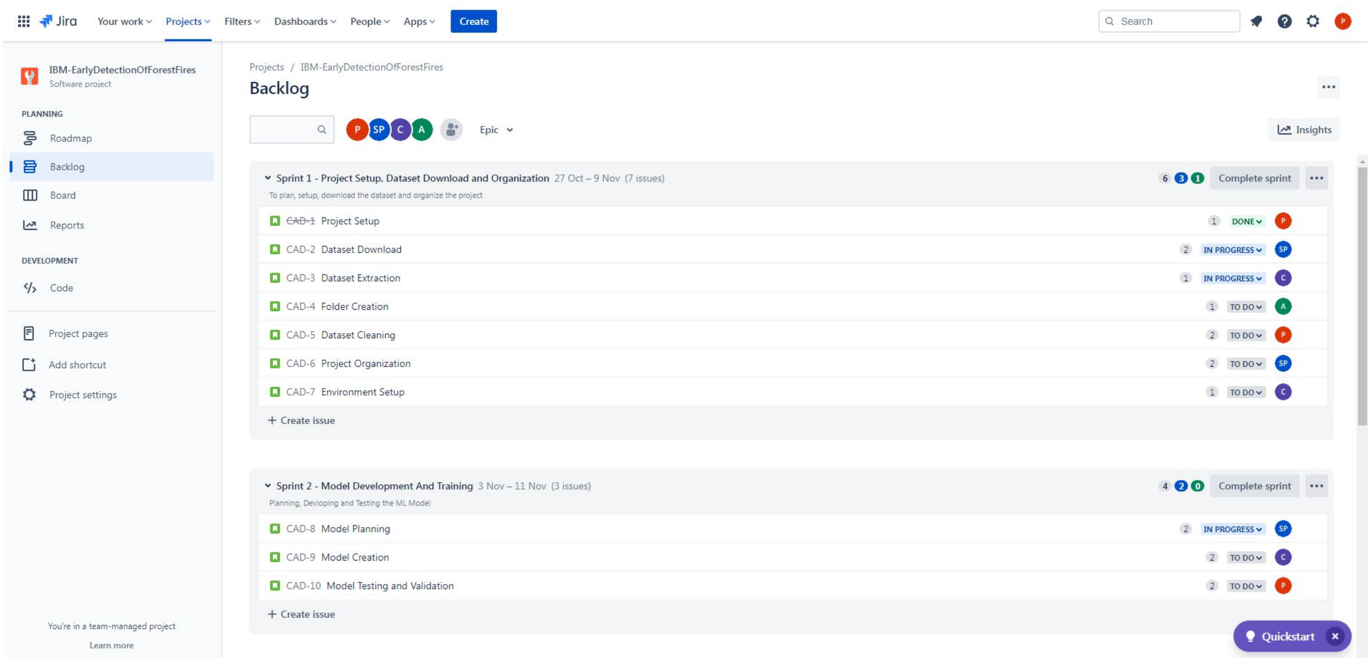
SPRINT	TOTAL STORY POINTS	DURATION	SPRINT START DATE	SPRINT END DATE (PLANNED)	STORY POINTS COMPLETED (AS ON PLANNED END DATE)	SPRINT RELEASE DATE (ACTUAL)
Sprint-1	20	6 Days	24 Oct 2022	20 Oct 2022	8	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Oct 2022	7	08 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	8	15 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	7	20 Nov 2022

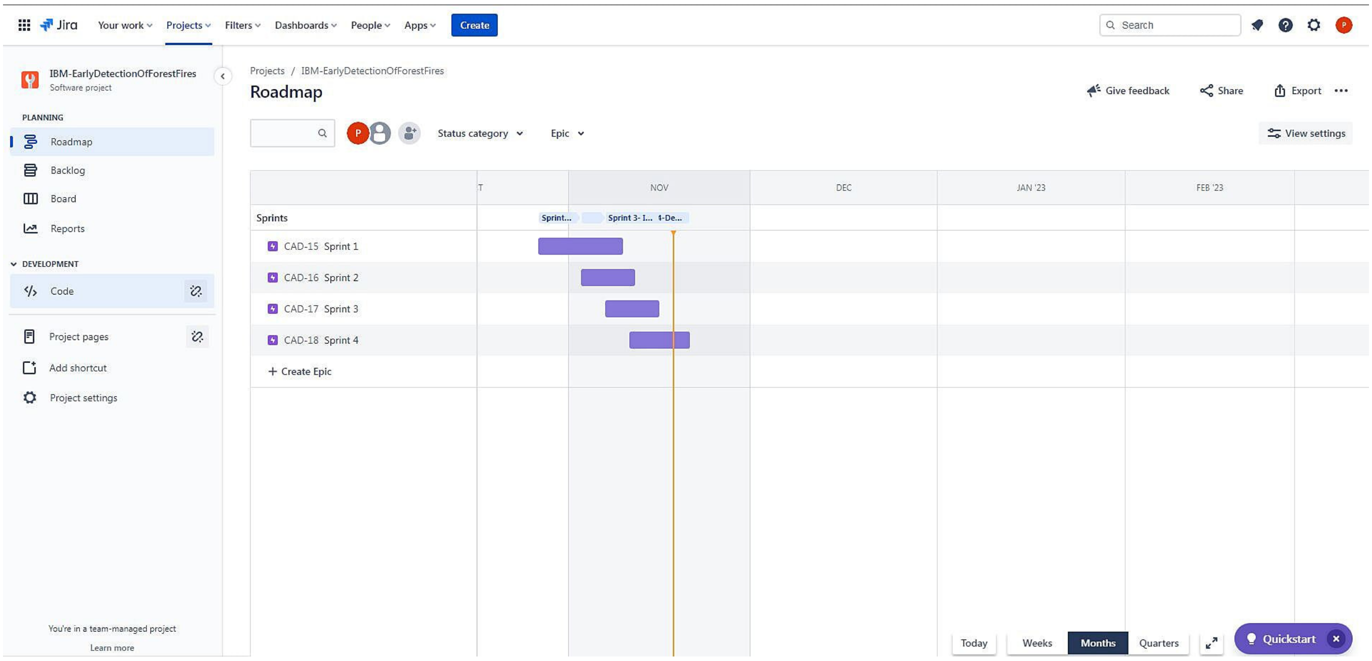
VELOCITY:

Imagine we have 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day).

$$AV = (\text{Sprint Duration}) / \text{Velocity} = 8 / 10 = 0.8$$

6.3 REPORTS FROM JIRA:




Jira
Your work
Projects
Filters
Dashboards
People
Apps
Create
Search
IBM-EarlyDetectionOfForestFires
Software project
PLANNING
Roadmap
Backlog
Board
Reports
DEVELOPMENT
Code
Project pages
Add shortcut
Project settings
You're in a team-managed project
Learn more
Projects / IBM-EarlyDetectionOfForestFires
Roadmap
Give feedback
Share
Export
Status category
Epic
View settings
NOV
DEC
JAN '23
FEB '23
Sprints
CAD-15 Sprint 1
CAD-16 Sprint 2
CAD-17 Sprint 3
CAD-18 Sprint 4
Create Epic
Today
Weeks
Months
Quarters
Quickstart

CHAPTER 7

CODING & SOLUTIONING

7.1 FIRE DETECTION:

Using early fire detection to alert users, image fire detection, a revolutionary fire detection technology, has recently played a critical role in lowering fire losses. An algorithmic analysis of photographs is the foundation for image fire detection. However, conventional detection systems, such as those that manually and automatically extract visual attributes, have reduced accuracy, delayed detection, and high computational costs. In this work, we aim to predict the onset of fire and alert as early as possible. We have developed a model that predicts if there is any onset of fire or not. If there is any evidence of catching fire, it immediately alerts us in time for intervention to save lives and property. The below is the snippet of the fire prediction algorithm.

```python
from keras.models import Sequential, load_model
from keras.layers import Conv2D, MaxPooling2D, Dense, Flatten, Dropout

def ForestFireDetector() -> Sequential:
    model: Sequential = Sequential(name="ForestFireDetector")

    model.add(Conv2D(64, (3, 3), activation="relu", input_shape=(128, 128, 3), name="Conv2D_01"))
    model.add(MaxPooling2D(pool_size=(2, 2), name="MaxPooling2D_01"))
    model.add(Dropout(0.25, name="Dropout_01"))

    model.add(Conv2D(64, (3, 3), activation="relu", input_shape=(128, 128, 3), name="Conv2D_02"))
    model.add(MaxPooling2D(pool_size=(2, 2), name="MaxPooling2D_02"))
    model.add(Dropout(0.25, name="Dropout_02"))
    model.add(Flatten(name="Flatten_01"))

    model.add(Dense(300, activation="relu", name="Dense_Relu_01"))
    model.add(Dense(150, activation="relu", name="Dense_Relu_02"))
    model.add(Dense(1, activation="sigmoid", name="Dense_Sigmoid"))

    return model

def train_model(override: bool = True) -> Sequential:
```

```python
    if not override and path.exists(MODEL_PATH):
        return load_model(MODEL_PATH)

    model: Sequential = ForestFireDetector()
    model.compile(optimizer="adam", loss="binary_crossentropy",
metrics=["accuracy"])
    model.summary()

    model.fit(training_images, steps_per_epoch=len(training_images), epochs=10,
validation_data=testing_images, validation_steps=len(testing_images))
    model.save(MODEL_PATH)

    return model

model: Sequential = train_model(override=False)
```

7.2 ALERT NOTIFICATION:

Today, it is common practice to use the vision-based fire detection method to locate fires. Additionally, a system is put in place that can detect forest fires and alert the administration before they become major disasters. People rely on high-tech devices that can detect a forest fire in real-time and transmit an alert to everyone. Even if a forest fire starts in an area without signal reception or communication, the system will send a message to inform everyone in time for them to take precautions before it gets out of hand. If a fire is discovered right away, the nearby fire departments can quickly arrive there.

```python
from PIL import Image
from playsound import playsound

AUDIO_PATH = path.join(Path(path.abspath("")), "content", "alert.wav")

capture = cv2.VideoCapture(0, cv2.CAP_DSHOW)
capturing: bool = True

while capturing and capture.isOpened():
    _, frame = capture.read()

    _frame = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
    image = Image.fromarray(_frame, mode="RGB").resize((128, 128))
    image = numpy.expand_dims(img_to_array(image), axis=0)
```

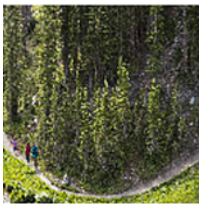
```

    prediction = round(model.predict(image, verbose=0)[0][0])

    text = ["No Fire", "Fire"][prediction]
    font = cv2.FONT_HERSHEY_SIMPLEX

    textsize = cv2.getTextSize(text, font, 1, 2)[0]
    x, y = (frame.shape[1] - textsize[0]) // 2, 100

    cv2.putText(frame, text, (x, y), font, 1, (41, 230, 63), 2)

    cv2.imshow("Fire Detection", frame)
    if prediction:
        playsound(AUDIO_PATH, block=False)

    if cv2.waitKey(1) == ord("q"):
        capturing = False

capture.release()
cv2.destroyAllWindows()
```

CHAPTER 8

TESTING

8.1 TEST CASES:

Test Frame	Expected Output	Actual Output	Accuracy	Result
	Fire	Fire	62%	Pass
	No Fire	No Fire	100%	Pass
	No Fire	No Fire	95%	Pass
	Fire	Fire	100%	Pass
	No Fire	No Fire	65%	Pass
	No Fire	No Fire	97.5%	Pass

	No Fire	No Fire	86%	Pass
	Fire	Fire	99.6%	Pass
	No Fire	No Fire	89%	Pass
	No Fire	No Fire	90%	Pass
	Fire	Fire	95%	Pass
	Fire	Fire	100%	Pass
	No Fire	No Fire	85%	Pass

CHAPTER 9

RESULTS

9.1 PERFORMANCE METRICS:

When we examine the system's performance, it is found that the model's predictions are 90 percent accurate. Furthermore, the model successfully detects forest fires using a live stream and generates a warning sound when a fire is spotted. And we tested our method using a webcam to feed real-time information, enabling the device to identify objects like trees and animals in front of it, and found that even with low-quality input, the model could make the prediction. As a consequence, the model's output is accurate and trustworthy in practice and it has learned to recognize fires from pixelated images taken by our webcam.

CHAPTER 10

ADVANTAGES & DISADVANTAGES

10.1 ADVANTAGES:

The vision-based fire detection method is now frequently utilized to find fires. The vision-based fire detection method can be added alongside surveillance equipment for a fairly small additional cost. The following are the advantages of vision-based fire detection techniques.

- The prompt response to flames.
- It detects the location of the fire rather than just the radiation.
- It can be used in outdoor settings that span broad areas.
- It can be used to analyze and store the acquired photos.
- It is not limited to indoor settings.

10.2 DISADVANTAGES:

Slash and burn fires are set every day to destroy large sections of forests. Of course, these forests do not just remove trees; they kill and displace wildlife, alter water cycles and soil fertility, and endanger the lives and livelihoods of local communities. Watchtowers were used in the past to identify forest fires, but they were ineffective because they relied on human observations. There are some forest fire detection techniques that have been used recently and even today, including watchtowers, satellite image processing techniques, optical sensors, and digital camera-based techniques. However, these techniques have many limitations, including inefficiency, power consumption, latency, accuracy, and implementation costs.

CHAPTER 11

CONCLUSION & FUTURE ENHANCEMENTS

11.1 CONCLUSION:

The goal of our initiative is to deploy cutting-edge techniques and technologies for the early detection of forest fires. Because of this, forest fires may be identified very early and prevented from escalating into big disasters. Both the wildlife that lives there and the nearby community will benefit from this. It is a serious problem since there are negative consequences on the forest's animals, residents' means of subsistence, and the destruction of their property and other valuable forest services.

11.2 FUTURE ENHANCEMENTS:

- Supporting thermal imaging.
- Examining the patterns of forest fires.
- Further statistical research to establish safety precautions.
- More dynamic and interactive visualization that aids in fire prediction.
- Support for handling enormous amounts of data and enhancing computing capacity.
- Combining the advantages of camera photos and thermal imaging to improve the prediction.

CHAPTER 12

APPENDIX

12.1 SOURCE CODE:

```python
import os
from os import path
from pathlib import Path
from matplotlib import pyplot

DATASET_PATH: str = path.join(Path(path.abspath("")), "content", "dataset")
MODEL_PATH: str = path.join(Path(path.abspath("")), "model", "forest_fire.h5")

from keras.preprocessing.image import ImageDataGenerator

training_image_generator: ImageDataGenerator = ImageDataGenerator(rescale=1/255, shear_range=0.2, rotation_range=180, zoom_range=0.2, horizontal_flip=True)
testing_image_generator: ImageDataGenerator = ImageDataGenerator(rescale=1/255)

training_images = training_image_generator.flow_from_directory(path.join(DATASET_PATH, "train_set"), target_size=(128, 128), batch_size=32, class_mode="binary")
testing_images = testing_image_generator.flow_from_directory(path.join(DATASET_PATH, "test_set"), target_size=(128, 128), batch_size=32, class_mode="binary")

import warnings

warnings.filterwarnings("ignore")

from keras.models import Sequential, load_model
from keras.layers import Conv2D, MaxPooling2D, Dense, Flatten, Dropout

def ForestFireDetector() -> Sequential:
    model: Sequential = Sequential(name="ForestFireDetector")

    model.add(Conv2D(64, (3, 3), activation="relu", input_shape=(128, 128, 3), name="Conv2D_01"))
    model.add(MaxPooling2D(pool_size=(2, 2), name="MaxPooling2D_01"))
    model.add(Dropout(0.25, name="Dropout_01"))

    model.add(Conv2D(64, (3, 3), activation="relu", input_shape=(128, 128, 3),
```

```
name="Conv2D_02"))
    model.add(MaxPooling2D(pool_size=(2, 2), name="MaxPooling2D_02"))
    model.add(Dropout(0.25, name="Dropout_02"))
    model.add(Flatten(name="Flatten_01"))

    model.add(Dense(300, activation="relu", name="Dense_Relu_01"))
    model.add(Dense(150, activation="relu", name="Dense_Relu_02"))
    model.add(Dense(1, activation="sigmoid", name="Dense_Sigmoid"))

    return model

def train_model(override: bool = True) -> Sequential:
    if not override and path.exists(MODEL_PATH):
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    model: Sequential = ForestFireDetector()
    model.compile(optimizer="adam", loss="binary_crossentropy", metrics=["accuracy"])
    model.summary()

    model.fit(training_images, steps_per_epoch=len(training_images), epochs=10, validation_data=testing_images, validation_steps=len(testing_images))
    model.save(MODEL_PATH)

    return model

model: Sequential = train_model(override=False)

from PIL import Image
from playsound import playsound

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capturing: bool = True

while capturing and capture.isOpened():
    _, frame = capture.read()

    _frame = cv2.cvtColor(frame, cv2.COLOR_BGR2RGB)
    image = Image.fromarray(_frame, mode="RGB").resize((128, 128))
    image = numpy.expand_dims(img_to_array(image), axis=0)

    prediction = round(model.predict(image, verbose=0)[0][0])
```

```python

    text = ["No Fire", "Fire"][prediction]
    font = cv2.FONT_HERSHEY_SIMPLEX

    textsize = cv2.getTextSize(text, font, 1, 2)[0]
    x, y = (frame.shape[1] - textsize[0]) // 2, 100

    cv2.putText(frame, text, (x, y), font, 1, (41, 230, 63), 2)

    cv2.imshow("Fire Detection", frame)
    if prediction:
        playsound(AUDIO_PATH, block=False)

    if cv2.waitKey(1) == ord("q"):
        capturing = False

capture.release()
cv2.destroyAllWindows()
```

12.2 GITHUB & PROJECT DEMO LINK:

GitHub Repository URL: https://github.com/IBM-EPBL/IBM-Project-4037-1658681277

Project Demo Link: https://github.com/IBM-EPBL/IBM-Project-4037-1658681277/blob/main/Final%20Deliverables/Early_Detection_of_Forest_Fires-Demo.mkv