ALFRED

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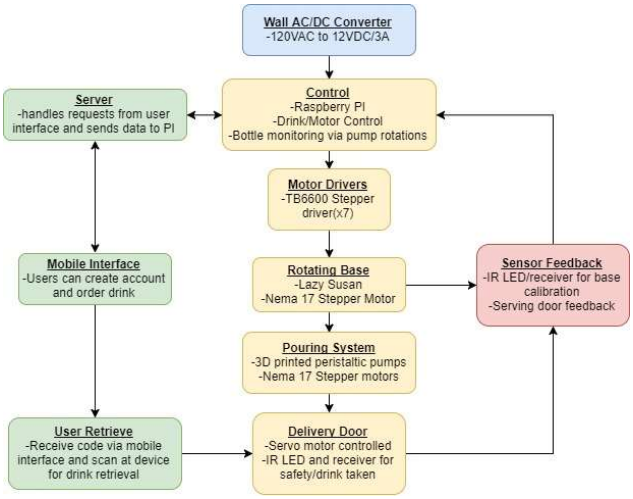
Abstract

College towns and major cities are often filled with overpopulated bars. Alfred helps alleviate congestion while also expediting the process of buying a drink by allowing customers to order a drink through their mobile device. When a drink is ordered by the customer, that drink choice is sent to a controller, which then rotates a base holding 8 cups. The correct cup is rotated to a certain position where a drink is dispensed with the correct proportions, and then rotated again to the dispensing door. The customer will receive a personal, four-digit identification code that he/she/they will be able to enter at Alfred, and the dispensing door will vend their drink to the customer. Alfred will pause its execution until the drink is removed by the customer, then continue its execution.

Block Diagram



System Overview

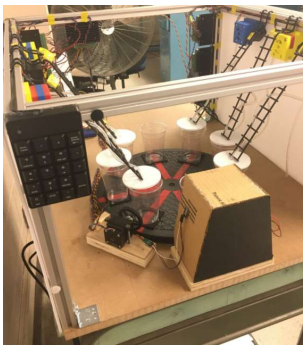
A Raspberry Pi is the brains behind Alfred, controlling all of the functionality behind it. A user orders a drink through a website, and Alfred does the rest. Seven stepper motors and one servo motor in total is used in Alfred. Six stepper motors control the six dispensing pumps, and the seventh controls the rotating base. The servo motor controls the serving door. A laser + photoresistor duo are used in the serving door and as a base calibrator. When the laser beam is refracted, the system knows a cup is still in the doorway. Once the cup is removed, the beam hits the photoresistor again, indicating that it is safe to close the door. When a small piece of rubber interferes with the base-calibrating laser + photoresistor, Alfred knows that the rotating base is perfectly aligned in the center with the serving door.

Specifications

Requirement	Specification
Pour a mixed drink	Correct proportions and completed in under 2 minutes
Multiple drink options	Bartender can insert choice of alcohol (750mL) and mixers into dispensers. Choice of 4 different drinks
Minimizes spilling	Spills less than 5% of drink, splash guards implemented
Online ordering	User orders through mobile website
Drink served to correct customer	Serving door only opens when 4-digit code is presented
Simultaneous pouring of liquids	15.9” rotating base with 8 cups and 6 pumps
Failsafe: detects positioning of base and cups	Sensors to make sure cup is removed before closing the serving door. Sensor also used to align base

Results

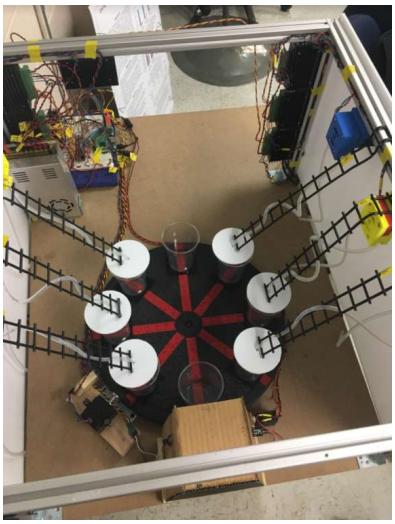
- **The average drink takes:**
  - **14 seconds to pour alcohol**
  - **29 seconds to pour mixer**
  - **4 seconds to serve**
- **Spillage is less than 1%**
- **Process threads allow for simultaneous pouring**
- **Clients can interact with the Pi-based bartender via the internet**
- **Text with ID code is sent through Twilio**
  - **Door only opens when the specific code is received**



Acknowledgement

Special thanks to our advisor Professor Andras Moritz and our evaluators Professor William Leonard and Professor Guangyu Xu. Also thanks to Professor Christopher Hollot, Professor Baird Soules, and Francis Caron.

Bird's Eye View



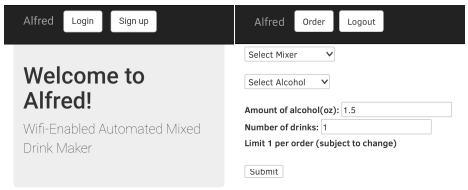
Pumps

This subsystem of Alfred is responsible for the liquid distribution. The main design goals of this system are speed, accuracy, and affordability. In order to meet these goals we used an open source 3D model of a peristaltic pump, that is driven by a Nema 17 stepper motor. By doing so, we were able to utilize the unique properties of these types of pumps, without paying the high market cost for them. These allow for high precision liquid distribution, without having liquid touch any mechanical or electrical components. Because these motors use a significant amount of power, they each require a motor driver. The drivers chosen for these motors was the TB6600. These drivers allow for variable microstepping if needed, but we found that the normal 200 step per rotation of the motors themselves was sufficient.

Cost

Part	Development Cost	Production Cost (1000)
PCB	$2.71	$0.70
Nema 17 Stepper Motors + Drivers	$149.94	$101.64
Silicon tubing	$29.97	$5.01
Ball bearings	$18.04	$4.99
USB Keypad	$8.99	$2.68
Power Supply	$17.99	$11.99
Lazy Susan Base	$17.95	$4.95
Raspberry Pi Kit	$57.91	N/A
Broadcom chip	N/A	$25.97
Total	$303.50	$157.93

Mobile Interface



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Server and Client

We utilized Amazon Web Services to help facilitate communication between our clients and system controls. The server implemented a Django framework to serve webpages and store vital information in the database. A Redis queue served as the communication link between the server and Raspberry Pi, allowing for scalability if a customer desired to use multiple Alfred machines in their bar. The circular nature of the rotating base inspired the use of modular arithmetic to form a mathematical ring to control the movement of the cups, allowing us to find the shortest path between two cup positions. In addition, multiple process threads were used in conjunction with state machines to allow for simultaneous pouring of drinks and listening for customer communication.

Serving Door

- **Door movement is controlled by a servo motor**
- **Personal ID Code is inputted to the number pad**
- **Door opens around the cup, allowing the user to retrieve it without exposing the other client's orders**