

June 13, 2021

Craig Scratchley  
School of Engineering Science  
Simon Fraser University  
Burnaby, British Columbia  
V5A 1S6



Re: ENSC 405W Requirements Specifications for the Smart Mask Box

Dear Dr. Scratchley,

In our requirement specification document for the Smart Mask Box, the functionality and physical layer will be outlined and presented for ENSC 405W. The vision that we have with our product is to make public areas safer once again. We wish to accomplish this by scanning the general areas of public gathering entrances and flagging individuals who are not wearing a mask.

The Smart Mask Box will use a camera(s) and identification software to determine if a person is wearing a mask or not. Using this feature, it will be seamless to integrate with existing security measures set up to send the saved picture of people who are not compliant with the safety measures put in place to keep everyone safe.

Within this document, we will cover the general requirements including system overview, functionality and physical, and software and electrical requirements. In addition, our document will also cover safety requirements and sustainability requirements for our product.

Safetech is made up of a group of 6 senior engineering students: Gurshaan Brar (Systems Engineering), Marshall Li (Systems Engineering), Michael Celio (Systems Engineering), Mohit Sharma (Systems Engineering), Nathaniel Huang (Electronics Engineering), Roy Zhong (Electronics Engineering).

We thank you for taking the time to review our requirements document, and if any questions may arise while going through our document please feel free to email our Chief Communications Officer, Mohit Sharma. He can address any questions and can be reached at [msa197@sfu.ca](mailto:msa197@sfu.ca).

Regards,

*Nathaniel Huang*

Nathaniel Huang  
Chief Executive Officer  
Safetech



## **Requirements Specification:**

### **Smart Mask Box**

#### **Team Members:**

Gurshaan Brar  
Marshall Li  
Michael Celio  
Mohit Sharma  
Nathaniel Huang  
Roy Zhong

#### **Contact Person:**

Mohit Sharma  
[msa197@sfu.ca](mailto:msa197@sfu.ca)

#### **Presented To:**

Craig Scratchley - ENSC 405W Prof  
Andrew R - ENSC 440 Prof  
Srishti Yadav - TA  
Timothy Yu - TA  
School of Engineering Science  
Simon Fraser University

#### **Issue Date:**

**Jun 13th 2021**

# Abstract

The purpose of this requirement specification document is to give the intended audience a clear overview of our product by listing its functional, hardware, software, engineering standard, sustainability and safety requirements. Each section will begin with a brief description followed by the lists of requirements. This document will summarize our goals as a company and our product's requirements with a conclusion. Finally, this document will end with an acceptance test plan regarding the proof of concept deliverables that we plan on demonstrating at the end of ENSC 405W.

The mask box product is meant to be a convenient and helpful aid in promoting safety and cleanliness to individuals in times of a pandemic, or more commonly, the flu season. The Mask Box makes masks and hand sanitizer readily available to individuals in public areas, such as, malls, hospitals, airports, grocery stores, movie theatres, sports arenas and other public heavy locations. Furthermore, the Mask Box will provide a sense of security to store owners who implement this product by giving them an extra source of income via the purchasing of masks through their device, while providing them with surveillance footage, pictures and analytics of individuals who are not wearing a mask near or around their business\store.

The main components and functionality of our Mask Box product is to:

- Dispense Personal Protective Equipment (PPE), particularly masks.
- Dispense hand sanitizer.
- Provide Mask Box owners with surveillance and images of individuals not wearing PPE via a Camera and object recognition.
- An integrated speaker used to attract individuals to buy a mask and sanitize.
- Promote safe practices during Pandemics and flu seasons.

The main aspects of this project that we plan on showing for our proof of concept:

- Mask dispensing mechanism.
- Hand sanitizer dispensing mechanism.
- Camera functionality
- User application and communication with device.
- Speaker functionality.

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# 1 - Introduction

The goal of our Smart Mask Box project is to provide convenience to individuals while promoting proper health and safety precautions in society, by making single use masks and hand sanitizer readily available in high volume public locations. The main function of the Smart Mask Box is to allow mall goers and grocery shoppers to purchase masks on the go. Using a camera and implementing facial recognition software, the Smart Mask Box is able to determine whether an individual is wearing a mask or not. If the Smart Mask Box determines that the user is mask-less, a speaker unit will kindly call out and request for the user to purchase a mask from the Smart Mask Box. The mask box will have the ability to accept Interac-tap credit card purchasing and will dispense a singular mask to the user. Furthermore, the user will have the option to sanitize their hands before or after purchasing the mask.

Conversely, while the general public will benefit from these Smart Mask Box installations in and around their local businesses, the businesses that do choose to implement our product will benefit again from the Smart Mask Box as well for different reasons. Businesses that choose to implement our Smart Mask Box will reap the benefits of a small side income received from the purchasing of masks. Furthermore, they will be able to use the Smart Mask Box App that will give access to Smart Mask Box configurability such as setting the price of each mask. The Smart Mask Box app will also provide the business owner with analytical data captured via the Smart Mask Box camera, regarding the amount of individuals with or without masks, the frequency of customers in and around their shops, and saved profiles of individuals who repeatedly refuse to wear masks. Last but not least, the App will have the ability to notify the business owner when the mask and sanitizer storage within the Smart Mask Box is running low and in need of a refill.

Safetech's goal is to make the Smart Mask Box device a societal norm, especially in areas such as the mall, grocery stores, airports and more. The Smart Mask Box will not only benefit businesses by partially acting as a surveillance system as well as providing a side income, but it is also beneficial to the various customers of those businesses as it promotes safety and healthy precautionary measures in times of a pandemic or more commonly the flu season.

## 1.1 - Background

The effects of the Covid-19 virus have been devastating to the world but have also been an important learning experience. Throughout this pandemic, society has been forced to adapt in ways it never has before. Masks and other PPE have become a societal norm, or more accurately a societal enforcement. Without a mask, it was almost impossible, in fact frowned upon, to go out in a public setting for almost 1.5 years. At first, there was a wide range of reluctance shown throughout the world with regards to the use of masks and there may have been many factors that were the cause of this general reluctance. However, Safetech will simply tackle the factor of inconvenience associated with the use of masks, specifically, carrying one around when not in use, remembering to bring one from home in the first place and remembering to wash it or exchange it for a new one.

It is clear that there are many inconveniences associated with using a mask and the Smart Mask Box strives to tackle if not solve these inconveniences.

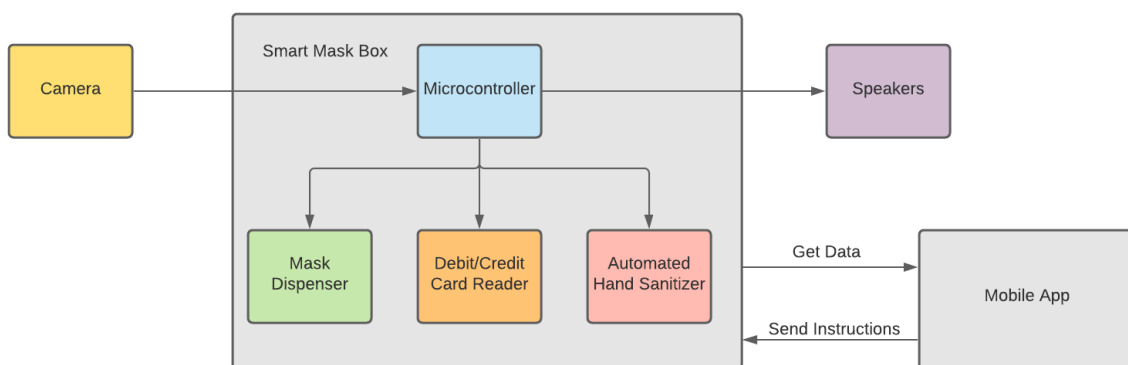


Figure 1: Block diagram of the Smart Mask Box

## 1.2 - Target Market

The intended target market for our product will be businesses and locations with high volume foot traffic areas, such as malls, airports, boutiques, and grocery stores. This will allow them an easy solution to control the flow of people in their stores without having to worry about people entering without masks. Likewise, the cost of our product will be minimized to allow for a wider range of potential customers and all sizes of businesses.

## 1.3 - Requirement Classification

The requirements in this document will follow the following format:

Req {section}.{Subsection}.{Requirement Number} - {Stage of Development}

This will allow us to easily reference and distinguish certain aspects of our project later on in development.

Stages of development can be broken up into three main categories:

Stage of Development	Shorthand
Proof of Concept	PC
Prototype	PT
Final Product	FP

Table 1.3 Development Stages

When referring to the stages of development, the proof of concept requirements are the ones that must be met by the end of ENSC 405W. The prototype requirements of our product are the ones that we must achieve by the end of ENSC 440. The final product stage requirements are for once our product goes into full scale production.



## 2 General Requirements

This section will outline the system requirements, functional requirements, and physical design requirements our product must have. The system requirements will describe our product's various sub-systems such as, the payment system, camera and speaker system, app communication system and mask dispensing mechanism. The functional requirements will describe the purpose and functionality of our product, such as, the purpose of the camera, speaker, application and payment system. Finally, the physical design requirements will describe the physical aspects and constraints of our device regarding its size, build materials, construction requirements, and user interface components.

### 2.1 System Requirements

Requirement Number	Requirement Description
Req 2.1.1 - PC	The product will integrate the use of a microcontroller, camera, speaker, a power source, and mask dispenser.
Req 2.1.2 - PC	The camera and the speaker will operate independently from the mask dispenser system.
Req 2.1.3 - PT	The product must be able to accept debit/credit cards for purchase of masks.
Req 2.1.4 - PC	The product must dispense exactly one mask each time.
Req 2.1.5 - PC	The product must be able to send pictures to the app.
Req 2.1.6 - PT	The product must be able to communicate with the app, and record faces under certain conditions.
Req 2.1.7 - FP	The product must hold 500 masks to sell.
Req 2.1.8 - PT	The product must be usable by the user with minimal to no touching required.

Table 2.1 System Requirements

## 2.2 Functional Requirements

Requirement Number	Requirement Description
Req 2.2.1 - PT	The product must be able to identify individual people.
Req 2.2.2 - PC	The product must then distinguish whether a customer has a mask on their face.
Req 2.2.3 - PT	The product must be able to sell the customer a mask from a point of sale on the unit.
Req 2.2.4 - PC	The product must announce to a customer that they can buy a mask if they do not have one.
Req 2.2.5 - PC	The product must be able to sense when masks are running low.
Req 2.2.6 - PT	The product must notify the administrator when the masks need a refill.
Req 2.2.7 - PT	The product must let the buyer know the price of the mask.
Req 2.2.8 - PT	The product must communicate with the user app and send a photo of people who are not wearing a mask or refuse to buy one to the administration.
Req 2.2.9 - PT	The product must dispense hand sanitizer.
Req 2.2.10 - PT	The product must have a sensor to detect a hand.
Req 2.2.11 - PT	The product must have a simple LCD display.

Table 2.2 Function Requirements

## 2.3 Physical Design Requirements

Requirement Number	Requirement Description
Req 2.3.1 - FP	The product must be about the size of a mid-tower PC case.
Req 2.3.2 - FP	The product must be mounted and usable at eye level (5 feet).
Req 2.3.2 - FP	The product chassis must be made from a sturdy material such as aluminum.
Req 2.3.3 - PT	The product must have no physical buttons on it.
Req 2.3.4 - FP	The products must weigh no more than 10kg.

Req 2.3.5 - FP	The product must survive fall impact from eye level.
Req 2.3.6 - FP	The product's internal elements must survive vibration tests of up to 1G.
Req 2.3.7 - FP	The product must be sealed and water resistant with a rating of IPX4.
Req 2.3.8 - FP	The product must be able to operate in temperatures of -10C to 40C.

Table 2.3 Physical Design Requirements

## 3 Hardware Requirements

### 3.1 Camera Requirements

Requirement Number	Requirement Description
Req 3.1.1 - PC	The camera must have 10 megapixels or more.
Req 3.1.2 - PT	The camera must have a 150 degree view.
Req 3.1.3 - PC	The camera must be able to automatically focus on the target.
Req 3.1.4 - PC	The camera must be able to take pictures in the .JPEG format.
Req 3.1.5 - PT	The camera must be mountable on a flat surface.
Req 3.1.6 - PT	The camera must be able to be powered by the available DC power.

Table 3.1: Camera Requirements

### 3.2 Microcontroller Requirements

Requirement Number	Requirement Description
Req 3.2.1 - PC	The microcontroller must have the ability to add a motor driver board.
Req 3.2.2 - PC	The microcontroller must be able to be powered with the available DC power.
Req 3.2.3 - PC	The microcontroller must be programmable.

Req 3.2.4 - PC	The microcontroller must be fitted with an ADC.
Req 3.2.5 - PC	The microcontroller must have a USB connection.

Table 3.2: Microcontroller Requirements

### 3.3 Speakers Requirements

Requirement Number	Requirement Description
Req 3.3.1 - FP	The speakers volume should higher than 80dB
Req 3.3.2 - PT	The speakers should be powered by an amplifier and the available DC power.
Req 3.3.3 - PT	The speakers must be mountable on a flat surface.

Table 3.3: Speaker Requirements

### 3.4 LCD Requirements

Requirement Number	Requirement Description
Req 3.4.1 - PT	The LCD must be a 16x2 matrix.
Req 3.4.2 - PT	The LCD must show the price of one mask.
Req 3.4.3 - PT	The LCD must show instructions on how to buy a mask.
Req 3.4.4 - PT	The LCD must be backlit.
Req 3.4.5 - PT	The LCD must be powered by the microcontroller.

Table 3.4: LCD Requirements

## 4 Software Requirements

This section will specify the requirements for the back-end detection software, front-end control mobile application, and performance of our product. The imaging processing requirements will outline the functionality and constraints of our image detection software system. The mobile application requirements will describe the various functionalities that our application will offer to the user as well as other aspects of the application itself. Finally, the performance section will outline our software’s performance in terms of its cross-platform capabilities, startup time, and long term usage.

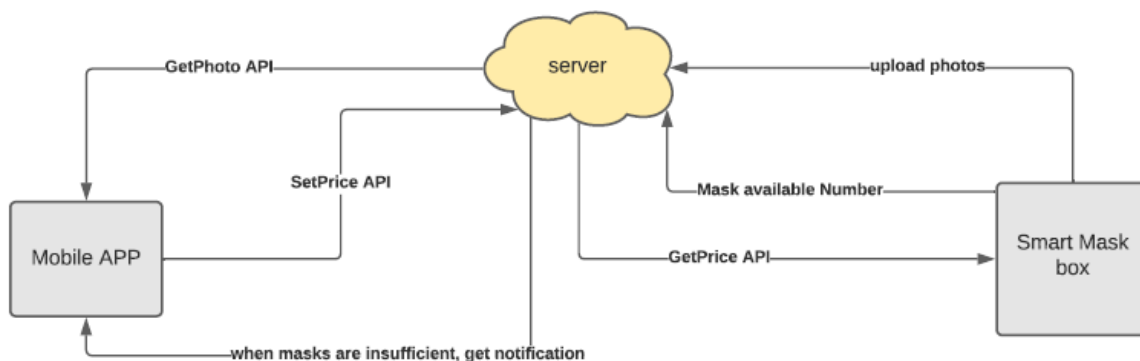


Figure 2: Block diagram of the software system

### 4.1 General Requirements

The following table includes the general requirements for the software system.

Requirement Number	Requirement Description
Req 4.1.1 - PC	The software must be able to upload pictures to the server.
Req 4.1.2 - PC	The software must be able to run on pc.
Req 4.1.3 - PT	The software size should be under 1 gigabyte.
Req 4.1.4 - PC	The software must communicate at a bit rate of 400 kb/s.
Req 4.1.5 - PT	The software must be able to communicate through I2C and configure the LCD display on the device.

Table 4.1 Software General Requirements

## 4.2 Image Processing Requirements

Faces will be detected by the programme using computer vision algorithms. The following table includes the image processing requirements for the software system.

Requirement Number	Requirement Description
Req 4.2.1 - PT	The software must be able to find people's faces.
Req 4.2.2 - PC	The software will use the OpenCV library.
Req 4.2.3 - PC	The software should be able to be trained.
Req 4.2.4 - PT	The accuracy of the software must be higher than 70%.
Req 4.2.5 - PT	The software must be able to detect multiple faces, simultaneously.
Req 4.2.6 - PT	The software should be working well around high contrast and low contrast environments.

Table 4.2 Image Processing Requirements

## 4.3 Mobile Application Requirements

The following table includes the mobile application requirements for the software system.

Requirement Number	Requirement Description
Req 4.3.1 - PC	The mobile application must receive photos from the smart box.
Req 4.3.2 - PT	The administrator can set the mask price through the mobile application.
Req 4.3.3 - PT	The mobile application can notify the administrator to refill the mask.
Req 4.3.4 - PT	The mobile application must have an interactable user interface.
Req 4.3.5 - FP	The mobile application should be updated.
Req 4.3.6 - FP	The mobile application should allow the user to remove information that has been registered.
Req 4.3.7 - PT	The mobile application must be able to run on iOS and Android.
Req 4.3.8 - FP	The mobile application user interface must be available in multiple languages.

Table 4.3 Mobile Application Requirements

## 4.4 Performance

Requirement Number	Requirement Description
Req 4.4.1 - FP	The software must be able to work stably for more than 10 hours per day.
Req 4.4.2 - PT	The mobile application must be able to run on iOS 11 and Android 10 or higher.
Req 4.4.3 - PT	The mobile application must have a startup time of less than 30 seconds.

Table 4.4 Performance Requirements

## 5 Electrical Requirements

Requirement Number	Requirement Description
Req 5.1.1 - PC	The product must be powered with a 24V DC input.
Req 5.1.2 - FP	The product must uphold wiring standards.
Req 5.1.3 - PT	The product must be fitted with a fuse.
Req 5.1.4 - FP	The outer chassis of the product must be grounded.

Table 5 Electrical Requirements

## 6 Engineering Standard Requirements

This section will list and outline the various engineering standards that our product must follow and uphold. These standards are regarding environmental management, safety with respect to electronics, wireless communication constraints, and more.

Standard Number	Standard Description
ISO/IEC PRF TR 29119 - FP	A series of five international standards for software testing [4].
IEEE 802.15.1 - FP	WPAN/Bluetooth[6].
ISO/IEC/IEEE 21840:2019 - FP	Guidelines for the utilization of ISO/IEC/IEEE 15288 in the context of system of systems [2].
IEC 60491:1974 - FP	Safety requirements for electronic flash apparatus for photographic purposes [1].
IEC 61508-2:2010 - FP	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems [3].
C22.2 No.0.8-M1986 (R2008) - FP	Safety Functions Incorporating Electronic Technology [5].
CAN/CSA-ISO 14040:06 (R2011) - FP	Environmental Management - Life Cycle Assessment - Principles and Framework [7].

Table 6 Engineering Standard Requirements



## 7 Sustainability and Safety Requirements

This section will outline the sustainability and safety requirements that our product will need, to uphold safety while being used.

### 7.1 General Requirements

Requirement Number	Requirement Description
Req 7.1.1 - FP	The device will be securely fastened or mounted to avoid fall damages.
Req 7.1.2 - FP	The device will be light weight (no more than 10kg), for easy installation and to avoid physical strain to the installer.
Req 7.1.3 - FP	The device will have warning labels regarding the ingestion of hand sanitizer.
Req 7.1.4 - FP	The device will avoid having sharp edges and rough textures.
Req 7.1.5 - FP	The device must be able to turn off incase of a short circuit malfunction.
Req 7.1.6 - FP	The masks compartment must be a clean and isolated environment to maintain the sterility of the masks.
Req 7.1.7 - FP	The product's internal compartment must seal to prevent water and dust from entering and causing damage.
Req 7.1.8 - FP	The device must ideally be made from recyclable materials.
Req 7.1.9 - FP	The device must not contain toxic or harmful materials that may jeopardize the health and safety of users.

Table 7.1 Sustainability and Safety Requirements

## 7.2 Product Lifecycle Management:

Our goal at Safetech is to reduce components of our product ending up at the landfill, which is why the majority of our parts will be selected in order for them to be able to be recycled once their life cycle is over. These are some of the methods we would use to recycle our components depending on the source material they are made from.

Part/Component	Material	Repurposing Uses
Camera	Electronics/Glass	Electronics recycling program
Speakers	Magnet	Electronics recycling program
Microcontroller	Silicon/Copper	Electronics recycling program
Chassis	Aluminum/Plastic	Municipal Recycling
Power Supply	Metals/Plastic	Electronics recycling program
Mask Storage/Dispenser	Plastic	Municipal Recycling

Table 7.2 Product Materials and Repurposing Uses

## 8 Acceptance Test Plan for Proof of Concept

### **Proof of Concept:**

For our proof of concept, we plan on demonstrating the key components of our device. Namely, the mask detection software functionality, the mask dispensing mechanism, the speaker functionality as well as the basic user interface of our mobile application and basic communication (receiving photographs from the Smart Mask Box device) with the main Smart Mask Box device.

### **Engineering Prototype:**

For our prototype, we plan on compiling and fine tuning the initial proof of concept components. We will construct the device and compile and prepare all subsystems for working functionality. In this stage, we will be adding the hand-sanitizer dispensing mechanism to the device.

### **Production model:**

In this final phase, we plan on finalizing the material and design of the Smart Mask Box. All subsystems within the device will now be fine tuned and seamless with the design. The mobile app will have full cross-platform functionality and capabilities. The product will be ready for production and public use.

## 9 Possible Feature Additions

The Smart Mask Box device has a lot of future potential and room for growth. In the future, a potential feature using a thermal camera to detect people's temperature in real-time may be added. This feature would allow the user to check their temperature while buying a mask. The Smart Mask Box would display the user's temperature on the display to notify them if they have a high fever. That information would then go to administration and they would decide what to do with that person. Another future addition could be a gate that would be used to control the flow of traffic of people by counting the number of individuals coming and going into a store and regulating the amount of people allowed in the store at one time.

## 10 Conclusion

As the whole world scrambles to find the solution to end the current global pandemic, our product is a stepping stone in slowing down transmission rates in high traffic areas. Mask Usage is one of the best forms in preventing the transmission of Covid. Our product will provide a clean sterile way to retrieve a mask, and keep everyone in the community safe. The Smart Mask Box will be able to identify people who enter an area without a mask, and will politely ask them if they would like to buy a mask. The customer will be able to sterilize their hands before and after the interaction, to give the customer peace of mind while using the device. The owners of this device will have access to its associated mobile app that will provide functionality such as, mask price configurability, data analytics, and surveillance.

# References

[1] *Standards Council of Canada - Conseil canadien des normes*. [Online]. Available: <https://www.scc.ca/en/standardsdb/iec/33142>. [Accessed: 13-Jun-2021].

[2] *Standards Council of Canada - Conseil canadien des normes*. [Online]. Available: <https://www.scc.ca/en/standardsdb/iso/169110>. [Accessed: 13-Jun-2021].

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