Automated Locker

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Objective

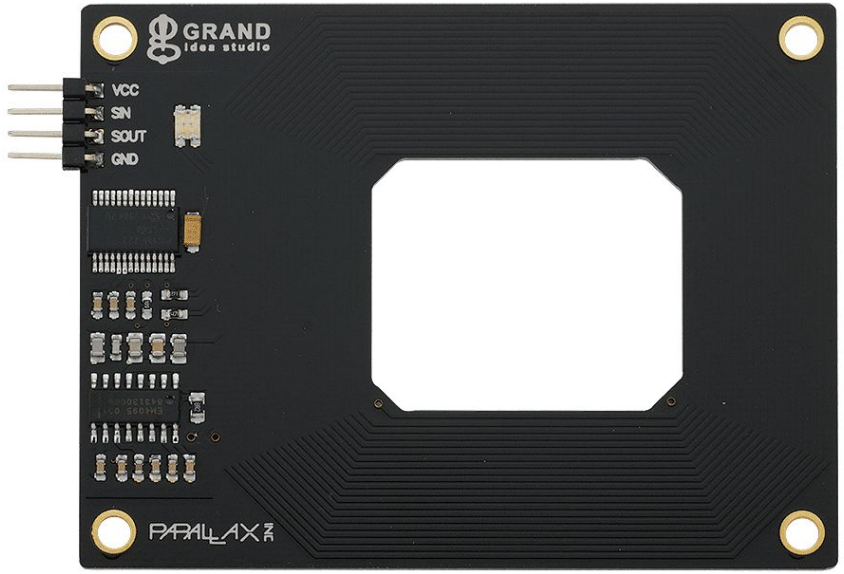
- Building an automated locker to assist high school students with special needs
- Replace use of a combination lock with a RFID scanner to allow simpler authentication
- Design a system that can be consistently implemented amongst similar styled lockers

Basic Design Outline

- Touchless Authentication using RFID
- Fail Safe Mechanical Override
- Energy Efficient System
- Easy Accessibility

Requirements

- Touchless Authentication
- To implement this design, we used an RFID Module to allow our client access into the locker
- Client is provided tags, with unique identifiers that can be scanned by the RFID reader
- Client simply turns the system on, scans the tag, and locker will automatically open up



Requirements

- Mechanical Unlock Override
- The client should be able to access the locker in case of a power failure or emergency
- The client and school administrator will be provided with keys to unlock the locker

Requirements

- Efficient power supply
- Using a 20V battery, we can provide long lasting power to our product
- These batteries are interchangeable, and use the same charger
- The power supply will be mounted using a charger base that has been engineered to output power

Requirements

- Custom 3D Printed Parts
- To add a personal touch to our product, we designed it with specifications accustomed to the client themself
- The client likes the colors red and black, so we created 3D housing that utilized red and black pieces

Requirements

- On/Off Switch
- To maintain efficient power consumption, we implemented a power button to turn the circuit on or off
- The circuit turns off after the locker is opened
- We also implemented a timeout feature that turns the circuit off if there is no activity after a set amount of time

Requirements

- LED Status
- The power button has a built in LED which we also utilize as a status indicator
- The LED is powered on with the circuit, and turns off once access is granted
- If entry is denied, the LED will briefly turn off
- If entry is accepted, the LED will blink twice before returning solid.

Parts List

Power Supply

- **2 x Dewalt DCB205CK 20V Battery**
- 2 x Dewalt Battery Charger Kits

Circuit

- Arduino Uno R3
- **Parallax Read/Write RFID Module**
- 2 x 12V DC Relay
- Micro Linear Actuator
- Adafruit Push-button Power Switch Breakout
- 30mm Arcade Button with LED

Operational Parts

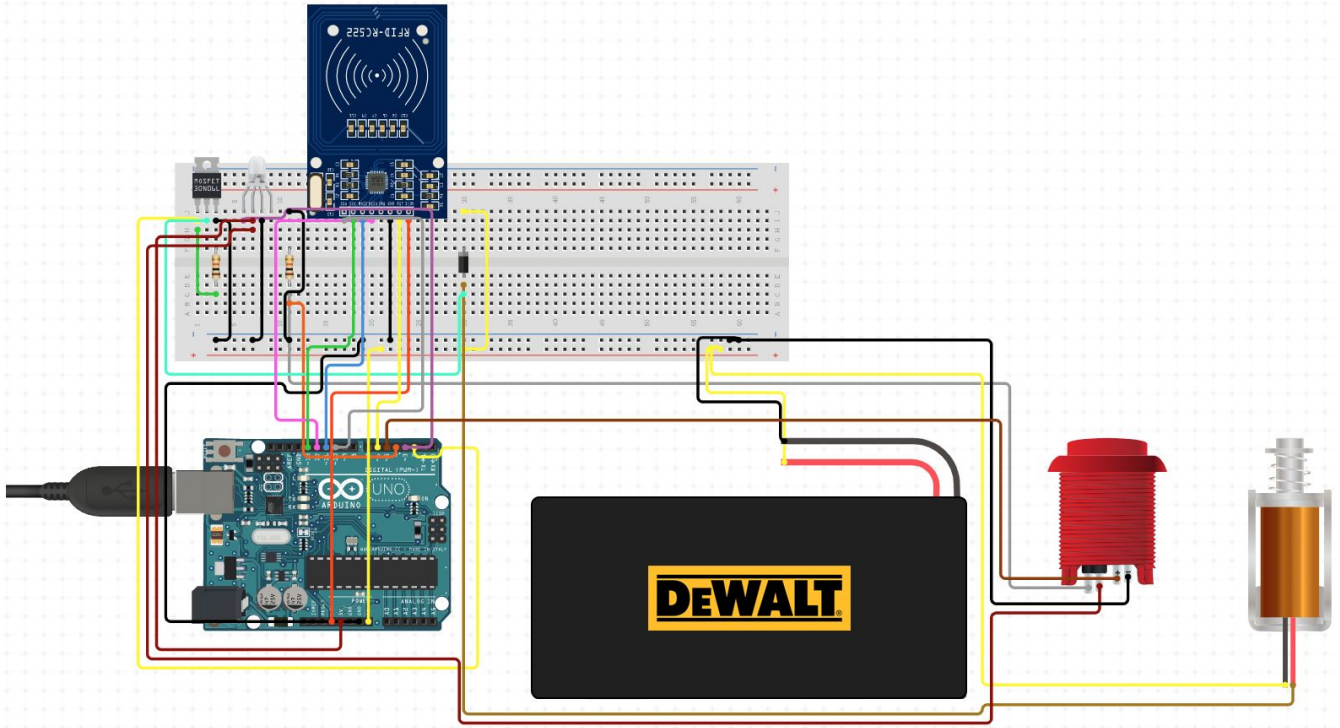
- Keychain RFID Tag
- Card RFID Tag
- Mechanical Lock Keys

Mechanical Parts

- **Tumbler Lock**
- 3D Printed housing
- 3D Printed Handle
- Push Latch

Original Design

- Solenoid implementation to push open locker
- Button to turn on/off circuit power
- RFID card reader to scan Identification
- Transistors and Diodes to activate solenoids

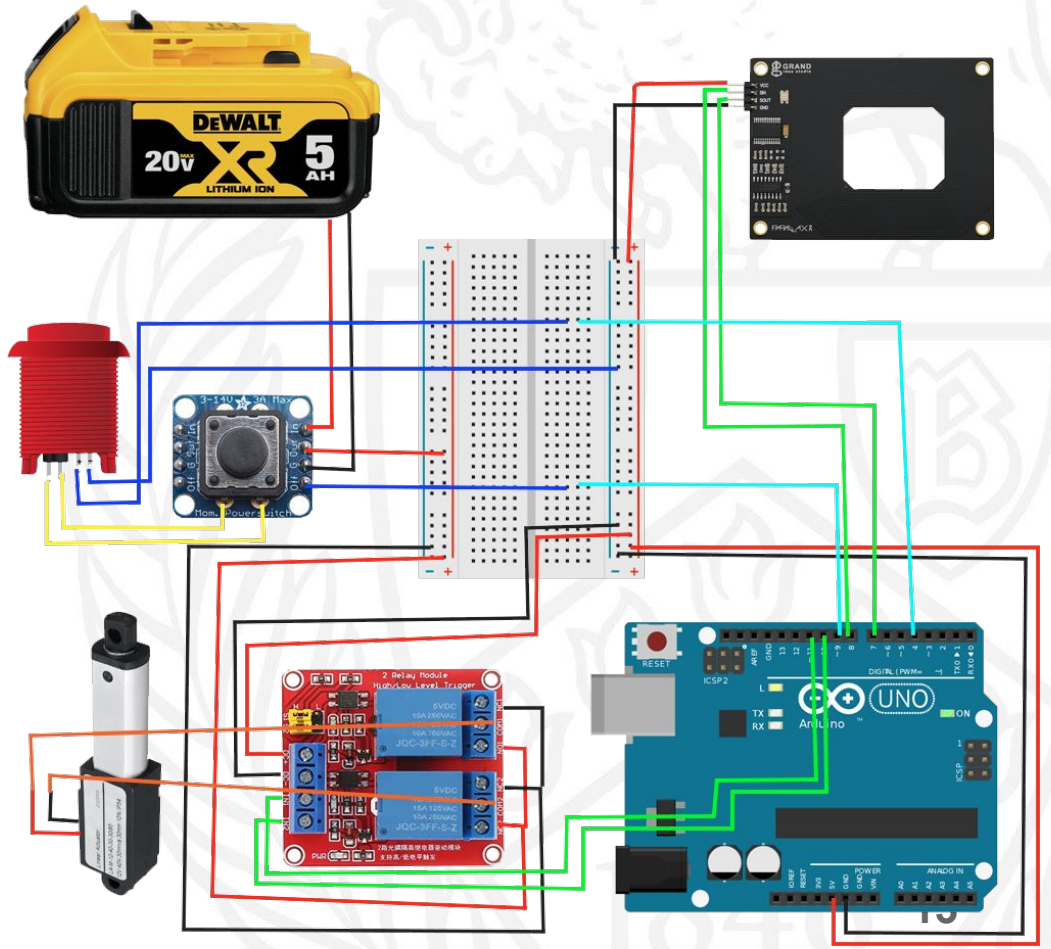


Major Problems Encountered

- Solenoids rapidly drained battery power and ultimately failed to push the latch up in order to unlock the locker.
- Solenoids drew 8 Amps !!! Presenting both a heat & shock hazard
- Thus, we replaced them with a linear actuator and redesigned the circuit to accommodate it.

Final Design

- Read/Write Module for ability to add/remove tags, and more support
- Linear actuator for a more energy and weight efficient solution
- Relays instead of transistors
- A power switch to control power output



Revisions

- Our main objective was completed successfully, and some of the factors were modified
  - Solenoid replaced with Linear Actuator
  - Status LED originally blinked on wrong tag
  - RFID Reader reads tag's pre-written unique ID instead of requiring passwords written to each tag.
  - Countless code revisions

Power Consumption

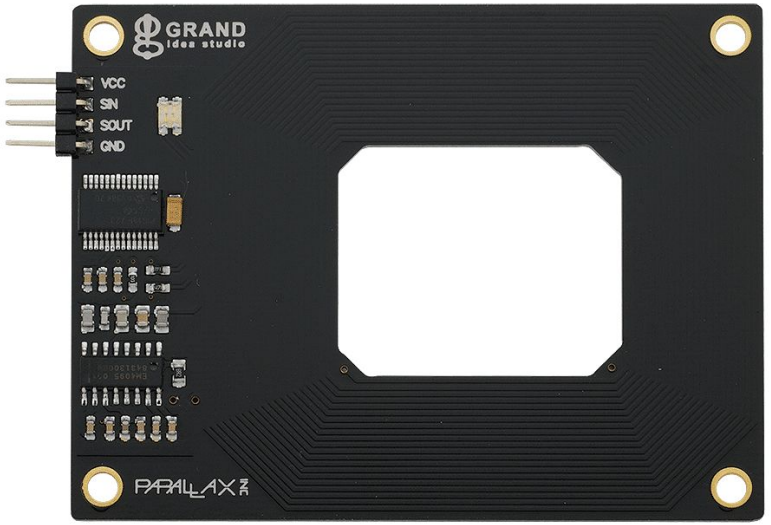
- After testing and calculating the battery life, we determined that on a full charge, the locker can be used on our system for approximately 4-6 months.
- Using linear actuators, we have a light current draw of 200mA and with a 5 Ah battery, it can handle it very a very long time.
- When the linear actuators are not in power, the circuit draws nano amps, which provide a very low power state when the circuit is off.

Linear Actuator

- By changing from solenoids to linear actuators, we don't have to rely on electromagnets which can potentially be harmful for electronics in the locker such as a laptop or tablet.
- The solenoids we tested also ranged from 2 Amp to 8 Amp current draw, which not only isn't efficient, but can possibly be dangerous in the case of a short or loose wire.
- The size and weight also proved better for the linear actuator, as we were able to include it in the 3D housing and not add too much weight.

Parallax Read/Write RFID Module

- Using the Parallax RFID module, we have the option to use custom tags and create unique identifiers for them, or read pre-written 125 kHz RFID tags.
- This is so for a future student, tags can easily be replaced, removed, or added.
- Our client will be receiving a custom bracelet, card with lanyard, and several keychain tags.



Power Switch

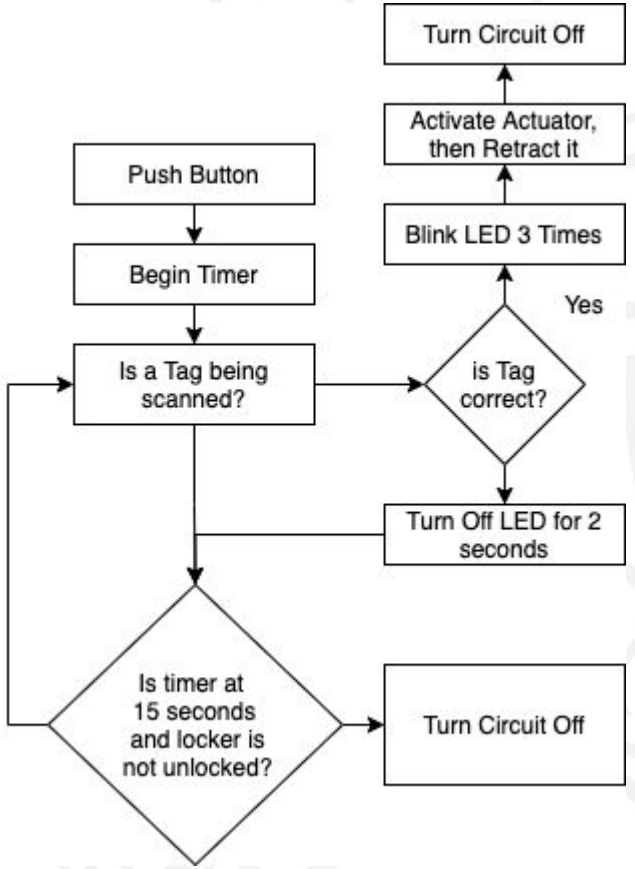
- We used two sources to implement our power switch
- First part is the Power Switch breakout by Adafruit
- It contains 4 pins: input, output, ground, and a kill switch
- It also has connector pins to add a button which we used for the Arcade button so it would work as our power button
- The power switch takes the input from the battery and outputs it to the circuit
- The kill switch is triggered by the Arduino

Mechanical Override

- Our mechanical override design is quite simple
- We were able to include it as a part of the housing to avoid the metal part of the locker to be altered
- We use a tumbler lock to lift the locker latch up when unlock
- The tumbler lock sits directly on the housing and below the latch

Software

- For this project we used C in the Arduino IDE as well as AutoCAD for 3D print designing
- For the circuit we implemented a timer interrupt to keep track of time elapsed to manage over usage
- We also implemented functions to read, write, and verify correct and incorrect tags being read
- For 3D parts, we designed them in AutoCAD and used FlashPrint software to render a printable file



Final Implementation

- By using dimensions provided by Dr. Schindler from the Alden High School lockers, we were able to put together a fully assembled unit that would be easily transferable from the lockers in Baldy to Alden High School.
- Install will take place on Friday, May 14th, and will be tested before, during, and after installation to ensure quality of the design.

Final Implementation

- The final implementation will also be using a push latch
- The push latch will be used to open the door wider when the actuator lifts the latch

Questions and Comments