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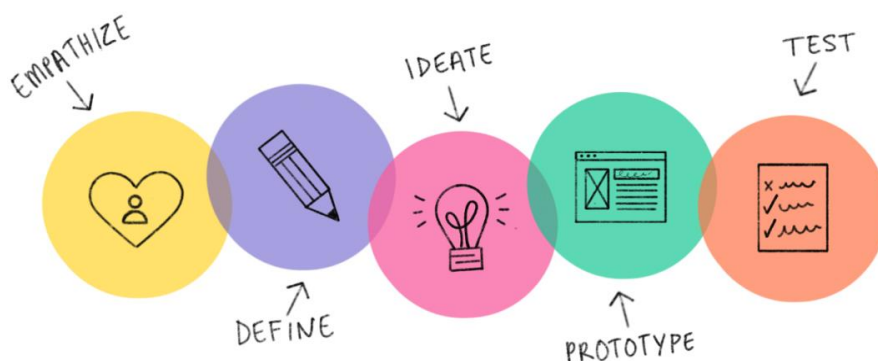
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Department of Electronics and Instrumentation Engineering

DESIGN THINKING LAB (18EI47)

MASK AND TEMPERATURE DETECTION

DTL REPORT

TEAM HYUGA

Submitted by

Ananya D	1RV19EI007
Ganesh C L	1RV19EI019
Shilpa S	1RV19EI052
Aftab Tamboli	1RV20EI400

Under the guidance of
Dr Kendaganna Swamy
Assistant Professor
Dr Sandesh R S
Assistant Professor

In partial fulfilment for the Design Thinking Lab
2020-2021

RV College of Engineering®, Bengaluru

(Autonomous institution affiliated to VTU, Belagavi)

Department of Electronics and Instrumentation Engineering

CERTIFICATE

Certified that the design thinking (18EI47) work titled "**Mask and Temperature Detection**" is carried out by Mr/Ms. **Ananya D (1RV19EI007), Ganesh C L (1RV19EI019), Shilpa S (1RV19EI052), Aftab Tamboli (1RV20EI400)** who are bonafide students of RV College of Engineering, Bengaluru, in partial fulfilment of the requirements for the degree of **Bachelor of Engineering** in **Electronics and Instrumentation** of the Visvesvaraya Technological University, Belagavi during the year 2020- 2021. It is certified that all corrections/suggestions indicated for the Internal Assessment have been incorporated in the DTL report deposited in the departmental library.

Marks (50)		
Name of the Student	**USN**	**Obtained Marks**
Ananya D	1RV19EI007	
Ganesh C L	1RV19EI019	
Shilpa S	1RV19EI052	
Aftab Tamboli	1RV20EI400	

Signature of Mentors   Signature of Head of the Department

Dr Kendaganna Swamy   Dr Renu Madhavi C.H.

Dr Sandesh R S

External Examiners

Name of Examiners   Signature with Date

1.

2.

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ii. Design Thinking Lab Rubrics (18EI47)

		LEVEL 1 (0-1)	LEVEL 2(2-4)	LEVEL 3 (5-7)	LEVEL 4(8-10)
Empathy	**Goal**	Understanding that other People experience thinks differently	Discover non-obvious insights	Discover deeper human- centred insights	Discover a full spectrum human centred insight (individual/group)
	Skill Level	Little experience/comfort eliciting info from others unlike themselves	Ability to develop diverse approach. Some experience eliciting info from others	Ability to understand perspective and experiences from others	Ability to understand others and the system/process in which they operate and ability to think like others
Define	**Goal**	Pick one insight/problem out of many in a very guided statement	Understand multiple insights and needs and synthesize into a single problem statement with guidance	Develop multiple deep insights and synthesize into a single problem statement with little or no guidance	Develop multiple complex problem statements with no guidance
	Skill Level	Ability to prioritize based on perceived importance of any insight/problem	Ability to synthesize information and prioritize insights based on perceived needs	Ability to synthesize info based on needs and insights originating from multiple non obvious internal and external sources	Ability to understand and synthesize deep insights based on complete system
Ideate	**Goal**	To be able to come up with lots of ideas and defer judgement	To develop over 20 ideas off a single well-crafted HMW	Develop multiple HMWs, generate a spectrum of ideas from the HMWs and narrow to a few actionable ideas	Use multiple techniques for ideation for a single insight and repeat
	Skill Level	Ability to generate and record ideas with others	Ability to build of others' ideas and develop wild ideas	Ability to lead a brainstorm through a spectrum of ideas from low hanging to wild	Ability to use multiple techniques to inspire a complete range of ideas.
Prototype	**Goal**	Create a representation of your idea that someone else can understand	Create a representation of an idea that can be evaluated by others	Create a representation that allows one to evaluate specific features of a given idea and develop multiple iterations	Create multiple representations that allow you to evaluate specific features from multiple perspectives and develop multiple iterations
	Skill Level	Ability to make a physical or visual representation of an idea	Ability to create a physical or visual representation of an idea that can be evaluated and improved	Ability to identify variables of an idea that needs to be evaluated and iterate off feedback	Ability to create more complex prototype addressing multiple approaches to solving a problem.
Test	**Goal**	To try or show a prototype to see how well it works	To try or show a prototype and efficiently solicit feedback	To create a testing scenario to specific feature and design clear team roles such as presenter, notetaker, observer.	Real world testing with a range of users and scenarios that address the needs and perspectives of the complete system.
	Skill Level	The ability to use a prototype to determine how well and idea works	Ability to set up an effective prototype test, solicit feedback, and organize feedback received into actionable results	Ability to solicit feedback about specific features, construct a representative testing situation and capture results to inform future iterations	Ability to identify best situations in the real world for testing and test with multiple representative populations and capture complex results to inform future iterations

1. INTRODUCTION

Design Thinking

Design thinking is a human-based approach to innovation that aims to establish creative ideas and effective business models by focusing on the needs of people. The basic idea behind design thinking is that you apply the approaches and methods of designers to the development of innovations while also engaging in a systematic, fact-based analysis of the feasibility and economic viability of these innovations just like what a researcher does. The shaping and design of material products is just one application area. You can use this approach for all areas in life and business. Maybe you want to enhance your customer service, introduce new ways of executing your business processes, or change the corporate culture. Then you're dealing with many-layered issues. When you have no simple solutions, design thinking helps you find an innovative solution. There are some things to keep in mind for the success of design thinking i.e., Free of prejudices about how something works, Free of expectations about what will happen, filled with curiosity to understand things more deeply, Open to a world of possibilities since we do not yet know at the beginning of our "journey" what is possible and what is not, fail early on and often; learn quickly.

The need of design thinking

- It helps to generate innovative solutions for problems.

- It also plays role in meeting the customer needs.

- It provides the modern solutions according to the needs.

- It is very useful in the current pandemic situation, as we need many solutions for the problems.

There are some stages in design thinking process. They are given below in *figure 1*
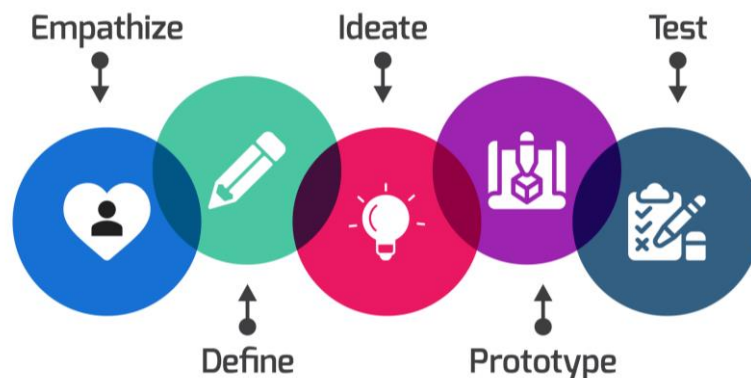
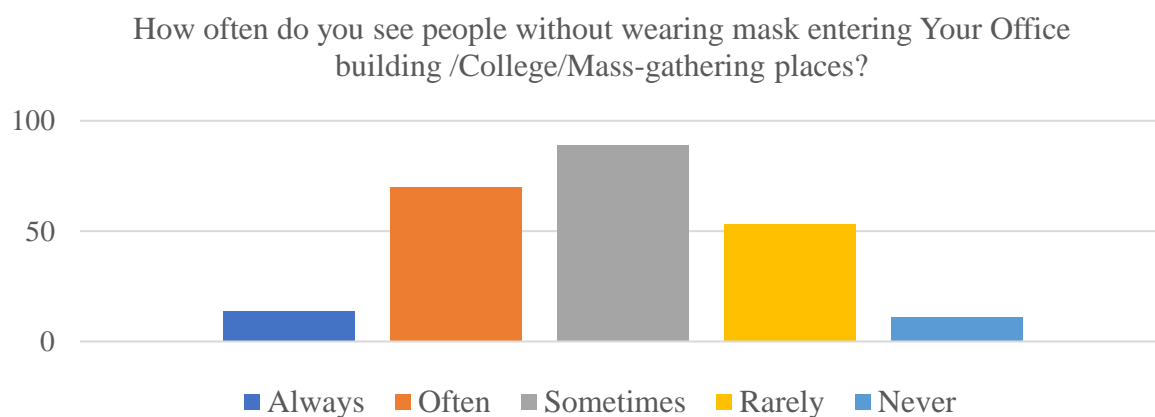

Figure 1. Stages in design thinking

2. EMPATHY

Design thinking is more than just customer orientation. It is centered on people. People are the beginning, middle, and end for every consideration. We must begin with people by taking up a problem faced by your target users or a wish expressed by them. Our task in design thinking is not to pursue a technology or business goal it's to satisfy the expressed needs of customers. So, the first phase of design thinking is empathizing. We did an online survey to understand people's stand point on this pandemic. We received about 237 responses and their reaction is represented below graphically.

2.1 QUESTIONS AND RESPONSES

How often do you go out of your house?
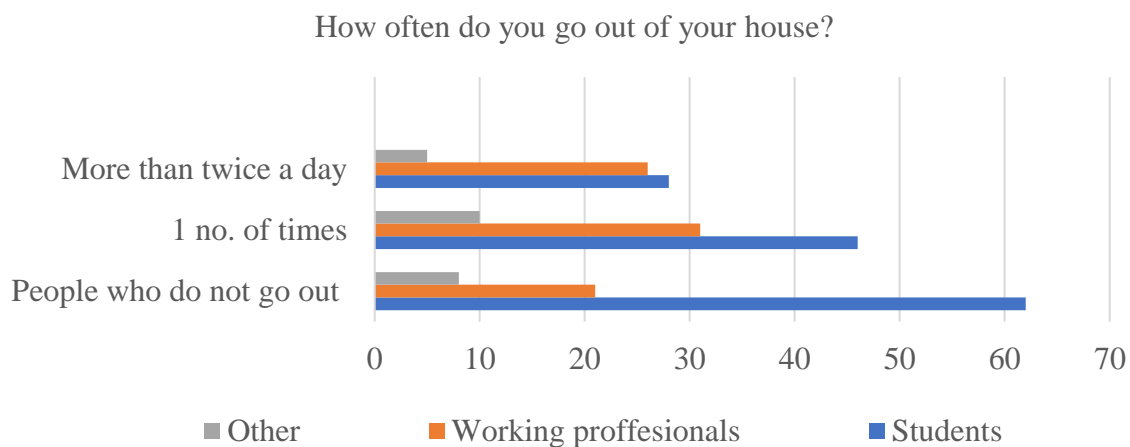
Graph 1. Question on Commuting

At this point of time, it's been continuous on and off lockdown going all over world for almost 18 months, but still people can't completely follow this rule as some basic necessities need to be fulfilled for survival. According to our survey, from *graph 1* most of the working professionals intend to go out of the house at least once a day. At the minimum on person from each house has to keep an absolute contact with the surrounding facilities.

How often do you see people without wearing mask entering Your Office building /College/Mass-gathering places?


Graph 2. Question on whether people wear mask or not

One of the most important social norms currently is wearing the mask outside the house or when being in contact with another person. Even though the pandemic is spreading like wildfire and the infection rate has skyrocketed there still are some ignorant people who does not view all these lifesaving standards as a necessity. This question shown in *graph 2* basically provides proof for the existence of irresponsible personalities whose action leads to unimaginable consequences.

How often do you see people not wearing mask properly?
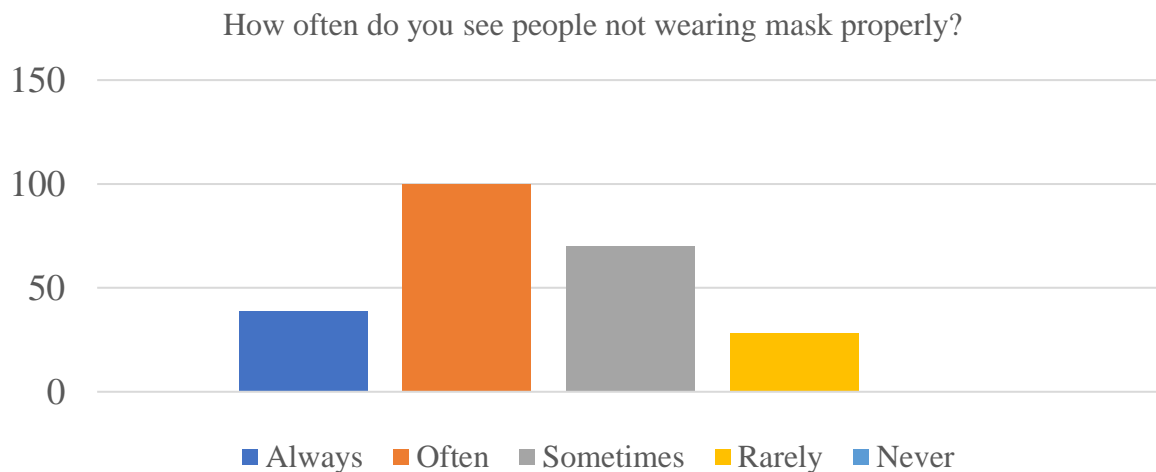
Graph 3. Question on people wearing mask properly

Even though most of the people wear mask whether they wear it properly completely covering their nose and mouth is the question to think about. Just casually wearing a mask without actually paying heeds to the way it should be worn does not help instead it aggravate the problem. According to the responses in *graph 3* we received we concluded that most of the people does not wear the mask properly. This behaviour is synonymous to not wearing mask

Does wearing masks plays an important role in reducing COVID-19?
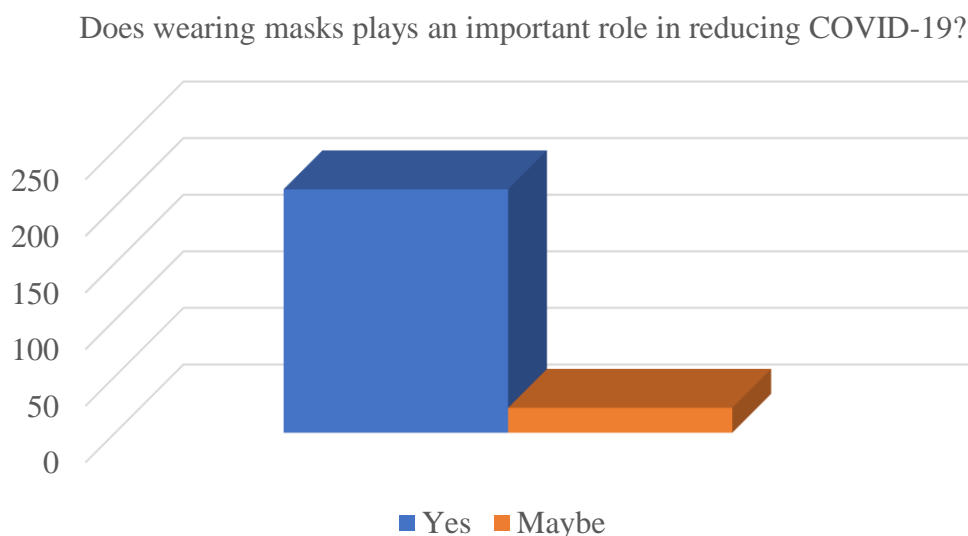
Graph 4. Question on role of mask

at all.

This is the crucial question where we tried to understand people's opinion on wearing the mask. We received an affirmatory response as shown in *graph 4*. Though wearing mask does not guarantee not acquiring the infection it still decreases the rate of getting infected by a lot. This means even though the end result of wearing mask is not determined to be providing utmost safety, it does not mean its prominence is any less. Wearing mask does play a big role in minimizing the viral spread.

Will it be helpful if a device which screens out people who do not wear mask and checks for temperature before entering a Office buildings/mass-gathering places?

■ Yes
■ Maybe
■ No
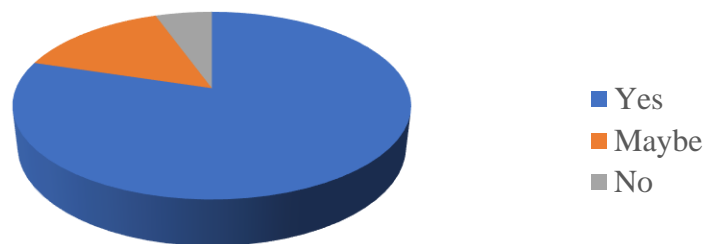
Graph 5. Question on helpfulness of a screening device

At last, we asked people about the device which helps in screening out the people who does not wear mask or who does not wear the mask properly. *Graph 5* shows the analytics of final question of the survey. By the responses we received we were motivated to move in this direction. Most of them were verry happy to encounter such device.

2.2 PROBLEMS IDENTIFIED FROM THE SURVEY

Survey provided a clear picture of today's situation. May be pandemic isn't an everlasting phenomenon but, the aftereffects aren't something to be ignored. In today's world even though, medical advances have reached to the level of conquering most of the deadliest diseases, The losses sustained due to the sudden outburst of a new viral disease still caught the world off guard. Even if the planet is recovering somehow slowly, it is still prone to the situation once again going out of control. Below are some of the problems which we will be focusing on:

- It's inevitable to go out and have a contact with the outside world. At least for the minimalistic requirement of ration and food people have to set foot outside of house. Every house will have one or more person going in and out of house for ensuring the needs of family.

- Even after strict prompting of government on following the set social hygiene norms there still are people who does not hesitate to break the law. Especially not wearing mask in public areas is equivalent to active being a virus transmitter.

- Not wearing mask properly is nothing but not at all wearing the mask. If the person does not have awareness of the risk produced by such half-hearted behaviour the end result will be dangerous.

- The behaviour of one person influences the other, if one person refuses to wear mask in public it encourages another to break the law as well. This acts as a chain instigating a rebel from many people.

- Even though we follow the rules and be conscious of our surrounding, due to the unacceptable bearing of some people at the end everybody has to pay the price.

2.3 INSIGHTS

After defining some of the problems we started to analyse the situation in a more distinct manner. In search of overall conclusion to the current scenario we ended up marking some points which proved to be beneficial:

- Avoiding going out of house unless it's absolutely necessary and minimizing the number of people per family who would have access to the surrounding.

- Most of the time people forget to wear the mask in indoor premises, which is a mistake. No matter wherever the person is in public as long as there is a third-party present, they must wear the mask for their and everyone's safety.

- Frontline workers who do not have a chance to sit at home are prone to more risk than anyone else. They have to do their duty irrespective of circumstances and people. So, if there is person not abiding by the set rules, along with the person the workers also have to go through the ordeal.

- An awareness alert system is necessary. People should be more accepting towards the difficulty and press along with the fellow citizens causing less disturbance to the state and order of the nation.

- If there is a security guard at the entrance of the building, he might have to deal with the people who does not wear mask on his own increasing the risk of him getting infected. Instead, if any system is introduced which can filter out the people who aren't wearing the mask and trying to enter it would then minimize the threat caused by the direct contact.

2.4 TARGETED AUDIENCE

Though every human being is prone to the virus, we have focused much on the fact that people tend to be more negligent in indoor premises. Keeping this in mind we rounded of the targeted audience. They are the people who must attain to crowded and enclosed spaces provided by an entrance door. Following are some classes of people:

- Daily essential buyers: People who visits a complex or big market place entrusted by entrance gates. These people are more prone to shopkeepers who meet a lot of customers but do not wear masks properly. Also, these places are devoid of fresh air.

- Office workers: These are the ones who go to their offices to earn their livelihood. They interact with a lot of people inside their workspace like having meeting, food, and passing documents etc., together

- Students and faculty: These are one of the biggest class of people. Students sit in a very small space. In some institutions, 3-4 students sit in the same bench provided. There is a high risk of infection if they do not follow the protocols as they are going to break the social distancing protocol.

- Commuters in public transport: Many of the classes mentioned above commute to different places through the medium of public transport. In buses, trains and metros, there will be people packed and sometimes they even commute while standing. In cases of such densely packed spaces, very high risks pertain.

2.5 PERSONA

Figure 2 Image courtesy: Google images

Figure 2 shows a google image referring to a woman whom we have considered as a person. Her details are given below.

- Name: Arunima Poojar
- Role: Bank cashier

- Demographics: Age 31, Full-time employee, takes care of family at home volunteer at a local NGO.
- Key assumptions: She contacts a lot of people throughout the day as an employee. Walks out of the house to buy house hold necessities.

3. DEFINE

In this phase, we focus on evaluating, interpreting, and weighting the findings we have gathered. The result eventually flows into the result synthesis. After the observations and surveys, we focused the insights on a selected group of people and summarized their problems and needs in a defined question. Gathering information on how people are currently solving the problem provides clues on how to give a more innovative solution, and learning about frustrations with those solutions serves to identify unmet needs.

The problem that we chose was, "People do not wear mask properly in very crowded places like government bus stations and metros, schools, temples, malls etc.,". This has happened to most of the people who responded to our online survey.

To address this issue, we have to come up with a possible solution where people who have not worn mask or not properly worn are screened out, from which we can further prevent the transmission of the virus and also create an effective awareness among people.

4. IDEATION

 Although people have learnt to accept the current scenario, it is not approving to continue the same way, but moving around freely comes with the risk of losing one's life. Even if we get over with these frightening times the social hygienic commands currently at practise will have to go on for a while longer. Here are some ideas we came up with to encounter the issue at hand.

- Posting of guards wearing PPE kits to warn people who are entering the indoor place.
- <u>Using object detection deep learning models in images to detect masks.</u>
- Mask dispensers to people who have noy been equipped with masks.
- Spraying of people with sanitizers before going inside the door.
- Programs to be held in schools and online classes by NGOs and teachers to educate the young ones about the importance of following COVID-19 protocols.
- Payable mask vending machines can be put up in public places and office entrances.

- Use of RFID in masks where when a person walks through the door entrance, a RFID scanner scans for the masks.
- Masks when weared, will be subject to hot air from breathing. So, the temperature density near the mask will be high. Use of thermal image scanner and then using pixel values near the face will predict whether a person is wearing a mask or not.
- QR codes on masks which should be scanned at the entrance of the office or other spaces.

5. PROTOTYPE/PRETOTYPE
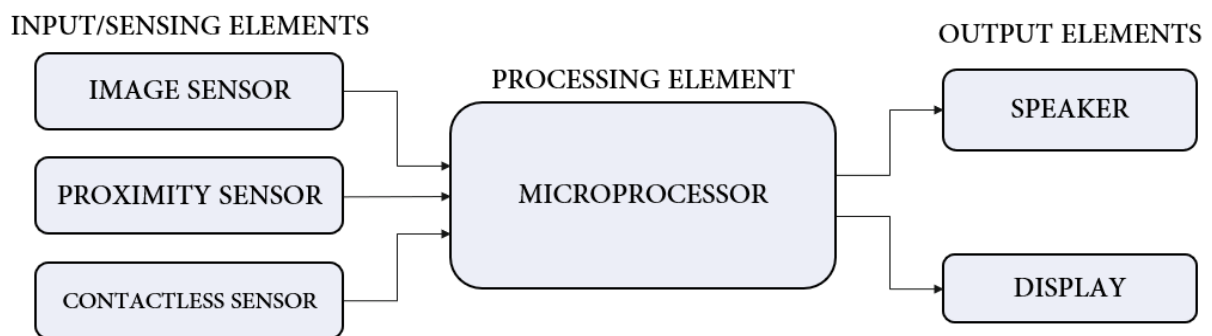
5.1 BLOCK DIAGRAM

Figure 3 Block Diagram

The device's fundamental structure is as shown in *figure 3*. It represents the components used and the implementation of the circuitry. The whole unit consists of 3 elements i.e.,

1. Input/Sensing element
2. Processing element
3. Output element

5.2 COMPONENTS

1. Raspberry Pi model 3b+ microprocessor: This was chosen as we need to execute the machine learning model python and we can connect the other components are easier to interface. Also, compared to other Microprocessor, this is easy to work on, as there is a lot of open-source documentation available across multiple domains. It's cheaper and faster compared to many embedded processors available in the market.

2. MLX90614n IR-temperature sensor: As the sensor needs to be contactless, we chose this temperature sensor.

3. For the Image sensor, we went with a commonly available webcam and chose it as its cheaper and give promising and required resolution.

4. Ultrasonic SR-04 sensor: This is used as a motion detector as its cheap and fulfils all requirements.

5. 16x2 LCD display: This will act as a visual output to the user who is interacting with the device.

6. Stepper motor: We chose this as we can use it for working on door. A rack and opinion arrangement connected to the motor will basically work as a motor-driven sliding door.

7. A generic speaker: This will act as an audio output to the user who is interacting with the device. It helps visually impaired persons especially.
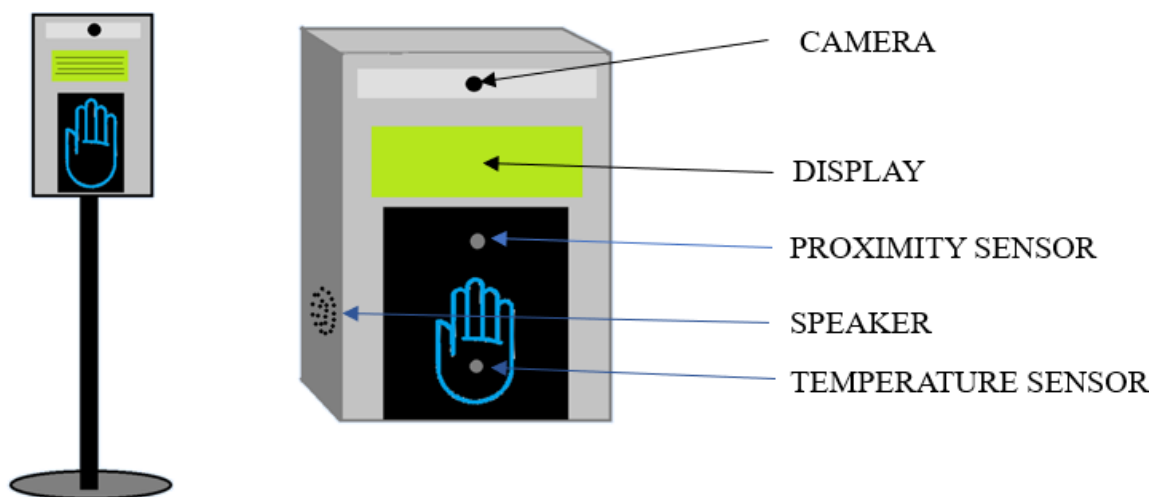
5.3 3D MODEL

Figure 4 3D Sketch

Figure 4 shows the 3D sketch we developed using microsoft paint. For the exterior we can make use High Density Polyethylene (HDPE) which is more durable and cost effective. It comes with an inbuilt camera and speaker for capturing the image of the person and sounding appropriate message respectively.

6. WORKING

The internal working of the product consists of two sections

1. Analyzing the person's photo and identifying whether the person is wearing mask or not.

2. Accessing the body temperature of the person and combining the output of both deciding whether the person is allowed to enter or not.

The first section is achieved by training a model using machine learning. In this part, we have used database containing 12k images which was sourced from Kaggle platform to train the model. The program starts with taking a snap from the camera. This image will be grey-scaled and fed to a face detection algorithm (Haar-Cascade). *Figure 5* shows the image output of it.

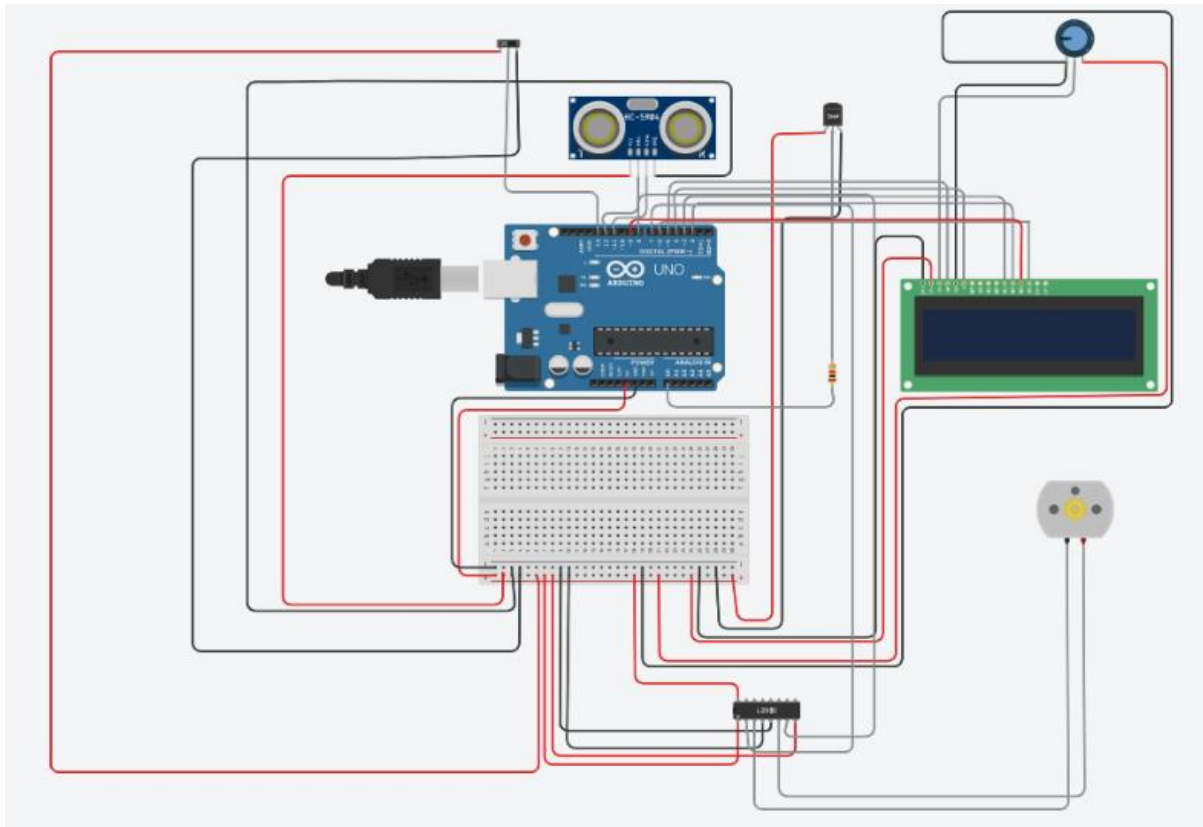Figure 6. Image output from the haar-cascading algorithm.

Figure 5 Circuit design and simulation in Tinkercad

This selects the face and crops out the rest of the image. The image will be cropped to 1:1 aspect ratio and converted to a numpy array. This image numpy array will be fed to the model that we have trained. The deep learning model has been trained using Tensorflow-Keras API package for python. The neural network has 6 layers consisting of core(dense), convolution (Conv2D), reshaping(flatten) and polling layers (Maxpool2D). The model has been compiled using Adam optimizer. The prediction is of binary classification type (0 or 1).

For the second section of our project, we tried to simulate the functions online using tinkercad. The circuit is shown in *figure 6*. In the above simulation we have used an Arduino, temperature sensor, LCD screen, ultrasonic sensor and a DC motor. We have used a switch to simulate the output value from the trained model contained in Raspberry pi. Once the person reaches in the limited range of ultrasonic sensor it detects the person's arrival and activates the LCD screen which shows WELCOME and also guides the person with stretching his hand in front of the device by providing appropriate message. Once the person stretches his hand in front of the device the contactless temperature sensor detects the person's body temperature. By now the trained model will determine whether the person is wearing a mask or not and inputs the data to Arduino. If the person is wearing the mask properly and his body temperature is stable the LCD screen shows "PLEASE ENTER" and the DC motor is turned on for the person to enter. The DC motor has a delay which helps it in rotating in clockwise direction for some time and then anticlockwise direction for the delay mentioned. So, this motor helps with the movement of sliding door by guiding the rack and pinion arrangement.

7. TEST

As the current situation does not support the interaction of people, we could not construct a non virtual prototype. We tried to simulate the requirements virtually. The trained model was a success even though the database is of only 12k images it did work as expected.

	precision	recall	f1-score	support
0	0.99	0.96	0.97	995
1	0.96	0.99	0.98	1005
accuracy			0.97	2000
macro avg	0.98	0.97	0.97	2000
weighted avg	0.98	0.97	0.97	2000

Figure 7. Classification matrix of the trained model

Figure 7 shows the classification report of the trained model. The classification matrix is a standard tool for evaluation of machine learning model which is imported from sklearn package. It makes it easy to understand and account for the effects of wrong predictions.

We have used the virtually available sensor for Arduino simulation nonetheless the result expected was achieved. We were supposed to use a microprocessor but due to inability to virtually interface Raspberry pi, we used Arduino as the replacement for the second section. Also, for the same reason could not merge both the section of our project.

8. COST ESTIMATION

Sl. no	Component Name	Price
1	Raspberry Pi Model 3B	Rs. 3,400/-
2	MLX90614n IR-temperature sensor	Rs. 995/-
3	Image sensor(webcam)	Rs. 300/-
4	Ultrasonic SR-04 sensor	Rs. 65/-
5	16x2 LCD	Rs. 90/-
6	Stepper motor	Rs. 490/-
7	Speaker	Rs. 100/-
8	Miscellaneous	Rs. 300/-
	Total	RS. 5740/-

*Prices are not fixed. All are online prices and correspond to time of submission.

9. CONCLUSION

By the process of design thinking we experienced the divergence in the over all activity of finding the solution to a problem. It was an innovative journey with small stepped phases. This approach helped us to invest most of our concerns on the grievances of the targeted audience which in turn broadened our thoughts and assisted in gaining a superior outcome. By narrowing our problem statement, we proceeded with finding a better and a creative solution. In this world of automation, a device which can robotically identify the mismatch and handles the things according to the guidance provided to it is much more useful. This provides an escape route to people who have to stand in line and work in any case and circumstances, they need not miss their job neither do they have to worry about being infected due to another individual's irresponsibility.