Project Title: Arduino Vending Machine



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1. Device Functionality

Our project is modeled after a conventional vending machine, the difference being we used an NFC card reader as our method of transaction. Using a card, we modeled "currency" in order to "buy" snacks. First, in order to know the cost of each snack, the buyer must push the buttons corresponding to the snack. This is labeled using different colors. Then from there, the buyer can scan the special card which the NFC reader will read and display the buyer's balance. If the buyer has enough balance he/she can choose the snack they want and the machine will dispense it. If the card does not have enough money, then the LCD screen will display not enough balance and will not dispense an item. The act of dispensing occurs by the button commanding the specific servo, where the snack is, to turn the coils which will push the snack forward until it falls. This will successfully occur only when there is enough balance in the card. Finally, in order to actually add currency, we used a chip which can also be scanned on the NFC which will add a balance.

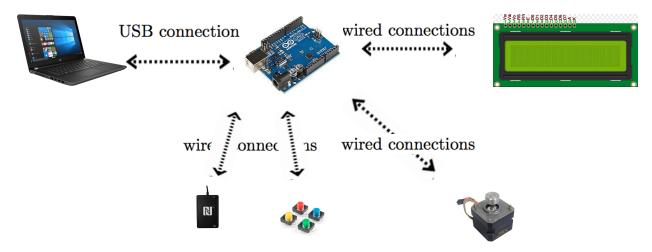


Figure 1: Outside of the Vending Machine (Instead of a coin acceptor, we will use a NFC key reader)

2. Hardware Components

- NFC Card/Chip reader [Source: Amazon(\$12)]
- 4 Arduino Push Buttons [Source: Amazon(\$7)]
- 4 Arduino Continuous Servo Motors [Source: Amazon(\$32)]
- LCD Screen Display
- Acrylic Screen [Source: Home Depot (\$10)]
- Arduino Uno
- Aluminum Wire[Source: Home Depot(\$4)]
- Cardboard[Source: Home Depot(\$2)]

- Foam Board[Source: UCSB Bookstore(\$2)]
- 12V Battery Pack [Source: ECE Shop(\$8)]

3. Design Timeline

<u>Week 5:</u> During this lab session we had already acquired the components we needed, so we were playing around with them and testing that they worked. At this point we got the servos to respond to the buttons.

<u>Week 6:</u> During this lab session we were able to build the circuits for the LCD, buttons, and servos. We started to cut and build the cardboard into the vending machine, but not fully. We were able to get some programming so the LCD, buttons, and servos worked together.

<u>Week 7:</u> We got the NCF to work during this session when the card would be tapped. From here we were able to program all of the various components we had with the NFC. This meant we had to scan the card before we could press the button to rotate the servo motors.

<u>Week 8:</u> Since we had most of the programming figured out we focused more on the hardware by soldering the button onto a perfboard as well as making the coils needed. We then glued these coils onto the servos.

<u>Week 9:</u> We started to get the vending machine close to completely built by adding the foam board as well as getting all the servos situated and finishing up on the soldering. Minor changes were made to programming such as displaying prices and instructions before buying.

<u>Week 10:</u> We fully assembled the box by placing the Acrylic screen, making cuts for the LCD, buttons, and the NFC. We also got the placement of the arduino situated so that it could stay inside. We also figured out how we would be able to access the inside once the vending machine was complete. We also tested different snacks to make sure the machine dispensed. Finally we treated ourselves as customers and made sure everything went smoothly when trying the vending machine.

4. Software Design

```
#include <LiquidCrystal.h>
#include <Servo.h>
#include direct.h
#include direct.h
#include Admirect.h
#include -Admirect.h
#include -Ad
                                                                                                                                                                                                                                                                                                                                                                        // Several Libraries
       const int rs = 13, en = 12, d4 = 11, d5 = 10, d6 = 9, d7 = 8;
iquidCrystal lcd(rs, en, d4, d5, d6, d7);
har = Text = "Scan Card Now.";
nt iLineNumber = 0;
nt iCursor = 0;
 int cardid = 0;
                                                                                                                                                                                                                                                                                                                                                                        // Variable for NFC Tag
                                                                                                                                                                                                                                                                                                                                                                          // Card Balance ($)
// Prices for Blue Button
// Prices for Green Button
// Prices for Yellow Button
// Prices for Red Button
 unsigned long time_now = 0;
   void setup()
                                                                                                                                                                                                                                                                                                                                                                        // Setups the Buttons
           lcd.begin(16,2);
                                                                                                                                                                                                                                                                                                                                                                        // Intializes the LCD Screen
           #ifndef ESP8266
  while (!Serial);
#endif
                                                                                                                                                                                                                                                                                                                                                                          // Intializes the NFC Reader
           nfc.begin();
uint32_t versiondata = nfc.getFirmwareVersion();
nfc.SAMConfig();
           if(millis() > time_now +
    time_now = millis()
                                                                                                                                                                                                                                                                                                                                                                            // Updates the LCD screen every 0.5 second, until other actions
```

```
lcd.setCursor(0,1);
lcd.print("s");
lcd.print(Blueprice);
delay(2000);
UpdateLCDDisplay();
lcd.clear();
                                                                                                                                                                    // Intializes the position of LCD
// Displays "$" on LCD
// Displays price for Blue
        }
if (readA1!=0)
                                                                                                                                                                    // If Green Button pressed
                                                                                                                                                                   // Clears the LCD Screen
// Intializes the position of LCD
// Displays "The price is" on LCD
// Intializes the position of LCD
// Displays "5" on LCD
// Displays price for Green
             lcd.clear():
            lcd.clear();
lcd.setUrvsor(0,0);
lcd.print("The price is");
lcd.print("The price is");
lcd.print("S");
lcd.print("Greenprice);
delay(2000);
UpdateLCDDisplay();
lcd.clear();
        }
if (readA2!=0)
                                                                                                                                                                    // If Yellow Button pressed
            lcd.clear();
lcd.setCursor(0,0);
lcd.print("The price is");
lcd.setCursor(0,1);
lcd.print("S");
lcd.print("S");
delay(2000);
UpdateLCDDisplay();
lcd.clear();
                                                                                                                                                                   // Clears the LCD Screen
// Intalizes the position of LCD
// Displays "The price is" on LCD
// Intalizes the position of LCD
// Displays "$" on LCD
// Displays price for Yellow
        }
if (readA3!=0)
                                                                                                                                                                    // If Red Button pressed
           lcd.clear();
lcd.setCursor(0,0);
lcd.print("The price is");
lcd.setCursor(0,1);
lcd.print("s");
lcd.print("s");
dcl.print(Redorice);
delay(2000);
UpdateLCODisplay();
lcd.clear();
                                                                                                                                                                    // Clears the LCD Screen
// Intializes the position of LCD
// Displays "The price is" on LCD
// Intializes the position of LCD
// Displays "$" on LCD
// Displays price for Red
       }
unt8_t success;
unt8_t suf[] = { 0, 0, 0, 0, 0, 0, 0, 0 };
unt8_t suf[st] = { 0, 0, 0, 0, 0, 0, 0, 0 };

unt8_t suf[st] = { 0, 0, 0, 0, 0, 0, 0, 0, 0 };

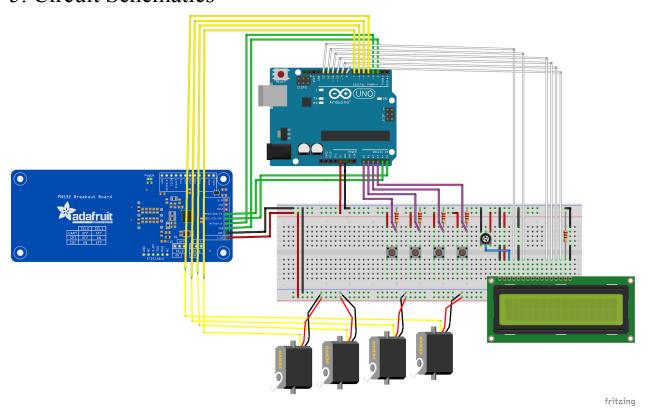
// Length of the UID (4 or 7 bytes depending on IS014443A card type)
success = nfc_readPassixeTargetID(PN532_MIFARE_IS014443A, wid, SuidLength, 100);

// If it reads.
// If it reads.
// If it reads.
// Identifies the MIFARE Card (A specific type of card)
                 \text{uint32,t sardid = uid(0);}
\text{sardid << 8};
\text{sardid == 4148560155}};
\text{if (sardid == 4148560155)}
                                                                                                                                                                                                                 // Assembles the UID into one line.
                                                                                                                                                                                                                  // Checks if refilling Key was scanned
                          cash = cash + 1.75;
lcd.clear();
lcd.setCursor(0,0);
lcd.setCursor(0,1);
lcd.print("Your new");
lcd.setCursor(0,1);
lcd.print("balance is");
dclay(1000);
lcd.clear();
                                                                                                                                                                                                                 // Adds a balance of 1.75 to the card
// Clears the LCD Screen
// Initalizes the position of LCD
// Initalizes "Your new" on LCD
// Antializes the position of LCD
// Antializes the position of LCD
// Displays "balance is" on LCD
                                                                                                                                                                                                                  // Clears the LCD Screen
                                                                                                                                                                                                                 // Intializes the position of LCD
// Displays "$" on LCD
// Displays the new balance of the card
                            lcd.setCursor(0,0);
lcd.print("$");
lcd.print(cash);
delay(1000);
                       }
if (<u>cardid</u> == 2799659557)
                                                                                                                                                                                                                // Checks if purchasing Card was scanned
                          lcd.clear();
lcd.setCursor(0,0);
lcd.setCursor(0,0);
lcd.setCursor(0,1);
lcd.setCursor(0,1);
lcd.print("balance is");
lcd.print(cash);
delay(3000);
AlmostPurchase();
                                                                                                                                                                                                              // Clears the LCD Screen
// Intializes the position of LCD
// Displays "balance is" on LCD
// Displays balance of card
                       }
success = 0;
, , ,
                                                                                                                                                                                                              // If nothing is scanned, it goes back to start
   void UpdateLCDDisplay()
                                                                                                                                                                                                            // Causes the scrolling in the LCD Screen
       int iLenOfLargeText = strlen(Text);
if (iCursor == (iLenOfLargeText - 1) )

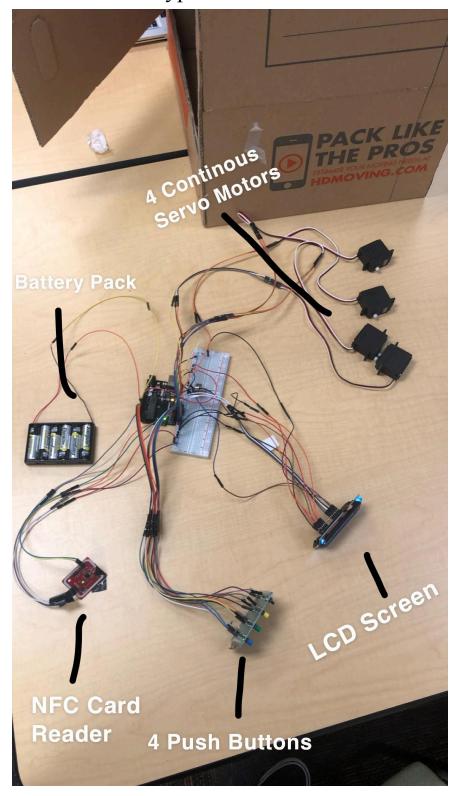
                                                                                                                                                                                                           // Length of Text
            iCursor = 0;
        lcd.setCursor(0,iLineNumber);
                                                                                                                                                                                                         // Sets where the first letter appears on the LCD
       if (iCursor < iLenOfLargeText - 16)
{</pre>
                                                                                                                                                                                                         // Moves the text by one letter each time
            for (int iChar = iCursor; iChar < iCursor + 16; iChar++)
                 lcd.print(Text[iChar]);
       else
            for (int iChar = iCursor; iChar < (iLenOfLargeText - 1); iChar++)
{</pre>
                 lcd.print(Text[iCharl):
             }
for (int iChar = 0; iChar <= 16 - (iLenOfLargeText - iCursor); iChar++)
                 lcd.print(Text[iChar]);
       }
iCursor++;
   void AlmostPurchase()
      lcd.clear();
lcd.setCursor(0,0);
lcd.print("Select something.");
time_now = millis();
while (millis() < time_now + 5000)</pre>
                                                                                                                                                                                                        // Clears the LCD Screen
// Intiglizes the position of LCD
// Displays "Select something." on LCD
                                                                                                                                                                                                       // Creates a timeout function if the person takes too long
       {
int readA0 = digitalRead(14);
int readA1 = digitalRead(15);
int readA2 = digitalRead(16);
int readA3 = digitalRead(17);
if (readA0!=0)
                                                                                                                                                                                                       // Reads if Blue Button pressed
// Reads if Green Button pressed
// Reads if Yellow Button pressed
// Reads if Red Button pressed
// If Blue Button pressed
           if (cash > Blueprice) {
    myservo.attach(7);
    myservo.writeMicroseconds(1000);
                                                                                                                                                                                                       // If there's enough balance on the card
// Assign Blue's Servo Motor
// Turn servo clockwise
```

```
delay(1800);
myservo.wristmicrosscondg(1500);
myservo.atisach(1);
lcd.ctear();
lcd.ctear();
lcd.setturor(0,0);
cd.setturor(0,0);
cost = cash = flwerrisc;
delay(2000);
break;
                                                                                                                                                                                                                                                   // Keep servo running clockwise for 1 second 
// Stops the servo from moving 
// Unassign Blue's Servo Motor 
// Clears the LCD Screen 
// Antializes the position of LCD 
// Displays "Purchase Completed!" on LCD 
// Subtracts the balance
                                                                                                                                                                                                                                                   // Goes back to start
      } else { | tcd.clear(); | tcd.setCursor(0,0); | tcd.setCursor(0,1); | tcd.setCursor(0,1); | tcd.setCursor(0,1); | tcd.print("Credit."); | tcd.print("Credit."); | tcd.clear(); | treak; | }
                                                                                                                                                                                                                                                    // Clears the LCD Screen
// Intializes the position of LCD
// Displays "Not Enough" on LCD
// Intializes the position of LCD
// Displays "Credit" on LCD
                                                                                                                                                                                                                                                    // Clears the LCD Screen
 }
if (readA1!=0)
   // If Green Button pressed
                                                                                                                                                                                                                                                  // If there's enough balance on the card
// Assign Green's Servo Motor
// Assign Green's Servo Motor
// Turn servo clockwise
// Keep servo running clockwise for 1 second
// Stops the servo from moving
// Unassign Green's Servo Motor
// Clears the LCD Screen
// Intializes, the position of LCD
// Displays "Purchase Completed!" on LCD
// Subtracts the balance
                                                                                                                                                                                                                                                   // Goes back to start
      // Clears the LCD Screen
// Intializes the position of LCD
// Displays "Not Enough" on LCD
// Intializes the position of LCD
// Displays "Credit" on LCD
                                                                                                                                                                                                                                                    // Clears the LCD Screen
 }
if (readA2!=0)
{
                                                                                                                                                                                                                                                   // If Yellow Button pressed
                                                                                                                                                                                                                                                  // If there's enough balance on the card
// Assign Yellow's Serve Motor
// Assign Yellow's Serve Motor
// Weep serve clockwise
// Keep serve running clockwise for 1 second
// Stops the serve from moving
// Unassign Yellow's Serve Motor
// Clears the LCD Screen
// Intializes, the position of LCD
// Displays "Purchase Completed!" on LCD
// Subtracts the balance
     if (cash > Yellowprice) {
    myseryo.attach(5);
    myseryo.writeMicroseconds(1000);
    delay(1000);
          // Goes back to start
      break;
lcd.clear();
lcd.setCursor(0,0);
lcd.print("Not Enough");
lcd.setCursor(0,1);
lcd.print("Not Enough");
lcd.setCursor(0,1);
lcd.setCursor(0,1);
lcd.setCursor(0,1);
lcd.setCursor(0,1);
lcd.setCursor(0,1);
break;
break;
                                                                                                                                                                                                                                                   // Clears the LCD Screen
// Intializes the position of LCD
// Intializes "Not Enough" on LCD
// Antializes the position of LCD
// Displays "Not Enough" on LCD
// Intializes the position of LCD
// Displays "Credit" on LCD
                                                                                                                                                                                                                                                   // Clears the LCD Screen
} if (readA3!=0)
   // If Red Button pressed
                                                                                                                                                                                                                                                  // If there's enough balance on the card
// Assign Red's Servo Motor
// Assign Red's Servo Motor
// Iurn servo clockwise
// Keep servo running clockwise for 1 second
// Stops the servo from moving
// Unassign Red's Servo Motor
// Clears the LCD Screen
// Intializes, the position of LCD
// Displays "Purchase Completed!" on LCD
// Subtracts the balance
                                                                                                                                                                                                                                                    // Goes back to start
      // Clears the LCD Screen
// Intializes the position of LCD
// Displays "Not Enough" on LCD
// Intializes the position of LCD
// Displays "Credit" on LCD
                                                                                                                                                                                                                                                    // Clears the LCD Screen
       delay(2000);
```

5. Circuit Schematics



6. Circuit Prototype



7. Testing

When we were figuring out how each component worked we decided to first test out how to command a servo motor based on simply pressing a button. During this test, we were having trouble getting the motor to spin but were eventually able to. From there, our second test came in when we wired the NFC card and LCD screen. We had to test showing text then after tapping the card, pressing a button which would subsequently spin the motor. Our process was simply adding a new component each time to the process. From there we added all the buttons, servos, and additional if and then statements. We also had to test the range that we had to spin the motors in order to dispense a single snack rather than many. Our final test came in when we simulated an actual vending machine by displaying prices then trying to buy something without actually having money; then actually having money allowed us to get a snack.