Zipcart

Team 26: Ryan Lagasse, Ricardo Henriquez, Jonathan Azevedo
Motivation
Universal Product Codes (UPCs)

- Unique, twelve-digit numbers that identify items
- Barcodes are machine-readable

<table>
<thead>
<tr>
<th>Digits</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 6</td>
<td>Manufacturer ID</td>
</tr>
<tr>
<td>7 – 11</td>
<td>Item ID</td>
</tr>
<tr>
<td>12</td>
<td>Check Digit</td>
</tr>
</tbody>
</table>
Reading UPCs with Computer Vision
Challenges

- Read moving barcodes at unpredictable angles
- Operate at the embedded scale
- Done in a way that comes natural to shoppers
Requirements

1. Recognize barcode as item is placed in cart
2. Detect when item is removed from cart
3. Display item list and current balance
4. Detect an unscanned item to prevent theft
5. Sustain power for a full business day
Specifications

1. 18 hours of continuous operation

2. One item entered/removed per two-second interval

3. Barcode surface must be reasonably flat

4. Maximum system latency: four seconds
Competitors
Design Alternatives

- Barcode Scanner
- Multiple Cameras
- Dedicated Display Terminal
Our Approach

- Single camera mounted to cart
  - Mirrors used see around product
- Cloud services
  - Intermediary between system and application
- Android smartphone application
  - Display item list and current balance
Block Diagram

Optics System
- Mirror
- Camera

Feedback System
- LED Strip

Detection System
- Microprocessor

Power Supply
- DC Motor
- Regulator
- Li-ion Battery

Smartphone
- Application
- Payment

Cloud Database
- Product DB/Cache
- Item Register

Barcode API

VDD

Feed
Signal
UPC
Block Diagram

**Optics System**
- Mirror
- Camera

**Feedback System**
- LED Strip

**Power Supply**
- DC Motor
- Regulator
- Li-ion Battery

**Detection System**
- Microprocessor

**Smartphone**
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- Payment

**Cloud Database**
- Product DB/Cache
- Item Register

**Barcode API**

[Diagrams showing signal flow and connections between components like Block Diagram, Power Supply, Smartphone, and Cloud Database]
Optics System

Cart, Top-Down Perspective

Front

Left

Front

Right

Back
Detection System

Optics System
- Mirror
- Camera

Optics System
- LED Strip

Power Supply
- DC Motor
- Regulator
- Li-ion Battery

Detection System
- Microprocessor

Smartphone
- Application
- Payment

Cloud Database
- Product DB/Cache
- Item Register

Barcode API

Image
- Signal

UPC
- VDD
Detection System

- Computer Vision algorithm
- Read UPCs from barcodes
- Network interface
- Send UPC, action to cloud
- Small, embedded platform
Feedback System

Optics System
- Mirror
- Camera

Detection System
- Microprocessor

Feedback System
- LED Strip

Power Supply
- DC Motor
- Regulator Circuit
- Li-ion Battery

Smartphone
- Application
- Payment

Cloud Database
- Product DB/Cache
- Item Register

Barcode API

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• Intent is to differentiate a good scan from a bad one
• LED strip along inner edge of cart
• Green = good scan
• Red = bad scan
Power Supply

Optics System
- Mirror
- Camera

Detection System
- Microprocessor

Feedback System
- LED Strip

Power Supply
- DC Motor
- Regulator Circuit
- Li-ion Battery

Cloud Database
- Product DB/Cache
- Item Register

Barcode API

Smartphone
- Application
- Payment
• Self-sufficient to avoid charging

• DC Motor to generate power mechanically

• Brushed DC Motors typically 75-80% efficient

• Regulator circuit to produce constant and stabilized voltage
Cloud Platform

Optics System
- Mirror
- Camera

Detection System
- Microprocessor

Feedback System
- LED Strip

Power Supply
- DC Motor
- Regulator Circuit
- Li-ion Battery

Smartphone
- Application
- Payment

Cloud Database
- Product DB/Cache
- Item Register

Barcode API

UPC

Data

Call

VDD

Feed

Signal
Cloud Platform

- Track orders with database
- Manage product information
  - Request from UPC API
  - Cache results in local database
GET api.barcodelookup.com/{}...
HTTP/1.1
Response:
UPC: 073149169396
Product: Sterilite File Crate
Price: 5.97 USD
User Interface

• Display item register, balance

• Enables a path to payment implementation
  • i.e. Samsung Pay, Venmo
Schedule of Work

10/1
- Benchside #1
  - Detection
  - Install OpenCV
  - Barcode Detection (Still Photo)
  - Barcode Detection (Video Feed)
  - UPC Recognition
  - UPC Lookup
  - Add Items to Cart Balance
  - Remove Items from Cart Balance
  - Detect Missed Items

10/8
- Power
- Planning
- DC Motor
- Regulator Circuit
- Booster Circuit
- Battery Protection Circuit
- Li-ion Battery
- PDR

10/15
- Benchside #2
- MDR
- Thanksgiving Break

10/22
- Feedback System Integration
- Order Tracking
- Theft Detection

10/29
- App Interface, Android
- Website
- Shopping Cart
- Install LEDs
- Mount Camera
- Install Mirrors
- Calibration

11/5
- 11/12
- 11/19
- 11/26
- 12/3
- 12/10
- 12/17
- 12/24
Bill of Materials

- Raspberry Pi
- Camera
- Intel Movidius Visual Compute Stick
- Android Phone
- Shopping Cart
- Mirrors
- DC Motor(s)
- VRUZEND Battery Kit
- Li-ion Battery Cells
- PCB
- RGB LED Strip
MDR Deliverables

- Detect barcode around 180° of camera perspective
- Successful integration of feedback system
- Update cloud database with product information
- Show power generation using DC Motor
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