EMERGING METHODS FOR EARLY DETECTION OF FOREST FIRES.

FINAL REPORT

TEAM ID : PNT2022TMID35102.

Team Members

1 A Abinaya

2 I Elakkiya

3 M Muthukumari

4 M Muthukavi

INTRODUCTION:

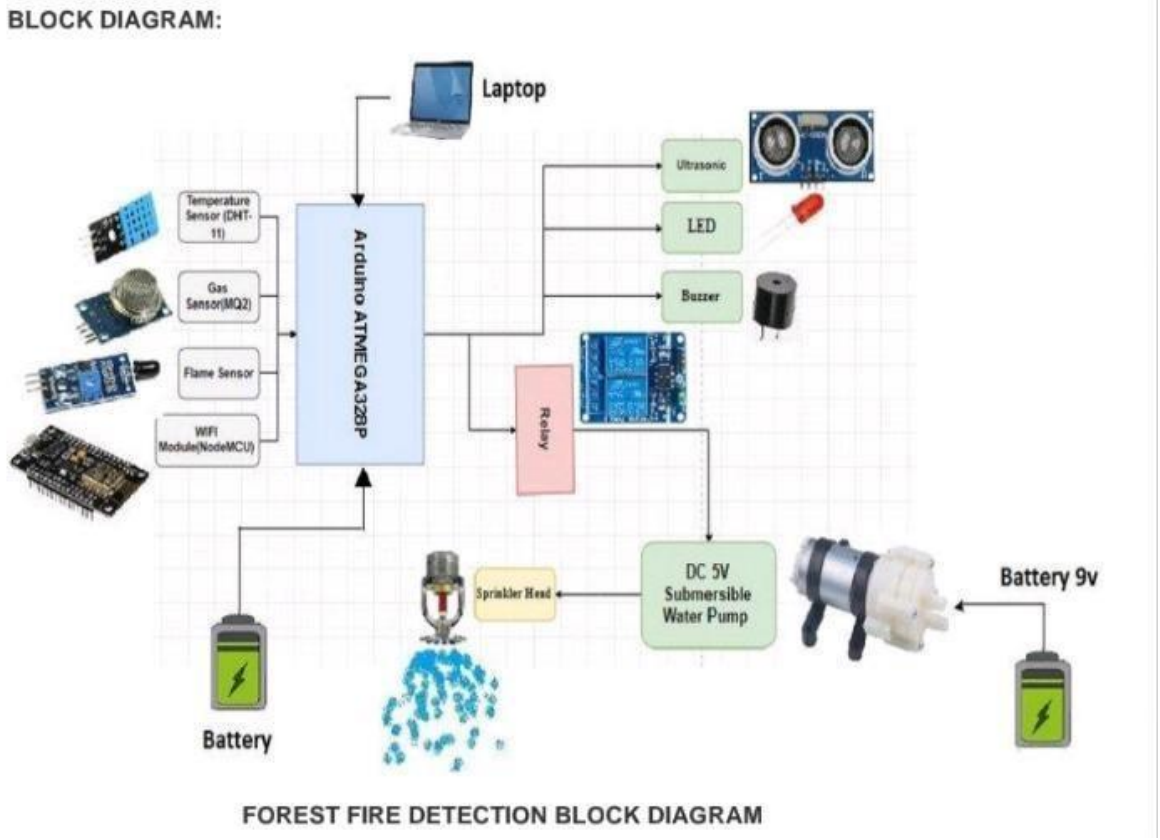
Automated early fire detection systems have recently received a significant amount of attention due to their importance in protecting the global environment. Some emergent technologies such as ground-based, satellite- based remote sensing and distributed sensor networks systems have been used to detect forest fires in the early stages. In this study, a radio-acoustic sounding system with fine space and time resolution capabilities for continuous monitoring and early detection of forest fires is proposed. Simulations show that remote thermal mapping of a particular forest region by the proposed system could be a potential solution to the problem of early detection of forest fires.

Apart from causing tragic loss of lives and valuable natural and individual properties including thousands of

hectares of forest and hundreds of houses, forest fires are a great menace to ecologically healthy grown forests and protection of the environment. Every year, thousands of forest fires across the globe cause disasters beyond measure and description. This issue has been the research interest for many years; there are a huge amount of very well studied solutions available out there for testing or even ready for use to resolve this problem. Aim. This work will summarise all the technologies that have been used for forest fire detection with exhaustive surveys of their techniques/methods used in this application. Methods. A lot of methods and systems are available in the market and for research. Automated early fire detection due to their importance in protecting the global environment.

Objectives :

The objective is to detect the fire as fast as possible and its exact localization and early notification to the fire units is vital.



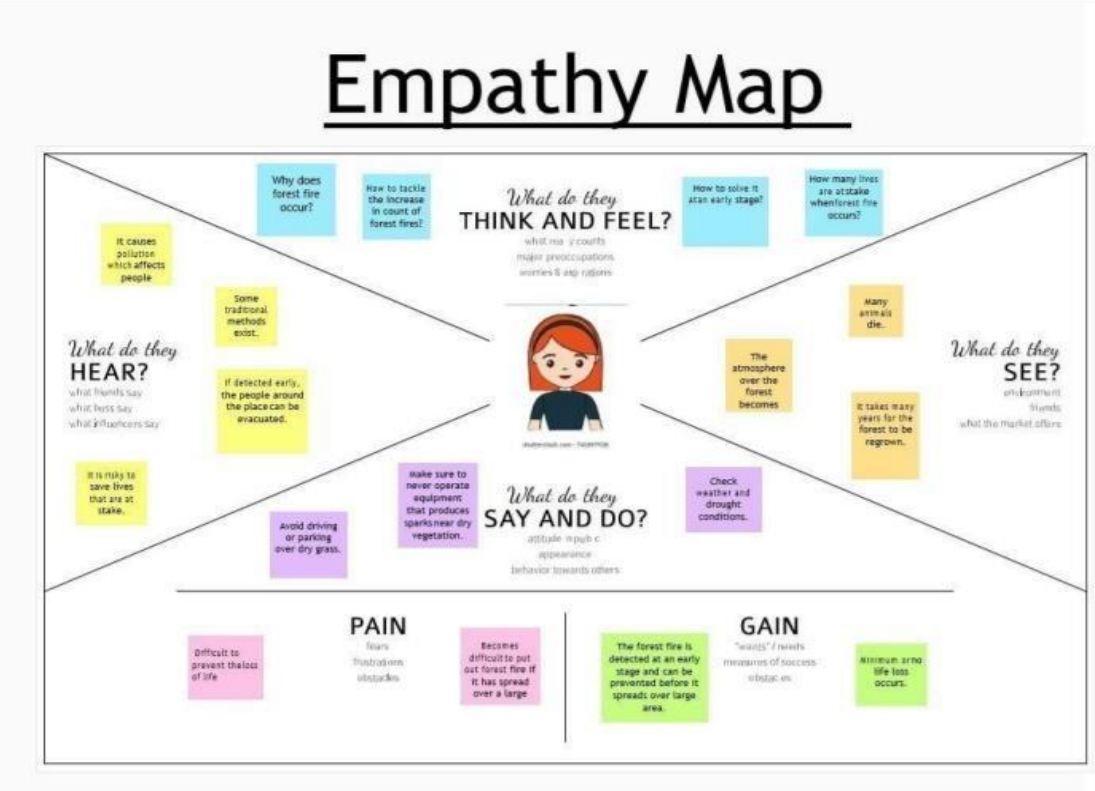
Aim: This work will summarise all the technologies that have been used for forest fire

Context: Apart from causing tragic loss of lives and valuable natural and individual p... Methods: A lot of methods and systems are available in the market and for research....

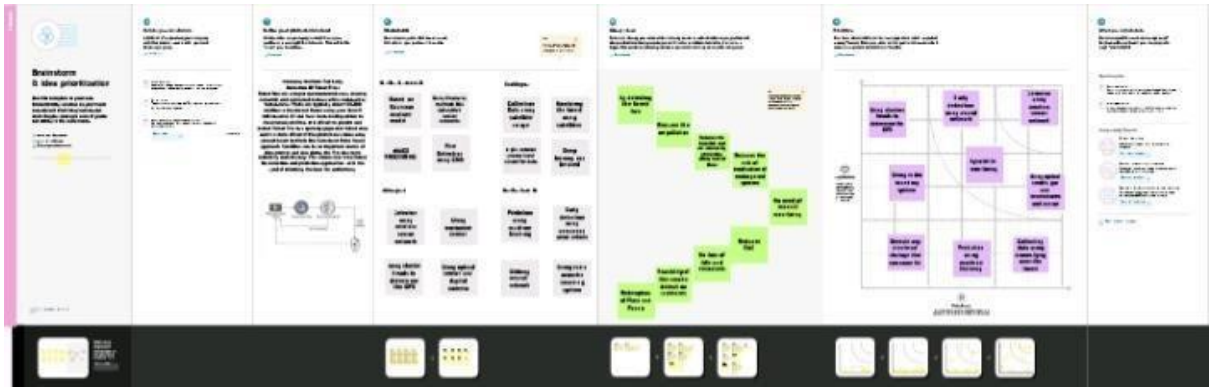
IDEATION PHASE

- Empathy Map Canvas
- Brain storming
- Proposed solution
- Literature survey

Empathy Map Canvas :



Brain storming:



Proposed solution :

The presences of fire in video streams are indicated by semantic events. Most of the existing systems can only be used for the videos obtained from stationary cameras and videos obtained from the controlled lightening conditions. These existing automatic fire detection systems cannot be used for video streams obtained from mobile phones or any hand held devices. The KILLFIRE method is proposed to overcome these limitations. The KILLFIRE method works on two sections: i) To improve the accuracy, the Fire-like pixel detector color model is used, ii) To avoid the problem occurring in stationary videos, the new technique of motion compensation is used .

Literature survey :

1. **Surapong Surit, Watchara Chatwiriya** proposed a method to detect fire by smoke detection in video. This approach is based on digital image processing approach with static and dynamic characteristic analysis. The proposed method is composed of following steps, the first is to detect the area of change in the current

2. **P. Piccinini, S. Calderara, and R. Cucchiara** proposed a method based on the wavelet model and a color model of the smoke. The proposed method exploits two features: the variation of energy in wavelet model and a color model of the smoke.

3. **R.Gonzalez** proposed a method to detect fire based on Wavelet Transform. Stationary Wavelet Transform is used to detect Region of Interest. This method involves three steps preprocessing, SWT, histogram analysis.

4. **Osman Gunay and Habiboglu** proposed a system based on Covariance Descriptors, Color Models, and SVM Classifier. This system uses video data.

Project phase 1:

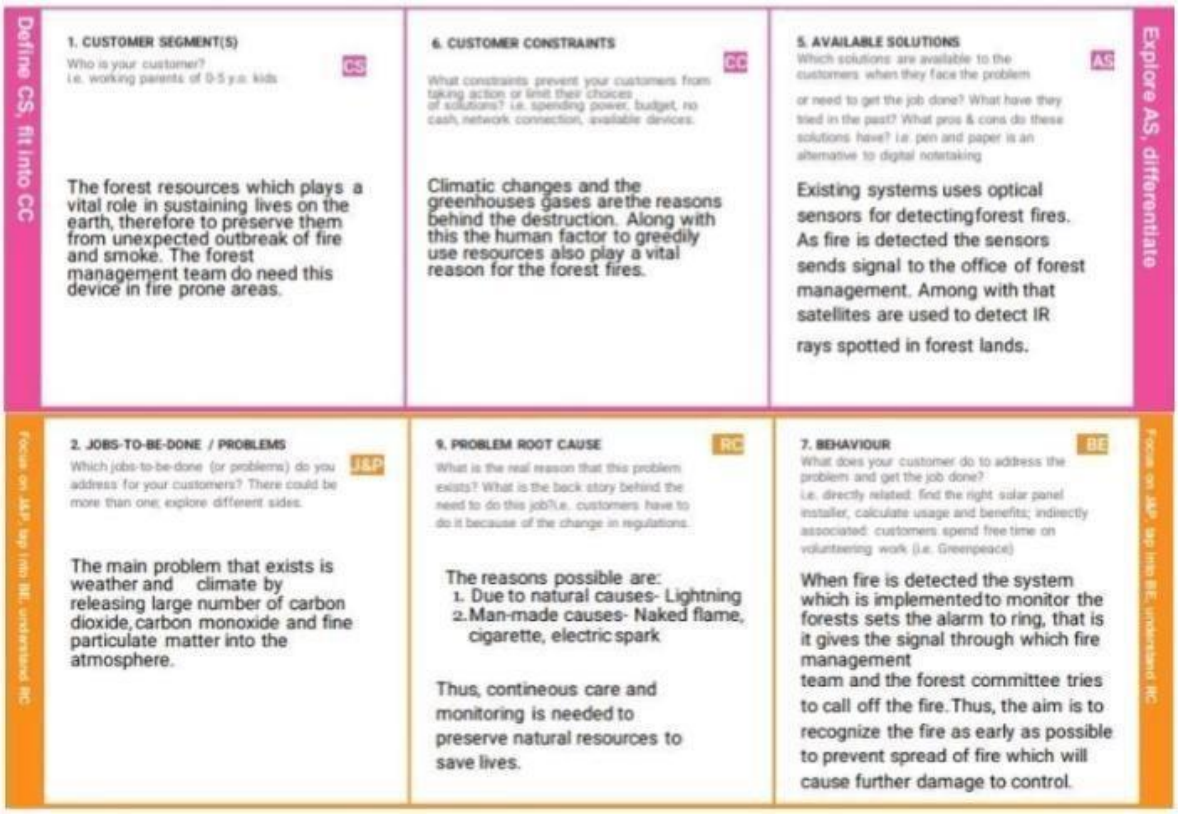
- **Proposal solution**
- **Problem solution fit**
- **Solution Architecture .**

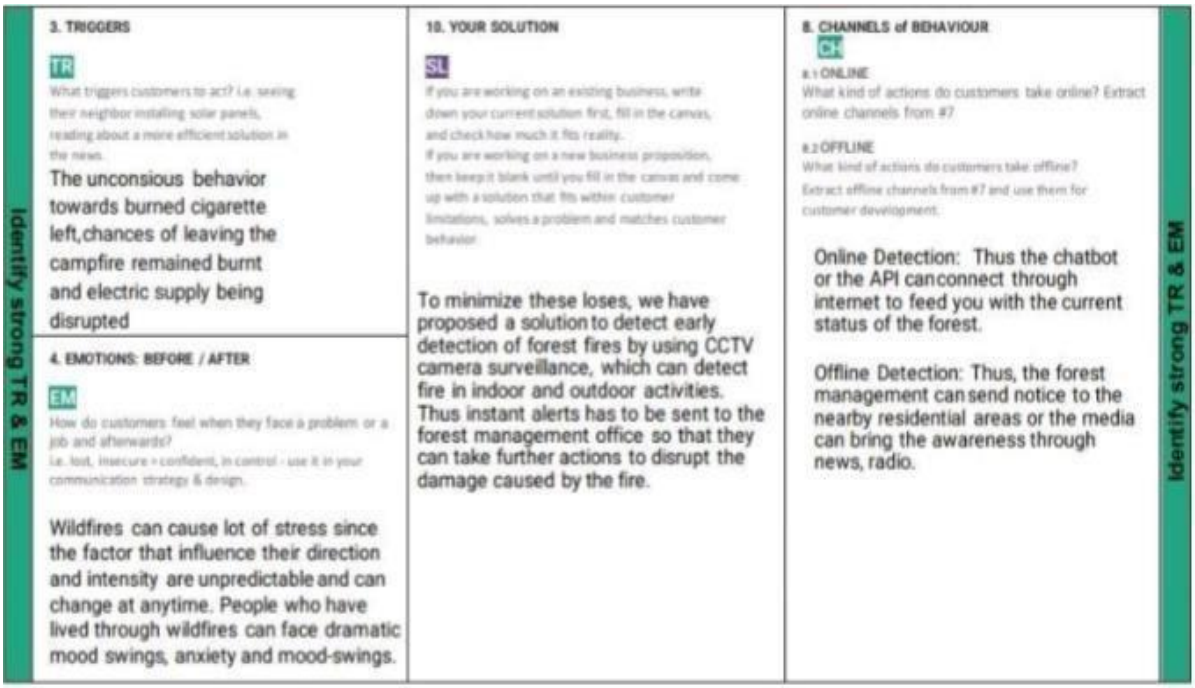
✞ **Proposal solution.**

Projectteam shall fill the following information in proposed solution template.

S/no	Parameter	Description
1	Problem Statement (Problem to be solved)	A forest fire risk prediction algorithm, based on support vector machines, is presented. The algorithm depends on previous weather conditions in order to predict the fire hazard level of a day.
2	Idea / Solution description	Use computer vision methods for recognitionand detection of smoke or fire.
3	Novelty / Uniqueness	Real time computer program detect forest fire in earliest before it spread to larger area.
4	Impact on society	Blocked roads and railway lines, electricity, mobile and land telephone lines cut, destructionof homes and industries.
5	Business Model (Revenue Model)	The proposed method was implemented using the Python programming language on a Core i3 or greater (CPU and 4GB RAM.)
6	Scalability of the Solution	Computer vision models enable land cover classification and smoke detection from satellite and ground cameras

✞ Problem solution fit phase :



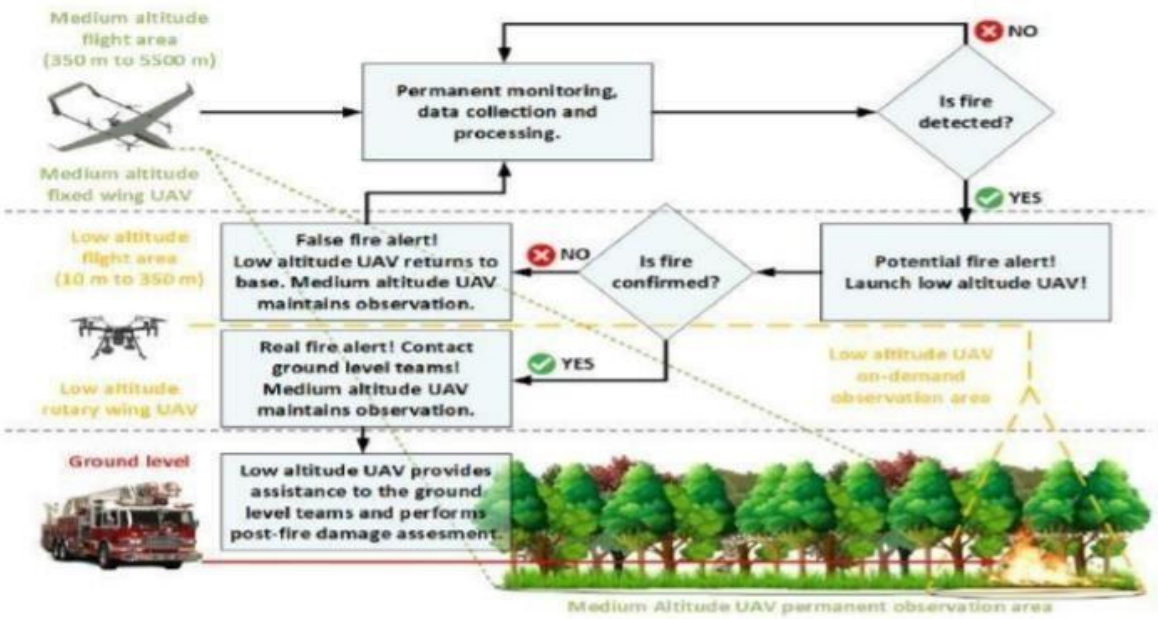


The change in temperature indicates the presence of fire or smoke in a region which can be detected by the sensors using radiation heat. As forests are in a remote location, installation and maintenance of sensors over large area is difficult. So the sensors cannot be used to deploy over large area such as forests, petrochemical plant, and saw mills etc [101 The other consequence is, the sensor would detect heat or smoke only when it reaches nearer.

Nowadays, the vision based fire detection technique is used widely to detect fires. Along with the surveillance systems the vision based fire detection technique can be incorporated at relatively low additional cost. The advantages of vision based fire detection techniques are listed here:i) the fast response to fires. ii) the location of fire is sensed using this method not just the radiation, iii) the captured images can be analyzed and it can be used for future purposes and storage, iv) it can be used for outdoor places which covers large area.

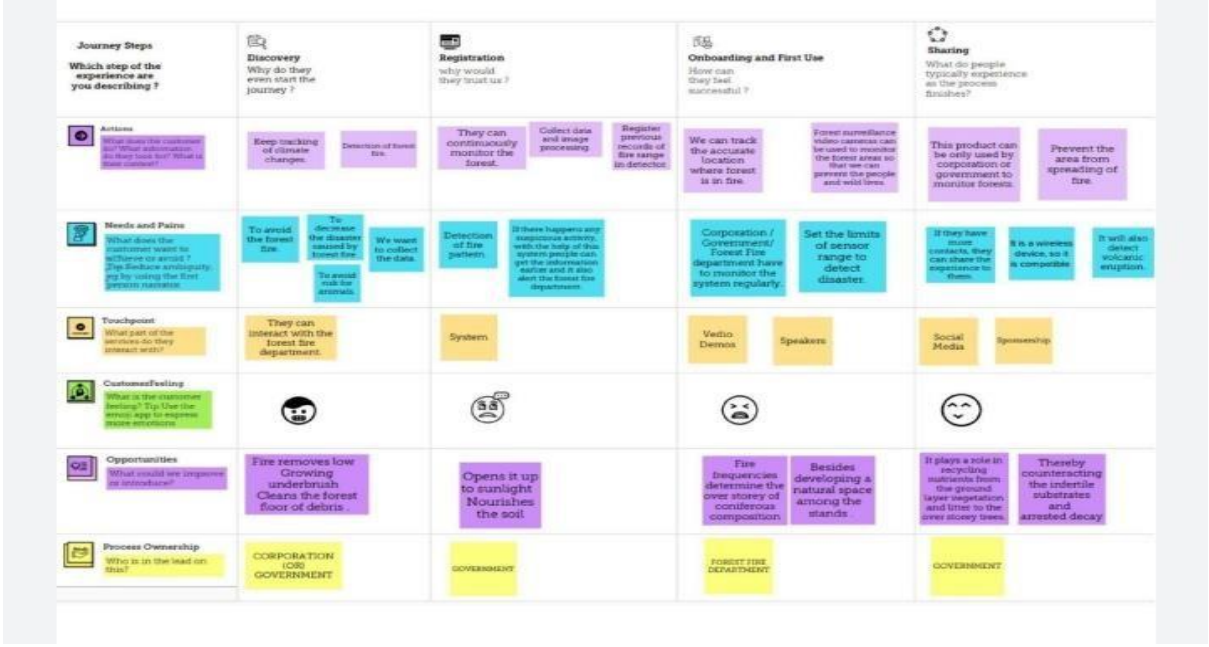
Solution Architecture

Solution Architecture Diagram:



Project phase 2 :

✪ Customer journey



✞ Functional Requirements:

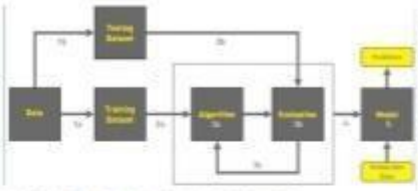
FR No.	Functional Requirement (Epic)	Sub Requirement (Story /Sub-Task)
FR-1	User Registration	Registration through Gmail
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	User Login	Login using credentials
FR-4	User Search	Search for Info on forest fire occurrence
FR-5	User Profile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

✞ Non-functional Requirements

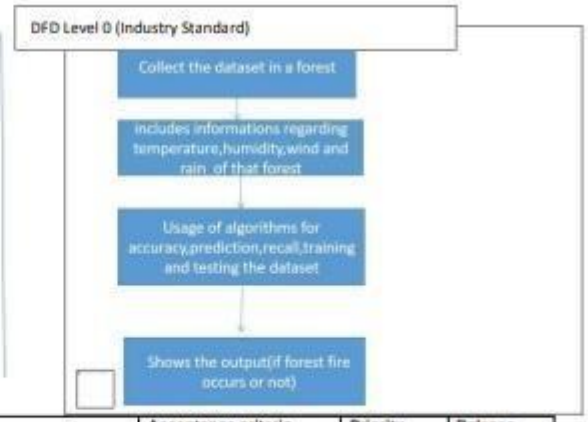
Following are the non-functional requirements of the proposed solution.

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

✞ Data Flow Diagram :



1. COLLECT DATA 2. EVALUATE DATA SET 3. IMPLEMENT ALGORITHMS 4. EVALUATE THE ACCURACY OF EACH ALGORITHMS 5. DISPLAY RESULTS



User Stories

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

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Environmentalist	Collect the data	USN-1	As an Environmentalist,it is necessary to collect the data of the forest which includes temperature,humidity,wind and rain of the forest	It is necessary to collect the right data else the prediction may become wrong	High	Sprint-1
		USN-2	Identify algorithms that can be used for prediction	To collect the algorithm to identify the accuracy level of each algorithms	Medium	Sprint-2
		USN-3	Identify the accuracy of each algorithms	Accuracy of each algorithm-calculated so that it is easy to obtain the most accurate output	High	Sprint-2
		USN-4	Evaluate the Dataset	Data is evaluated before processing	Medium	Sprint-1
		USN-5	Identify accuracy,precision,recall of each algorithms	These values are important for obtaining the right output	High	Sprint-3
		USN-6	Outputs from each algorithm are obtained	It is highly used to predict the effect and to take precautionary measures.	High	Sprint-4

✞ Technology Architecture:

Table 1 – components and technology

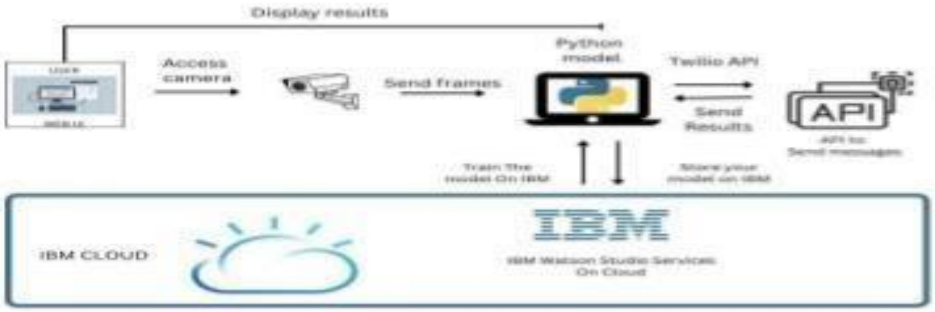


Table 1 apparatus and components

S.No	Characteristics	Description	Technology
1.	Open-Source Frameworks	Python Flask framework is used	Technology of Opensource framework
2.	Security Implementations	Mandatory Access Control (MAC) and Preventative Security Control is used	e.g. SHA-256, Encryptions, IAM Controls, OWASP etc.
3.	Scalable Architecture	High scalability with 3-tier architecture	Web server – HTML ,CSS ,JavaScript Application server – Python , Anaconda Database server –IBM DB2
4.	Availability	Use of load balancing to distribute traffic across servers	IBM load balancer
5.	Performance	Enhance the performance by using IBM CDN	IBM Content Delivery Network

S.No	Component	Description	Technology
1.	User Interface	The user uses the console to access the interface	Python/HTML ,CSS , Javascript and react.Js
2.	Input	Video Feed	Web Camera/Video on a site
3.	Conversion	Video inputted is converted into Frames	Frame Converter
4.	Feeding the Model	The Frames are sent to the Deep learning model	Our Model
5.	Dataset	Using Test set and train set , train the model	Data set from Cloud Storage , Database
6.	Cloud Database	The model is trained in the cloud more precise with detections more images can be added later on.	IBM Cloudant ,Python Flask.
7.	Infrastructure (Server / Cloud). API	Application Deployment on Local System / Cloud Local ,Cloud Server Configuration , Twilio API to send messages	Java/python ,React.Js ,JavaScript ,HTML ,CSS ,IBM Cloud ,OPEN CV ,Anaconda Navigator ,Local.

Table 2 – application characteristics

Project Planning & Scheduling :

Sprint Planning Estimating & Delivery Schedule

Sprint	Functional Requirement	User Story Number
Sprint-1	Installation of Beacons	USN-1
Sprint-1	Providing Wearables	USN-1
Sprint-2	Cloud Setup	USN-2
Sprint-3	Online Monitoring via Web	USN-3
Sprint-4	Monitoring via Mobile	USN-4

User Story / Task	Story Points	Priority
First the Admin will be installing smart beacons at necessary places.	15	High
The admin will be providing everyone at the industry a wearable device.	5	Medium
The smart Beacons will connect with the cloud services. Where we can get the realtime data from the wearable.	20	High
Websites will be created and connected with the cloud services.	20	High
Mobile Application will be created and fast SMS will be used to alert abnormality to the user.	20	High

Sprint 1 to 4

- **USER STORIES**
- **USER ACCEPTANCE TESTING**

The list are the following of user stories

User Type	Functional Requirement	User Story Number	User Story/Task	Acceptance criteria	Priority	Release
Technician	Installation	USN-1	The technician must install the smart beacons at points to ensure the entire area of the plant is covered.	A beacon can be found in every area of the plant.	High	Sprint-1
	Data Gathering	USN-2	The beacons obtain the temperature of their respective area using sensors.	The temperature of areas within the plant is obtained.	High	Sprint-1
	Data Sync	USN-3	The beacons send their data to the cloud in the real time which is in turn sent to nearby wearable devices and the administrators dashboard.	Data is sent to the cloud successfully and synced with other devices.	High	Sprint-1
Worker	Wearable device display	USN-4	The wearable devices should display the data sent by beacons within the area.	The user can see the temperature of the area on their device.	High	Sprint-1
	Wearable device adjustments	USN-5	The user can adjust the size of the wearable device to better suit them.	The user can make adjustments to the device to make working with it more comfortable.	Low	Sprint-2
	Wearable display customization	USN-6	The user can adjust the device display to suit their needs on the device itself.	The user can modify the display of the device to increase readability.	Medium	Sprint-2
	SMS Notification	USN-7	The user is sent a notification to their phone from the wearable device through an API when the area they are in reaches dangerous temperatures.	The user is informed of potential danger via SMS as soon as it is detected by the beacons.	High	Sprint-1
Administrator	Admin Dashboard	USN-8	The beacons send the data through the cloud to a dashboard which is run by the administrator.	The data of all the beacons can be viewed by the administrator of the plant.	High	Sprint-1

Results:

Performance Metrics

Forest fires are very intense deadly destroying the homes, wildlife, timber also polluting the atmosphere with hazardous compounds of pollutants. Forest fire produces various ill effects and increases the global temperature; it has a prolonged impact on landscapes and deduces the production of oxygen as it

destroys past spreading. As wildfire is a part of nature its intensity cannot be handled after crossing a threshold level. The proposed system detects the forest fire at minimal stage with assistance of cameras fixed at the towers. With real time fire detection algorithm programmed, fire alerts the respective forest department with unique node set location with Long Range network (LoRa). Proposed Fire detection system is placed at the end of node networks with gateway connected and intern with intermitted to local forest control areas.

Shot of forest fire detection.

Advantages :

The most frequently used fire detection and suppression techniques employed by authorities can be summarised as follows:

1 controlled burning.

2 fire weather forecasts and estimates of fuel and moisture,watch towers.

3 optical smoke detection lightning detectors which detect the coordinates of the strike.

4 infrared,

5 mobile/smart phone calls becoming increasingly common for detecting fires.

Disadvantages:

1 Neither easy to capture suitable animals from the environment nor equip them with sensors.

2 Possibility of lack of appropriate animals for special forests.

3 Determining climate conditions, daily temp differences, seasonal normal temp values, etc. are problematic.

4 Use of batteries create environmental pollution, introducing extra radiation and cadmium to the forest and animals.

5 Moreover, each battery needs to be changed capturing the MBS to do this is not easy.

Conclusion:

New wireless technologies and new satellite tracking systems can be adapted to increase the efficiency of the system. New sensors can be produced or existing sensors can be improved to increase robustness of the proposed system.

A number of investigations can be made regarding animal behavior in case of fire to improve system reliability.

Future Scope :

To limit the damage caused by forest fires and to control the start of fires and its spread, we have presented in this study a method

of early de- tection of forest fires. This method is based on three steps: Estimate the general risk level of the forest, assess and predict in several places the existence or not of fires, and alert the necessary first responders to quell the spread of the fires.

The originality of this work lies in the use of a wireless sensor and RF network distributed over the entire forest area and the deep learning methods to predict in real-time a possible origination and predicted path of the forest fire.

The current system will be implemented on a large scale with multi-ple sensor nodes to power and augment the data set in order to improve the accuracy and collaboration of data between multiple nodes. We plan in future work to use wind direction sensors to property estimate and lo-cate the start of the fire, and to collaborate with SpaceX's Star Link Pro-gram to monitor rural forest areas as well.

Appendix

Huang and K. Boyle, Antennas, "From Theory to Practice", West Sussex, United Kingdom: John Wiley & Sons Ltd, 2008. [2] AA Portable Power Corp, "Category: Li-lon/Polymer Single Cells," 2019. [Online]. Available: https://www.batteryspace.com/ll- ionsinglecell.aspx

Demo Link:

Demo Link: https://youtu.be/S6JPgIz1gA0