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I. Introduction

Statement of Purpose:

As technology progressed, lives have been significantly improved due to the emergence of laborsaving and intelligent utilities. However, as we noticed, the shopping carts in major stores have experienced little changes and served only simple purposes ever since they were first manufactured. Pushing these carts around becomes noticeably painful when they carry heavy loads. Even though generally people are not moving fast in stores, there is a risk of collision if obstacles arise out of sight. Moreover, products can be extremely difficult to locate before people get familiar with the store layout. Considering all the disadvantages discussed above, we aim to implement a smart shopping cart that provides great convenience and efficiency to customers.

Objectives

Goals:
● Automatic customer tracing via communication between transceivers
● Avoid collisions with obstacles and detect accessible routes
● Optimize the path required to accommodate custom shopping list
● Alert system to warn customers on condition that carts fall behind

Benefits:
● Self-motion cart aiming to save human labor
● Optimal guiding system to reduce searching time
● Delicate user interface with multiple entering modes
● High-sensitivity sensors to minimize the possibility of collisions

Features:
● Sensors with minimum detection radius of 0.2 m
● Signal transmitters installed in store for precise navigation
● High CPU calculation speed for rapid moving decision
● Enclosed store map and product catalogs intended for searching function
II. Design

Block Diagram

Figure 1 Block diagram
Block Descriptions

Common components:

a. Power supply: Generally, five A23 12 V DC batteries serve as the power supply in this project. Due to the different operating voltages of various components, a 5 V voltage regulator and four 3.3 V voltage regulator will be used to provide appropriate operation environments to the entire circuit. This module is divided into three parts: the cart power supply provides power to two 12 V DC motors, a Arduino microcontroller, a wireless transceiver, a 12-button keypad with LCD screen and four ultrasonic distance sensors; the customer power supply powers a transceiver and an alarm; and the store power supply sustains two transceivers. Total current and power consumed is given by

\[
I_{\text{Arduino}} = 0.8 \text{ A} \\
I_{\text{ATmega328}} = 3.2 \text{ mA} \\
I_{\text{motor}} = 4 \text{ A} \\
I_{\text{transceiver}} = 17 \times 4 = 68 \text{ mA} \\
I_{\text{LED}} = 0.5 \text{ mA} \\
I_{\text{tot,max}} = 4.9 \text{ A} \\
P_{\text{tot,max}} = 58.5 \text{ W}
\]

b. Transceiver: For instantaneous position update of the customer, a GPS-like positioning system is embedded in the cart. Since commercial GPS may not provide enough precision, we will use four Bluetooth RF RS232 Transceivers to implement accurate navigation, which require 3.3 V DC voltages. Two of them are installed in store and attached to the ceiling for maximum coverage. They will receive signals from the transceivers carried by the cart and customer then reflect these signals back at a data rate at 1.2 kbps. By measuring the time delay compared to the original signals, the microcontroller, which collects information from the cart transceiver and customer transceiver, is able to determine the positions of the cart and customer in a coordinate system based on the signal travelling speed. Detailed calculation strategy is shown as below.
**Cart:** We will build a 25 × 30 cm² vehicle platform with two 12 V DC motors for the mechanical part of the project. The approximate weight of the finished cart is 2.5 kg.

a. **Motor:** Two GM9236S025 motors with reduction ratio 65.5:1 are installed in the platform to provide driving force for the shopping cart and directly controls its moving speed. The encoders that are included in the platform are going to encode instructions from the Arduino microcontroller to achieve desired cart speed and turning angle. There are three speed levels in this project: 1.5 m/s for rapid catch-up, 1.4 m/s for intermediate distances and 1.3 m/s for simply following mode.
b. Sensor: Four HC-SR04 ultrasonic distance sensors will be placed to each side of the cart to accomplish our obstacle-avoiding feature. They receive 5 V DC power supply from the 5 V voltage regulator. When any sensor detects an obstacle within its detection radius, it will trigger a voltage signal to the microcontroller in order to adjust the direction of the cart. HC-SR04 sensor covers a range from 2cm to 5m with 0.3cm resolution. Since we are only interested in specific distance intervals in determination of avoidance strategy, the voltage signals corresponding to 0.2 m and 0.5 m are recorded to serve as threshold values. More detailed information is presented in Figure 7.

c. Microcontroller: This is the most critical component in our design. An Arduino and an ATmega328 microcontroller are used to process all the data and calculations. The microcontroller is responsible for determination of the shopping cart’s speed and direction when tracing the customer and avoiding obstacles via feedbacks from transceivers and sensors, respectively. It will also generate routes from the current position to places where desired goods are located. To implement this function, we need to enclose the store layout and catalog information within the microcontroller. The Arduino is powered up by 5 V DC voltages, which comes out of the 5 V voltage regulator, and collects all signals from sensors, transceivers and the user interface.

d. User Interface: We aim to provide a convenient and multi-functional user interface, which includes three main subcomponents. A push button on/off switch will be used to enable/disable the user interface. A 16 × 2 LCD screen shield and a 12-button keypad are presented to the customer to enter goods they wish to purchase and display the shopping list for their record. All products are classified into ten general categories so that customers may narrow down the ranges for easier search. Each of the categories is represented by a numerical button. Customers can choose between two modes of navigation: item-by-item entry mode that leads customers to the product immediately after they finish entering the item, or the multiple-item mode that determines the most efficient route covering all items entered. A flow chart that demonstrates the logic determination process is included in Figure 8.
Customer: In our design, the customer will carry a transceiver attached with an alarm system. The transceiver will frequently send signals to the microcontroller to track the position of customer. An alarm will be triggered to remind the customer when the cart falls more than 2 m behind.

a. Alarm: We will connect a red LED light to the transceiver carried by the customer. Once the distance between the cart and customer exceeds 2 m, the transceiver receives a signal from the microcontroller to light the LED. 1.8V-2.2V DC voltages will be applied to the LED in this case.

Store: In order to implement the navigation system of the cart, we need to include the store layout and how products are located into the microcontroller. So a store map is designed as follows.

![Figure 3 Store layout](image)

Figure 3 Store layout
Schematics

Figure 4 Schematic for microcontroller, sensors, cart transceiver and keypad
Figure 5 Schematic for LCD screen and motors
Figure 6 Schematic for customer and store transceivers
Flow Charts

1. **Shopping cart Power on**
2. **Locate current cart’s position**
3. **Locate current customer’s position**
4. **Send customer’s position to the cart; Store the distance between them into d; Determine the angle of turning, \( \theta \)**
5. **d > 0.5?**
   - Yes: Speed (v) = 1.5 m/s
   - No: **d > 0.2?**
     - Yes: Speed (v) = 1.3 m/s
     - No: **d > 0.2?**
       - Yes: **Continue moving until next check**
       - No: **Obstacle detected within 0.5 m?**
         - Yes: **Exit Tracing System**
         - No: **Obstacle detected within 0.2 m?**
           - Yes: **Stop temporarily**
           - No: **Obstacle detected within 0.2 m?**
             - Yes: **Stop temporarily**
             - No: **Obstacle detected within 0.5 m?**
               - Yes: **Stop temporarily**
               - No: **Turn left or right by 15° based on obstacle’s position**

**Figure 7 Tracing system flow chart**
Find the nearest item in the list

Go to the next item from current position

n = n – 1;
Remove that item from list

n = 0?

Yes

Locate items from memory;
Store the total number of items into n

Finish entering all items?

Yes

No

Locate current position

Receive user input from keypad

Display items on LCD

1 ≤ n ≤ 6?

Yes

No

Calculate the lengths of all possible routes;
Determine the shortest path;
Rearrange the item list

Go to the next item from current position

n = n – 1;
Remove that item from list

n = 0?

Yes

No

All items found;
Exit Navigation System

Figure 8 Navigation system flow chart
### III. Requirements and Verification

**Requirements & Verification**

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Supply:</strong></td>
<td>1. Connect the probes of a multimeter to the ends of each battery to measure the output voltage. The multimeter should read 12 ± 1 V.</td>
</tr>
<tr>
<td>1. Output voltage of A23 batteries should be 12 ± 1 V in order to provide steady power supply to motors.</td>
<td>2. After wiring the 5 V voltage regulator to an A23 battery, measure the output voltage with a multimeter. Expected value is 5 ± 0.5 V. Connect a 3.5 ohms resistor as load, measure the current through the load to test if the regulator can sustain a 1.5 A current.</td>
</tr>
<tr>
<td>2. 5 V voltage regulator (connected to Arduino and sensors) should output voltage of 5 ± 0.3 V with maximum current 1.5 A.</td>
<td>3. Connect the 3.3 V voltage regulator to an A23 battery, use a multimeter to measure the terminal voltage of the regulator. Make sure the voltage falls in the 2.2 – 3.8 V range. Use a 200 ohms resistor as load and test if the regulator functions properly with 17 ± 2 mA current.</td>
</tr>
<tr>
<td>3. 3.3 V voltage regulator should supply 2.2 – 3.8 V to transceivers while current maintained within 17 ± 2 mA.</td>
<td>4. Connect the potentiometer to the SDO pin of a transceiver and adjust the resistor value. Use a multimeter to measure its output voltage when SDO is set to high. The multimeter should read 1.8 – 2.2 V.</td>
</tr>
<tr>
<td>4. Output voltage of the 1K Ohm potentiometer needs to be restricted within 1.8 – 2.2 V, which provides the working current of the LED.</td>
<td>1. Place two transceivers 10 m apart and make one serves as receiver and the</td>
</tr>
<tr>
<td><strong>Transceiver:</strong></td>
<td></td>
</tr>
<tr>
<td>1. Transceivers should cover an effective</td>
<td></td>
</tr>
</tbody>
</table>


range of $10 \pm 0.5 \text{ m}$ with no more than 5% distortion.

2. Working at 433 MHz band, receiver bandwidth is fixed at $67 \pm 5 \text{ kHz}$, while transmitter frequency deviates from the carrier frequency at $45 \pm 3 \text{ kHz}$.

3. Data rate should be maintained at $1.2 \pm 0.2 \text{ kbps}$.

Other as transmitter. Use two oscilloscopes to monitor the waveforms sent and received by the transceivers, respectively. The received signal should differ from the origin one by less than 5%.

2. Set all transceivers and a spectrum analyzer to operate at 433 MHz. The analyzer is expected to receive the signal at frequency within $\pm 36 \text{ kHz}$ after one transceiver sends a signal at 433 MHz. Then retrieve the signals received by other transceivers using the microcontroller to check if they deviate from 433 MHz by $45 \pm 3 \text{ kHz}$.

3. Under transmitter operation, measure the interval between signals sent by a transceiver using an oscilloscope. Desired interval should be $0.71 - 1 \text{ ms}$.

**Motor:**

1. The cart should move at $1.5 \pm 0.1 \text{ m/s}$, $1.4 \pm 0.1 \text{ m/s}$ and $1.3 \pm 0.05 \text{ m/s}$ for the three speed levels.

2. Percentage error of the actual turning angle of the front ball wheel cannot exceed 10%.

1. For each of the three levels, let the cart move for 5 s in open area. Measure the distance that the cart goes by a metric ruler and divide the result by 5. The expected results should be $1.5 \pm 0.1 \text{ m}$, $1.4 \pm 0.1 \text{ m}$ and $1.3 \pm 0.05 \text{ m}$, respectively.

   If test fails:

   Use a stroboscope to measure the rotation speed of the motor. The stroboscope should read $1 \pm 0.02 \text{ Hz}$ for $1.5 \text{ m/s}$ level, $0.93 \pm 0.02 \text{ Hz}$ for $1.4 \text{ m/s}$ level.
and 0.87±0.02 Hz for 1.3 m/s.

2. Mark the start position of the cart and set the turning angle from 0 to 90° with 5° increment each time. Let the cart move for 5 s in open area. Measure the angle between the cart’s path and the direction it originally faced by a protractor. The calculated error percentage should be less than 10%.

**Sensor:**

1. Under 5 V DC voltages, sensor will operate at a current of 15 ± 2 mA.
2. Sensor should be able to detect objects 0.5 ± 0.05 m and 0.2 ± 0.02 m away and differentiate these two distances by triggering voltage signals of different magnitudes.
3. Working frequency of the sensor should be 40 ± 4 Hz to provide updated information of obstacles.

1. Apply 5 V DC voltages to each sensor, measure the passing current by a multimeter. The multimeter should read 15 ± 2 mA.
2. Place an object at 0.5 ± 0.05 m in front of a sensor and measure the voltage response using an oscilloscope. Repeat the same process after moving the object to 0.2 ± 0.02 m. The sensor is expected to trigger steady voltages in both cases, as long as the distance is constant. Furthermore, the former voltage should be smaller than the latter one by more than 0.2 V. These two voltages will be recorded as threshold values.
3. Set the rotation frequency of a rotor with only one tooth to 36 – 44 Hz and fix the sensor at any point that could detect the tooth. Use an oscilloscope to monitor the output voltage of the sensor. If the voltage signal is steady
Microcontroller:

1. Microcontroller needs to calculate the positions of the cart and customer based on information collected from transceivers, and output speed and turning angle of the cart. The calculated positions should not deviate from the real positions by more than 5 cm.

2. If an obstacle is detected within 0.2 m in front or the left, the microcontroller should modify the turning angle by 15° to the right until all obstacles are cleared; if something is found in the right, increase the angle to the left by 15°.

3. Microcontroller should be able to determine which button is pressed on the keypad and correctly reflected that information on the LCD screen.

4. If the number of items entered is less than 6, the microcontroller should determine the optimal solution in 3 s; if the number is between 7 and 10, the processing time is restricted in 5 s.

5. When the distance between the cart and customer exceeds 2 m, the microcontroller will send a ‘high’ signal through cart’s transceiver to

| and constant, the sensor frequency is the same as the rotor, which means the specification is satisfied. |
| 1. Pick arbitrary positions for the cart and customer and record their coordinates. Export the positions determined by the microcontroller to a computer and check if they are within 5 cm of the real locations. Distances are measured based on geometric centers. |
| 2. Place an object at a distance of less than 0.2 m from the cart in each of the three sides. Check if the microcontroller makes correct turning instructions by exporting data to a computer. If test fails: Measure the output voltage of the corresponding pins by a multimeter, which should read ±(0.83±0.05) V. Positive voltages indicate right-turning and negative voltages are for left-turning. |
| 3. Press each button on the keypad and write Arduino codes to test if the microcontroller correctly decodes which button is pressed. Display the corresponding product names stored in the microcontroller on LCD. Make sure they match the names assigned to each button. If test fails: |
customer’s transceiver, which provides voltage to light the red LED. Measure the voltage of the pins connected to the LCD by a multimeter. They should be properly turned on and off according to the programming codes of Arduino, which display correct product names.

4. Test the case of n = 6 and n = 10. Trace the ‘ready’ signal of Arduino using an oscilloscope. Time delay should be within 3 s and 5 s, respectively.

5. Set the distance between the cart and customer to be larger than 2 m. Measure the output voltage of the corresponding pin of Arduino and check if it is set to high.

<table>
<thead>
<tr>
<th>User Interface:</th>
<th>Alarm:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. LCD display needs be refreshed in 0.5 s after a new item is entered by keypad. And the information displayed should be the same as what the microcontroller outputs.</td>
<td>1. The red LED is expected to light when the distance between the cart and customer exceeds 2 m.</td>
</tr>
<tr>
<td>2. All output pins of the keypad should produce correct low/high signals in order to properly reflex which button is pressed.</td>
<td>1. Set the distance between the cart and customer to be larger than 2 m. Measure the output voltage of the potentiometer that is connected to the</td>
</tr>
</tbody>
</table>

1. Connect the LCD display to the microcontroller. Use an oscilloscope to measure the time delay for the LCD to output a high signal after one button is pressed on the keypad. That time interval needs to be less than 0.5 s.

2. For each button on the keypad, connect the corresponding two pins that should be set to high if that button is pressed to a multimeter. If both of them are ‘on’ and the remaining five are ‘off”, the keypad is working properly.
customer transceiver. The expected value is 1.8 – 2.2 V.

**Tolerance Analysis**

In this project, the microcontroller processes a larger amount of information than any other part of the cart and it communicates with all the rest components. Consequently, the microcontroller critically affects the performance of the entire project. A minor mistake in calculating the cart’s speed and direction may result in significant inefficiency when trying to avoid an obstacle. And the cart fails to perform functionally if the microcontroller is not able to figure out the best route in GPS mode. Therefore, the moving decisions of the microcontroller demands great accuracy and its connections with the transceiver, sensors and motors should be fast and reliable. The cart is expected to turn from 0 to 180 degrees both clockwise and counterclockwise and have a speed to sweep from 0 to 1.5 m/s. The turning angle is especially important so its tolerance is within ±10%. Additionally, the store layout and product locations need to be properly stored in the microcontroller.

**IV. Cost and Schedule**

**Labor Cost**

<table>
<thead>
<tr>
<th>Member</th>
<th>$/hour</th>
<th>Hours/week</th>
<th>Total hours</th>
<th>Subtotal</th>
<th>Subtotal * 2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ying He</td>
<td>40</td>
<td>12</td>
<td>144</td>
<td>5760</td>
<td>14400</td>
</tr>
<tr>
<td>Di Fan</td>
<td>40</td>
<td>12</td>
<td>144</td>
<td>5760</td>
<td>14400</td>
</tr>
<tr>
<td>Xuyang Yao</td>
<td>40</td>
<td>12</td>
<td>144</td>
<td>5760</td>
<td>14400</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>43200</strong></td>
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</tr>
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# Parts Cost

<table>
<thead>
<tr>
<th>Name</th>
<th>Part Number</th>
<th>Unit Price</th>
<th>Quantity</th>
<th>Total Price</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Supply</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 V DC Battery</td>
<td>Energizer A23</td>
<td>$1.15</td>
<td>5</td>
<td>$5.75</td>
</tr>
<tr>
<td>Voltage Regulator 5V</td>
<td>COM-00107</td>
<td>$1.25</td>
<td>1</td>
<td>$1.25</td>
</tr>
<tr>
<td>Battery Storage Clip Holder</td>
<td>YS320925515181</td>
<td>$0.996</td>
<td>5</td>
<td>$4.98</td>
</tr>
<tr>
<td><strong>Microcontroller</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Arduino Uno</td>
<td>DEV-1102</td>
<td>$29.95</td>
<td>1</td>
<td>$29.95</td>
</tr>
<tr>
<td>Atmega328</td>
<td>DEV-10524</td>
<td>$5.50</td>
<td>1</td>
<td>$5.50</td>
</tr>
<tr>
<td>Voltage Regulator 3.3V</td>
<td>COM-00526</td>
<td>$1.95</td>
<td>4</td>
<td>$7.80</td>
</tr>
<tr>
<td><strong>User Interface</strong></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Keypad 12-button</td>
<td>COM-08653</td>
<td>$3.95</td>
<td>1</td>
<td>$3.95</td>
</tr>
<tr>
<td>LCD Keypad Shield</td>
<td>SainSmart 1602</td>
<td>$9.99</td>
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<td>$9.99</td>
</tr>
<tr>
<td>Push Button Switch</td>
<td>COM-09177</td>
<td>$0.99</td>
<td>2</td>
<td>$1.98</td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td></td>
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<td></td>
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<tr>
<td>12V DC Gearmotor/Encoders</td>
<td>GM9236S025</td>
<td>$37.95</td>
<td>2</td>
<td>$75.90</td>
</tr>
<tr>
<td><strong>Transceiver</strong></td>
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</tr>
<tr>
<td>RFM12B-S2 Wireless Transceiver</td>
<td>WRL-09582</td>
<td>$6.95</td>
<td>4</td>
<td>$27.80</td>
</tr>
<tr>
<td>Red LED</td>
<td>COM-09590</td>
<td>$0.35</td>
<td>2</td>
<td>$0.70</td>
</tr>
<tr>
<td>1K Ohm Potentiometer</td>
<td>023-510</td>
<td>$1.79</td>
<td>1</td>
<td>$1.79</td>
</tr>
<tr>
<td><strong>Sensor</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultrasonic Distance Sensor</td>
<td>HC-SR04</td>
<td>$5.59</td>
<td>4</td>
<td>$22.36</td>
</tr>
<tr>
<td><strong>Miscellaneous</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistors, capacitors, inductors, transistors, wires, PCB and etc.</td>
<td></td>
<td></td>
<td>20</td>
<td>$15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td>$214.70</td>
</tr>
</tbody>
</table>

Grand Total = $43200 + $214.7 = $43414.7
# Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Tasks</th>
<th>Assigned to</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2/4/13</td>
<td>Finish primary proposal and mock DR sign-up</td>
<td>Ying He</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Order vehicle frame, install motors</td>
<td>Di Fan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assemble the vehicle</td>
<td>Xuyang Yao</td>
</tr>
<tr>
<td>2</td>
<td>2/11/13</td>
<td>Learn Arduino software and design store map</td>
<td>Di Fan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Learn Arduino software, install receiver and sensors to the vehicle</td>
<td>Xuyang Yao</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Record the map into the memory of the controller</td>
<td>Ying He</td>
</tr>
<tr>
<td>3</td>
<td>2/18/13</td>
<td>Finish the customer tracking unit</td>
<td>Xuyang Yao</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prepare for the Design Review: requirement and verification &amp; flow chart</td>
<td>Di Fan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prepare for the Design Review: block description &amp; schematics</td>
<td>Ying He</td>
</tr>
<tr>
<td>4</td>
<td>2/25/13</td>
<td>Finish the detection &amp; decision unit for stationary obstacles</td>
<td>Di Fan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Order the rest parts we need to use</td>
<td>Xuyang Yao</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test the parts we order</td>
<td>Ying He</td>
</tr>
<tr>
<td>5</td>
<td>3/4/13</td>
<td>Detection &amp; decision unit algorithm &amp; write individual progress report</td>
<td>Ying He</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assemble detection &amp; decision unit parts &amp; write individual progress report</td>
<td>Di Fan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Debug detection &amp; decision parts algorithm &amp; write individual progress report</td>
<td>Xuyang Yao</td>
</tr>
<tr>
<td>6</td>
<td>3/11/13</td>
<td>Design the position system</td>
<td>Ying He</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Create circuit board and order PCB</td>
<td>Di Fan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LCD display and store catalog</td>
<td>Xuyang Yao</td>
</tr>
<tr>
<td>7</td>
<td>3/18/13</td>
<td>Spring Break</td>
<td></td>
</tr>
</tbody>
</table>
8  3/25/13  Set up user interface  Ying He
       Design one-by-one searching scheme  Di Fan
       Check and test LCD screen & keypad  Xuyang Yao
9  4/1/13  Design multiple-item searching scheme  Ying He
       Finish the most-efficient-path determination unit  Di Fan
       Debug algorithm and test all components before assemble  Xuyang Yao
10 4/8/13  Assemble all components  Ying He
       Finish attach components to PCB  Di Fan
       Debug and test  Xuyang Yao
11 4/15/13  Prepare for demo and presentation & write final report  Ying He
12 4/22/13  Demo and presentation  Di Fan
13 4/29/13  Final paper and lab notebook due  Xuyang Yao
       Check out

V. Ethical Considerations and Safety

Ethical Considerations

Our project aims to build a shopping cart that provides great convenience and efficiency to customers in store. Thus, we need to address several items in the IEEE Code of Ethics.

<table>
<thead>
<tr>
<th>IEEE Code of Ethics</th>
<th>Our concerns</th>
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</thead>
<tbody>
<tr>
<td>1. to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;</td>
<td>We need to ensure that the future use of our project in stores will not contain any potential danger.</td>
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<td>2. to avoid real or perceived conflicts of</td>
<td>Our interest of shopping cart project has no</td>
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</table>
interest whenever possible, and to disclose them to affected parties when they do exist; conflict with any other existing object by research.

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<td>3. to be honest and realistic in stating claims or estimates based on available data;</td>
<td>We will be honest and realistic with TA and Instructor while giving explanation and presentation of our project.</td>
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<td>4. to reject bribery in all its forms;</td>
<td>Bribery should not be a problem in the project.</td>
<td></td>
</tr>
<tr>
<td>5. to improve the understanding of technology; it’s appropriate application, and potential consequences;</td>
<td>We will learn and improve our understanding of any project related knowledge.</td>
<td></td>
</tr>
<tr>
<td>6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;</td>
<td>We will try our best to make the project perfect by using the knowledge we have obtained by far.</td>
<td></td>
</tr>
<tr>
<td>7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;</td>
<td>We promise to guarantee that all the technical works are honest, and will admit the error if there is any. We will not take credits from other people’s work.</td>
<td></td>
</tr>
<tr>
<td>8. to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin;</td>
<td>We will treat all people fairly regardless of their race, religion, gender, disability, age, or national origin.</td>
<td></td>
</tr>
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</table>

**Safety**

In this project, safety issues are emphasized by restricting the maximum cart moving speed to be 1.5 m/s, which is slightly higher than average walking speed. Additionally, the obstacles-avoidance feature eliminates all potential collisions between carts and human or among carts. Ultimately, our design aims to provide safe and enjoyable shopping experience to customers.
VI. References


2. “Pittman Express – GM9236S025 Datasheet”.


4. “RFM12B-S2 Wireless Transceiver Datasheet”.

5. “Tutorial testando o transceptor RFM12B-S2 Wireless Transceiver com Arduino”