



# ShowMi Technology Inc.

February 12<sup>th</sup>, 2016

Dr. Andrew Rawicz  
School of Engineering Science  
Simon Fraser University  
Burnaby, BC, V5A 1S6

**RE: ENSC 440 Functional Specification for *MagicMirror***

Dear Dr. Rawicz,

The document attached from *ShowMi Technology Inc.* describes the functional specification for the *MagicMirror*, which details our project for ENSC440 – Capstone Engineering Project. We intend to design and build a smart and interactive mirror that is connected with a monitor and a distance sensor, which can perform instant checkout and information check while a customer interact with the mirror itself.

The purpose of this functional specification is to provide the detailed system, hardware, software and mechanical requirements for the *MagicMirror*. At the same time, an overview of the system along with sustainability and safety are introduced and discussed. In return, this document will act as a guideline for future designing, implementing and testing of *MagicMirror*.

ShowMi is a partnership of five engineering science students: ChangShuo(Tony) Feng, Xukai(Aaron) Zhong, Ziyue(Nick) Zhu, Hongji(Terrence) Dai and Yanjie(Jenny) Zhan. If you have any questions or concerns about our proposal, please feel free to contact me by phone at 778-385-2407 or by e-mail at [csfeng@sfu.ca](mailto:csfeng@sfu.ca).

Sincerely,

CEO – Tony Feng

*ShowMi Technology Inc.*



**ShowMi Technology Inc.**

Functional Specification for the

## **MagicMirror**

SHOWMI

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## Executive Summary

Appearance is something that is very important to most people, sometimes a good appearance can lead to one's success, if done otherwise, failure and bad impression can be left behind [1]. In 21<sup>st</sup> century, there is a huge evolution within in places like supermarkets that integrate human capabilities with electronics and apps. As of right now, self-checkout in supermarket is a very hot option chosen by customers since it shortens line-up time and creates an ease on the cashiers [2]. To improve that idea even more, *ShowMi Technology Inc.* is trying to implement this function in clothing stores to perform storage check and self-checkout by using a special designed mirror known as the MagicMirror. In return, there will be a brand new experience and more convenience created to customers and stores when it comes to shopping.

At *ShowMi Technology Inc.* we are trying to follow the waterfall methodology [3] for carrying out the creation of the MagicMirror. Simply speaking, the design process will be divided into the following 5 stages:

1. **Idea Exploration:** team gathers and discuss about the ideas and at the same time discuss about the feasibility of each idea to decide which one would be the most optimal idea.
2. **Requirement Analysis:** jobs are divided among 5 team members to do individual researches and at the end gather and discuss about the design for the product including functionalities and scope.
3. **Design:** using the researches done to start designing the software, hardware and mechanical components of the product and to make sure they meet the standard.
4. **Implementation:** building the MagicMirror using a two-way mirror, a mini-desktop, a QR barcode scanner, a Kinect2 sensor and a 27" monitor.
5. **Testing:** Testing different modules individually, then combining the modules and lastly testing the whole system.

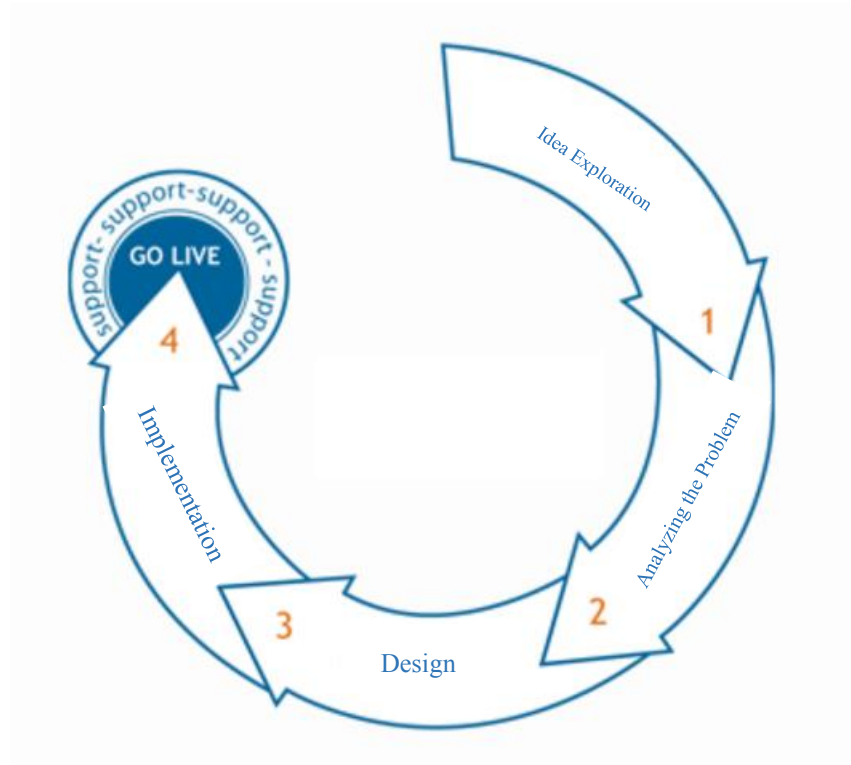


Figure 1: Execution Frameworks

Later on in this document, software, hardware and mechanical requirements will be provided as a guideline for *ShowMi Technology Inc.* and will be followed strictly.



## Contents

Executive Summary.....	i
Contents.....	iii
List of Figures .....	iv
Glossary.....	v
1. Introduction: .....	1
1.1 Scope.....	1
1.2 Intended Audience.....	2
1.3 Classification .....	2
2. System Requirement.....	3
2.1 System Overview.....	3
2.2 General Requirements .....	4
2.3 User Interface/Software Requirements .....	5
2.4 Physical Requirements .....	5
2.5 Standard.....	6
3. Mechanical Requirement.....	6
3.1 Two Way Mirror .....	6
3.2 Distance Sensor.....	6
3.3 Monitor &PC .....	7
3.4 Arduino.....	7
3.5 QR Code Scanner.....	7
4. Hardware Requirement.....	8
5. Software Requirement .....	8
5.1 Web Application.....	8
	iii



5.2 RealSense Controller Application..... 9

6. System Test Plan..... 9

6.1 Temperature Test ..... 10

6.2 Remote Control Test..... 10

6.3 Power Test ..... 10

6.4 Physical Test ..... 10

7. Safety and Sustainability Analysis ..... 11

8. Conclusion..... 12

9. References..... 13

## List of Figures

Figure 1: Execution Frameworks..... ii

Figure 2 Display of the Web Application on the Monitor..... 1

Figure 3 General Design of the MagicMirror and its Parts ..... 2

Figure 4 Functional Block Diagram of the MagicMirror ..... 4



## **Glossary**

<b>CAD</b>	Canadian Dollar
<b>QR</b>	Quick Response Code
<b>Kg</b>	Standard metric unit, kilogram
<b>mm</b>	Standard metric unit, millimeter
<b>V</b>	Volt
<b>GPIO</b>	General Purpose Input/Output
<b>PC</b>	Personal Computer
<b>AC</b>	Alternating Current
<b>DC</b>	Direct Current
<b>HDMI</b>	High-Definition Multimedia Interface
<b>C</b>	C Programming Language
<b>CSA</b>	Canadian Standards Association
<b>C2C</b>	Cradle-to-cradle Design Process
<b>Arduino</b>	Simple microcontroller family
<b>°C</b>	Degree Celsius
<b>IEEE</b>	The Institute of Electrical and Electronics Engineers

## 1. Introduction:

*MagicMirror* is to make a full use of time when customs go shopping in clothing stores. The product has three major functions. First of all, it could help the customs check the price of the clothing. Secondly, when the customs scan the cloth label, its detail information, like size, color, and the amount in stock will be displayed, this will help the customs to choose their most favorite items and add to cart. Lastly, people can use their phone and scan the barcode that provides from the *MagicMirror* to pay for those items, which is also the highlighted feature of our product. After they finish the check out, customers can bring the receipt to store assistances to pick up their purchased items from the storage. On the other hand, this product will also have an advantage of labor saving, so that the shop assistance could use their limited time and energy focusing on helping customs pick up their items from the storage, instead of cleaning up the entire messy

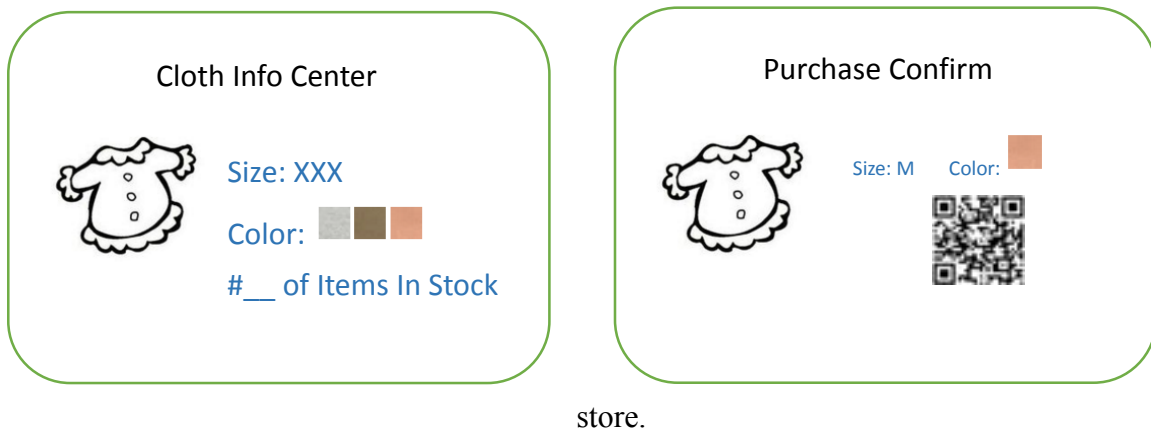


Figure 2 Display of the Web Application on the Monitor

### 1.1 Scope

This document outlines the detailed functional specifications of *MagicMirror*. It describes the functionality of the system including the software program, hardware assembly, mechanical design and the general system set up. Additionally, requirements listed in this document will be used as guidelines for the design, development, and testing



of *MagicMirror* to ensure safety and reliability.

## 1.2 Intended Audience

This functional specification is intended for use by all members of *MagicMirror*. Our group will refer to this document as overall design goals through development. This documentation will also be used as a reference by the marketing department when promoting the product to the potential investors or customers.

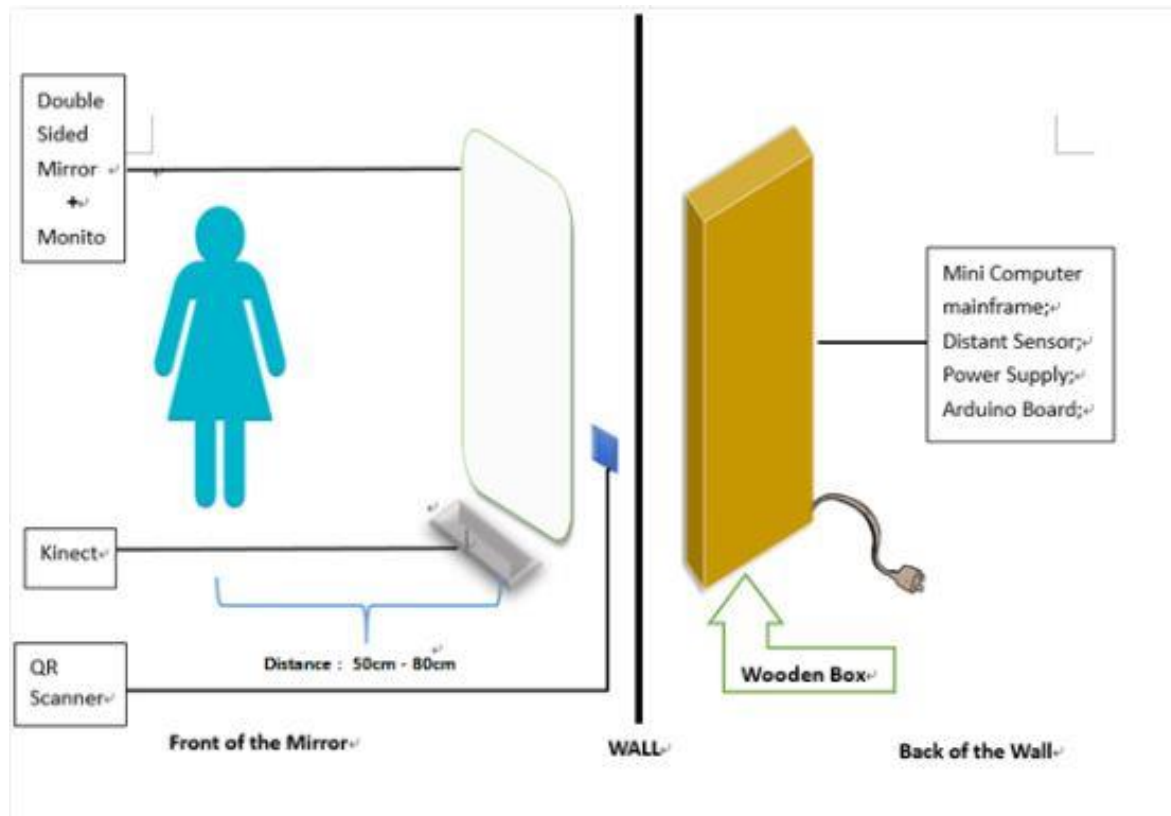


Figure 3 General Design of the *MagicMirror* and its Parts

## 1.3 Classification

The functional requirement specification is shown as follow:

[MX-Y-Z]

‘M’ is an abbreviation for product name – *MagicMirror*;

‘X’ represents the section:

- A –System Set up
- B –Hardware Assembly
- C –Software Program

**D** –Mechanical Design

‘**Y**’ is the number in each section

‘**Z**’ stands the priority of the requirement

**I** –proof the concept

**II** –apply to the prototype

**III** –apply to the final product

## 2. System Requirement

### 2.1 System Overview

*MagicMirror*, as a clothing store mirror, is a revolutionary design that will satisfy the needs for different stores and customers. The idea and solution that *MagicMirror* bring to customers is to make the whole shopping process time-efficient and convenient.

Customers can easily check their interesting item information and check out their bills.

Also, clothing stores’ advertisements can be shown on a striking place because customers who visit a clothing store always need to use a mirror. *MagicMirror* project contains four main parts: software system, mechanical system, hardware system and user interface design. Physically, we have three objects: two-way mirror, monitor and wooden box that fit mirror and monitor.

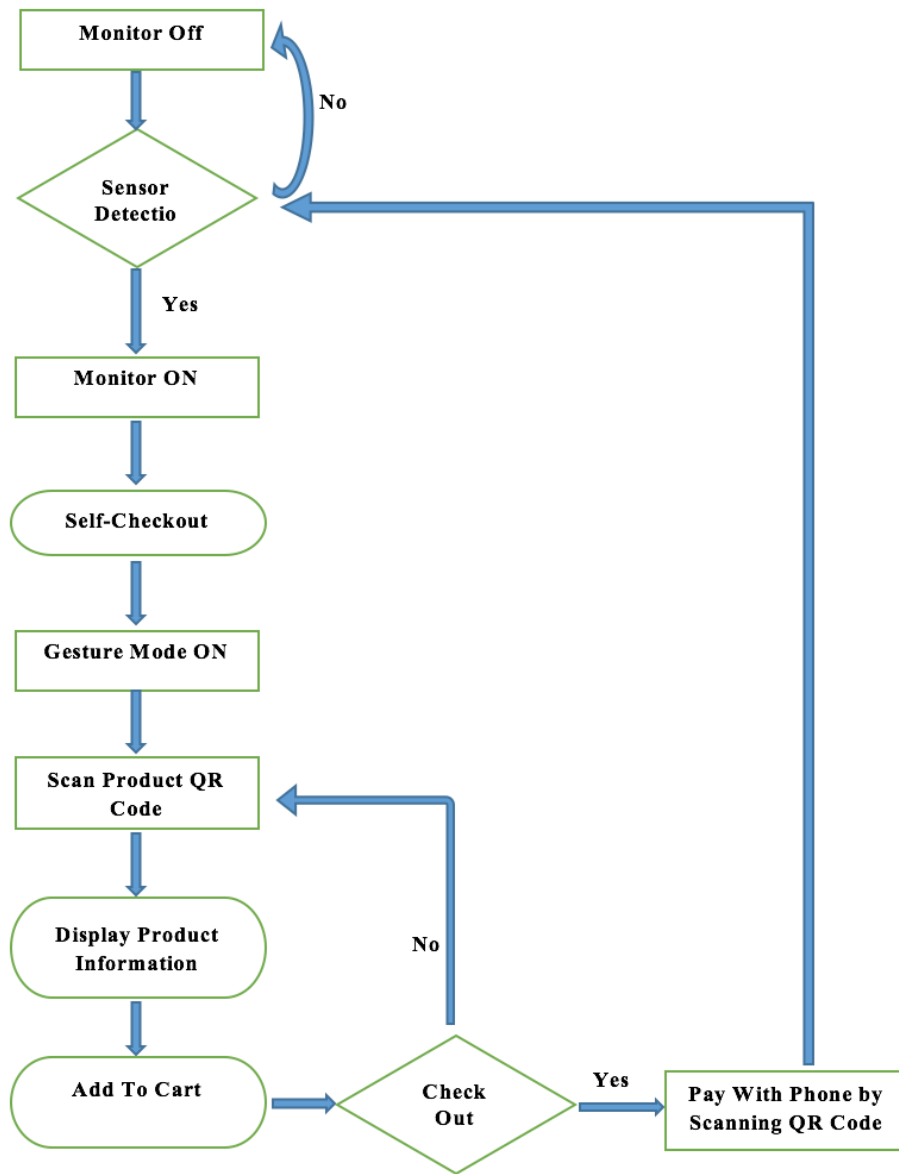


Figure 4 Functional Block Diagram of the MagicMirror

## 2.2 General Requirements

- [MA - 2.2.1 - I] *MagicMirror* is designed to be used indoor.
- [MA - 2.2.2 - II] *MagicMirror* has display function and reflection function.
- [MA - 2.2.3 - II] The final price of *MagicMirror* should not exceed CAD 500.



- [MC - 2.2.4 - I] *MagicMirror* can scan/generate QR code for identify items.
- [MB - 2.2.5 - I] *MagicMirror* has distance sensor that detect whether customer is in front of mirror. Specially, if distance is between 50 ~ 80(cm), the screen will automatically turn on and show the main page.
- [MA - 2.2.6 - III] Power Supply required.
- [MB - 2.2.7 - II] Control panel designed by using Kinect gesture control.
- [MD - 2.2.8 - I] The material for the backend should be thermolytic or has cool down function.

## 2.3 User Interface/Software Requirements

- [MC - 2.3.1 - I] First page has two options: scan QR code and store promotions.
- [MC - 2.3.2 - I] Once scan the QR code, basic item information will be shown on the display.
- [MC - 2.3.3 - I] Shopping cart section is provided.
- [MC - 2.3.4 - I] The display will show greeting when the screen is activated.
- [MC - 2.3.5 - I] Allow customers to cancel or return the bill.

## 2.4 Physical Requirements

- [MA - 2.4.1 - II] The weight of *MagicMirror* should not exceed 40kg.
- [MA - 2.4.2 - I] *MagicMirror* should not exceed 170x85x15 (cm) in dimension.
- [MA - 2.4.3 - II] Using wood to build backend.
- [MA - 2.4.4 - I] The backend structure is customized by our design team

## 2.5 Standard

- [MA – 2.5.1 - II] All electronic devices meet the Canadian Standards Association (CSA) standards
- [MA – 2.5.2 - II] Sensor comply with the IEEE Standard FileSA-2700-2014 for Sensor Performance Parameter Definitions.[4].
- [MA – 2.5.3 - II] All electric components comply with the CSA Standard File Z463 for Maintenance of Workplace Electrical System.[5]
- [MA – 2.5.4 - II] Wooden Frame comply with the IEEE Standard File O86-09 Consolidation.[6]

## 3. Mechanical Requirement

The mechanical part includes a 27inch monitor as a display screen. A two-way mirror acts as a normal mirror but same time displaying the content of the monitor. A mini-computer as a center controller will be used to run web applications and to connect with the monitor. A Kinect will be used to simulate the mouse.

### 3.1 Two Way Mirror

- [MD - 3.1.1 - II] The height of two-way mirror should be 1 meter and width 500mm.
- [MD - 3.1.2 - III] The two-way mirror should cover the monitor and mini-computer.
- [MD - 3.1.3 - III] One side of two-way mirror should be brighter than another side.
- [MD - 3.1.4 - III] Mirror is fragile so will be stabilized by wooden frame.
- [MD - 3.1.5 - II] Two-way mirror is replaceable.

### 3.2 Distance Sensor

- [MD - 3.2.1 - III] Distance Sensor HC-SRO4 is operated under 5V DC voltage.



[MD - 3.2.2 - I] Distance Sensor is able to measure at least 4 meters.

[MD - 3.2.3 - I] Distance Sensor connects to Arduino GPIO port.

[MD - 3.2.2 - III] Distance Sensor is placed on the top of the mirror.

## 3.3 Monitor & PC

[MD - 3.3.1 - III] Monitor is operated under 110V AC voltage.

[MD - 3.3.2 - III] Monitor is connected with mini PC via HDMI cable to show the screen.

[MD - 3.3.3 - III] Monitor is turned on/off when receiving the signal from Arduino.

[MD - 3.3.4 - III] Monitor is directed connect to the wall plug.

[MD - 3.3.5 - III] Mini PC is powered under 110V.

[MD - 3.3.6 - III] Mini PC supports the configuration of Kinect (Real Time Sensor)

## 3.4 Arduino

[MD - 3.4.1 - I] The type of Arduino is Arduino UNO.

[MD - 3.4.1 - III] Arduino is operated under 5V DC

[MD - 3.4.2 - III] Arduino receives the measurement value sent back from distance sensor

[MD - 3.4.3 - II] Arduino sends the signal to turn on/off the monitor.

[MD - 3.4.4 - I] Arduino should be reprogrammable.

[MD - 3.4.5 - III] Arduino is protected within a wooden box.

[MD - 3.4.6 - III] Arduino is connected to the Switch unit of the monitor.

## 3.5 QR Code Scanner

[MD - 3.5.1 - III] QR Code Scanner is installed aside of the mirror.

[MD - 3.5.2 - II] Scanner is able to scan the code within 10cm.

[MD - 3.5.3 - II] Scanner will trigger the pop up of the designated website.

## 4. Hardware Requirement

- [MB - 4.1 - I] Arduino is programmed via a specific program-Arduino with C.
- [MB - 4.2- III] Whole circuit will be stored in a wooden box.
- [MB - 4.3- III] All the electronic parts can endure the tempura range from -10°C to 45°C.
- [MB - 4.4- III] All objects are replaceable and user-friendly.
- [MB - 4.5- III] The whole object should be stable and steady.

## 5. Software Requirement

The software part of the *MagicMirror* includes a web application which allows the customers to check the information of their items by screening the Bar Code and the RealSense camera application.

### 5.1 Web Application

- [MC - 5.1.1 - III] The users need to screen the bar code to get in the application.
- [MC - 5.1.2 - III] The application gives greeting to the users when it is activated
- [MC - 5.1.3 - II] The application allows the users to check the alternative color of selected item.
- [MC - 5.1.4 - II] The application allows the users to check the alternative size of the selected item.
- [MC - 5.1.5 - III] The application allows the users to check whether the alternative color/size is in stock or not.
- [MC - 5.1.6 - II] The application shows the users the current price of the selected item
- [MC - 5.1.7 - II] The application notifies the users if the selected item is on sales
- [MC - 5.1.8 - I] The application provides users a virtual shopping cart so that users

can put the items that they are willing to purchase into the shopping cart

[MC - 5.1.9 - I] The shopping cart section provides a QR that is used to check –out the items in shopping cart

[MC - 5.1.10 - III] The application returns to the greeting page when it is inactive for 40 seconds

[MC - 5.1.11 - III] The application allows users to cancel items in the shopping cart.

[MC - 5.1.12 - I] The application allows users to empty the shopping cart.

## 5.2 RealSense Controller Application

[MC - 5.2.1 - II] The RealSense controller allows the users to select the desired color of their items.

[MC - 5.2.2 - II] The RealSense controller allows the users to select the desired size of their items.

[MC - 5.2.3 - III] The RealSense controller allows the users to add items to their shopping cart.

[MC - 5.2.4 - III] The RealSense controller allows the users to click the purchase button to check items of their shopping cart.

[MC - 5.2.5 - III] The RealSense controller allows the users to click the empty button to clear the shopping cart.

## 6. System Test Plan

At *ShowMi Technology Inc.*, the *MagicMirror* will undergo a significant amount of testing procedures before it is put into use and finalized for product production to ensure it meets all the functional specifications suggested by the requirements. More specifically speaking, each part of the system will be tested separately first to ensure the meeting of the requirements. Then, the parts will be combined into the product where stress tests for



temperatures, sustainability and power consumption tests will be performed to make sure the product meets the international standards.

### **6.1 Temperature Test**

Inside the product, there is a mini-desktop which acts as the “brain” for the product will be placed inside sealed wooden box (with a door that can be opened for maintenance) generate most of the heat needed by the product. To test this problem, we will use a thermometer to measure the temperature inside the box for a duration of 3 days and take measurements along the way to ensure that the system can last through a long period of time.

### **6.2 Remote Control Test**

For the *MagicMirror*, Kinect2 gesture sensor will be used to detect the movements of operators’ hands and be able to represent the mouse. To test the accuracy and durability of Kinect2 and its ability to interact with the software, all possible gestures will be performed at least 10 times and the measurements of accuracy will be recorded to see the variance within the system.

### **6.3 Power Test**

Within the wooden box, there will be many items that need power in order for the product to function properly, therefore a power test is mandatory and vital to the success. To be more specific, the durability, range and safety for the power would be tested. Durability and range will be tested to see how long the product can last approximately, if no big issue the product should last for quite long since it will be plugged in to normal standard power outlet, however different voltages are needed for different components. As for the safety, measurements will be taken at different nodes of cables and connecting junctions to check the leaking of cables or potential drop in voltage.

### **6.4 Physical Test**

This product is combined together from 5 different parts, hence the stability of the system

as whole would be tested. These include being able to move the product from one place to another without having mirror shattered or disconnection between parts, as well as having the product being able to stand small amount of force before it breaks down.

## 7. Safety and Sustainability Analysis

The purpose of the *MagicMirror* is to improve the life quality and creates convenience for customers when they shop in a store. Since this device will interact with customers, hence extensive measures will be taken into consideration to ensure the safety of the device when it comes to operation. During our safety analysis, we will look extensively at electronic, mechanical and cosmetic components of the device to avoid risks that could potentially harm or damage customers or the operators:

- When it comes to picking electronic components, we know that the device will be in contact indirectly with the customers hence different components of the device will be checked before putting into operation to guarantee the sealing of electricity.
- As for the mechanical components, all wires and placement of the parts of the device will be considered in a way such that they are organized and easy to operate. Most important things would be the placement of the screen, the desktop and the connection between mirror and the wooden box. We will keep in mind that if these parts are not positioned will and stabilized, potential accidents such as shattering of glass could happen and would deal damage to the operator.
- For cosmetic component of the device, we will make sure that the mirror and the placement of Kinect can be easily accessed and that the design looks refreshing, because a good mood can reduce the happening of accidents.

At *ShowMi* Technology, the *MagicMirror* is designed based on C2C design concept, meaning that there is no waste of materials and that all of the materials we used for *MagicMirror* are environmental friendly and most parts are recyclable.

## 8. Conclusion

This documentation provides all the functional and safety requirements of a regular mirror functions as a self-shopping and check-out system. Our company, *ShowMi Technology Inc.*, believes that this *MagicMirror* could help people shopping more efficiently, meanwhile solve limited labor resource. Furthermore, the functional specifications documents in this paper ensures that the system is safe, efficient ad follows CSA standards and regulations. Moreover, the features might be added to this design if these functional/safety requirements are met ahead of completion date which is set for early April 2016.

## 9. References

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