Smart Automatic Door

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INTRODUCTION

Project Description

Dr. Choi tasked CRE8 Technologies with designing the Smart Automatic Door. This device will allow the client to enter and exit his office hands-free. The specifications outlined by the client are that the device:

- Does not require physical contact
- Unlocks and opens the door when Dr. Choi is within a specified radius
- Identifies Dr. Choi via wireless cell phone connection
- Allows the door to retain its original functionality
- Will keep the door open for as long as Dr. Choi is in his office
- Closes and locks the door once Dr. Choi has exited his office
- Has an override button that can open and close the door

Project Deliverables and Initial Design

The deliverables of the Smart Automatic Door project are the following:

• Door Opener System • Handle Turner System • Cell Phone Compatibility

The Door Opener System allows for effective opening and closing of the client's office door, the Handle Turner System allows for effective turning of the door handle, and the Cell Phone Compatibility allows for the system to operate properly hands-free. The selected design for the Smart Automatic Door consists of the following three systems:

• Motorized Wheel • Motorized Winch • Raspberry Pi Zero W

METHODS

Work Accomplished

Covid-19 Complications

- Last in-person meeting between team members took place on March 13th, 2020
- Motorized Winch prototype was never constructed
- Motorized Wheel prototype, electrical prototype, and computer program prototype were separately completed by respective team members
- Team was unable to connect separate systems and install on the client's office door

Key Decisions

- Addition of linear actuator to the Motorized Wheel design
- Addition of 1.5 A current-limiting resettable circuit breaker to the electrical design
- Purchase of L298 motor controller with H-bridge output current of 7 A

Design Successes and Failures

Design Successes

- Successfully fabricated 3D printed wheel
- Beneficial tread was printed on wheel
- Easy fabrication and assembly

Design Failures

- U-bracket jams on bolt threads
- Springs slip through bolt holes
- Unable to wire power to both motor controllers

Testing

Linear Actuator Maximum Current Test

Using the variable DC power supply provided by the Mercer University Electronics Laboratory, the maximum current draw of the linear actuator was measured to be 5 A. This discovery led CRE8 Technologies to purchase an L298 motor controller with H-bridge current output of 7 A. This current output is high enough to drive the linear actuator, resulting in an electrically safe design.

Motor Synchronization Test

The two wheel motors were discovered to rotate at drastically different RPMs and were visibly out of sync within only two rotations of the motor shaft. This discovery led CRE8 Technologies to revise the Motorized Wheel design and use only one DC motor.

Bluetooth™ Behavior Test

The distance for the Raspberry Pi's Bluetooth™ Module to connect to a sample cell phone was measured to be approximately 27 feet (8.2 meters). This result suggests that the Bluetooth™ properties of the Raspberry Pi allow for the Smart Automatic Door system to engage when the client is within appropriate distance.

RESULTS

Revisions

Mechanical Revisions

- Addition of linear actuator to Motorized Wheel design
- Removal of one motor from Motorized Wheel design
- Addition of washers and hex nuts to the bolt and spring assembly of the Motorized Wheel design

Electrical Revisions

- Replacement of one L298N motor controller with an L298 motor controller with H-bridge output current of 7 A
- Addition of 1.5 A current-limiting resettable circuit breaker

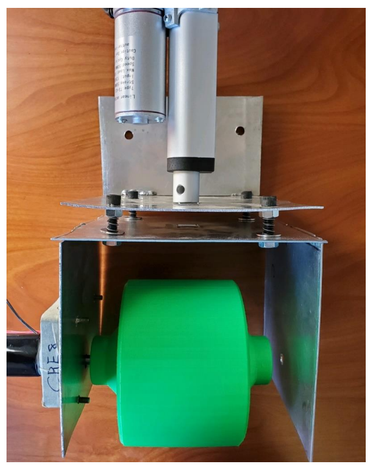

Figure 1: Motorized Wheel Prototype

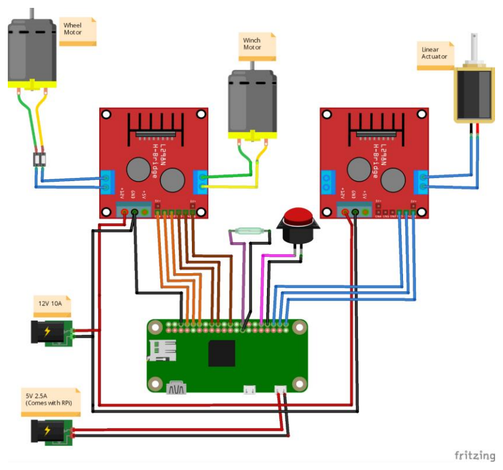

Figure 2: Electrical Wiring Diagram

```
def mainLoop():
    devices = Scanner.scan(10.0)

    contact = GPIO.input(c)
    buttonPress = GPIO.input(b)
    near = False

    for device in devices:
        if(device.addr == mydevice):
            near = True

    if(near and closed):
        wasFar = False
        closed = False
        openDoor()
    if(near and (not closed) and buttonPress):
            while(not contact):
                d_motor.backwards()
            d_motor.stop() #door is closed

            while(True):
                buttonPress = GPIO.input(b)
                if(buttonPress):
                    openDoor()
                    break

        if((not near) and (not closed) and (not wasFar)):
            while(not contact):
                d_motor.backwards()
            d_motor.stop() #door is closed
            closed = True
            wasFar = True
```

Figure 3: Raspberry Pi Program Prototype

CONCLUSIONS

Final Expenditures

Item Name	Quantity	Price
12V 10A DC Power Supply	1	$17.99
100 ft. Stranded Wire AWG 14	1	$18.05
Vilros Raspberry Pi Zero W Basic Starter Kit	1	$26.99
Pin Connector and Crimp Kit	1	$9.99
DC Momentary Push Button	1	$14.95
Magnetic Contact Switch	1	$3.95
1.5 A Current-Limiting Circuit Breaker	1	$39.50
Linear Actuator	1	$48.88
L298N Motor Controller	1	$10.99
L298 7A Motor Controller	1	$15.59
Aluminum Sheet (12" x 6" x 1/8")	2	$51.66
Aluminum Sheet(24" x 6" x 1/8")	1	$29.66
Steel Wire Cable (1/32")	1	$8.64
Compression Springs	4	$10.87
Socket Screws	4	$7.86
Hex Nuts	4	$4.88
Total		**$320.45**

Summary

- Team members of CRE8 Technologies separately created prototypes of the Motorized Wheel, electrical design, and computer program
- These prototypes were shown to be as functional, efficient, and safe as possible through testing
- Necessary design revisions were made in response to test results and guidance from the client
- Team members of CRE8 Technologies were unable to meet to create the complete assembly of the Smart Automatic Door and thus were unable to install the final version of the device on the client's office door

Recommendations

Door Open Contact Switch

- One end of the switch is attached to the Motorized Wheel assembly and the other end is attached to the wall that the assembly contacts when the door is fully open
- When the switch is closed, the wheel motor will stop running, terminating the door opening process
- This modification will make the wheel motor runtime more exact

Bolt and Spring Assembly

- Use shoulder screws instead of threaded bolt. The shoulder length of the screw should be the same length as the ¾ in. compression spring used in the design
- ¼ in. washers should be placed at both ends of the compression springs located between the U-bracket and L-bracket
- This modification will prevent jamming during compression

Raspberry Pi Zero W Replacement

- Use an Arduino microcontroller for the computer program instead of the Raspberry Pi Zero W
- USB input will decrease production time of the device
- This modification would make future updates to the computer program easier to implement

Acknowledgements

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