Washington University in St.Louis

Dispensing Robotic Integrated Natant Kinematic System

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Abstract

In this project we focus on building an autonomous system for dispensing beverages. We use LabVIEW algorithms to send messages to an Arduino microcontroller, which actuates dispensing circuitry. Circuitry controls solenoid valves that allow desired liquids to pour. Compressed carbon dioxide is used to regulate flow for high accuracy. The system is capable of mixing a number of preprogrammed drinks using ingredients from its four-bottle mounted rack. In addition, the chassis and system are custom designed for this project. Our prototype and analysis demonstrates the feasibility of this product for commercial and individual use.

Project Objectives

Drink Accuracy

An integral component to producing an effective drink mixer is ensuring the accuracy of the quantities poured by the device, meaning that measurements are in the desired amounts and pours are repeatable. This serves a competitive advantage for the DRINKS automated bartender over a traditional one, because the amount of beverage dispensed is controlled. According to Nightspot Consulting, bartenders typically over pour in the range of 0.25-0.75 ounces per drink, resulting in a significant financial loss fir an establishment between wasted liquor and loss of future revenue. Drink accuracy is also vital from a liability perspective – if the system over pours, it could be potentially dangerous for users.

Ease of Use

The DRINKS bartender is designed to be extremely easy for the end-user to operate. In a casual setting, this frees up user's time while his drink is poured and mixed automatically. In a high-volume setting, such as a bar, the efficiency of the system will allow operators to quickly dispense a number of drinks which results in increased customer satisfaction, lower personnel needs, and consistency. The interface is designed such that drink recipes can be entered easily, and then an operator only needs to select a drink – all other details are taken care of.

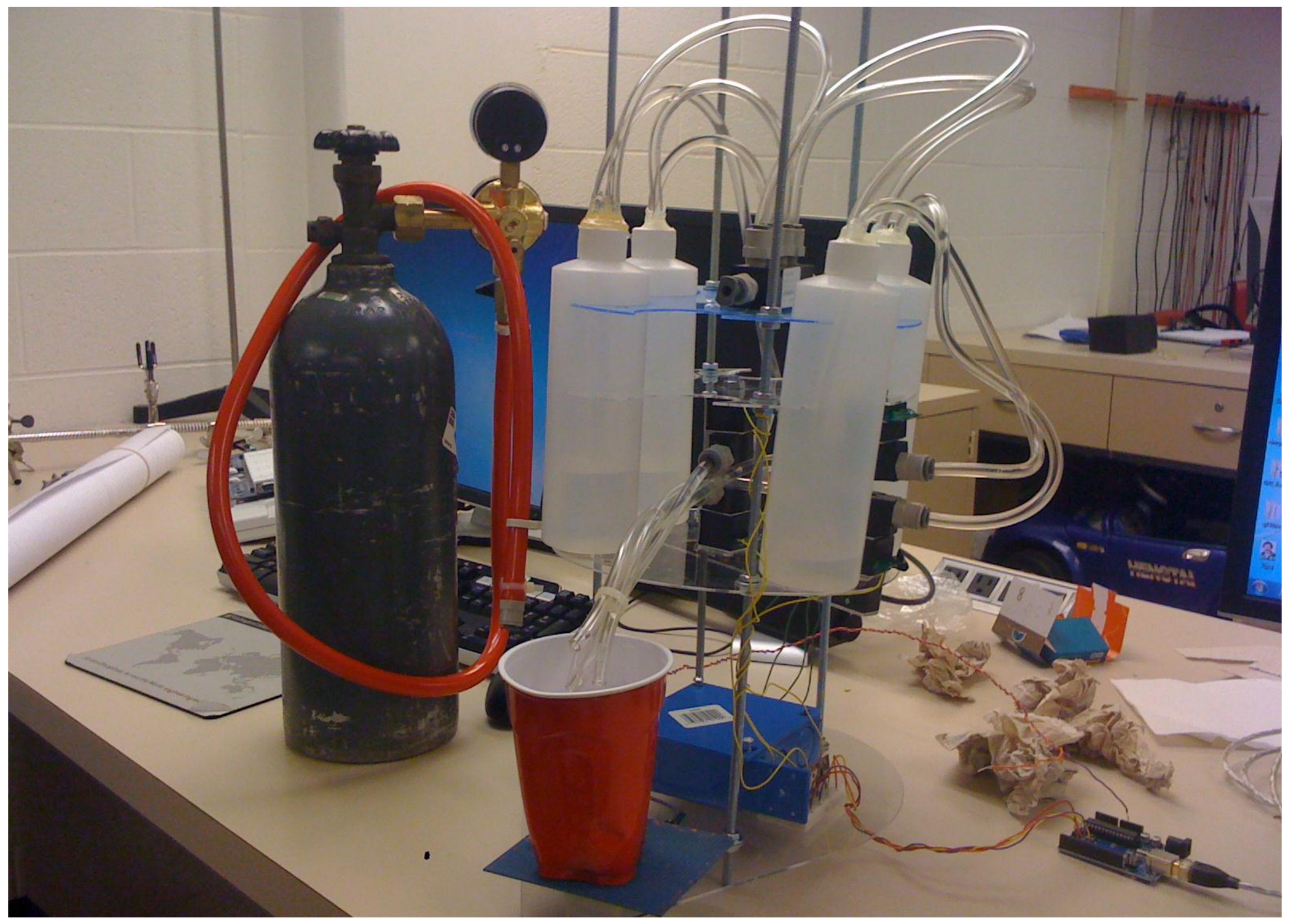
Cost Minimization

A significant advantage of the product is that it can be mass produced at a reasonable cost (see 'Bill of Materials'). In a commercial setting, the DRINKS bartender should easily pay for itself quickly due to the many aforementioned cost-saving benefits it would provide. Furthermore, the system is not prohibitively expensive for an individual user looking to bring more sophistication to his libations.

Health and Safety

All parts of the DRINKS bartender to which the liquid is exposed, including Tygon plastic tubing and Alcon solenoid valves, are FDA-approved to hold liquids (NSF 61 certification). From a health perspective, the automated system helps users to regulate their drinking portions and attain consistency in consumption. Wire leads and circuitry are safely covered and housed away from the dispensing platform.

Mixing Algorithm and Control Process



Pouring Process

(1) Determine amounts needed from each bottle given chosen drink

(2) Initialize communications with Arduino, setup digital outputs

(3) Pour specified amount of first ingredient into drinking glass

- (a) Set Arduino output for specified bottle to 5V
- (b) Arduino pin opens MOSFET between power supply and solenoid
- (c) Solenoid opens, allowing pressure from regulator to push liquid through tubing and solenoid into drinking glass
- (d) Set Arduino pin to low voltage after desired volume poured

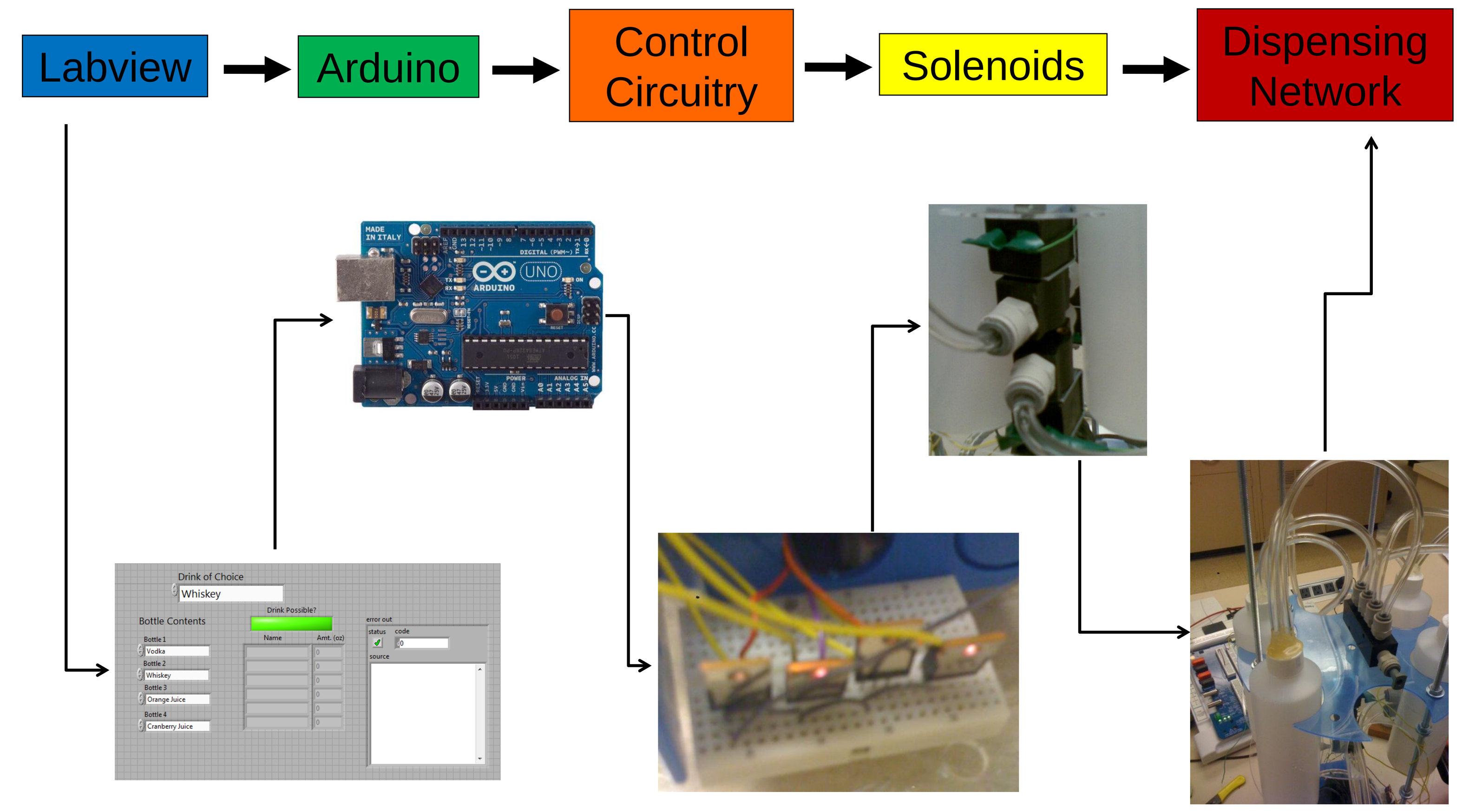
(4) Repeat step 3 for each additional ingredient

(5) Close active communications with Arduino

Mass Production Cost Analysis and Bill of Parts

		Cost	
Part	**Quantity**	**Prototype**	**Bulk**
Air Tank / Compressor	1	$40.00	$40.00
Solenoids	4	$25.00	$16.00
Arduino	1	$22.00	$14.00
Regulator	1	$20.00	$15.00
Pressure Manifold	1	$12.00	$7.50
Cut Metal	1	$10.00	$4.00
Casing	1	$5.00	$1.00
Nuts (x20)	2	$3.00	$1.80
Threaded Connectors	14	$1.80	$0.80
Threaded Rods	4	$1.47	$2.40
IRF640 MOSFET (x4)	4	$1.27	$0.68
Washers (x20)	2	$1.00	$0.60
Plastic Tubing (ft)	16	$0.97	$0.80
Bottles	4	$0.89	$0.67
Connector Plugs	2	$0.10	$0.05
Total		**$272.44**	**$165.40**

System Overview of Drink Mixer



Design Considerations and Planned Modifications

Applied Pressure vs. Gravity

We chose to use pressure to dispense liquids as opposed to gravity based on several advantages of pressure-based systems. One advantage of pressure systems is the ability to dispense carbonated beverages – carbonated liquids in gravity fed systems would build up pressure when not dispensing, and may create leaks or shoot liquids too quickly when opened. Pressure systems also allow the system to dispense liquids at a constant, fine-tunable rate via adjustment of the pressure regulator.

Mass Sensing Equipment

Our mass sensing equipment consists of a variable force resistor mounted under the drink platform. Combined with circuitry that maps the range of the force resistor to the Arduino input range, this equipment was designed to give us more accuracy in our pour volumes. Unfortunately, this equipment proved to be fairly unreliable – in a revised design, we would consider using more precise load cell equipment.

Circuit Design

We chose to use very simple circuitry – we did not find a need for additional electronic circuitry to perform the tasks we set out to accomplish.

Arduino Microcontroller

The Arduino Microcontroller is an ideal choice as a DAC and digital output because of its low cost and easy integration into LabVIEW and other engineering platforms. The current system is highly configurable given easy reprogramability of the Arduino or LabVIEW software.

Usability

One of the most important features of this system is its ease of use. We designed the system to have upright bottles with enough extra tubing slack to easily remove bottles from their positions and refill them.

Safety

We chose our tubing and solenoid valves to be FDA approved for holding potable water. In addition, our system is easy to clean and promotes safe beverage dispensing.