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# Microcontroller Based Automated Tool Dispenser with Touchless Activation

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**Abstract**

Keeping and utilizing common tools for different technical applications can make a desk or drawer cluttered with numerous items. Introducing a means of organizing these tools within a confined area on one's desktop and allowing for that item to present itself to the user automatically is the primary objective of the design project described in this manuscript. The content of the manuscript covers the key aspects of the tool dispenser design and construction. The CAD development of the housing, the electronic circuit design, the microcontroller programming, and the hardware construction are described in this manuscript.

***Keywords:*** *Tool dispenser, microcontroller, PWM, Computer Aided Design (CAD)*

## 1. Introduction

Maintaining a secure and organized means of storing commonly used tools is one of two primary goals of this system design. Allowing for the tool to present itself to the user is the second. The tools that are used most often should not get lost in a drawer containing numerous items. Special consideration is given to the size and the functionality of this automated tool dispenser. Since the tool dispensing system must fit on a desktop where a user has easy access to the needed tools, the overall size of the housing and the power supply were given special consideration.

The key components for the tool dispenser include the Arduino Nano microcontroller, a Funduino Extension Board for the Arduino Nano, two SG90 servo motors, an HC-SR04 ultrasonic sensor, and a system housing developed using CAD and built using 3D printing.

The Arduino Nano is a microcontroller board that uses an ATmega 328 microcontroller chip. There are 8 analog pins and 22 digital I/O pins, of which 6 are utilized for PWM signals. Operating voltage for the Arduino Nano is 5 volts with an on-board voltage regulator able to accept 7-12 volts. The Funduino Board Extension expands the functionality of the Arduino Nano by incorporating servo capable pins for all the input pins of the Nano.

Arduino boards are extensively utilized in robotics, microprocessor embedded systems, and electronic projects requiring automation Yu et al. describe the use of Arduino microcontroller board to teach the control applications of microcontrollers in the undergraduate engineering technology courses. A Minaie and R. Mehrizy discuss the use of Arduino for the capstone design projects in an undergraduate computer engineering program in [2]. In [3], W. Rosen, Y. Ertekin, and M. E. Carr describe the design and construction of an autonomous Arduino based racecar. Also in [4], S. Warren, C. Carlson, A. McKittrick, and S. Wang discuss the RF duino 13 which is a fingertip sized, Bluetooth enabled ARM-based microcontroller that can be programmed through Arduino integrated development environment.

The HC-SR04 sensor utilizes a ping and return signal as an input system. It has an operating voltage of 5 volts and utilizes 4 connections; including power,

ground, trigger, and echo. The SG90 servo motors have an operating voltage of 4.8 volts with a torque output of 1.8 kg-cm. They utilize plastic gears within their own housing and have three pins; including power, ground, and signal.

CAD development of the housing space was completed using 123D Design, a computer-based 3-dimensional development space created by the company Ultimaker. This software was selected due to its ease of use and functionality.

## 2. System Design

As mentioned earlier, the automated tool dispenser design utilizes an Arduino Nano microcontroller board with attached Funduino board. The Funduino board utilizes the 5-volt and ground pins of the Arduino Nano to specifically add additional pins for servo motor units and a DC power cord port. Utilization of this board allows for ease of wiring the servo motor components without the need for soldering or recombining ports due to the limited pin access of the Arduino Nano.

The circuit board wiring schematic is shown in Figure 1.

As shown in Figure 1, a 9-volt battery provides power to the system since there is a voltage regulator is within the Funduino board itself. The HC-SR04 ultrasonic sensor is used to provide sensor feedback to the system and detect when a user activates the model. The power for the sensor is supplied through a regulated pin and the ground wire will be attached to this set. The trigger signal is attached to the D2 pin of the board, corresponding to a digital PWM signal, and is used as Input 1. The echo signal has been attached separately to pin D3. This pin corresponds to Output 1.

The servo motor units are wired as they as intended to be. The power and ground wires are attached to the regulated 5-volt and ground pins that correspond to each output. One of the servo motor signal wires is attached to pin D4 and the other to D5. These correspond to Output 3 and Output 4 respectively. All pins used are digital (PWM) pins that can be programmed for either input or output characteristics depending on their intended use.

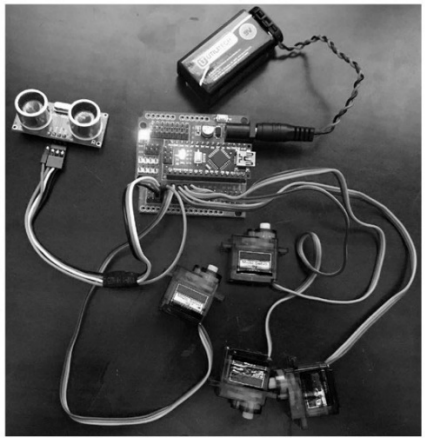

Fig.1: Wiring Schematic for the Circuit Board

The Funduino board receives the input power and distributes it to the Arduino Nano board and peripheral devices. All four 9G servo motors and the HC-SR04 sensor receive power from the Funduino board regulators. The software for this tool dispenser produces an automated system in which the sensor input triggers the engagement of one set of servo motors. The servo motors then trigger the opening of the main housing door and the movement of the internal shelf component.

## 3. System Housing Design

The housing design for the automated tool dispenser is accomplished through the use of 123D Design by Ultimaker. The Figure 2 below shows the housing component design and the layout using the 123D Design software.

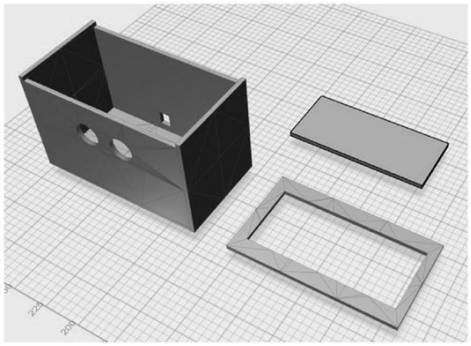

Fig.2: The Housing Layout

The figure 3 below depicts the process of fitting components into the housing to ensure the proper functionality of the tool dispenser system.

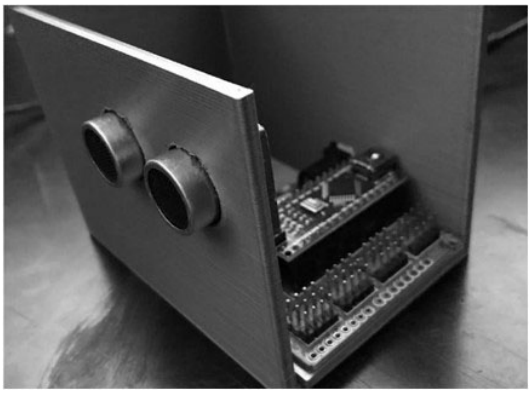

Fig.3: The Housing Construction

## 4. System Programming

Programming this model to perform in the necessary manner involves the generation of servo motor control processes and a sensor loop. Using the Arduino IDE, with Java programming language enabled, allows for a proper programing environment for the Arduino Nano. The Figure 4 shows the final program utilized in this design project.

DesignProjectv2

```
#include <Servo.h>

const int trigPin = 3;
const int echoPin = 2;
Servo servo1;
Servo servo2;

long microsecondsToInches(long microseconds)
{
  return microseconds / 74 / 2;
}
long microsecondsToCentimeters(long microseconds
{
  return microseconds / 29 / 2;
}

int pos = 0;
int pos2 = 360;
void setup() {
  Serial.begin(9600);
  servo1.attach(4);
  servo2.attach(5);
}
```

```
void loop() {
  long duration, inches, cm;
  pinMode(trigPin, OUTPUT);
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  pinMode(echoPin, INPUT);

  duration = pulseIn(echoPin, HIGH);
  inches = microsecondsToInches(duration);
  cm = microsecondsToCentimeters(duration);
  Serial.print(inches);
  Serial.print("in, ");
  Serial.print(cm);
  Serial.print("cm");
  Serial.println();

 if (inches <= 4) {
   servo1.attach(4);
   servo2.attach(5);
   servo1.write(pos2);
   servo2.write(pos2);
   delay(250);
   servo1.detach();
   servo2.detach();

  delay(5000);

   servo1.attach(4);
   servo2.attach(5);
   servo1.write(pos);
   servo2.write(pos);
   delay(250);
   servo1.detach();
   servo2.detach();
   }
 else if (inches >= 4) {
   servo1.write(pos);
   servo2.write(pos);
 }
 delay(100);
}
```

Fig.4: System Program

As seen in the program, initial values were stated for the determination of the distance for sensor determination and the signal processes of the sensor itself. This allows for a specific distance to be written in terms of sensor operation while preventing triggering of the sensor from objects at larger distances. For this process, a distance of anything within 4 inches was selected.

The main operating program focuses on the utilization of a loop in which a ping is sent from the

sensor and a return signal was measured. If the return signal is found to bounce off an object within 4 inches, a signal is sent to trigger the servo motors and change their position. If the object is sensed outside of the 4-inch range, the servo motors maintain their original position.

The movement of the servo motors is also delayed to operate over a specific time period. Once initiated, a delay is also necessary to maintain the open position of the housing to allow the user to select the necessary tool before returning to their original position. To accomplish this, the servo motors were detached before a delay was implemented. After the delay period, they were necessarily reattached for return movement.

## 5. System Construction

The completed assembly of the automated tool dispensing system is shown in Figure 5.

Fig.5: The Completed Assembly of the Tool Dispenser

The final phase for the design and construction of the automated tool dispenser involves gluing the housing components together and inserting all the electronic components. Rubber sections are placed across the door and top wall hinge assembly to provide a dampening effect for the door action and to allow it to remain in a position capable of returning to a closed position.

## 6. Conclusions

This manuscript describes the design and construction of automated tool dispenser. Two key objectives for the design and construction of this system consist of maintaining a secure and organized means of storing commonly used tools and then allowing for a tool to present itself to the user through a sequence of automated movements. While the design process described in the manuscript successfully achieves the two objectives listed above, there are a couple of possible design improvements for this system. Firstly, the servo motors utilized here are shown to be a bit weak to function, as intended, with heavier work tools. Servo motors with higher torque values may be used to resolve this issue. Secondly, a mechanism should be developed to alter the delay in the servo motor movement to slow down the opening and closing process.

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