**XFM Vending Machine**

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C458 Project Proposal

April 25, 2017

### Abstract

This project designs and implements a robotic system that acts as a bar waiter. We use a robotic arm mounted on a mobile robot to bring consumables to customers who are sitting at the bar counter. The robot decides the delivery of consumables based on a color-coded card that each customer presents to the robot. We accomplish a robot control software architecture utilizing Arduino controlled sensors and effectors. Our project demonstrates how a familiar task, such as tending bar, can be handled by a low cost intelligent robot.

### Introduction

Attending customers at a counter is a repetitive task. First, the waiter/waitress must ask the customer if they desire a consumable. Then, the waiter must retrieve the consumable from where it is stored. Once the consumable is retrieved, the waiter makes a pass over the length of the counter, giving customers the order they desired. One notable model for attending customers can be found at Brazeiros in Louisville, Kentucky.

At Brazeiros, customers are given a color-coded coaster, with one side being red and other side being green. Based on the color of the coaster the customer shows, the customer may or may not be continually served freshly prepared meat. Our project proposes to take the repetitive task of attending customers at a counter and make that task the responsibility of an intelligent robot rather than a human.

The idea is a human will load the robot with a special “magazine” containing consumables (such as mint patties). Customers will each have a double-sided card with a certain color (e.g. red) on one side and a different color (e.g. green) on the other side. Similar to how other restaurants such as Brazeiros operate, one color will indicate the customer wants an order and the other color will indicate the customer is content and does not desire an order.

The robot will make cycles through the counter, ignoring unoccupied spaces and customers who use the color-coded card to indicate they don’t desire an order. The robot’s goal will be to deliver items only to customers who desire an order as quickly as possible via the attached arm.

# System Details

### Environment

The environment will consist solely of the counter, which will be simulated with a long and thin table. There will be a line for the robot to follow and there will be cards for the customers to mark their order and red cards to mark the ends of the path where the robot will reverse direction.

The storage and loading area is on the robot’s deck. There we will manually load a plastic storage magazine, which will contain up to eight mint patties.

The bot travel area is the space on the counter where the bot moves. The space stretches from one end of the counter to the other end. The bot will move forward from the far end of the counter following a predetermined, taped path. As the bot follows the path it reads the green color cards the customers have laid on the counter alongside the tape. Once the bot reaches a red card it traverses back over the taped path, dropping off mint patties in the appropriate places. We also used blue cards to serve as false orders which the robot was intended to ignore.

The customer area is the area closer to the edge of the counter where customers will display their color-coded card to the bot, and where the bot will also place the customer’s order. Due to the scope and time constraints of this project a static number of six customers was chosen.

### Sensors

The sensors needed for the bot to perform the aforementioned tasks are: one IR reflectance sensor and a Red Green Blue (RGB) color sensor.

The Infrared (IR) reflectance sensor is for 1) allowing the bot to follow the taped navigation path and 2) for notifying the bot when it has reached the loading area (where the tape would end).

The color sensor is used to notify the bot what color card the customer is displaying, thus notifying the bot if it needs to give the customer a consumable on the return trip.

### Performance Matrices

Two primary performance metrics we intend to use in this project are: the number of orders the bot is supposed to fulfill (based upon the number of green colored cards displayed by customers), and the time the bot takes in fulfilling those orders.

For the first metric, a count will be taken on the number of green colored cards displayed on a run, which can then be compared with the number of consumables the bot handed out. For the second metric, a timer will be implemented externally via a physical timer, which will track the time taken to make a delivery run.

### System Functionalities

* Bot will move forward along the counter, following taped path using the line follower sensor
* Bot will recognize and register colored cards using the RGB sensor
* Bot will move back along the counter, following the taped path
* Arm will grab and hold on to a consumable
* Arm will unload a consumable onto the order card

### Related Research

Our approach was to define the problem first, then design the robot. As the problem was refined, we also needed to alter the design. Some designs solving a similar problem include Zexuan, et al (2015), and Casavela (2012). Our design intends to combine movement of a wheeled base with the delivery capabilities of an arm into an autonomous delivery system for small solid objects.

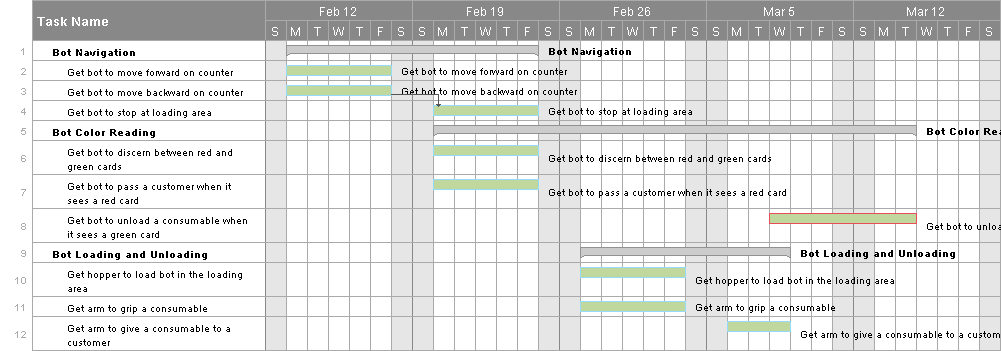
We decided to use a color coding system for ordering based on observations of the system in use at Brazeiros. Their system uses a green card to start service and a red card to stop service. (Brazeiros 2017)

Path planning is a difficult obstacle to overcome for autonomous robots. Zexuan, et al, (2015) shows an example the procedures needed to plan transportation along a set path. Our project plans to use a combination of physical aids and programming to overcome obstacles in the path. We intend to use a fixed and relatively small path traversed in two directions.

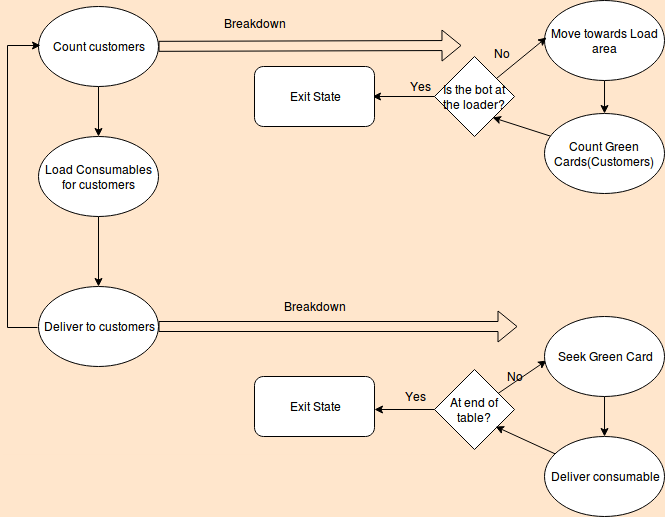
Ju (2016) explains a strategy for manipulating small round objects using positive air pressure. In this project they found that having a more flexible solution added efficiency and gave unexpected side benefits. We were unable to add a similar system, but were able to make a flexible platform which could be extended with this technology.

Casavela (2012) explains the challenges he overcame in using C++ to program an Arduino. We were able to draw many lessons to design the necessary programs to drive our systems. Casavela’s paper also gave several insights on how to engineer robotic systems and properly interface them.

### Timeline (Feb 12 – Mar 12)



### State Transition Diagram



### Division of Labor

**Version Control Manager** – Branden Wagner

**Bot Navigation** – Michael Roark

**Bot Color Reading** – Joseph Olin

**Bot Loading and Unloading** – Branden Wagner and Michael Roark

**Presentation Preparer** – Joseph Olin and Branden Wagner

### References

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