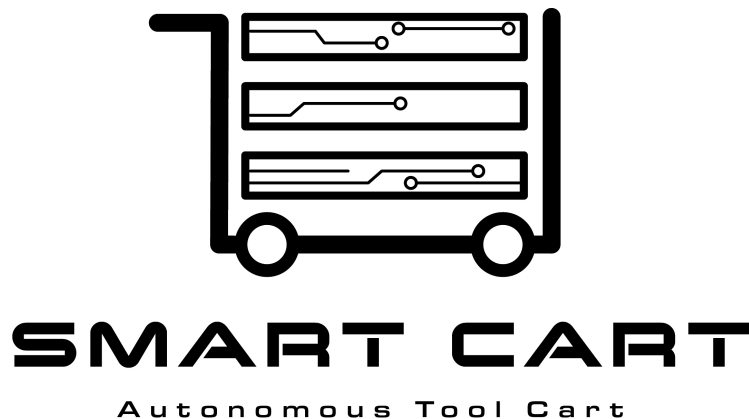


**DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING  
THE UNIVERSITY OF TEXAS AT ARLINGTON**

**SYSTEM REQUIREMENTS SPECIFICATION  
CSE 4316: SENIOR DESIGN I  
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**TEAM HAWT WHEELS  
SMART CART**

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## REVISION HISTORY

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# 1 PRODUCT CONCEPT

This section describes the purpose, use and intended user audience for the Smart Cart. The Smart Cart is an autonomous system that will help carry and power tools. Users of the Smart Cart will be able to use it to hold demonstrations outdoors.

## 1.1 PURPOSE AND USE

The Smart Cart will provide assistance by being an autonomous carrier. The cart needs to be able to do the following things:

- Follow a "master" to the designated destination
- Avoid collision with obstacles such as walls and other people
- Include an integrated power supply
- Holonomic mobility

## 1.2 INTENDED AUDIENCE

The intended audience of the Smart Cart is Dr. McMurrough. If this product were to be made available publicly or commercially, educators and others who are interested in an autonomous carrying robot may find the Smart Cart useful. The product is designed for Dr. McMurrough to use in the University of Texas at Arlington's outreach program. However, the use of the Smart Cart is not limited to just that. It can be for general use as well.

## **2 PRODUCT DESCRIPTION**

This section provides the reader with an overview of the Smart Cart. The primary operational aspects of the product, from the perspective of end users, maintainers and administrators, are defined here. The key features and functions found in the product, as well as critical user interactions and user interfaces are described in detail.

### **2.1 FEATURES & FUNCTIONS**

The main function of the Smart Cart is to help its user carry tools from one point to another. It will also have an integrated power supply to allow its user to charge or power his or her tools. A unique feature of the Smart Cart is that the cart will identify and follow its "master" by using the Intel RealSense. Another unique feature of the cart is its holonomic wheels. This allows the cart to easily maneuver and avoid collisions with objects by using image processing from a camera.

### **2.2 EXTERNAL INPUTS & OUTPUTS**

The Smart Cart will require external input from the user. The user must wear a colored band that is provided with the Smart Cart. This band is used by the cart for tracking its "master". External outputs produced by the cart will be messages to let its user know whether it has successfully identified its master. There are no other external inputs or outputs.

### **2.3 PRODUCT INTERFACES**

A simple user interface may be implemented for identification of master depending on the availability of time.

### **3 CUSTOMER REQUIREMENTS**

Customer requirements are those required features and functions specified for and by the intended audience for this product. This section establishes, clearly and concisely, the "look and feel" of the product, what each potential end-user should expect the product do. Each requirement specified in this section is associated with a specific customer need that will be satisfied. In general Customer Requirements are the directly observable features and functions of the product that will be encountered by its users. Requirements specified in this section are created with, and must not be changed without, specific agreement of the intended sponsor.

#### **3.1 FOLLOW MASTER**

##### **3.1.1 DESCRIPTION**

The Smart Cart shall use image recognition to identify its master and autonomously follow its master to the destination. The master shall be wearing the colored band provided. The colored band will be red to ensure that the Smart Cart can easily track the band.

##### **3.1.2 SOURCE**

CSE Senior Design project specifications

##### **3.1.3 CONSTRAINTS**

The band may be too small or big for some users to wear comfortably on their wrists.

##### **3.1.4 STANDARDS**

None

##### **3.1.5 PRIORITY**

Critical

#### **3.2 AVOID COLLISION**

##### **3.2.1 DESCRIPTION**

The Smart Cart shall be capable of recognizing objects in its path and avoid collision with them. The cart shall also avoid collision with walls.

##### **3.2.2 SOURCE**

CSE Senior Design project specifications

##### **3.2.3 CONSTRAINTS**

If the obstacle blocking the path of the Smart Cart is too large, the cart may lose track of its owner.

##### **3.2.4 STANDARDS**

None

##### **3.2.5 PRIORITY**

Critical

#### **3.3 HOLONOMIC MOVEMENT**

##### **3.3.1 DESCRIPTION**

The Smart Cart shall have the capability to move in any direction from any orientation. This allows the cart to easily move about and avoid collision with obstacles.

### **3.3.2 SOURCE**

CSE Senior Design project specifications

### **3.3.3 CONSTRAINTS**

The cost of holonomic wheels that can bear large loads may cause the project to go over budget.

### **3.3.4 STANDARDS**

None

### **3.3.5 PRIORITY**

Critical

## **3.4 INTEGRATED POWER SUPPLY**

### **3.4.1 DESCRIPTION**

The Smart Cart shall provide a power source to be used with electronic devices and other tools.

### **3.4.2 SOURCE**

CSE Senior Design project specifications

### **3.4.3 CONSTRAINTS**

The power provided by the integrated power supply may be insufficient if too many devices or tools are connected to it.

### **3.4.4 STANDARDS**

None

### **3.4.5 PRIORITY**

Critical

## **4 PACKAGING REQUIREMENTS**

Packaging requirements are requirements that identify how the Smart Cart will look when finished and delivered.

### **4.1 CABLES**

#### **4.1.1 DESCRIPTION**

The Smart Cart shall provide the necessary cables for charging the batteries.

#### **4.1.2 SOURCE**

Peggy Soh

#### **4.1.3 CONSTRAINTS**

The batteries may lose its capacity to hold a charge over time.

#### **4.1.4 STANDARDS**

US Voltage Standards

#### **4.1.5 PRIORITY**

Moderate

### **4.2 SOFTWARE**

#### **4.2.1 DESCRIPTION**

The Smart Cart shall have all necessary programs pre-installed and pre-loaded.

#### **4.2.2 SOURCE**

Or Zoarets

#### **4.2.3 CONSTRAINTS**

None

#### **4.2.4 STANDARDS**

None

#### **4.2.5 PRIORITY**

Low

### **4.3 MANUALS**

#### **4.3.1 DESCRIPTION**

The Smart Cart shall be delivered with instruction manuals and trouble shooting guides to properly explain how to operate the cart.

#### **4.3.2 SOURCE**

Peggy Soh

#### **4.3.3 CONSTRAINTS**

The manual will only be written in English.

#### **4.3.4 STANDARDS**

None



#### **4.3.5 PRIORITY**

Low

### **4.4 HARDWARE**

#### **4.4.1 DESCRIPTION**

The Smart Cart shall be delivered with all necessary hardware components mounted on the cart, no installation necessary.

#### **4.4.2 SOURCE**

Peggy Soh

#### **4.4.3 CONSTRAINTS**

The Smart Cart may be difficult to package for delivery for long distances.

#### **4.4.4 STANDARDS**

None

#### **4.4.5 PRIORITY**

Moderate

## **5 PERFORMANCE REQUIREMENTS**

Performance requirements address items such as: how fast critical operations must complete; how long the battery must last; time it must take to set up; etc. The requirements are necessary for the Smart Cart to perform for extended periods of time with a reasonable product life.

### **5.1 CALIBRATION OF MASTER**

#### **5.1.1 DESCRIPTION**

The Smart Cart shall be able to recognize its master in less than a minute.

#### **5.1.2 SOURCE**

David Harvey

#### **5.1.3 CONSTRAINTS**

None

#### **5.1.4 STANDARDS**

None

#### **5.1.5 PRIORITY**

Moderate

### **5.2 SPEED**

#### **5.2.1 DESCRIPTION**

The Smart Cart shall be able to follow its master at walking speed of 3 mph.

#### **5.2.2 SOURCE**

David Harvey

#### **5.2.3 CONSTRAINTS**

The user may walk too fast or too slow.

#### **5.2.4 STANDARDS**

None

#### **5.2.5 PRIORITY**

Moderate

### **5.3 BATTERY LIFE**

#### **5.3.1 DESCRIPTION**

The battery that powers the Smart Cart and the integrated power supply shall last at least 5 hours.

#### **5.3.2 SOURCE**

David Harvey

#### **5.3.3 CONSTRAINTS**

None

#### **5.3.4 STANDARDS**

None

#### **5.3.5 PRIORITY**

Moderate

### **5.4 MASTER TRACKING**

#### **5.4.1 DESCRIPTION**

The Smart Cart shall ignore any other person who is not the master. It shall only follow the master.

#### **5.4.2 SOURCE**

David Harvey

#### **5.4.3 CONSTRAINTS**

The Smart Cart may lose track of its master in a crowd.

#### **5.4.4 STANDARDS**

None

#### **5.4.5 PRIORITY**

Critical

### **5.5 DISTANCE OF MASTER**

#### **5.5.1 DESCRIPTION**

The Smart Cart shall be able to recognize and track its master up to 2 meters from the cart.

#### **5.5.2 SOURCE**

David Harvey

#### **5.5.3 CONSTRAINTS**

The master must not walk too fast.

#### **5.5.4 STANDARDS**

None

#### **5.5.5 PRIORITY**

High

### **5.6 PRODUCT USAGE ENVIRONMENT**

#### **5.6.1 DESCRIPTION**

The Smart Cart shall be able to operate indoors and outdoors.

#### **5.6.2 SOURCE**

Peggy Soh

#### **5.6.3 CONSTRAINTS**

Do not use outdoors when raining, snowing or other weather conditions.

#### **5.6.4 STANDARDS**

None

#### **5.6.5 PRIORITY**

High

## **6 SAFETY REQUIREMENTS**

Safety requirements address items specific to the Smart Cart such as: no exposure to toxic chemicals; lack of sharp edges that could harm a user; no breakable glass in the enclosure; no direct eye exposure to infrared/laser beams; packaging/grounding of electrical connections to avoid shock; etc. The Smart Cart will provide the necessary protection from its electrical components. If there is any overheating, short-circuiting or any other problems that occur during the operation of the cart, the user should stop using it immediately.

### **6.1 FUSE PROTECTION**

#### **6.1.1 DESCRIPTION**

The Smart Cart shall draw power from a fuse-protected power supply. The total current drawn from the electrical subsystem must not exceed 10A at 12V. An inline automotive 10A fuse will be wired between the positive power supply terminal and the voltage supply input of the electrical subsystem.

#### **6.1.2 SOURCE**

Dennis Otieno

#### **6.1.3 CONSTRAINTS**

None

#### **6.1.4 STANDARDS**

None

#### **6.1.5 PRIORITY**

Critical

### **6.2 ELECTRICAL PROTECTION**

#### **6.2.1 DESCRIPTION**

The Smart Cart shall have a casing on all electrical components. The casing will help protect the components from external elements and protect the user from any electrical problems.

#### **6.2.2 SOURCE**

Brian Wong

#### **6.2.3 CONSTRAINTS**

None

#### **6.2.4 STANDARDS**

None

#### **6.2.5 PRIORITY**

Moderate

### **6.3 KILL SWITCH**

#### **6.3.1 DESCRIPTION**

The Smart Cart shall have a kill switch. This will allow the user to stop the cart from operating if it were to malfunction.

### **6.3.2 SOURCE**

Brian Wong

### **6.3.3 CONSTRAINTS**

None

### **6.3.4 STANDARDS**

None

### **6.3.5 PRIORITY**

Critical

## **7 MAINTENANCE & SUPPORT REQUIREMENTS**

Maintenance and support requirements address items specific to the ongoing maintenance and support of the Smart Cart after delivery. It will specify items such as: where, how and who must be able to maintain the product to correct errors, hardware failures, etc.

### **7.1 SOURCE CODE**

#### **7.1.1 DESCRIPTION**

The source code for the Smart Cart shall be open-source. The source code and its documentation can be found at: [https://github.com/peggysoh/Senior\\_design](https://github.com/peggysoh/Senior_design)

#### **7.1.2 SOURCE**

Or Zoarets

#### **7.1.3 CONSTRAINTS**

None

#### **7.1.4 STANDARDS**

None

#### **7.1.5 PRIORITY**

Low

### **7.2 HARDWARE FAILURES**

#### **7.2.1 DESCRIPTION**

The user shall be responsible for any hardware failures. The user may refer to the instruction manual or trouble shooting guide provided.

#### **7.2.2 SOURCE**

Peggy Soh

#### **7.2.3 CONSTRAINTS**

The user may lack the necessary knowledge to identify and repair the hardware failures.

#### **7.2.4 STANDARDS**

None

#### **7.2.5 PRIORITY**

Low

### **7.3 ERROR CORRECTION**

#### **7.3.1 DESCRIPTION**

The user shall be responsible for any error correction that may be needed. The user may refer to the instruction manual or trouble shooting guide provided.

#### **7.3.2 SOURCE**

Peggy gSoh

#### **7.3.3 CONSTRAINTS**

The user may lack the necessary knowledge to identify and correct errors.

#### **7.3.4 STANDARDS**

None

#### **7.3.5 PRIORITY**

Low

## **8 OTHER REQUIREMENTS**

This section will specify anything else that is required for the Smart Cart to be deemed complete. It will include requirements related to customer setup and configuration if not specified in a previous requirement, any known requirements related to product architecture/design, such as modularity, extensibility (for future enhancements), or adaptation for a specific programming language.

### **8.1 OS PORTABILITY**

#### **8.1.1 DESCRIPTION**

The software shall be portable to other operating systems such as Linux, Windows and MacOS.

#### **8.1.2 SOURCE**

Or Zoarets

#### **8.1.3 CONSTRAINTS**

None

#### **8.1.4 STANDARDS**

None

#### **8.1.5 PRIORITY**

Low

### **8.2 COLORED BAND**

#### **8.2.1 DESCRIPTION**

The colored band shall be red and made of rubber. The user shall wear the colored band on his or her wrist. This will be used by the Smart Cart to identify its master.

#### **8.2.2 SOURCE**

Peggy Soh

#### **8.2.3 CONSTRAINTS**

The user may have a rubber allergy. The cart may lose track of its master if there are other people other than the user wearing a similar band.

#### **8.2.4 STANDARDS**

None

#### **8.2.5 PRIORITY**

Low



## 9 FUTURE ITEMS

This last section will reiterate all requirements that are listed as priority 5. This is repetitive, but necessary as a concise statement of features/functions that were considered/discussed and documented herein, but will NOT be addressed in the prototype version of the product due to constraints of budget, time, skills, technology, feasibility analysis, etc. However, there are currently no future items defined in this current version of the documentation. This section shall be updated to reflect any addition of future requirements.