
Chapter 1

Introduction

Introduction to Design Engineering

- Much of the world around us is designed in some way. Modern living relies on the products, systems, and services created to support how we live. The design comes from the ability to think.
- Design Engineering is an initiative taken by Gujarat Technology University (GTU) in this direction with the help and guidance of the professors of IITs and the GTU introduction council is being started. We are looking ahead and moving towards the path of innovation.
- Design Engineering is a general term that covers multiple Engineering disciplines including Electrical and communication, Mechanical, Chemical, Civil, Computer Engineering, Information Technology, and structural building/architectural Engineering.
- Design is a plan of system, its implementation and utilization for attending a goal. It is to change the undesired situation into the desired situation means to find the solution of the undesired situation. Designing means involving goal-oriented processes.
- Design thinking is a methodology used by the designer to solve a complex problem, and finding a desirable solution for the client. A design mindset is not the problem-focused; it is solution-focused and action-oriented towards creating a preferred future. Design thinking drop upon logic, imagination, intuition and systemic reasoning to explore possibilities of what could be and to create desired outcomes that benefit the end-user.
- Design thinking is the process of thinking out of the box, therefore, we can find the best/useful information for our domain and project. And using this technique, we can easily find the best solution for that domain.

Design Engineering Steps

- Select the domain and project
- Find the problem
- Develop possible solution
- Select the best possible solution
- Design a prototype
- Test and evaluate the solution
- Communicate
- Redesign

Introduction of Domain

Fire detection systems have been an integral part of safeguarding lives and property. Traditional methods have often relied on human vigilance and sensor-based technologies. However, advancements in artificial intelligence (AI) have revolutionized the realm of fire safety. AI-based fire detection systems utilize sophisticated algorithms and machine learning techniques to analyze visual, thermal, or environmental data in real-time.

These systems can swiftly identify potential fire hazards, detect smoke or flames, and raise alarms promptly, significantly reducing response times and mitigating the risk of catastrophic damage. By harnessing the power of AI, these systems offer heightened accuracy, faster detection, and enhanced safety measures in diverse environments, from homes to industrial settings.

Reverse Engineering

Reverse engineering, also called backward engineering or back engineering, is the process by which an artificial object is deconstructed to reveal its design, architecture, code or to extract knowledge from the object.

For example, if a processor manufacture wants to see a how a competitor's processor works, they can purchase a competitor's processor, disassemble and study it, and then make a processor similar to it.

Reverse engineering is viewed as the process of analysing a system to identify the system's components and the relationship between them. It is also used to recreate a same software with improvements.

For example, we have to find the application related to our domain and search for the problems of that application. At last, we have to solve those problems as well as we can add new features in our application which we are going to develop.

Team building & logbook exercise with its importance

Teamwork is most important in design engineering because one person can't make perfect design and can't find the best solution. So when we work in a team, we can easily find the best solution and we can finish work in a short time.

Team building means sharing each other's ideas and come to a point. Everyone has many ideas or thought so that they can share their ideas with their mates and research on those ideas and make it better.

A logbook is a record of observations, events or operation taking place. It is important as we can store our rough idea of the project. It is also important as if we want to continue our project in the future, we can easily reuse the logbook's information.

Chapter 2

AEIOU Summary & Mind Mapping

Observations through AEIOU Framework

AEIOU Summary:		Group ID:	Date:	Version: 1.0
		Domain Name: A FIRE SEFTY SYSTEM		
Environment: Crowdy Noisy	Interactions: Between family members Security guard to public Passenger to Assistant Between airport staff	Objects: Computer Telephone Reception Vehicles CCTV camera Luggage		
Activities: Walking Typing Sitting Calling Eating Stamping	Users: Medical staff Security guards Air hostess Passengers Taxi drivers Pilot Police			

Fig 2.1 AEIOU Canvas

AEIOU stands for “Activities Environment Interaction Object User”.

In AEIOU canvas, there were five phases – Activities, Environment, Interaction, Object and User. Therefore, we pass with all phase and one by one checked and note down all the information of each phase. All phases are described below.

Environment

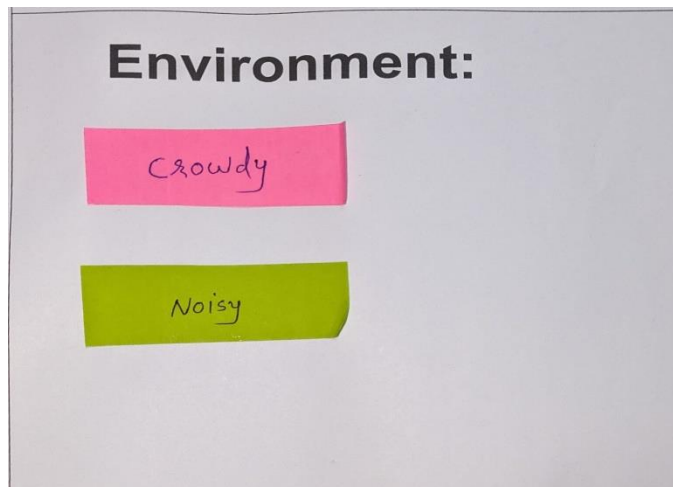


Fig 2.1.1 Environment

During the survey, we had found the following environment.

- Crowdy
- Noisy
- Happy
-

Interactions

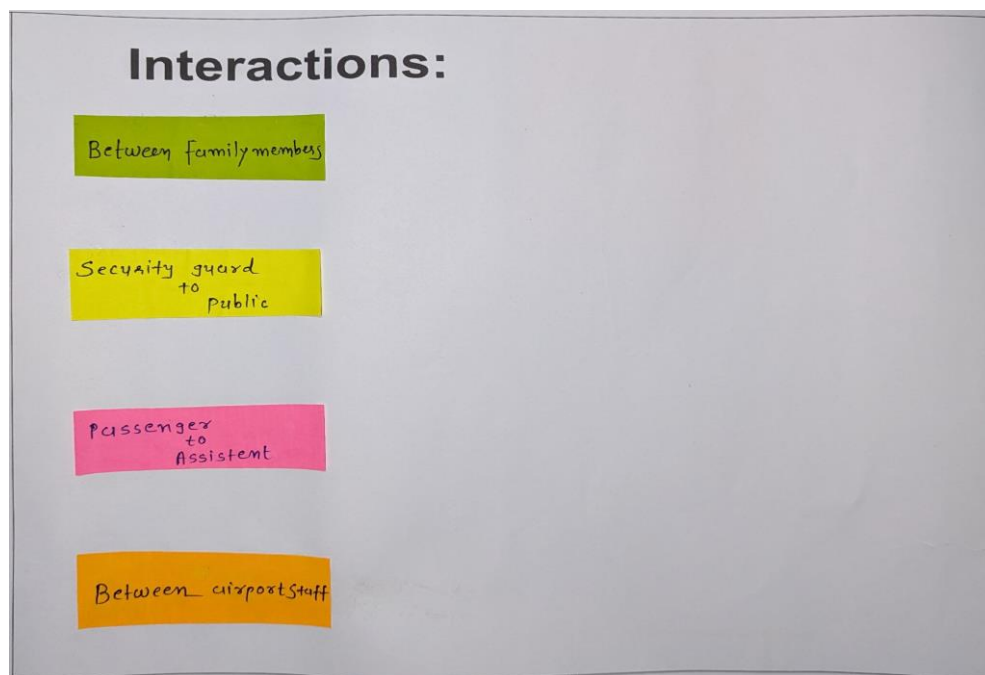


Fig 2.1.2 Interactions

During the survey, we had observed the interaction between the following people.

- Between Family Members
- Security Guard → Public
- Passenger → Assistance
- Between Airport Staff
- Worker → Visitor

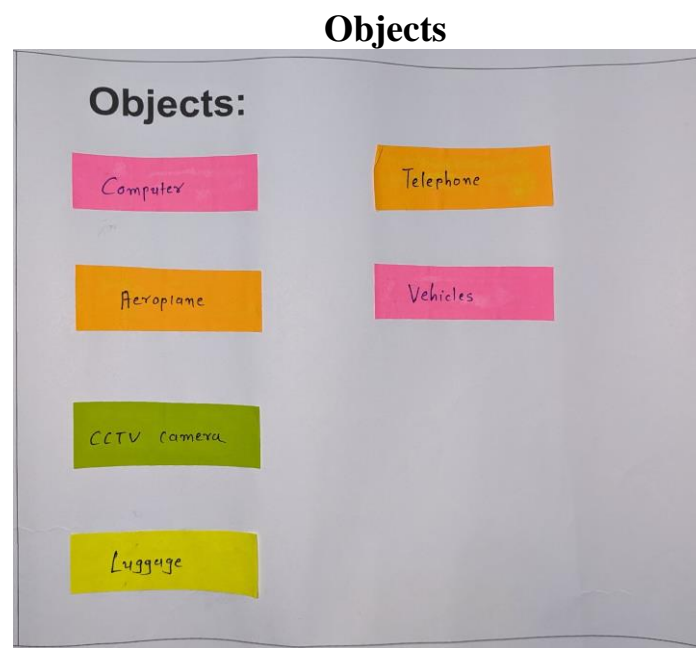


Fig 2.1.3 Objects

During the survey, we had found the following the objects.

- Computer
- Aero planes
- CCTV Cameras
- Luggage
- Telephone
- Vehicles



Fig 2.1.4 Activities

During the survey, we had observed the following activities.

- Walking
- Sitting
- Typing
- Calling
- Talking
- Stamping

Users

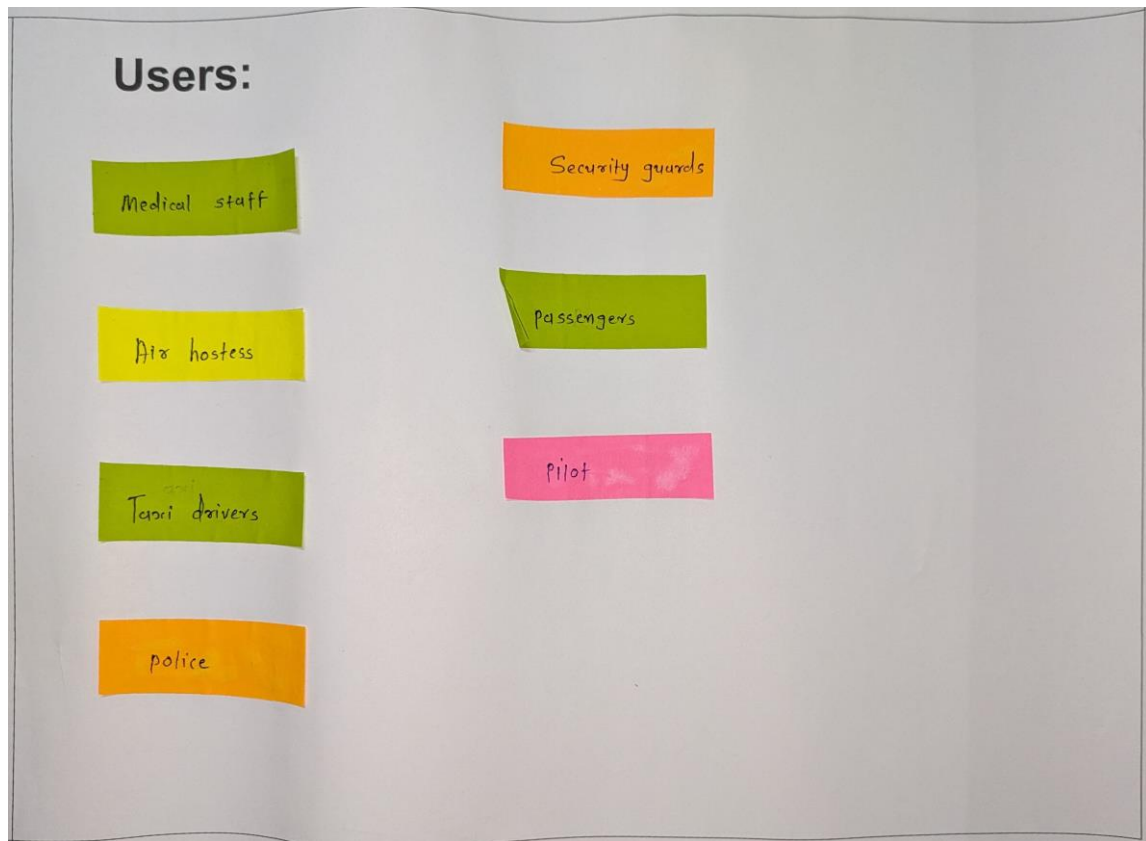


Fig 2.1.5 Users

People who are found are as follow.

- Medical Staff
- Air Hostess
- Taxi Drivers
- Police
- Security Guard
- Passengers
- Pilot

Mind Mapping

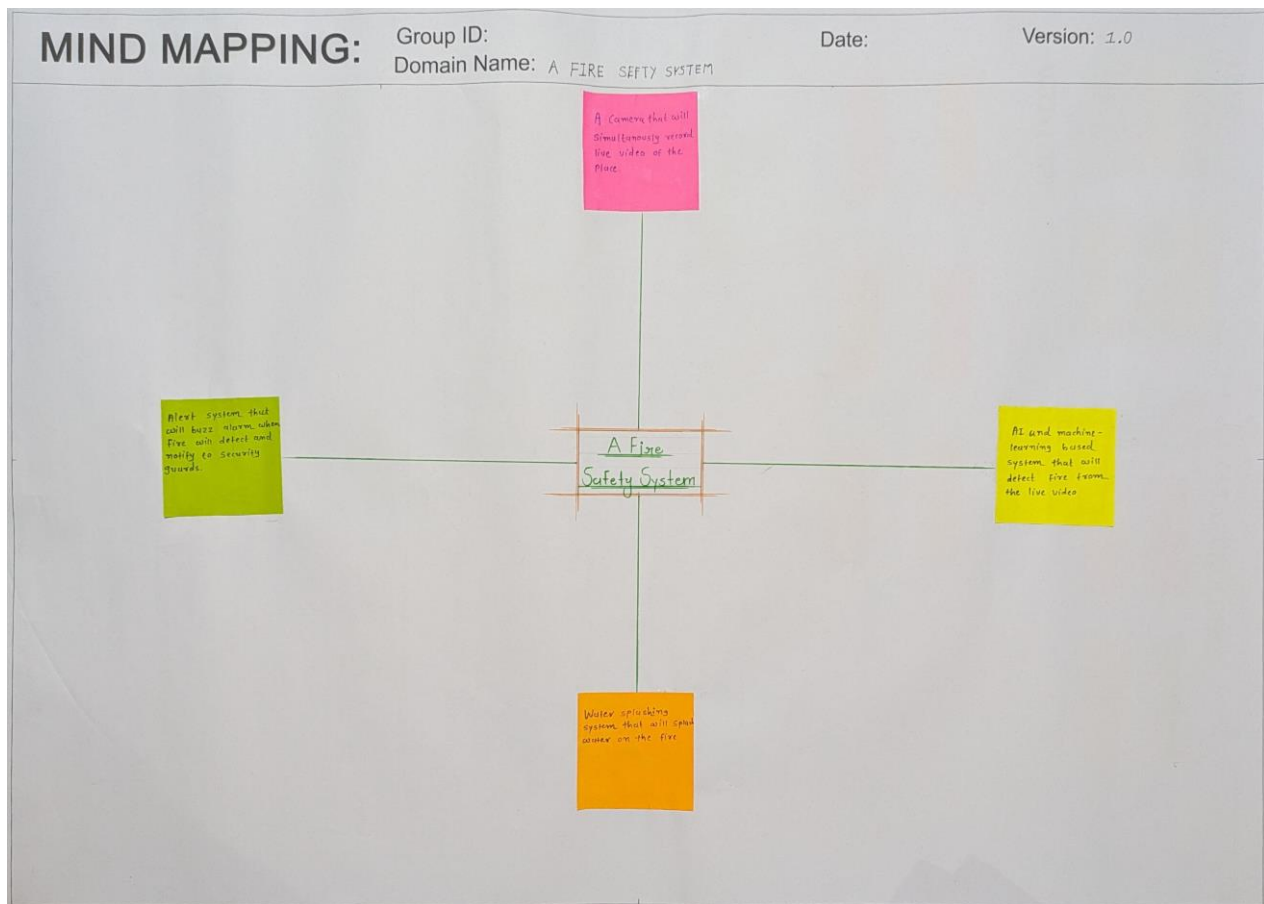


Fig 2.2 Mind Mapping

The mind map illustrates the comprehensive landscape of an AI-driven fire detection safety system. At its core, this visual representation outlines the key components, operational principles, benefits, challenges, and future prospects of employing artificial intelligence in fire detection technology. By breaking down the system into its constituent parts, it showcases the crucial role of sensors, data analysis through AI algorithms, and the subsequent actions taken in response to potential fire hazards. Additionally, it highlights the advantages, obstacles, and the evolving nature of this technology, providing a holistic view of its current status and future potential in ensuring heightened safety standards across various environments."

Chapter 3

Empathy Canvas

Observations through Empathy Mapping Canvas

Empathizing Canvas

Design For A FIRE SEFTY SYSTEM Design By

Date Version 1.0

USER	STAKEHOLDERS
Medical staff	Airport staff
Police	Security staff
Air hostess	Police
Taxi drivers	Passengers
Security guards	

ACTIVITIES

Walking	Stamping	Calling
Sitting	Talking	Typing

STORY BOARDING

HAPPY At the Airport, Sarah and Emily reunited after years apart. Their tearful embrace filled the bustling terminal with joy, and they walked out hand in hand, ready to make up for lost time.

HAPPY Emma faced a flight delay that threatened to make her miss her sister's wedding. A kind pilot named Tom helped her secure a seat on his airline's flight, allowing her to surprise her sister at the rehearsal dinner. Their chance meeting turned a stressful situation into a heartwarming airport story, and they remained friends.

SAD A fire erupted at the airport, causing panic and chaos. Lisa got separated from her elderly mother in the smoke and flames. Tragically, her mother didn't make it out alive, leaving Lisa in deep grief.

SAD In the chaos of an airport fire, Amelia and her infant son were trapped in thick smoke. Firefighters heroically rescued them, but the trauma left a lasting impact on both, serving as a reminder of the unexpected dangers in everyday places.

Fig 3.1 Empathy Canvas

In this canvas, we had learned new things like stakeholders and storyboarding. Stakeholders are the people who are directly connected to the system like the founder. In storyboarding, we have learned that what the happy or sad things are being observed by a user.

User

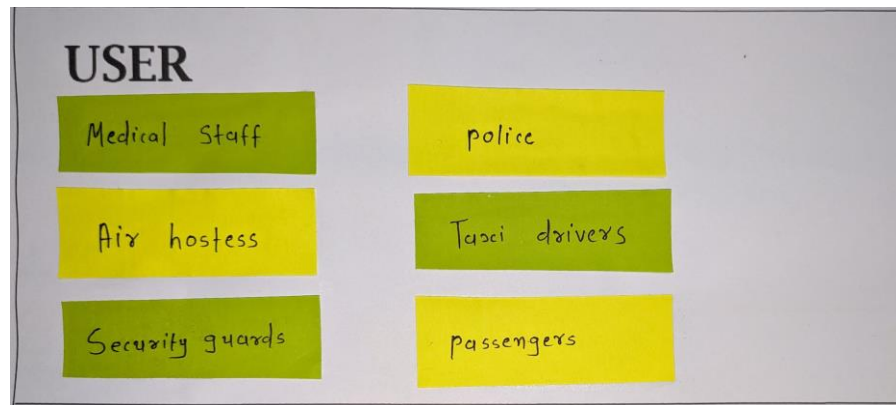


Fig 3.1.1 User

The user who are directly or indirectly connected to system are listed below.

- Medical Staff
- Air Hostess
- Taxi Drivers
- Security Guard
- Passengers
- Pilot

Stakeholders

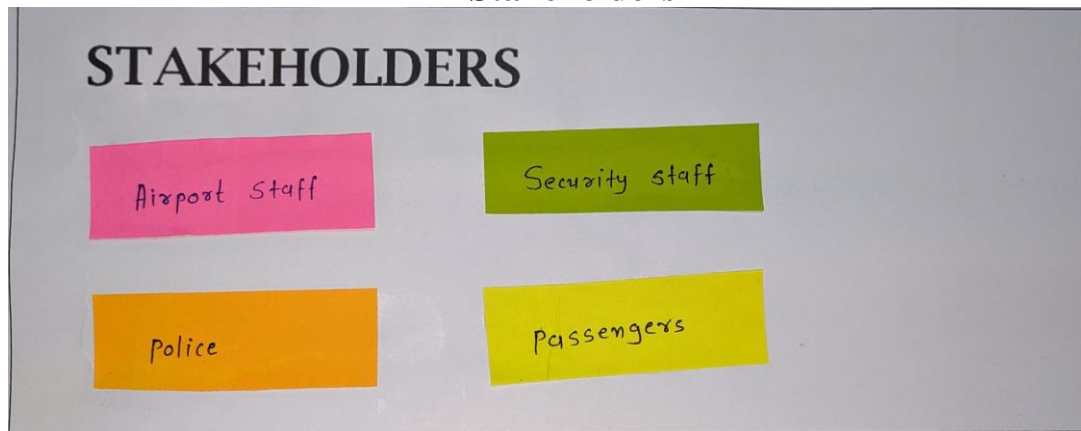
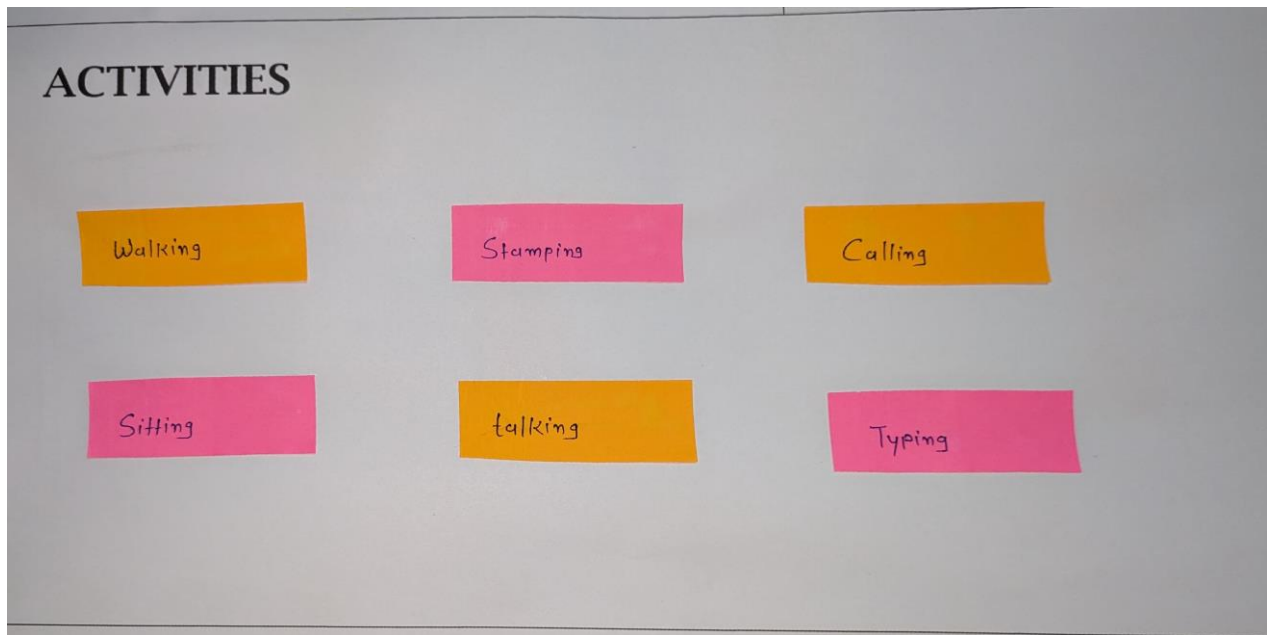


Fig 3.1.2 Stakeholders

Stakeholders are the people who are directly connected to the system. They are listed below.

- Airport Staff
- Police
- Security Staff
- Passenger

Activitie**Fig 3.1.3 Activities**

The activities that are happening are manifests below.

- Walking
- Sitting
- Stamping
- Calling
- Talking
- Typing

Story Boarding

STORY BOARDING

HAPPY At the Airport, Sarah and Emily reunited after years apart. Their tearful embrace filled the bustling terminal with joy, and they walked out hand in hand, ready to make up for lost time.

HAPPY Emma faced a flight delay that threatened to make her miss her sister's wedding. A kind pilot named Tom helped her secure a seat on his airline's flight, allowing her to surprise her sister at the rehearsal dinner. Their chance meeting turned a stressful situation into a heartwarming airport story, and they remained friends.

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Fig 3.1.4 Story Boarding

Following are the stories, we have experienced during the survey.

Happy

- Emma faced a flight delay that threatened to make her miss her sister's wedding. A kind pilot named Tom helped her secure a seat on his airline's flight.
- Allowing her to surprise her sister at the rehearsal dinner. The chance meeting turned a stressful situation into a heartwarming airport story and they remained friends.

Sad

- In the chaos of an airport fire, Amelia and her infant son were trapped in thick smoke.
- Firefighters heroically rescued them, but the trauma left a lasting impact on both, serving as a reminder of the unexpected dangers in everyday places.

Chapter 4

Prior Art Search

A brief overview of the aim and importance of the prior art search related to AI-based fire detection.:

- Explanation of the methods and databases used for the search, including specific criteria applied.
- Summary of relevant patents, literature, and existing products pertaining to AI-based fire detection.
- Comparison of discovered prior art, highlighting their contributions, strengths, and limitations.
- Recap of key findings and gaps identified, concluding with recommendations for potential innovations or further research directions



Fig 4.1 Prior Art Search for fire detection system

[Home](#) >> [Project List](#)

Please Enter Keyword to search:

Search Projects: 9878 / 204549

Project List

1.

Student/ Team Members : Vasani Dipali, Puri Krunal, Raichura Sonali**Guide By** : PROF. H. M. NIMBARK**College** : B. H. Gardi College Of Engineering & Technology, Rajkot

The development of microelectronics began in 1948 and continued with the miniaturization of sensors during the last ten years Today Microsystems which are used in silicon micro technology are called micro electromechanical systems MEMS Micro sensors are defined as very small sized devices that convert humidity moisture temperature pressure pollutants The development of microelectronics began in 1948 and continued with the miniaturization of sensors during the last ten years Today Microsystems which are used in silicon micro technology are called micro electromechanical systems MEMS Micro sensors are defined as very small sized devices that convert humidity moisture temperature pressure pollutants ... [read more](#)

Fig 4.2 Result of PriorArt Search

Chapter 5

Ideation Canvas

Observation through Ideation Canvas

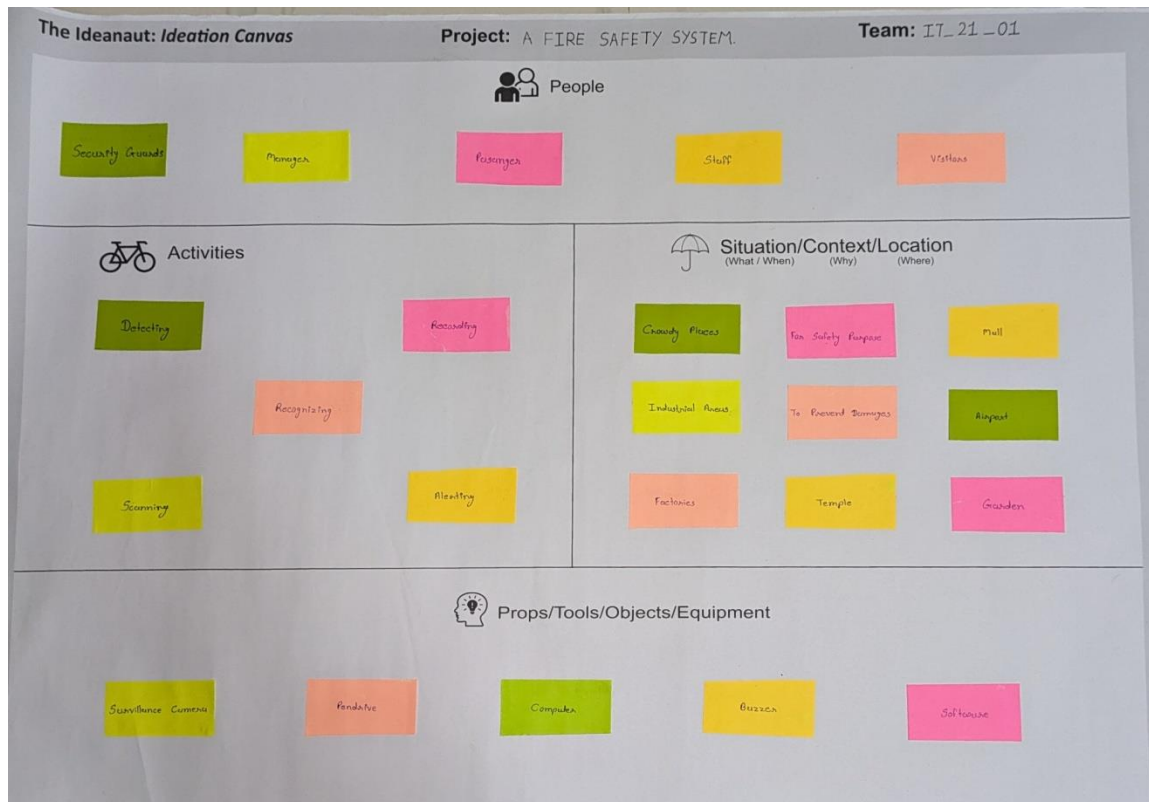


Fig 5.1 Ideation Canvas

In the ideation canvas, we have learned how to choose the most suitable problem from the list of the problem and we have to research to find the possible solution to the problem. We have even identified the props which can be used to make our solution efficient.

People

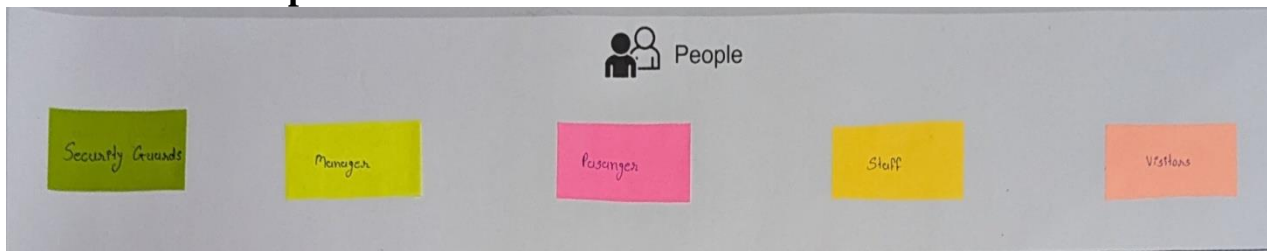


Fig 5.1.1 People

Generally, people who are part of an NGO are as follow.

- Safety guard
- Manager
- Workers
- Passenger
- Visitor
- Staff

Activities



Fig 5.1.2 Activities

The following list shows the activities noticed during the survey.

- Detecting
- Recording
- Recognizing
- Scanning
- Alerting

Situation / Context / Location

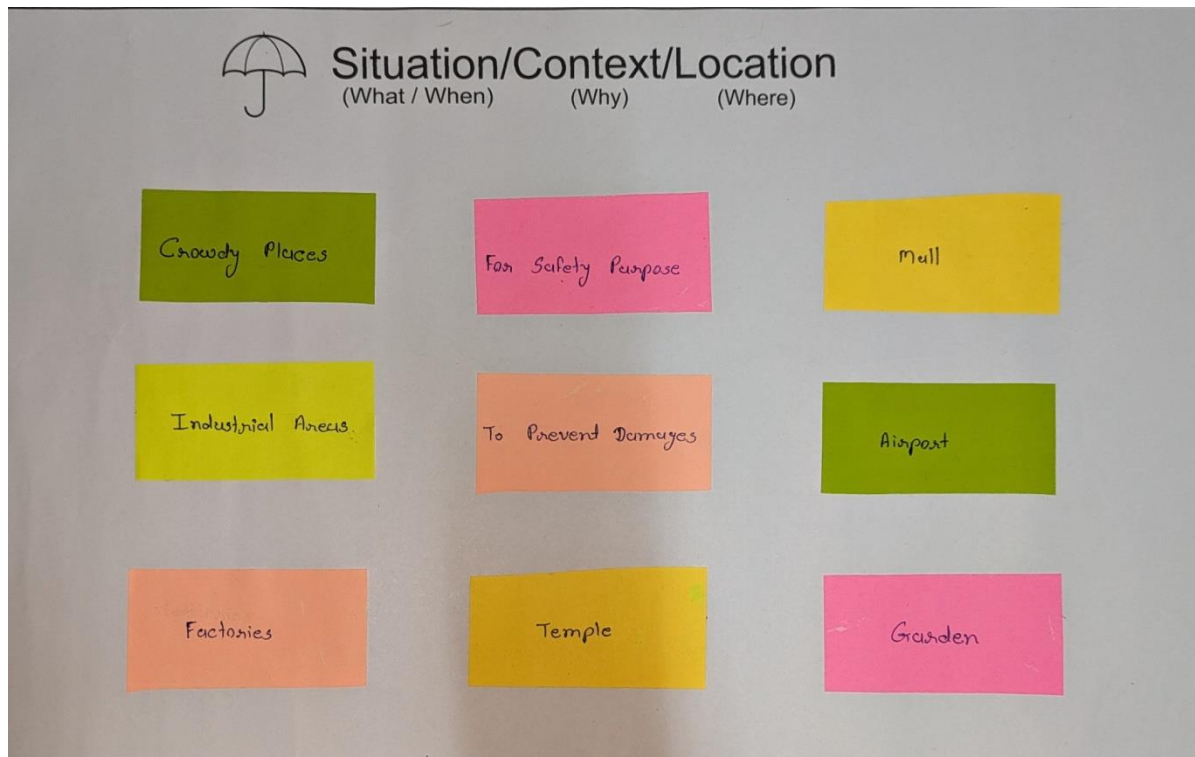


Fig 5.1.3 Situation / Context / Location

Below is a list of problems that we have observed during the survey.

Situation	Context	Location
Crowded places	For safety purpose	Malls, airport ,factor iess
Industrial works	To prevent damages	
Risky situations	Prevent life loss	

Props / Possible Solution

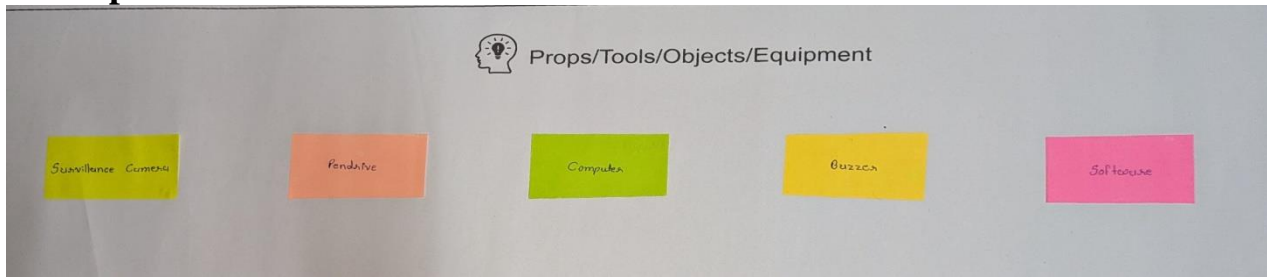


Fig 5.1.4 Props / Possible Solution

The props we needed for solving the above problem are listed below.

- Surveillance camera
- Computer
- Buzzer
- Software

Chapter 6

Product Development Canvas

Observation through Product Development Canvas

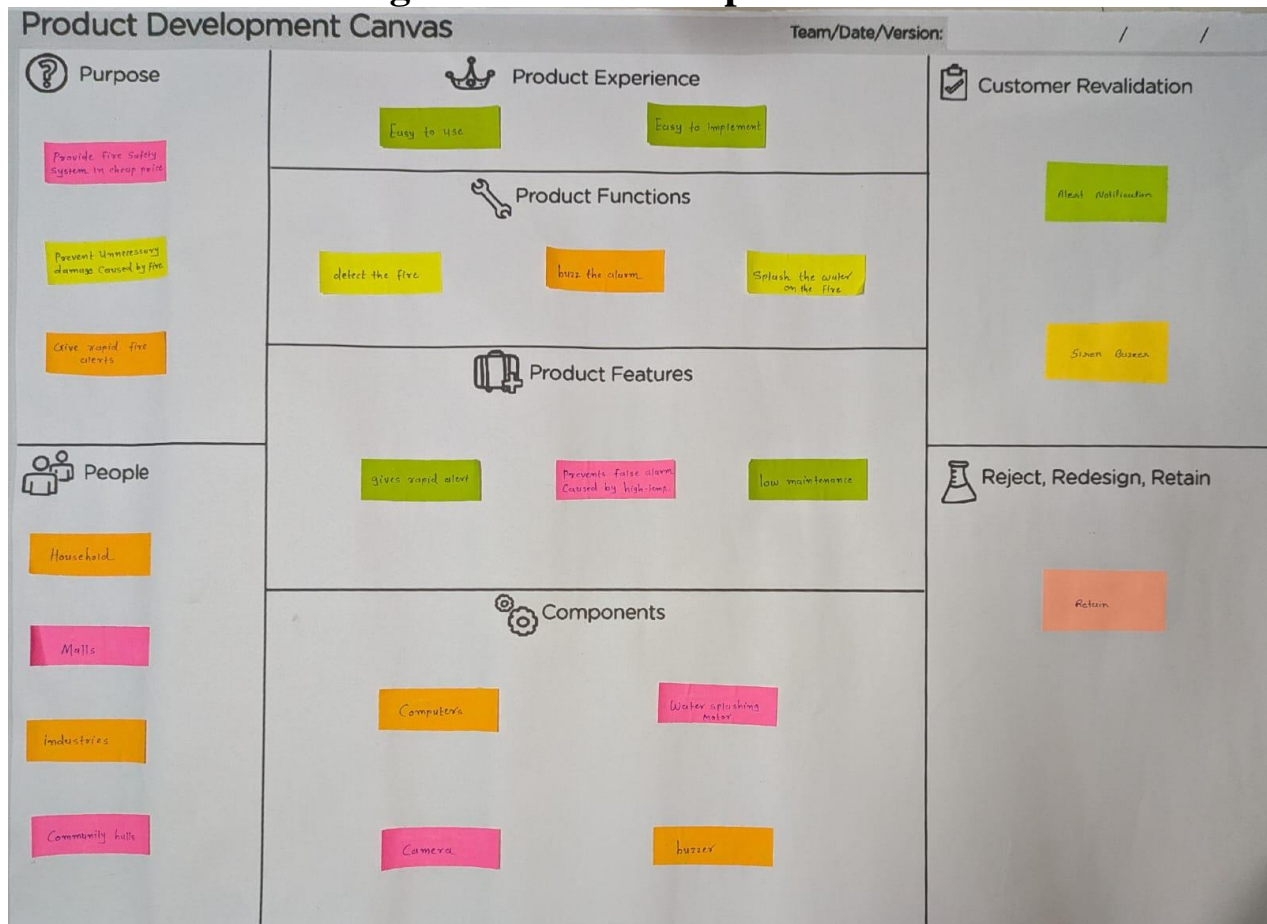


Fig 6.1 Product Development Canvas

In product development canvas, we have learned about how to plan our product on the canvas. We have written about our product experience, product features, and product function. We also went for the survey for asking the customer about designing the product. In reject, redesign and retain part we have shared our ideas of the product with our guide and we had to write what they think about our product.

Purpose

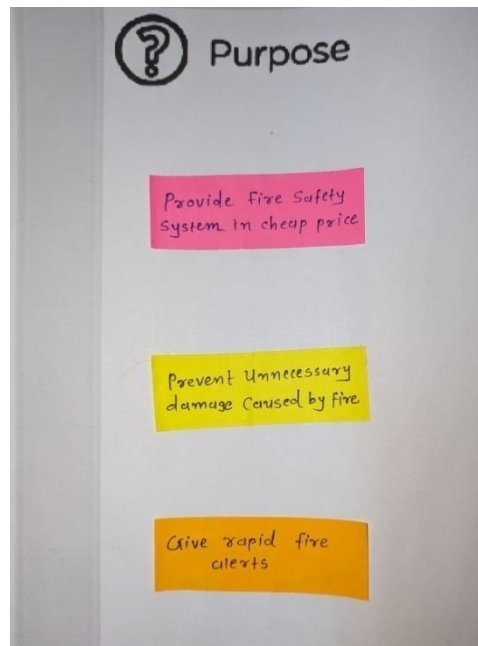


Fig 6.1.1 Purpose

The purpose behind creating an application listed below.

- Provide fire safety system in cheap price
- Prevent unnecessary damages caused by fire
- Give rapid fire alerts

People



Fig 6.1.2 People

Following people are found at NGO.

- Households
- Officers
- Visitors
- Managers

Product Features

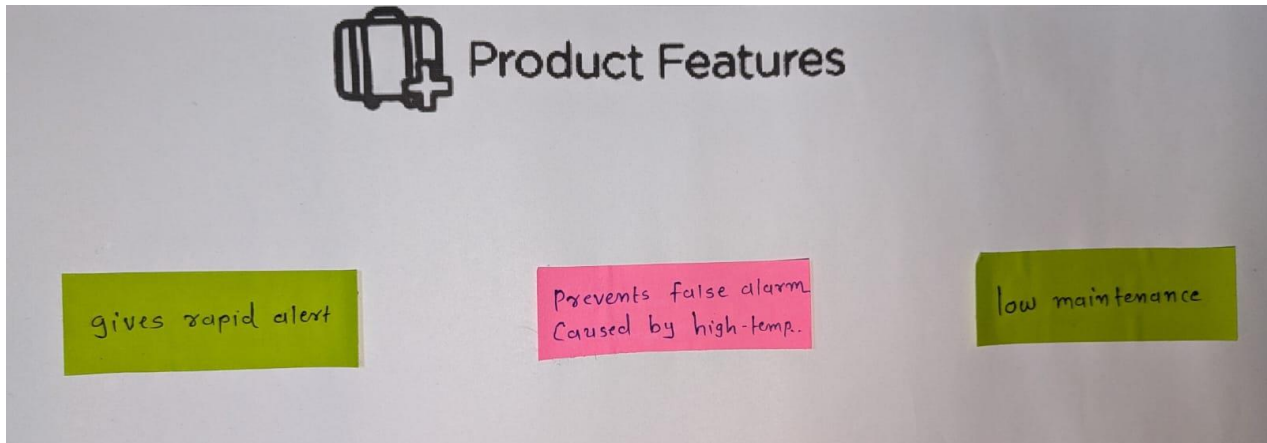


Fig 6.1.3 Product Features

The following list shows features of our application.

- Give rapid alerts
- Prevent false alarm caused by high temperature
- Low maintenance

Product Function

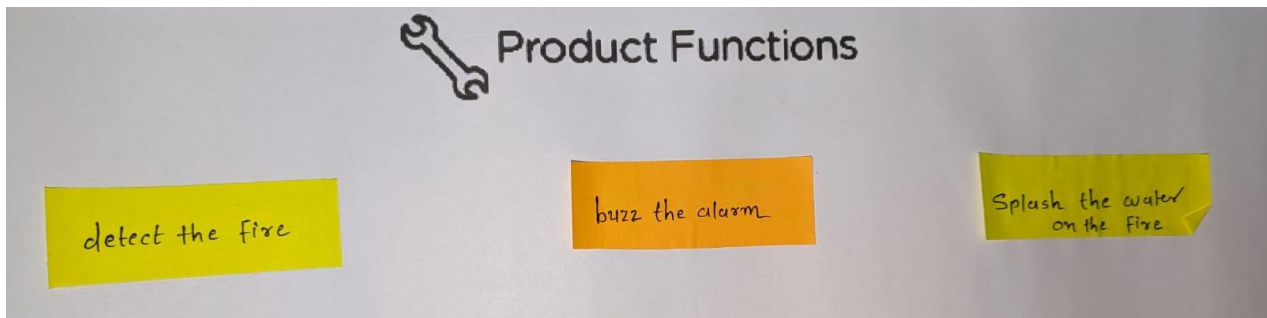


Fig 6.1.4 Product Function

The following list shows the function of mobile application.

- Camera view
- Show boxes around fire when detected
- Turn the alarm on

Product Experience

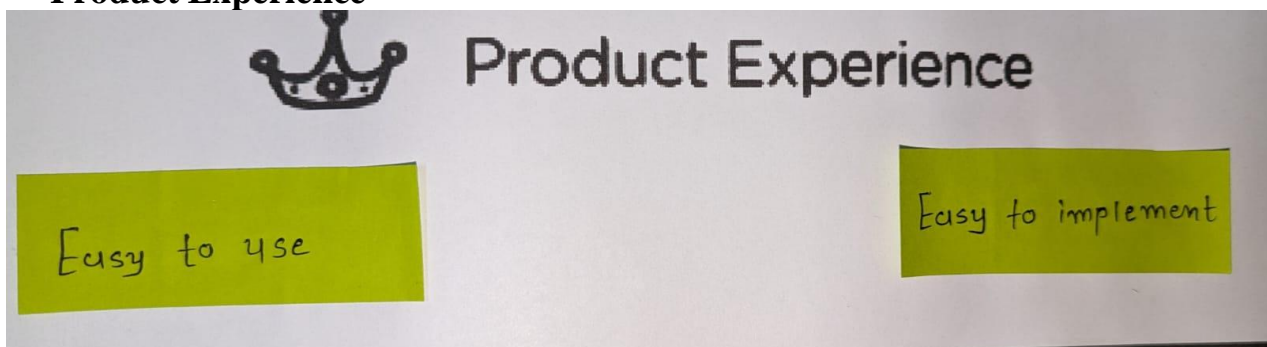


Fig 6.1.5 Product Experience

The below list shows what might be the product experience of our mobile application.

- Easy to use
- Easy to implement
- Reliable to use

Components

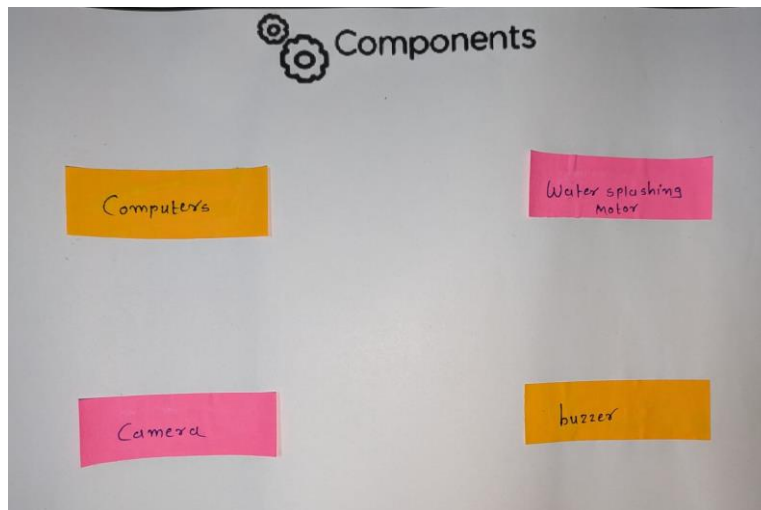


Fig 6.1.6 Components

For our mobile application, the components required are as follow.

- Computer
- Water splashing motor
- Camera
- Buzzer

Customer Revalidation

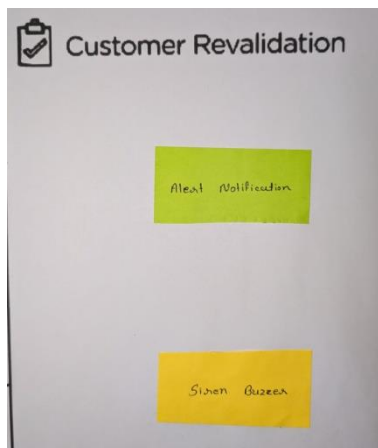


Fig 6.1.7 Customer Revalidation

Following are the feedback we received from the different people.

- Alert notification
- Siren buzzer

Reject, Redesign, Retain

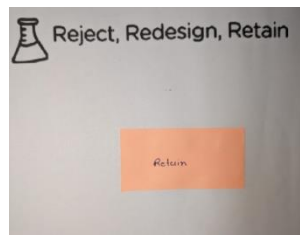


Fig 6.1.8 Reject, Redesign, Retain

This section tells us about the difference in thinking between students & guide.

- Retain

Observation through LNM

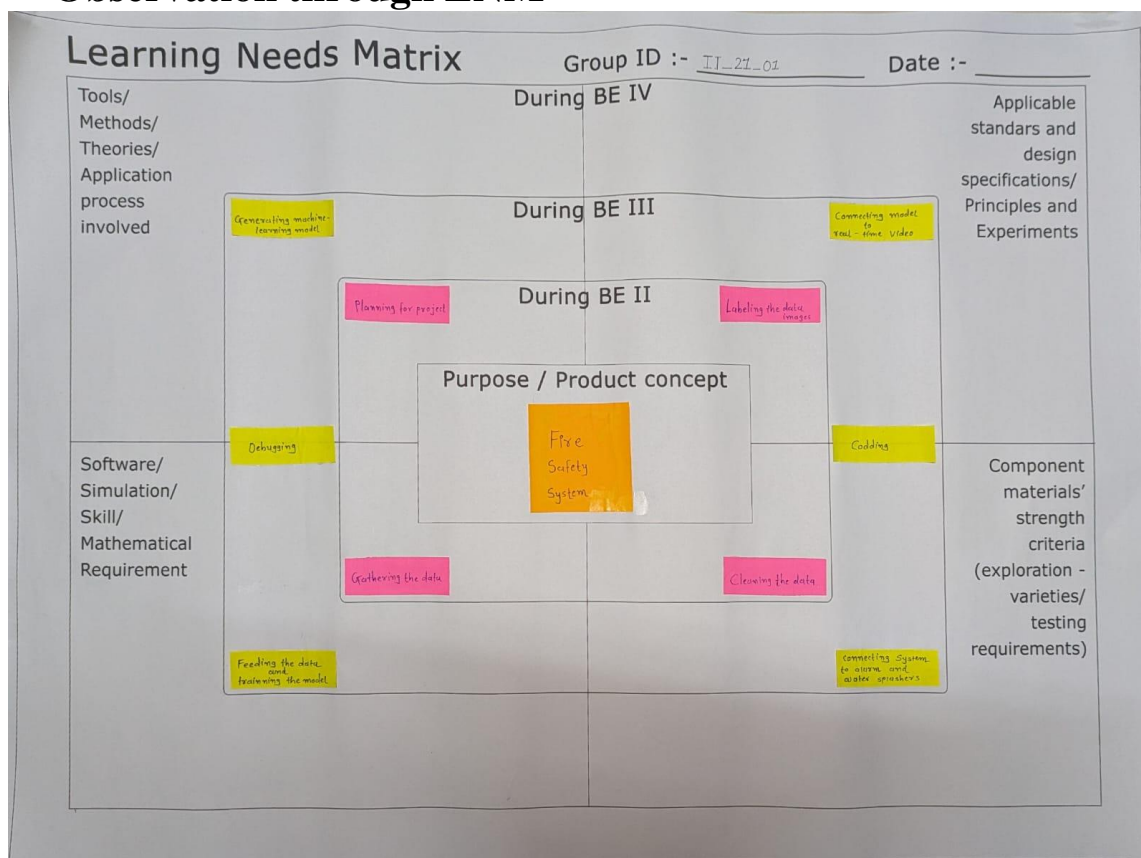


Fig 6.2 LNM Canvas

Learning needs matrix will help us to identify the learning requirements that are much needed in the industry or the career at an early stage along with the prioritization of specific learning. Our purpose behind creating an application is to give safe experience in public or private places. The software which will be used is anaconda and spider. Our application will have features like detecting fire in real time camera view and give alert notification when the fire is detected. Components like computers, the internet and camera will be used to build our application.

Chapter 7

Prototype

Observation through Prototype

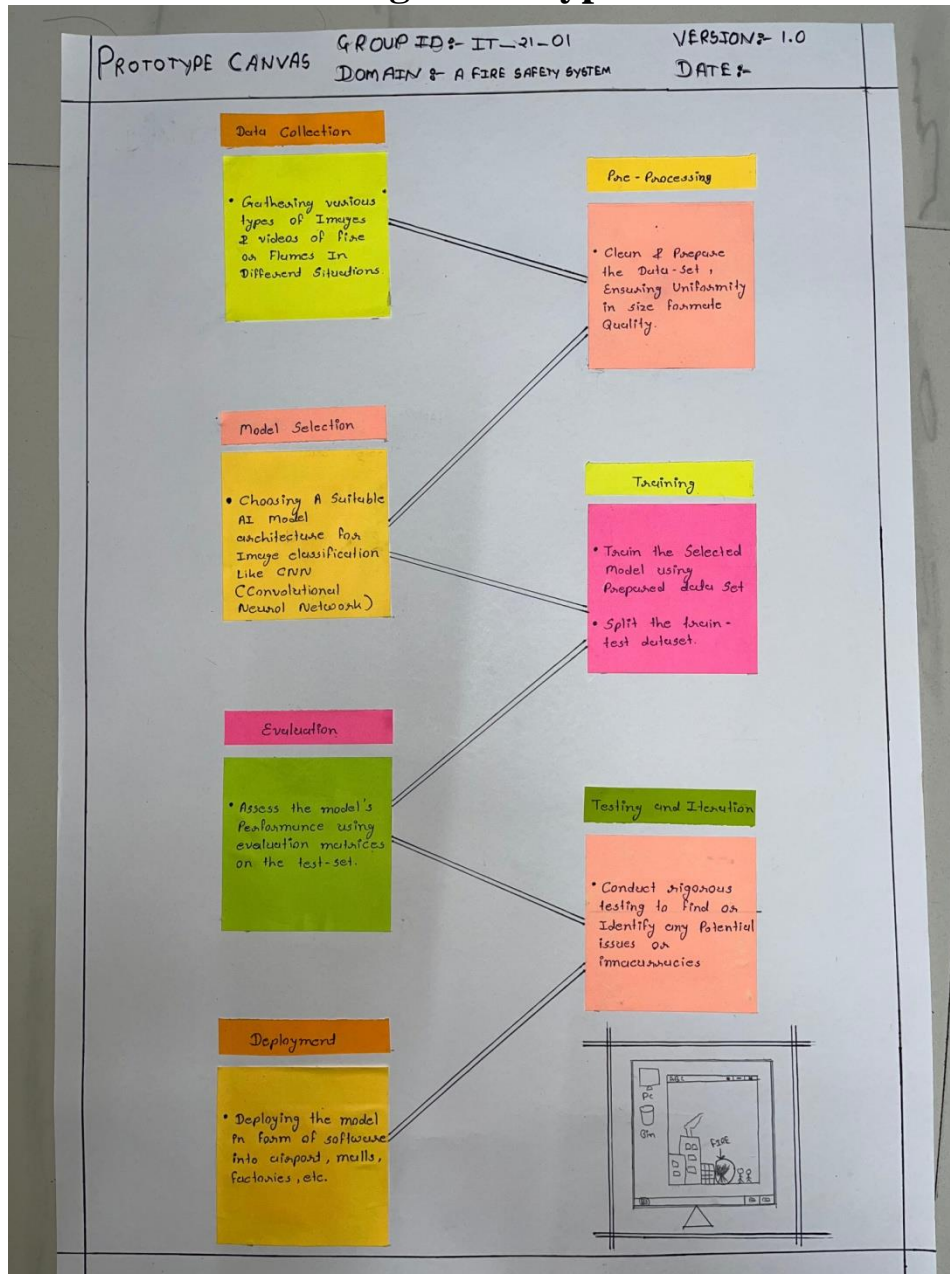


Fig 7.1 Prototype

A prototype is a model of the product that we have an idea as a solution. Prototype makes it easy to understand the project solution. In the prototype, we have tried our best that how our mobile application will work. As you will open the application, you will see a camera view and when a fire is captured in the camera the app will detect the fire and will notify you by alert notification.

Chapter 8

Implementation

all 150 256 0.594 0.469 0.495 0.196

3 epochs completed in 2.901 hours.

Optimizer stripped from runs\train\exp\weights\last.pt, 14.4MB

Optimizer stripped from runs\train\exp\weights\best.pt, 14.4MB

Validating runs\train\exp\weights\best.pt...

Fusing layers...

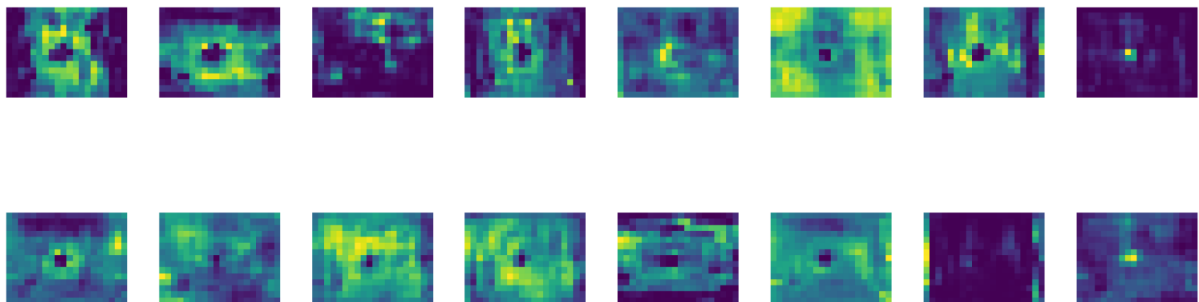
Model summary: 157 layers, 7012822 parameters, 0 gradients, 15.8 GFLOPs

Class	Images	Instances	P	R	mAP50	mAP50-95
Class	Images	Instances	P	R	mAP50	mAP50-95
Class	Images	Instances	P	R	mAP50	mAP50-95
Class	Images	Instances	P	R	mAP50	mAP50-95
Class	Images	Instances	P	R	mAP50	mAP50-95
Class	Images	Instances	P	R	mAP50	mAP50-95
Class	Images	Instances	P	R	mAP50	mAP50-95
all	150	256	0.59	0.465	0.489	0.194

Results saved to runs\train\exp

display(Image(filename="runs/detect/exp4/004dec94c5de631f/stage23_C3_features.png"))

34



Chapter 9

Conclusion & Future Work

Conclusion

In this semester, we had completed all the observations related to our domain. We have worked on canvas such as AEIOU summary canvas, Mind Mapping activity Empathy canvas, Ideation canvas, Product Development canvas, LNM canvas and Prototype canvas. We studied some research papers related to our domain and hence we found out the appropriate solutions for problems. To solve those problems.

Future Work

- We will add feature like a siren buzzer. So, people can be alerted rapidly.
- We will add feature like alert notification of upcoming activities.
- At last, we will make necessary changes to our application. So, it can be more efficient..

Chapter 10

References

- <https://www.scylla.ai/smoke-fire-detection/>
- <https://www.youtube.com/watch?v=7AFHVG-N-jM>
- https://www.w3schools.com/python/python_ml_getting_started.asp
- <https://www.youtube.com/@krishnaik06>