The Smart Cart – An Enhanced Shopping Experience

Kartik Sanghi

Rohan Singh

Nikhil Raman

TA: Justine Fortier

Date: 02/05/2012

Team 41

Contents

Motivation

The motivation for this project is to replace the existing shopping experience with a new and revolutionary technology by including the new device on every cart. This device would allow the user to keep track of the total cost as and when items are added to the cart. The device will further include functionality that will allow the shoppers to make their payments on the go using a credit card using the integrated payment terminal. In the case of any ambiguity, the shopper will also have the option of going up to the checkout counters. This new system would reduce the long wait times at the checkout counters, increase the efficiency of the checkout procedure, and would provide the shopper with up to date cost and total information which makes the whole experience more convenient.

Objectives

The goal of this project is to design a system which reads the barcode on each item that is placed in the cart and updates the product information which is available to the shopper. Pressure/Weight sensors will be used to detect the presence of new items in the cart.
The barcode scanner extracts the barcode which is transmitted to the microcontroller through an USB connection. The microcontroller then extracts all the necessary information about the product like product name and product price. This data is then formatted and presented to the user for review and confirmation.

New items in the cart will be detected by tracking the change in the output of pressure sensors. The same sensors will be used to detect when items are removed from the cart. A program will be implemented to confirm the removal from the shopper's shopping cart. Another program will be implemented to work as an anti-theft mechanism to prevent the shopper from leaving without a successful payment.

Benefits

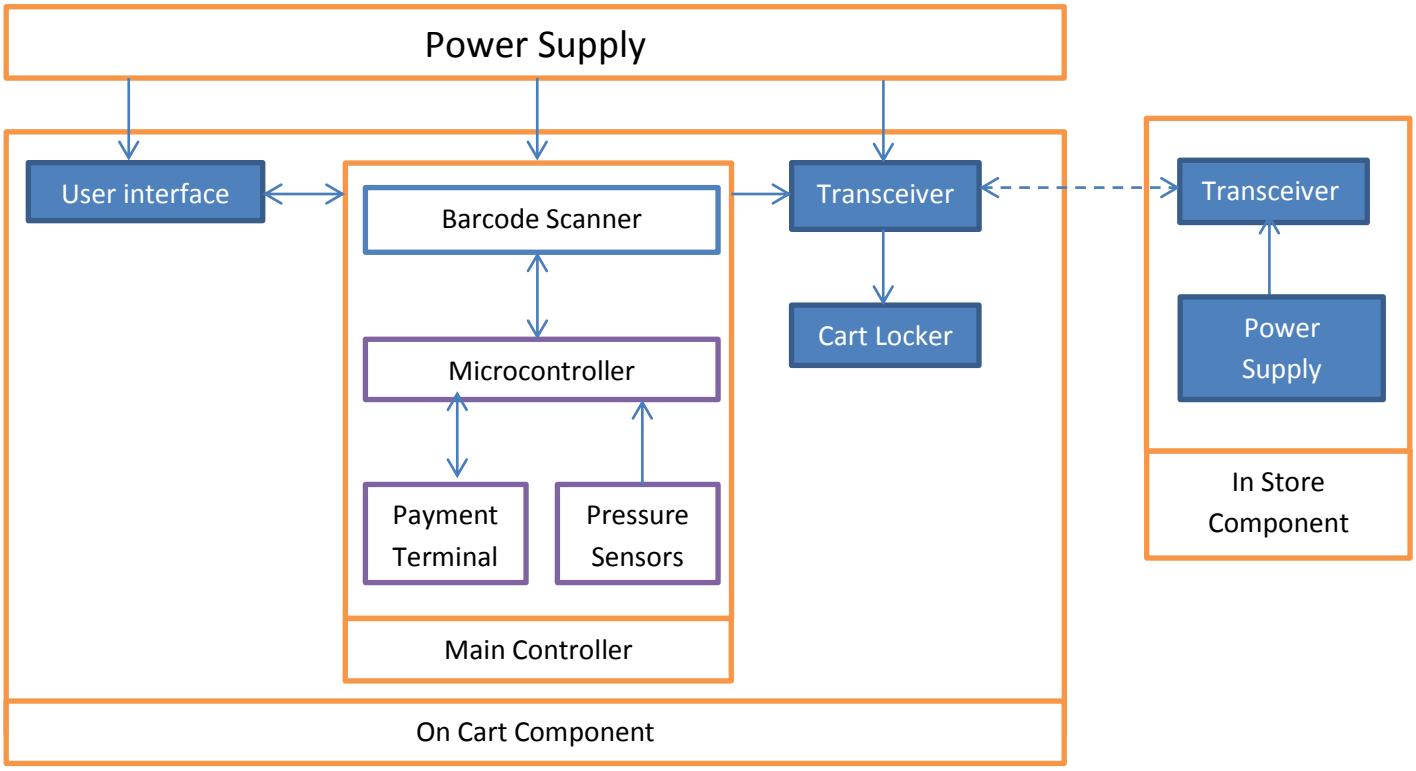
- Improve the shopping experience for all the patrons of the store
- Increase efficiency of the checkout process
- Eliminate long waiting queues at the checkout counter

Features

- User interface with LCD monitor to provide immediate feedback to user inputs
- Automated shopping item detection
- Automated self-pay option using integrated payment terminal
- Automated data formatting and organization for use by the shopper
- Self-locking functionality to prevent theft (for use in the case of non-payment for items in cart)

Design

Block Diagram



Block Descriptions

1. **User interface:**
   This block consists of the LCD screen included for the purpose of providing the user feedback to inputs. This block will be controlled by the main controller.
2. **Main controller:**
   This block consists of the barcode scanner and the microcontroller being used for data processing. The barcode scanner transmits the barcode data to the microcontroller which looks up the details on the store database and presents this data after formatting to the user through the user interface.
   The microcontroller also receives feedback from the user interface block about successful reception and also data when items are removed from the cart.
   This block also includes the payment terminal and pressure sensors. The pressure sensors also send feedback to the microcontroller.
3. **Transceivers:**
   These blocks are present as part of the anti-theft mechanism. The transmitter on the cart receives signals from the microcontroller based on the data available from the payment terminal. The transmitter only transmits when the payment is not successfully processed. The in-store transceiver receives this signal when it is in range and transmits a signal to the receiver on the cart which then signals the locking mechanism (a program we will be defining on our own) to activate.

4. **Cart locker:**
   This block locks the cart wheels when it is signaled to do so by the receiver. This is a simple braking mechanism.

Performance Requirements:

- Barcode detection with 0% error
- Perfect detection of placement and removal of items i.e. 100% success rate for pressure sensor
- Error-free look up of items using barcode data
- LCD screen output to match what is available at the traditional checkout counters
- System battery life of a minimum of 5 days in order to require recharging on only a weekly basis
- 100% credit card processing rate
- Transceiver range of 25 feet
- Memory requirement of 15MB to store all products' barcode data
- No errors in self locking mechanism

Verification

Testing Procedure:

1. The most important performance metric for the device is the time required between battery recharges. It is therefore essential that the power supply meet the requirements. The device will be tested under standard use conditions (4 Hours active, 20 Hours standby) before any other tests. If the performance requirements are met, the rest of the device can be tested. However, if the requirements are not met, it is imperative that the design be optimized.
2. The barcode scanner is another core component of the device. It is absolutely necessary that the data read from the barcode scanner is transmitted error-free to the microcontroller. It is also critical that this data be correctly correlated to the products in the store product data base. A supplemental but equally important requirement is that this data be displayed correctly to the customer on the LCD screen. Therefore, the data being transmitted through to the microcontroller needs to be verified, the product correlation needs to be verified and finally the LCD display needs to be verified.
3. The pressure sensors will also need to be tested. They can be checked by measuring the voltage change that they generate when the weight (pressure) on them changes.
4. It is also essential that all the programs written on the microcontroller are working satisfactorily. These programs include the credit card data processor, and the self-locking functionality. These can be tested using standard software debugging techniques.
5. The cart locking functionality also needs to be tested. It needs to be verified that the signal being transmitted from the cart is successfully received by the transceiver present at the store exits and that the signals from those transceivers are successfully received at the cart.

Tolerance Analysis

The single most critical component of the device is the battery (power supply). In order for this device to be successfully deployed storewide, it is critical that the time between charges for the battery be maximized i.e. battery life needs to be optimized. The store management would ideally like the device to be functional over multiple degrees of use per day. Unfortunately, the more the device is used, the greater the drain will be on the battery's power.

Thus, we will need to test various use cases involving different periods of active use of the device and track how our battery power depletes. This will involve increasing the active use of the device and monitoring remaining battery charge. Ideally, the cart should be available for multiple uses between charges in order to save store management the hassle of frequent recharging.

Cost and Schedule

Cost Analysis:

Labor

Employee Name	Hourly Rate	Estimated No. of Hours	Total = Rate*Hours*2.5
Rohan Singh	$40	160	$16,000
Kartik Sanghi	$40	160	$16,000
Nikhil Raman	$40	160	$16,000

Parts

Part	No. of Units	Supplier	Cost Per Unit	Total Cost
Pressure Sensors	1	Analog Devices AD7192	$6.00	$6.00
Barcode Scanner	1	Amazon.com	$21.55	$21.55
Microcontroller	1	TI CC430F5137 (Digi-key)	$6.75	$6.75
Transceiver	2	Lynx (Available in Lab)	$13	$26
LCD Screen	1	Sparkfun	$14.95	$14.95

Total Cost = Labor + Parts = 48000 + 75.25 = $48,075.25

Schedule

Week	Kartik Sanghi	Rohan Singh	Nikhil Raman
1/23	Brainstorm project ideas	Brainstorm project ideas	Brainstorm project ideas
1/30	Research possible design solutions	Research possible design solutions	Research possible design solutions
2/6	Write Proposal (Testing and verification)	Write Proposal (Cost and Scheduling)	Write proposal (Design and objectives)
2/13	Acquire parts	Come up with design flowcharts	Draw up circuit schematics
2/20 (All work towards design review)	Test parts and update requirements and tolerance analysis	Perform necessary simulations and required calculations	Update block diagram and design considerations
2/27	Design power supply for each component	Design in-store transceiver circuit	Design on-cart transceiver circuit
3/5	Build and test power supply	Build and test in-store transceiver	Build and test on-cart transceiver
3/12	Interface microcontroller with power supply	Interface microcontroller with barcode reader	Interface microcontroller with RF circuitry
3/12	Connect with Wal-mart and improve design specs		
3/19	Spring Break Chilling in Mexico	Spring Break Chilling in Mexico	Spring Break Chilling in Mexico
3/26	Interface microcontroller with LCD monitor	Interface microcontroller with weight sensor	Interface microcontroller with credit card reader
4/2	Test LCD interface	Test sensor interface	Test scanner interface
4/9	Integrate product database with device memory	Design casing for extremities	Design cart-locking mechanism
4/16	Integrate and test microcontroller	Integrate and test sensors and barcode scanner	Integrate and test cart locking mechanism and RF Circuitry
4/23	Write final report (Testing and verification)	Write final report (Cost, measurements and future scope)	Write final report (Design)
4/30	Demo and graduate!!		