

EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES

A PROJECT REPORT

Submitted by

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**BACHELOR OF ENGINEERING IN
ELECTRONICS AND COMMUNICATION
ENGINEERING**

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INTRODUCTION

1.1. PROJECT OVERVIEW

Forests are the protectors of earth's ecological balance. Unfortunately, the forest fire is usually only observed when it has already spread over a large area, making its control and stoppage arduous and even impossible at times. 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 damage to the ecology (huge amounts of smoke and carbon dioxide (CO₂) in the atmosphere). Fast and effective detection is a key factor in forest fire fighting. To avoid uncontrollable wide spreading of forest fires it is necessary to detect fires in an early state and to prevent the propagation. Nowadays, image processing are critical components of the increasingly object detections . Such systems have a large applicability, and the environmental monitoring field can also benefit from their innovation.

1.2. PURPOSE:

. The purpose of the image processing concept is to capture the image from the real world and every day scenario appliances, etc., into intelligent interconnected virtual objects. By keeping the user informed on the state of things and giving the users control of things, a better global humans-devices-humans communication can be achieved.

LITERATURE SURVEY

2.1. EXISTING METHOD:

S.NO	AUTHOR	TITLE	YEAR
1.	G.V.Hristor Diyana kyuchukova Jordan Raychev	Emerging method for early detection of forest fires using unmanned Aerial vehicles and Lorawan sensor network	2018

S.NO	AUTHOR	TITLE	YEAR
2.	Panagiotis barmpoutis Konsmas dimitropoulas Nikos grammalidis.	A review on early forest fire detection systems using optical remote sensing	2020

S.NO	AUTHOR	TITLE	YEAR
3.	Hamdy soliman	S-mart forest fires early detection sensory system: Another approach of utilizing wireless sensor and neutral networks	2010

S.NO	AUTHOR	TITLE	YEAR
4.	Lilu cui Chaolong yao Zhengbo zou	The influence of climate change on forest fires in Yunnan province, Southwest china detected by GRACE satellites	2022

2.2. REFERENCES:

[1]Krizhevsky, Alex, Ilya Sutskever, and Geoffrey E. Hinton.

"Imagenet classification with deep convolutional neural networks." Advances in neural information processing systems. 2012.

[2]A. Grivei, A. Rdoi, C. Vduva and M. Datcu, "An Active-Learning approach to the query by example retrieval in remote sensing images," International Conference on Communications (COMM), pp. 377-380, 2016.

[3]G. Suciu, et al. "Remote Sensing for Forest Environment Preservation" WorldCIST, Recent Advances in Information Systems and Technologies, pp. 211-220, 2017.

[4]E. Olteanu, et al. "Forest Monitoring System Through Sound Recognition." In 2018 International Conference on Communications

(COMM), pp. 75-80. IEEE, 2018.

[4] Arasvathi, Nahalingham and Chelsea, Ferdianti Kosasih “Study and Implementation of Internet of Things (IoT) Based Forest Fire Automation System to Detect and Prevent Wildfire”. INTI Journal, 1 (15) , pp. 1-5, 2018.

[5]J. Papán, M. Jurecka, J. Púchyová, “WSN for Forest Monitoring to Prevent Illegal Logging”, Proceedings of the Federated Conference on Computer Science and Information Systems, pp. 809-812, 2012.

[6] Krivtsova et al. “Implementing a broadcast storm attack on a mission-critical wireless sensor network” In: International Conference on Wired/Wireless Internet Communication, 2016.

[7] Chen, Thou-Ho, Cheng-Liang Kao, and Sju-Mo Chang. "An intelligent real-time fire-detection method based on video processing." Security Technology, 2003. Proceedings. IEEE 37th Annual 2003 International Carnahan Conference on. IEEE, 2003.

[8] Chen, Thou-Ho, et al. "The smoke detection for early fire-alarms system base on video processing." Intelligent

Information Hiding and Multimedia Signal Processing, 2006. IHH-MSP'06. International Conference on. IEEE, 2006

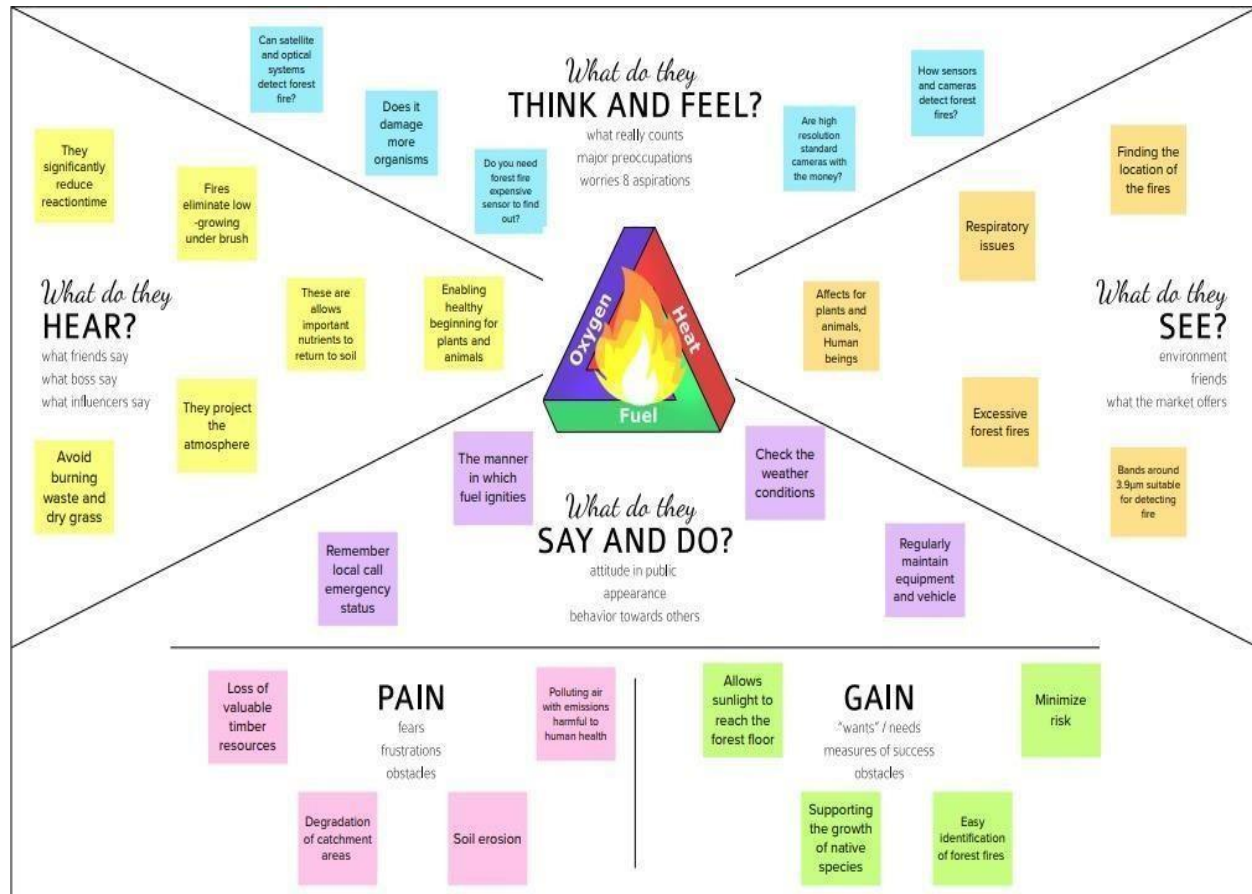
2.3. PROBLEM STATEMENT DEFINITION:

The most common hazard in forests is forests fire. They pose a treat not only to the forest wealth but also to the entire regime to fauna and flora seriously disturbing the bio – diversity and the ecology and environment of region. During summer , when there is no rain for months, the forests become littered with dry senescent leaves and twinges, which could burst into flames ignited by the slightest spark. Forest fire causes imbalances in nature and endangers biodiversity by reducing faunal and floral wealth. Traditional methods of fire prevention are not proving effective and it is now essential to raise public awareness on the matter , particularly among those people who live close to or in forested areas.

I am	Humans are responsible for 75% of all forest fire. Naturally occurring forest fires can be caused by lightning, volcanic activity and coal seam fires , though these are relatively rare.
I'm trying to	Using the recent technologies to avoid forest fires in Deep learning based on pre-trained satellite image processing and forest officer can view the recommendable forest fires through Gmail sms so avoid overexposure.
But,	I don't know much about the recent technology that helps me predict forest fires, and I haven't found the right solutions for forest fires.
Beacaus	I don't want to cause devastating damage to both nature and humans, air pollution, every fire huge amounts of gases released in the atmosphere .
Which makes me feel	I'm not capable of early detect the fires and maintaining the area clean of forest but I trying solution for this problem.

IDEATION & PROPOSED SOLUTION

3.1. EMPATHY MAP CANVAS



3.2. BRAINSTORMING :

PROBLEM :

1

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

PROBLEM

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

Brainstorm:

2

Brainstorm

Write down any ideas that come to mind that address your problem statement.



TIP



You can select a sticky note and hit the pencil (switch to sketch) icon to start drawing!

BALAJI R



ARUN K



KOTA KARTHIK K



DINESH R



Group ideas:

3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

🕒 20 minutes

USING TEMPERATURE

Detect the forest fires by temperature regularly monitoring

Detect the forest fire using CO2

Detecting the fire light and smoke plumes emitted from the fire

USING VISUALS

Detecting fire using movements of Birds

Collecting data using drones flying over the forest

USING METHODS

Deep learning based Mathematical for detecting forest fires

Forest officer can view the recommanable forest fire through SMS

Collecting data using satellite image

TIP

Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

Prioritize:

4

Prioritize

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

🕒 20 minutes



3.3. PROPOSED SOLUTION:

S. No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	<p>Forests are one of the main factors in balancing the ecology. Forest fires 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.</p> <p>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</p>
2.	Idea / Solution description	<p>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.</p>
3.	Novelty / Uniqueness	<p>Real time computer program detect forest fire in earliest before it spread to larger area. Our proposed system depends on using AI to make it cheaper and easier for the forest management. Accuracy and timely prediction using AI, CNN and API made it possible.</p>
4.	Social Impact / Customer Satisfaction	<p>The destroying homes, wildlife habitat and timber, and polluting the air with emissions harmful to human health. The proposed solution fulfills the satisfaction requirements of the customer as it provides instant alerts on fire detection which helps the forest officer to take action as soon as possible.</p>

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 exact location of the fire and can be activated by SMS. The fire officer can implement quick responses and preventive measures.
6.	Scalability of the Solution	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. Testing and training undergo using latest technology like KERAS, TENSORFLOW, NUMPY and PILLOW

3.4. PROPOSED SOLUTION FIT:

Project Design Phase-I - Solution Fit Template

Project Title: Emerging Methods for Early Detection of Forest Fires

Team Id :PNT2022TMID42101

Define CS, fit into CC	1. CUSTOMER SEGMENT(S) CS <p>In order to protect the forest resources, which are essential for supporting life on Earth, from sudden fire and smoke outbreaks. The forest management group does require this gadget, in places at risk of fire.</p>	6. CUSTOMER CONSTRAINTS CC <p>The devastation is caused by greenhouse gases and changes in the climate. The human tendency to consume resources greedily is another important contributing cause to forest fires</p>	5. AVAILABLE SOLUTIONS AS <p>For the purpose of detecting forest fires, existing systems use optical sensors. The sensors alert the office of forest management when a fire is spotted. In addition, satellites are utilised to find IR rays seen in forested areas</p>	Explore AS, differentiate
	2. JOBS-TO-BE-DONE / PROBLEMS J&P <p>By releasing a lot of carbon dioxide, carbon monoxide, and fine particulate matter into the environment, the main issue is weather and climate. As a result, air pollution can lead to a variety of health problems, such as respiratory and cardiovascular disorders.</p>	9. PROBLEM ROOT CAUSE RC <p>The following are some rationales 1. Lightning, a natural occurrence 2. Man-made causes: cigarettes, naked flames, and electric sparks Therefore, ongoing care and observation are required to protect natural resources in order to save lives.</p>	7. BEHAVIOUR BE <p>When fire is detected the system which is implemented to monitor the forests sets the alarm to ring, that is it gives the signal through which fire management team and the forest committee tries to call off the fire. Thus, the aim is to recognise the fire as early as possible to prevent spread of fire which will cause further damage and it'll become difficult to control.</p>	
Identify strong TR & EM	3. TRIGGERS TR <p>Due to the existence of a great deal of dry grass all around and the possibility of the campfire remaining scorched, the uncontrolled behaviour toward burned cigarettes can spread.</p>	10. YOUR SOLUTION SL <p>We have presented a method to detect forest fires early using CCTV camera surveillance, which can detect fire in both indoor and outdoor activities, in order to reduce these losses. In order for the forest management office to stop the damage brought on by the fire, immediate alarms must be given to them</p>	8. CHANNELS OF BEHAVIOUR CH <p>Online detection: As a result, the chatbot or the API can connect over the internet to provide you with information on the forest's present condition. Offline Detection: As a result, the forest managers can notify surrounding residential areas or raise awareness through the media (news, radio).</p>	Identify strong TR & EM
	4. EMOTIONS: BEFORE / AFTER EM <p>Since the variables that affect a wildfire's course and intensity are erratic and subject to alter at any time, they can be very stressful. People who have experienced wildfires may experience severe anxiety and mood swings.</p>			

REQUIREMENT ANALYSIS

4.1. FUNCTIONAL REQUIREMENTS:

FR No.	Functional Requirement(Epic)	Sub Requirement(Story/Sub-Task)
FR-1	Images surveillance start	Start surveillance from satellites is a trained model
FR-2	Image processing is being used to monitor the fire	Exact location monitoring through camera
FR-3	Detect the fire	Fire is detected through CNN model
FR-4	Aler	sending notification to the fire authorities

4.2. NON-FUNCTIONAL REQUIREMENTS

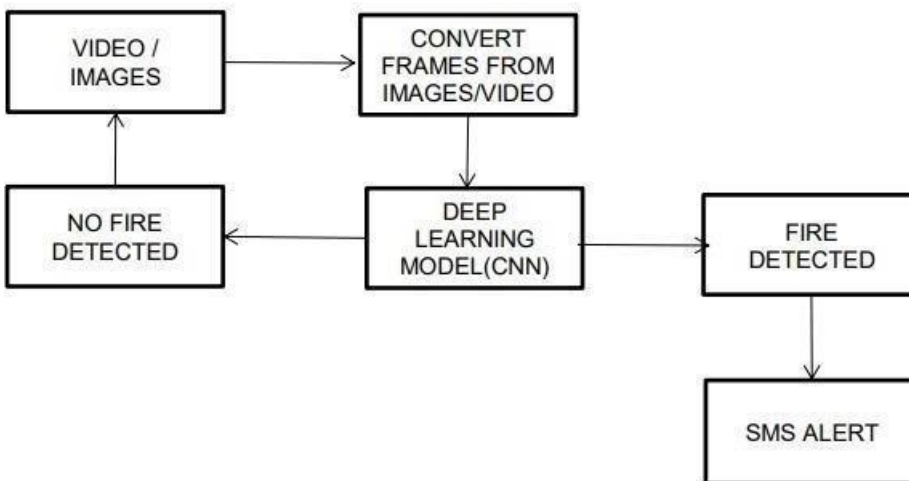
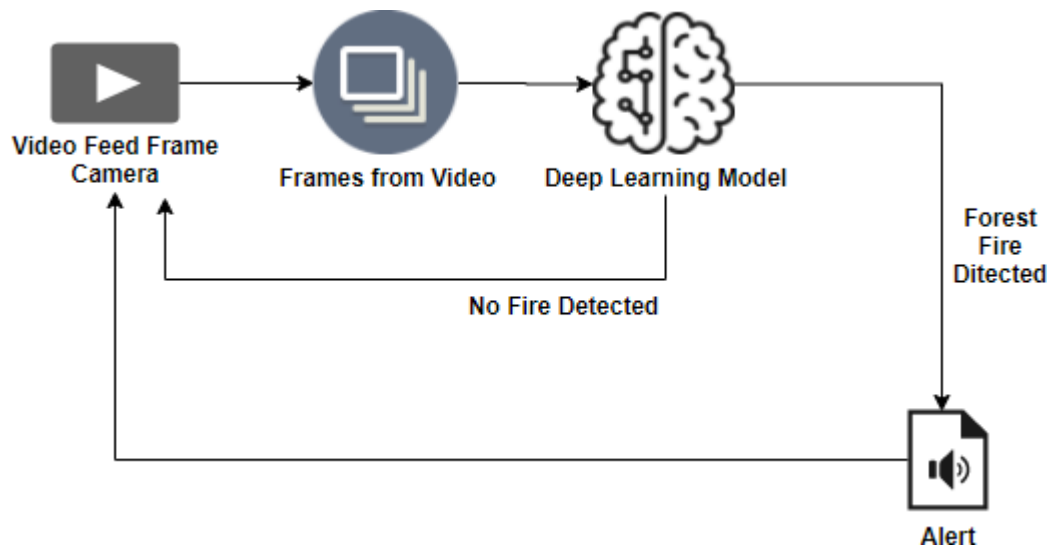
FR No.	Non-Functional Requirement	Description
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NFR-1	Usability	Usability is a unique and significant perspective to analyze user requirements, which can further improve the design quality, according to AI devices with machine learning.
NFR-2	Security	<ul style="list-style-type: none"> ➤ HD and powerful CCTV cameras are used. ➤ The fire is found using image processing and 24-hour monitoring.
NFR-3	Reliability	A real-time and dependable fire detection method for an early warning system is required to ensure an effective response to an incident.
NFR-4	Performance	<ul style="list-style-type: none"> • The system is intended to monitor forest fires through image processing via a camera. • CCTV cameras are used to process images and detect forest fires. • The twilio module is used to send the forest officer an alert message
NFR-5	Availability	<ul style="list-style-type: none"> o By progressing to a more advanced system that uses real-time CCTV cameras to detect and alert on fires. o The convolutional neural network algorithm is extremely useful for detecting fire in captured images
NFR-6	Scalability	By detecting forest fires early, we can prevent loss of life as well as resource damage while decreasing air pollution, landslides, soil erosion, and Emission emissions into the environment

5. PROJECT DESIGN

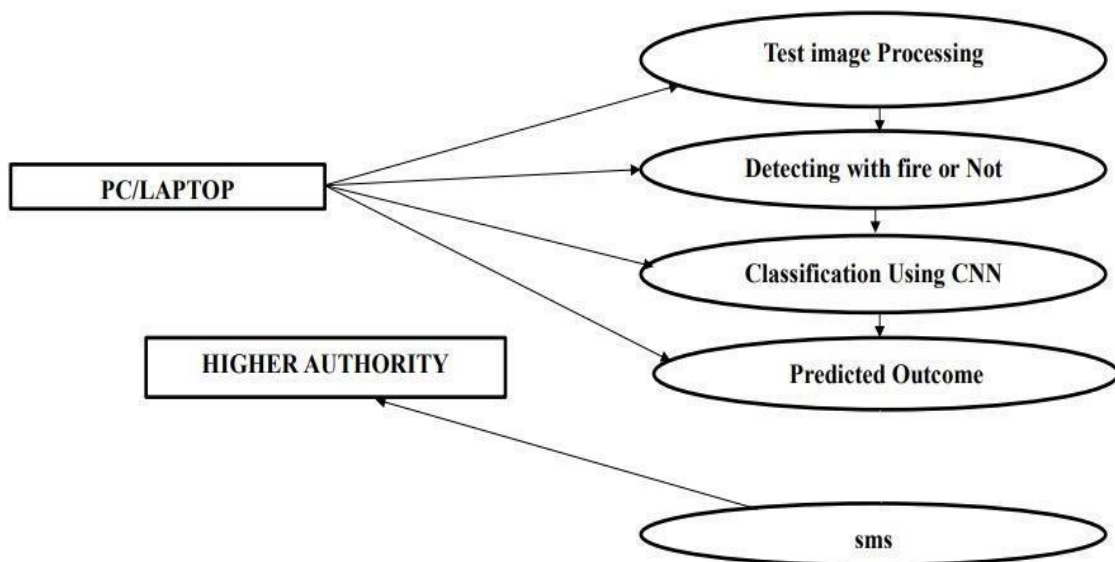
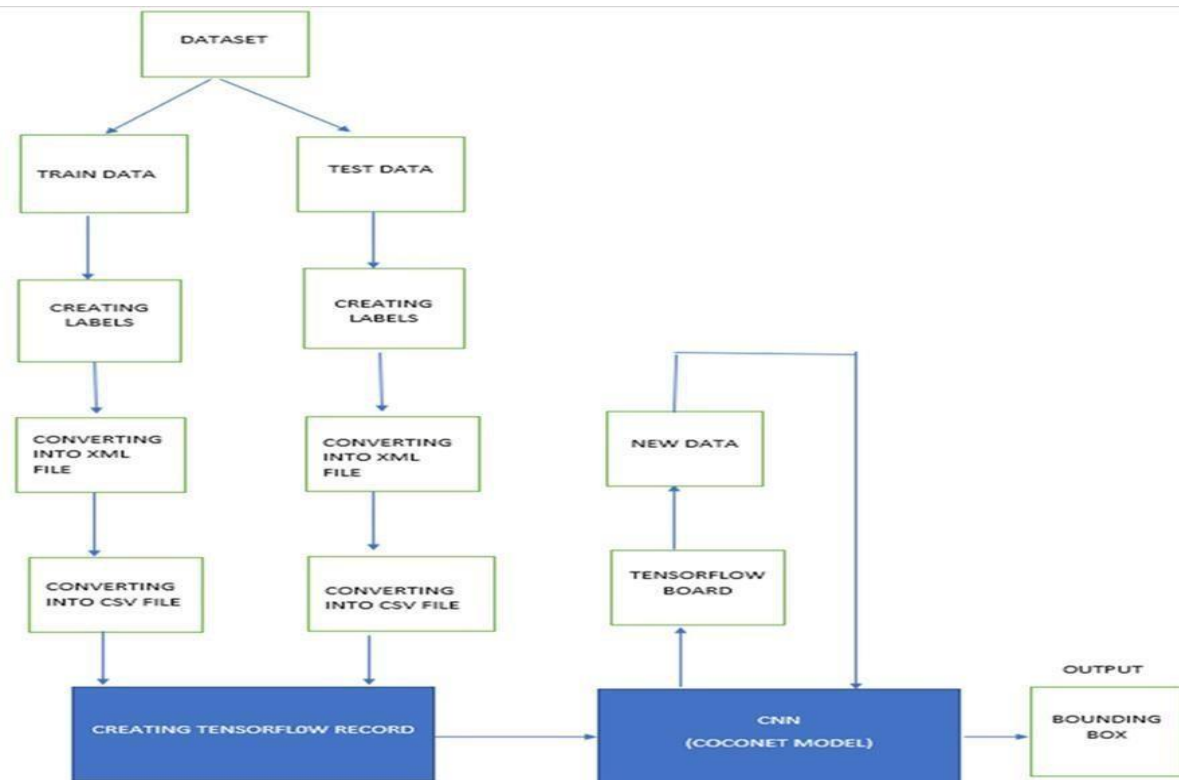
5.1.DATA FLOW DIAGRAMS:

The traditional visual representation of how information moves through a system is a data flow diagram (DFD). A tidy and understandable DFD can graphically represent the appropriate amount of the system requirement. It demonstrates how information enters and exits the system, what modifies the data, and where information is kept.



5.2.SOLUTION AND TECHNICAL ARCHIETECTURE:

Solution Architecture:



5.3.USER STORIES:

Use the below template to list all the user stories for the product.

User story	Functional Requirement(Epic)	User Story Number	User Story/Task	Acceptance criteria	Priority	Release
Environmentalist	Collect the data	USN-1	It is necessary for an animal rights activist to gather information about forest fires.	We must collect the correct data.because of prediction.	High	Sprint-1
		USN-2	Determine which algorithms can be used for prediction.	To gather the algorithms and determine each algorithm's accuracy .	Medium	Sprint-2
	Implement Algorithm	USN-3	Determine each algorithm's accuracy.	Accuracy of the algorithm is must to be calculated .	High	Sprint-2
		USN-4	assess the data set	Data is preprocessing before the training.	High	Sprint-1
	Evaluate Accuracy of Algorithm	USN-5	Decide the precision, accuracy, as well as recall of each algorithm.	Accuracy is important to detect the severity of fire	High	Sprint-3

6.PROJECT PLANNING & SCHEDULING:

6.1.SPRINT PLANNING & ESTIMATION:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
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Sprint-1	Download data set	USN-1	The data is downloaded from the Kaggle website and then the data set is classified into training and testing images.	5	High	Dinesh V Kavipriya M
Sprint-2	Image preprocessing	USN-2	<p>In Image processing technique the first step is usually importing the libraries that will be needed</p> <p>In the program. Import Keras library from that library and import the ImageDataGenerator Library to your Python script.</p> <p>The next step is defining the arguments for the ImageDataGenerator And next step is applying the ImageDataGenerator arguments to the train and test dataset.</p>	10	Medium	Dinesh V Karthick Kumar M
Sprint-3	Training image	USN-3	In this training phase the ImageDataGenerator arguments is applied to the training images and the model is tested with several images and the model is saved.	5	High	Dinesh V Mathesh
Sprint-4	Testing Image, Evaluation metrics and accuracy	USN-4	In this testing phase the Image processing techniques is applied to the testing images and executed for prediction. In this phase the result, prediction, accuracy, and performance of the project are tested.	5	High	Dinesh V Kavipriya M

MILESTONE & ACTIVITY LIST:

Activity Number	Activity Name	Detailed Activity Description	Assigned To	Status
1.a	Access Resources	Access the resources (courses) in project dashboard	All Members	COMPLETED
1.b	Rocket chat Registration	Join the mentoring channel via platform & rocket-chat mobile app.	All Members	COMPLETED
1.c	Access Workspace	Access the guided project workspace	All Members	COMPLETED
1.d	IBM Cloud registration	Register on IBM Academic Initiative & Apply Feature for IBM Code Cloud Credits.	All Members	COMPLETED
1.e	Project Repository Creation	Create GitHub account & collaborate with Project Repository in project workspace.	All Members	COMPLETED
1.f	Environment Setup	Set-up the Laptop / Computers based on the pre-requisites for each	All Members	COMPLETED

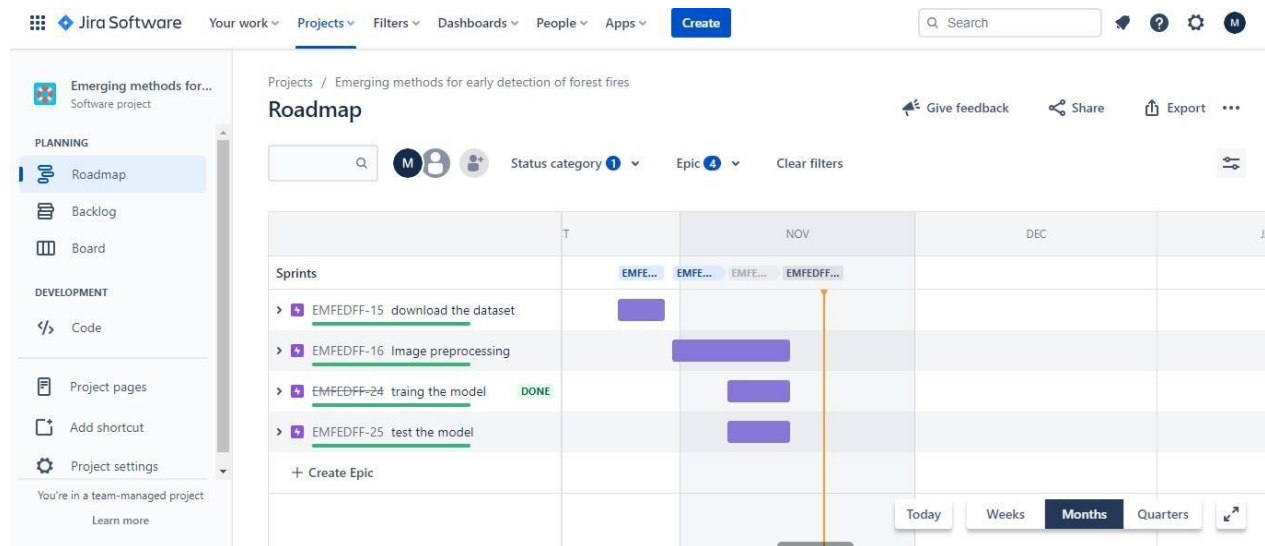
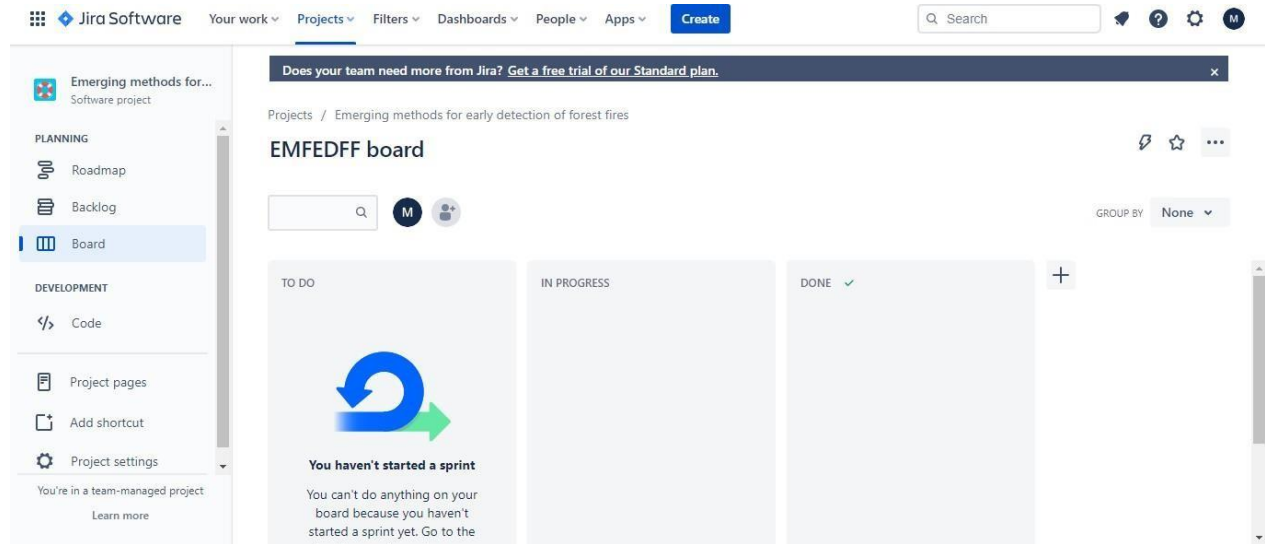
		understand the user interactions & experiences with the application (entry to exit).		
4.b	Technology Training	Attend the technology trainings as per the training Calendar.	All Members	COMPLETED
4.c	Functional Requirements & Data Flow Diagrams	Prepare the Functional Requirement Document & Data-Flow Diagrams.	All Members	COMPLETED
4.d	Technology Architecture	Prepare Technology Architecture of the solution.	All Members	COMPLETED
4.e	Technology Training	Attend the technology trainings as per the training Calendar.	All Members	COMPLETED
5.a	Milestone & Activity List	Prepare Milestone & Activity List.	All Members	COMPLETED
5.b	Sprint Delivery Plan	Prepare Sprint Delivery Plan	All Members	IN PROGRESS
6	Data Collection	Collect datasets from different open sources like kaggle.com, data.gov, UCI machine learning repository, etc.	All Members	IN PROGRESS
7.a	Image Preprocessing	Importing the ImageDataGenerator Library	All Members	IN PROGRESS
7.b	Image Preprocessing	Define the parameters/arguments for ImageDataGenerator class.	All Members	IN PROGRESS
7.c	Image Preprocessing	Applying ImageDataGenerator functionality to trainset and test set.	All Members	IN PROGRESS
8.a	Model Building	Importing the model building libraries	All Members	IN PROGRESS
8.b	Model Building	Initializing the model	All Members	IN PROGRESS
8.c	Model Building	Adding CNN Layers	All Members	IN PROGRESS
8.d	Model Building	Adding Dense Layers	All Members	IN PROGRESS
8.e	Model Building	Configuring the learning	All Members	IN PROGRESS

		process		
8.f	Model Building	Training the Model	All Members	IN PROGRESS
8.g	Model Building	Save the model	All Members	IN PROGRESS
8.h	Model Building	Predictions	All Members	IN PROGRESS
9.a	Video Analysis	OpenCV for video processing.	All Members	IN PROGRESS
9.b	Video Analysis	Creating an account in Twilio service	All Members	IN PROGRESS
9.c	Video Analysis	Sending alert message	All Members	IN PROGRESS
10.a	Train CNN Model on IBM	Register for IBM Cloud	All Members	IN PROGRESS
10.b	Train CNN Model on IBM	Train Image Classification Model	All Members	IN PROGRESS

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	5	6 Days	24 Oct 2022	29 Oct 2022	5	29 Oct 2022
Sprint-2	10	6 Days	31 Oct 2022	05 Nov 2022	10	05 Nov 2022
Sprint-3	5	6 Days	07 Nov 2022	12 Nov 2022	5	12 Nov 2022
Sprint-4	5	6 Days	14 Nov 2022	19 Nov 2022	5	19 Nov 2022

6.3. REPORTS FROM JIRA:



7.CODING & SOLUTIONING

7.1.FEATURE 1:

Keras leverages various optimization techniques to make high level neural network API easier and more performant. It supports the following features:

- Consistent, simple and extensible API.

- Minimal structure - easy to achieve the result without any frills.
- It supports multiple platforms and backends.
- It is user friendly framework which runs on both CPU and GPU.
- Highly scalability of computation.

1.IMAGE DATA GENERATOR:

Keras ImageDataGenerator is used for getting the input of the original data and further, it makes the transformation of this data on a random basis and gives the output resultant containing only the data that is newly transformed. It does not add the data.

```
From keras.preprocessing.image import ImageDataGenerator
```

2.PARAMETRES

2.1. Rescale:

The ImageDataGenerator class can be used to rescale pixel values from the range of 0-255 to the range 0-1 preferred for neural network models. Scaling data to the range of 0-1 is traditionally referred to as normalization.

2.2. Shear Range:

Shear range means that the image will be distorted along an axis, mostly to create or rectify the perception angles. It's usually used to augment images so that computers can see how humans see things from different angles.

2.3. Rotation range:

ImageDataGenerator class allows you to randomly rotate images through any degree between 0 and 360 by providing an integer value in the rotation_range argument. When the image is rotated, some pixels will move outside the image and leave an empty area that needs to be filled in.

2.4. Zoom Range:

The zoom augmentation method is used to zooming the image. This method randomly zooms the image either by zooming in or it adds some pixels around the image to enlarge the image. This

method uses the `zoom_range` argument of the `ImageDataGenerator` class. We can specify the percentage value of the zooms either in a float, range in the form of an array.

2.5. Horizontal Flip:

Horizontal flip basically flips both rows and columns horizontally. So for this, we have to pass the `horizontal_flip=True` argument in the `ImageDataGenerator` constructor.

3.CONVOLUTION NEURAL NETWORK:

Convolutional neural network is one of the most popular ANN. It is widely used in the fields of image and video recognition. It is based on the concept of convolution, a mathematical concept. It is almost similar to multi-layer perceptron except it contains series of convolution layer and pooling layer before the fully connected hidden neuron layer.

3.1. Convolutional Layer:

Convolution layer: It is the primary building block and perform computational tasks based on convolution function.

3.2. Pooling Layer:

Pooling layer: It is arranged next to convolution layer and is used to reduce the size of inputs by removing unnecessary information so computation can be performed faster.

3.3. Fully Connected Layer:

Fully connected layer: It is arranged to next to series of convolution and pooling layer and classify input into various categories

7.2.FEATURE 2(CODE):

Image Pre-Processing:

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

Importing ImageDataGenerator from Keras

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

Defining the Parameters

```
train_datagen = ImageDataGenerator(rescale = 1./255,
                                   shear_range = 0.2,
```

```
        zoom_range = 0.2,  
        horizontal_flip = True)  
  
val_datagen = ImageDataGenerator(rescale = 1./255)
```

Applying ImageDataGenerator functionality to train dataset

```
training_set = train_datagen.flow_from_directory('/content/drive/  
MyDrive/Data set Collection',  
                                                target_size = (512,512),  
                                                batch_size = 8,  
                                                class_mode = 'binary')  
val_set = val_datagen.flow_from_directory('/content/drive/MyDrive/  
Data set Collection',  
                                          target_size = (512,512),  
                                          batch_size = 8,  
                                          class_mode = 'binary')  
x_train = train_datagen.flow_from_directory(r'/content/drive/MyDrive/  
Data set Collection')  
x_test = val_datagen.flow_from_directory('/content/drive/MyDrive/  
Data set Collection')
```

Training code:

To train the model we will use the train.py file, which is located in the object_detection/legacy folder. We will copy it into the object_detection folder and then we will open a command line and type default.

```
train.py - E:\foresttt\train.py (3.6.5)
File Edit Format Run Options Window Help

import os
import tensorflow as tf

from object_detection.builders import dataset_builder
from object_detection.builders import graph_rewriter_builder
from object_detection.builders import model_builder
from object_detection.legacy import trainer
from object_detection.utils import config_util

tf.logging.set_verbosity(tf.logging.INFO)

flags = tf.app.flags
flags.DEFINE_string('master', '', 'Name of the TensorFlow master to use.')
flags.DEFINE_integer('task', 0, 'task id')
flags.DEFINE_integer('num_clones', 1, 'Number of clones to deploy per worker.')
flags.DEFINE_boolean('clone_on_cpu', False,
                    'Force clones to be deployed on CPU. Note that even if '
                    'set to False (allowing ops to run on gpu), some ops may '
                    'still be run on the CPU if they have no GPU kernel.')
flags.DEFINE_integer('worker_replicas', 1, 'Number of worker+trainer '
                    'replicas.')
flags.DEFINE_integer('ps_tasks', 0,
                    'Number of parameter server tasks. If None, does not use '
                    'a parameter server.')
flags.DEFINE_string('train_dir', '',
                    'Directory to save the checkpoints and training summaries.')

flags.DEFINE_string('pipeline_config_path', '',
                    'Path to a pipeline_pb2.TrainEvalPipelineConfig config '
                    'file. If provided, other configs are ignored')

flags.DEFINE_string('train_config_path', '',
                    'Path to a train_pb2.TrainConfig config file.')
flags.DEFINE_string('input_config_path', '',
                    'Path to an input_reader_pb2.InputReader config file.')
flags.DEFINE_string('model_config_path', '',
                    'Path to a model_pb2.DetectionModel config file.')

FLAGS = flags.FLAGS
```

TESTING OBJECT DETECTOR

In order to test our newly created object detector, we can use the code which we already created.

```
final.py - E:\foresttt\final.py (3.6.5)
File Edit Format Run Options Window Help
sys.path.append( .. )
from object_detection.utils import ops as utils_ops

if StrictVersion(tf.__version__) < StrictVersion('1.9.0'):
    raise ImportError('Please upgrade your TensorFlow installation to v1.9.* or later')

from utils import label_map_util
from utils import visualization_utils as vis_util

MODEL_NAME = 'inference_graph'
PATH_TO_FROZEN_GRAPH = MODEL_NAME + '/frozen_inference_graph.pb'
PATH_TO_LABELS = 'training/labelmap.pbtxt'

detection_graph = tf.Graph()
with detection_graph.as_default():
    od_graph_def = tf.GraphDef()
    with tf.gfile.GFile(PATH_TO_FROZEN_GRAPH, 'rb') as fid:
        serialized_graph = fid.read()
        od_graph_def.ParseFromString(serialized_graph)
        tf.import_graph_def(od_graph_def, name='')

category_index = label_map_util.create_category_index_from_labelmap(PATH_TO_LABELS)

def email():
    with open('capture.jpg', 'rb') as f:
        file_data = f.read()
        file_type = imghdr.what(f.name)
        file_name = f.name
    msg.add_attachment(file_data, maintype = 'image', subtype = file_type, filename = file_name)
    with smtplib.SMTP_SSL('smtp.gmail.com', 465) as smtp:
        smtp.login(email_add, email_pass)
        smtp.send_message(msg)

def run_inference_for_single_image(image, graph):
    if 'detection_masks' in tensor_dict:
        # The following processing is only for single image
        detection_boxes = tf.squeeze(tensor_dict['detection_boxes'], [0])
        detection_masks = tf.squeeze(tensor_dict['detection_masks'], [0])
        # Reframe is required to translate mask from box coordinates to image coordinates
        real_num_detection = tf.cast(tensor_dict['num_detections'][0], tf.int32)
        detection_boxes = tf.slice(detection_boxes, [0, 0], [real_num_detection, 4])
        detection_masks = tf.slice(detection_masks, [0, 0], [real_num_detection, 4])
```

8. TESTING

8.1. Test Cases:

8.2. 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).

1. 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
External	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

2. Test Case Analysis:

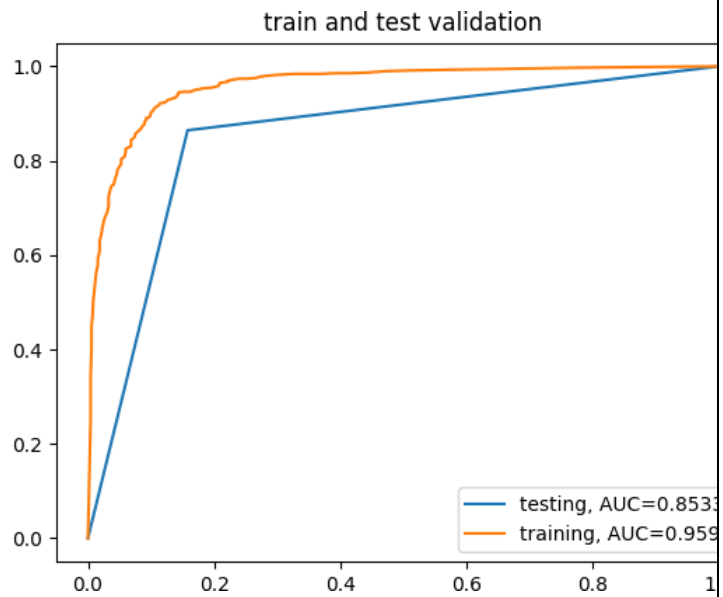
This report shows the number of test cases that have passed, failed, and untested.

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

RESULTS

9.1. PERFORMANCSE METRICS:

S.No.	Parameter	Values
1.	Model Summary	<pre>Model: "sequential_5" Layer (type) Output Shape Param ===== conv2d_4 (Conv2D) (None, 126, 126, 32) 896 max_pooling2d_4 (MaxPooling (None, 63, 63, 32) 0 2D) flatten_4 (Flatten) (None, 127008) 0 dense (Dense) (None, 256) 325 dense_1 (Dense) (None, 1) 257 Total params: 32,515,457 Trainable params: 32,515,457 Non-trainable params: 0</pre>
2.	Accuracy	Training Accuracy - 94.50% Validation Accuracy - 98.35%



10. ADVANTAGES & DISADVANTAGES:

ADVANTAGES:

- ✓ CNN gives best accuracy when compared to machine learning techniques.
- ✓ Can be used for classification with above 96% accuracy.

DISADVANTAGES:

- The temperature sensor which has a particular range to detect fire in a forest.
- We can't cover large area to detect fire in a whole forest.
- There is some specific range to sense the smoke using smoke sensor as same as temperature sensor which only covers limited area.

11. CONCLUSION

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.

12.FUTURE SCOPE

- ❖ Supporting research to improve the understanding of forest fires and their ecology, ecological and social costs and benefits, causes and management options.
- ❖ Building awareness among st policy-makers, the public and the media of the underlying causes of catastrophic forest fires.
- ❖ Mandating and equipping managers to implement integrated fire management programs.

- ❖ Involving local communities and land managers in management planning and implementation, assisting them to participate effectively.
- ❖ Developing and enforcing compatible and mutually reinforcing land-use laws that provide a legal basis for the ecologically appropriate use of fire.
- ❖ Discouraging land management practices that predispose forests to harmful fires.
- ❖ Promoting management strategies to mimic natural fire regimes, including techniques such as prescribed burns and managed wildfires.
- ❖ Avoiding manipulating natural or well-established fire regimes.
- ❖ Establishing reliable fire monitoring systems that provide early warning of high fire risk and fire occurrence, and include evaluation of ecological and human impacts of fire.
- ❖ Preventing further forest loss and degradation from recurrent catastrophic fires, and reduce fire risk in forested landscapes, through ecologically appropriate restoration.

13.APPENDIX:

SOURCE CODE:

TRANING CODE:

```
import functools
```

```
import json
```

```
import os

import tensorflow as tf

from object_detection.builders import dataset_builder

from object_detection.builders import graph_rewriter_builder

from object_detection.builders import model_builder

from object_detection.legacy import trainer

from object_detection.utils import config_util


tf.logging.set_verbosity(tf.logging.INFO)


flags = tf.app.flags

flags.DEFINE_string('master', '', 'Name of the TensorFlow master to use.')

flags.DEFINE_integer('task', 0, 'task id')

flags.DEFINE_integer('num_clones', 1, 'Number of clones to deploy per worker.')

flags.DEFINE_boolean('clone_on_cpu', False,
                    'Force clones to be deployed on CPU. Note that even if '
                    'set to False (allowing ops to run on gpu), some ops may '
                    'still be run on the CPU if they have no GPU kernel.')

flags.DEFINE_integer('worker_replicas', 1, 'Number of worker+trainer '
                    'replicas.')

flags.DEFINE_integer('ps_tasks', 0,
                    'Number of parameter server tasks. If None, does not use '
                    'a parameter server.')

flags.DEFINE_string('train_dir', '',
                    'Directory to save the checkpoints and training summaries.')
```

```

flags.DEFINE_string('pipeline_config_path', "",
                    'Path to a pipeline_pb2.TrainEvalPipelineConfig config '
                    'file. If provided, other configs are ignored')

flags.DEFINE_string('train_config_path', "",
                    'Path to a train_pb2.TrainConfig config file.')
flags.DEFINE_string('input_config_path', "",
                    'Path to an input_reader_pb2.InputReader config file.')
flags.DEFINE_string('model_config_path', "",
                    'Path to a model_pb2.DetectionModel config file.')

FLAGS = flags.FLAGS

@tf.contrib.framework.deprecated(None, 'Use object_detection/model_main.py.')
def main(_):
    assert FLAGS.train_dir, "`train_dir` is missing."
    if FLAGS.task == 0: tf.gfile.MakeDirs(FLAGS.train_dir)
    if FLAGS.pipeline_config_path:
        configs = config_util.get_configs_from_pipeline_file(
            FLAGS.pipeline_config_path)
    if FLAGS.task == 0:
        tf.gfile.Copy(FLAGS.pipeline_config_path,
                      os.path.join(FLAGS.train_dir, 'pipeline.config'),
                      overwrite=True)
    else:
        configs = config_util.get_configs_from_multiple_files(

```

```

    model_config_path=FLAGS.model_config_path,

    train_config_path=FLAGS.train_config_path,

    train_input_config_path=FLAGS.input_config_path)

if FLAGS.task == 0:

    for name, config in [('model.config', FLAGS.model_config_path),

                        ('train.config', FLAGS.train_config_path),

                        ('input.config', FLAGS.input_config_path)]:

        tf.gfile.Copy(config, os.path.join(FLAGS.train_dir, name),

                      overwrite=True)


model_config = configs['model']
train_config = configs['train_config']
input_config = configs['train_input_config']


model_fn = functools.partial(
    model_builder.build,
    model_config=model_config,
    is_training=True)


def get_next(config):
    return dataset_builder.make_initializable_iterator(
        dataset_builder.build(config)).get_next()


create_input_dict_fn = functools.partial(get_next, input_config)


env = json.loads(os.environ.get('TF_CONFIG', '{}'))
cluster_data = env.get('cluster', None)

```

```

cluster = tf.train.ClusterSpec(cluster_data) if cluster_data else None

task_data = env.get('task', None) or {'type': 'master', 'index': 0}

task_info = type('TaskSpec', (object,), task_data)

# Parameters for a single worker.

ps_tasks = 0

worker_replicas = 1

worker_job_name = 'lonely_worker'

task = 0

is_chief = True

master = ""

if cluster_data and 'worker' in cluster_data:

    # Number of total worker replicas include "worker"s and the "master".

    worker_replicas = len(cluster_data['worker']) + 1

if cluster_data and 'ps' in cluster_data:

    ps_tasks = len(cluster_data['ps'])

if worker_replicas > 1 and ps_tasks < 1:

    raise ValueError('At least 1 ps task is needed for distributed training.')

if worker_replicas >= 1 and ps_tasks > 0:

    # Set up distributed training.

    server = tf.train.Server(tf.train.ClusterSpec(cluster), protocol='grpc',

                             job_name=task_info.type,

                             task_index=task_info.index)

    if task_info.type == 'ps':

```

```
server.join()

return

worker_job_name = '%s/task:%d' % (task_info.type, task_info.index)

task = task_info.index

is_chief = (task_info.type == 'master')

master = server.target


graph_rewriter_fn = None

if 'graph_rewriter_config' in configs:
    graph_rewriter_fn = graph_rewriter_builder.build(
        configs['graph_rewriter_config'], is_training=True)

trainer.train(
    create_input_dict_fn,
    model_fn,
    train_config,
    master,
    task,
    FLAGS.num_clones,
    worker_replicas,
    FLAGS.clone_on_cpu,
    ps_tasks,
    worker_job_name,
    is_chief,
    FLAGS.train_dir,
    graph_hook_fn=graph_rewriter_fn)
```



```
if __name__ == '__main__':
```

```
    tf.app.run()
```

TEST CODE:

```
import warnings
```

```
warnings.filterwarnings("ignore")
```

```
import numpy as np
```

```
import sys
```

```
import tensorflow as tf
```

```
from distutils.version import StrictVersion
```

```
from collections import defaultdict
```

```
from object_detection.utils import ops as utils_ops
```

```
import os
```

```
from twilio.rest import Client
```

```
account_sid = 'AC17937b910b4774c95b3b07358838a842'
```

```
auth_token = '4b511b022adaac785f6b79b32cac4f28'
```

```
client1 = Client(account_sid, auth_token)
```

```
def sms():
```

```
    message = client1.messages \
```

```
        .create(
```

```
            body='fire detected successfully',
```

```
            from_='+13465214387',
```

```
            to='+9199434 63572'
```

```
        )
```

```
print(message.sid)
```

```
# This is needed since the notebook is stored in the object_detection folder.
```

```
sys.path.append("..")
```

```
if StrictVersion(tf.__version__) < StrictVersion('1.9.0'):
```

```
    raise ImportError('Please upgrade your TensorFlow installation to v1.9.* or later!')
```

```
from utils import label_map_util
```

```
from utils import visualization_utils as vis_util
```

```
MODEL_NAME = 'inference_graph'
```

```
PATH_TO_FROZEN_GRAPH = MODEL_NAME + '/frozen_inference_graph.pb'
```

```
PATH_TO_LABELS = 'training/labelmap.pbtxt'
```

```
detection_graph = tf.Graph()
```

```
with detection_graph.as_default():
```

```
    od_graph_def = tf.GraphDef()
```

```
    with tf.gfile.GFile(PATH_TO_FROZEN_GRAPH, 'rb') as fid:
```

```
        serialized_graph = fid.read()
```

```

od_graph_def.ParseFromString(serialized_graph)

tf.import_graph_def(od_graph_def, name=")

category_index = label_map_util.create_category_index_from_labelmap(PATH_TO_LABELS,
use_display_name=True)

def run_inference_for_single_image(image, graph):

    if 'detection_masks' in tensor_dict:

        # The following processing is only for single image

        detection_boxes = tf.squeeze(tensor_dict['detection_boxes'], [0])

        detection_masks = tf.squeeze(tensor_dict['detection_masks'], [0])

        # Reframe is required to translate mask from box coordinates to image coordinates and fit the image
        size.

        real_num_detection = tf.cast(tensor_dict['num_detections'][0], tf.int32)

        detection_boxes = tf.slice(detection_boxes, [0, 0], [real_num_detection, -1])

        detection_masks = tf.slice(detection_masks, [0, 0, 0], [real_num_detection, -1, -1])

        detection_masks_reframed = utils_ops.reframe_box_masks_to_image_masks(

            detection_masks, detection_boxes, image.shape[0], image.shape[1])

        detection_masks_reframed = tf.cast(

            tf.greater(detection_masks_reframed, 0.5), tf.uint8)

        # Follow the convention by adding back the batch dimension

        tensor_dict['detection_masks'] = tf.expand_dims(

            detection_masks_reframed, 0)

    image_tensor = tf.get_default_graph().get_tensor_by_name('image_tensor:0')

    # Run inference

    output_dict = sess.run(tensor_dict,

                            feed_dict={image_tensor: np.expand_dims(image, 0)})

```

```

# all outputs are float32 numpy arrays, so convert types as appropriate
output_dict['num_detections'] = int(output_dict['num_detections'][0])
output_dict['detection_classes'] = output_dict[
    'detection_classes'][0].astype(np.uint8)

output_dict['detection_boxes'] = output_dict['detection_boxes'][0]
output_dict['detection_scores'] = output_dict['detection_scores'][0]
if 'detection_masks' in output_dict:
    output_dict['detection_masks'] = output_dict['detection_masks'][0]
if output_dict['detection_classes'][0] == 1 and output_dict['detection_scores'][0] > 0.70:
    print('FIRE')
    sms()

if output_dict['detection_classes'][0] == 2 and output_dict['detection_scores'][0] > 0.70:
    print('FIRE')
    sms()

if ((output_dict['detection_classes'][0] == 1 or output_dict['detection_scores'][0] < 0.70) and
(output_dict['detection_classes'][0] == 2 or output_dict['detection_scores'][0] < 0.70)):
    print('No Fire')

return output_dict

import cv2
cap = cv2.VideoCapture(0)

```

try:

with detection_graph.as_default():

with tf.Session() as sess:

Get handles to input and output tensors

ops = tf.get_default_graph().get_operations()

all_tensor_names = {output.name for op in ops for output in op.outputs}

tensor_dict = { }

for key in [

'num_detections', 'detection_boxes', 'detection_scores',

'detection_classes', 'detection_masks'

]:

tensor_name = key + ':0'

if tensor_name in all_tensor_names:

tensor_dict[key] = tf.get_default_graph().get_tensor_by_name(
tensor_name)

while True:

ret, image_np = cap.read()

Expand dimensions since the model expects images to have shape: [1, None, None, 3]

image_np_expanded = np.expand_dims(image_np, axis=0)

Actual detection.

output_dict = run_inference_for_single_image(image_np, detection_graph)

Visualization of the results of a detection.

vis_util.visualize_boxes_and_labels_on_image_array(
image_np,

image_np,

output_dict['detection_boxes'],

```
        output_dict['detection_classes'],
        output_dict['detection_scores'],
        category_index,
        instance_masks=output_dict.get('detection_masks'),
        use_normalized_coordinates=True,
        line_thickness=8)
cv2.imshow('Frame', cv2.resize(image_np,(800,600)))

if cv2.waitKey(1) == ord('q'):
    cap.release()
    cv2.destroyAllWindows()
    break
except Exception as e:
    print(e)
    cap.release()
```

```
train.py - E:\foresttt\train.py (3.6.5)
File Edit Format Run Options Window Help

import os
import tensorflow as tf

from object_detection.builders import dataset_builder
from object_detection.builders import graph_rewriter_builder
from object_detection.builders import model_builder
from object_detection.legacy import trainer
from object_detection.utils import config_util

tf.logging.set_verbosity(tf.logging.INFO)

flags = tf.app.flags
flags.DEFINE_string('master', '', 'Name of the TensorFlow master to use.')
flags.DEFINE_integer('task', 0, 'task id')
flags.DEFINE_integer('num_clones', 1, 'Number of clones to deploy per worker.')
flags.DEFINE_boolean('clone_on_cpu', False,
                    'Force clones to be deployed on CPU. Note that even if '
                    'set to False (allowing ops to run on gpu), some ops may '
                    'still be run on the CPU if they have no GPU kernel.')
flags.DEFINE_integer('worker_replicas', 1, 'Number of worker+trainer '
                    'replicas.')
flags.DEFINE_integer('ps_tasks', 0,
                    'Number of parameter server tasks. If None, does not use '
                    'a parameter server.')
flags.DEFINE_string('train_dir', '',
                    'Directory to save the checkpoints and training summaries.')

flags.DEFINE_string('pipeline_config_path', '',
                    'Path to a pipeline_pb2.TrainEvalPipelineConfig config '
                    'file. If provided, other configs are ignored')

flags.DEFINE_string('train_config_path', '',
                    'Path to a train_pb2.TrainConfig config file.')
flags.DEFINE_string('input_config_path', '',
                    'Path to an input_reader_pb2.InputReader config file.')
flags.DEFINE_string('model_config_path', '',
                    'Path to a model_pb2.DetectionModel config file.')

FLAGS = flags.FLAGS
```

```
final.py - E:\foresttt\final.py (3.6.5)
File Edit Format Run Options Window Help
sys.path.append( .. )
from object_detection.utils import ops as utils_ops

if StrictVersion(tf.__version__) < StrictVersion('1.9.0'):
    raise ImportError('Please upgrade your TensorFlow installation to v1.9.* or later')

from utils import label_map_util
from utils import visualization_utils as vis_util

MODEL_NAME = 'inference_graph'
PATH_TO_FROZEN_GRAPH = MODEL_NAME + '/frozen_inference_graph.pb'
PATH_TO_LABELS = 'training/labelmap.pbtxt'

detection_graph = tf.Graph()
with detection_graph.as_default():
    od_graph_def = tf.GraphDef()
    with tf.gfile.GFile(PATH_TO_FROZEN_GRAPH, 'rb') as fid:
        serialized_graph = fid.read()
        od_graph_def.ParseFromString(serialized_graph)
        tf.import_graph_def(od_graph_def, name='')

category_index = label_map_util.create_category_index_from_labelmap(PATH_TO_LABELS)

def email():
    with open('capture.jpg', 'rb') as f:
        file_data = f.read()
        file_type = imghdr.what(f.name)
        file_name = f.name
    msg.add_attachment(file_data, maintype = 'image', subtype = file_type, filename = file_name)
    with smtplib.SMTP_SSL('smtp.gmail.com', 465) as smtp:
        smtp.login(email_add, email_pass)
        smtp.send_message(msg)

def run_inference_for_single_image(image, graph):
    if 'detection_masks' in tensor_dict:
        # The following processing is only for single image
        detection_boxes = tf.squeeze(tensor_dict['detection_boxes'], [0])
        detection_masks = tf.squeeze(tensor_dict['detection_masks'], [0])
        # Reframe is required to translate mask from box coordinates to image coordinates
        real_num_detection = tf.cast(tensor_dict['num_detections'][0], tf.int32)
        detection_boxes = tf.slice(detection_boxes, [0, 0], [real_num_detection, 4])
        detection_masks = tf.slice(detection_masks, [0, 0], [real_num_detection, -1])
```