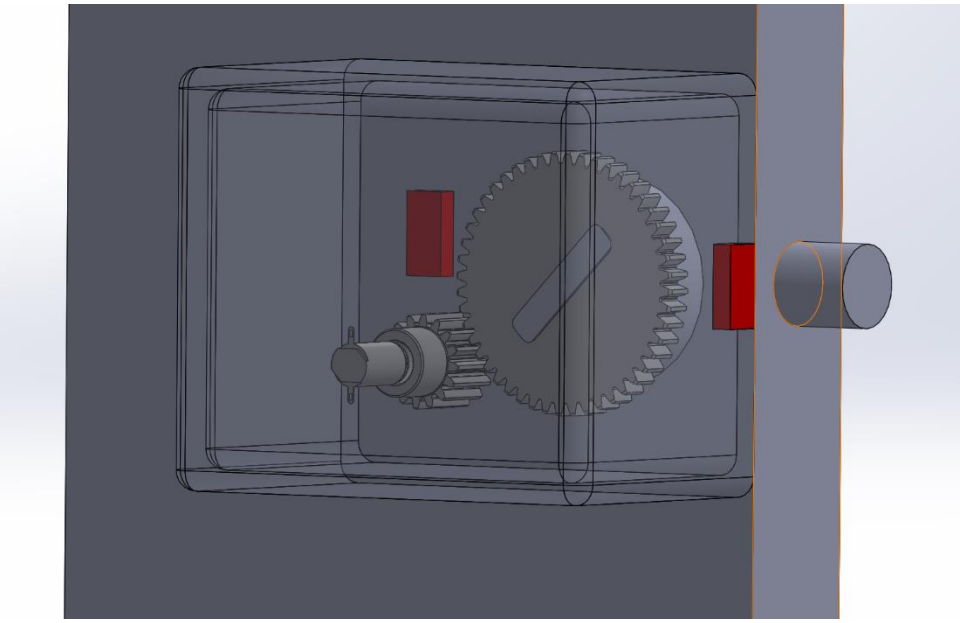
Final Documentation

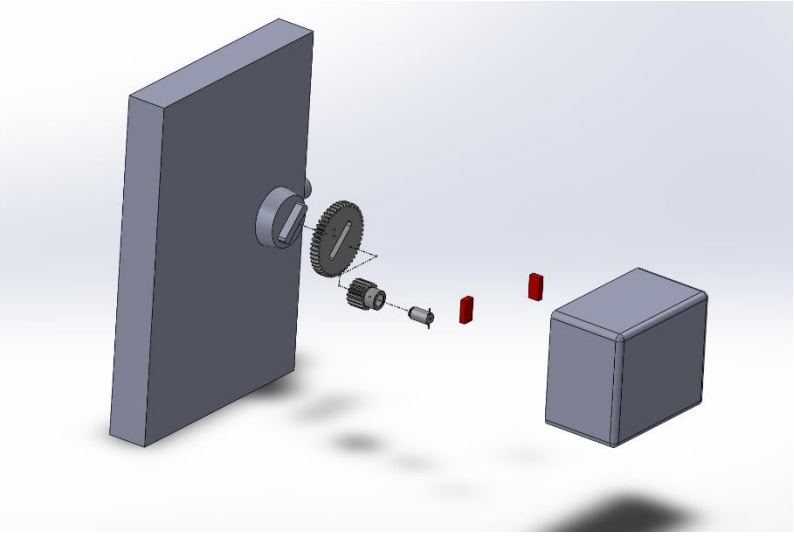
Team # 17

Names: Tyler Clark, Jamie Laughlin, Zachary Yoder

SOLIDWORKS MODEL



The red boxes represent the system's sensors. The red box on the left represents the musical instrument pickup which attaches directly onto the door via an adhesive pad. The second sensor is a limit switch that is HI when the door is closed. A small gear is directly mounted to the DC motor and turns a larger gear that attaches to the deadbolt via press-fit cavity. The turning of the motor turns the gears to flip the deadbolt. The motor is mounted to the interior of the door inside a cavity. The motor pictured is not the specific, selected motor, but rather a visual CAD model that is there to demonstrate the functionality of the device. The electronics and breadboards are mounted to the interior of the door. Below is an exploded view of the assembly.



SYSTEM DESCRIPTION

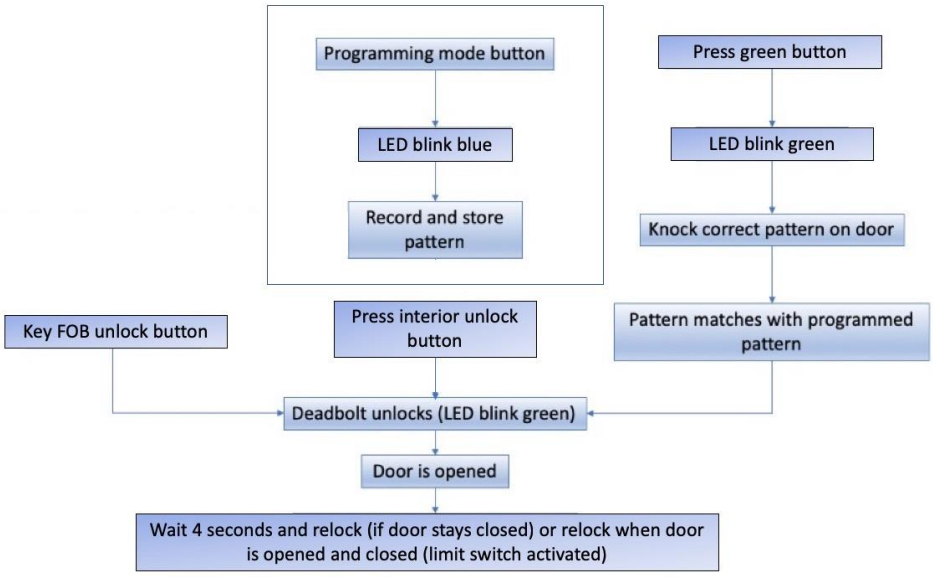
The project is a knock pattern deadbolt sensor system. The system listens for a specific knock pattern and, after proper input, unlocks the door. The system receives input from a piezo-electric musical instrument pickup that converts the analog knock signal and discretizes it into a pattern of 8 bits to determine the knock pattern. There is a stepper motor to lock/unlock the deadbolt, and an LED display to provide feedback if the knock pattern was correct. When the door closes, a limit switch provides input to re-lock the door. In addition to the knock pattern, the door can be opened via a remote control, which immediately unlocks the door and interrupts the musical instrument pickup from receiving input.

SEQUENCE OF OPERATIONS

1. General behavior
    a. System waits and polls input pin, programming mode pin, unlock pin, and key FOB pin (“resting mode”)
2. When green input button is pressed
    a. System enters pattern matching mode
        i. Green LED blinks 8 times- each time listening for the presence of a knock
    b. Input signal is processed through an op-amp which amplifies the signal such that a knock can be detected from other noise
        i. The code itself acts as a “filter”- only reading knocks over a certain amplitude
    c. This input signal is converted to a pattern of 1s (indicating a knock) and 0s (indicating no knock), based on a specified cutoff (amplitude required to say “this is a knock”).
    d. This pattern is compared to the pattern recorded in programming mode (see “programming mode”).
    e. LED light responds

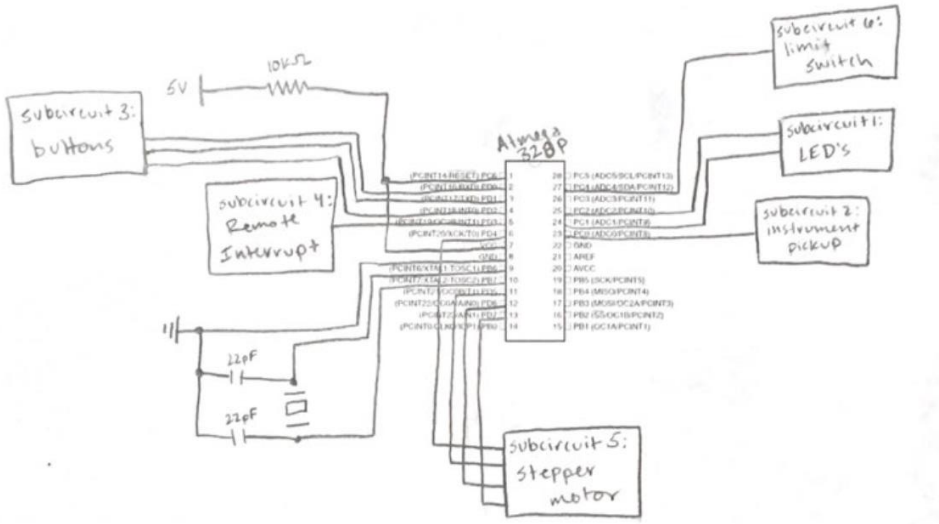
        i. LED green indicates correct pattern
    f. If correct pattern is knocked, the stepper motor moves to the appropriate position and unlocks the deadbolt
        i. Door is open and limit switch goes LO
        ii. If door stays closed (limit switch stays HI) for 4 seconds, stepper motor relocks deadbolt
    g. Once the door is closed, and the limit switch is HI, the stepper motor moves back to its original position- relocking the deadbolt.
3. When blue programming button is pressed
    a. Interior LED starts blinking, indicating it is listening for knocks
    b. System "listens" for pattern (as described earlier), but this time records the pattern for future comparison
        i. In each of 8 blinks, the system records either a 1 (knock) or 0 (no knock).
    c. Blue LED blinks 8 times rapidly to indicate successful recording
    d. Blue LED blinks knock pattern back to user
4. When white unlock button is pressed
    a. The unlock LED lights up
    b. Stepper unlocks deadbolt
        i. Relocking functionality is the same as described earlier
5. Key FOB unlock button is pressed
    a. The button is an interrupt
    b. Stepper immediately unlocks the deadbolt
    c. Any function being performed will continue as expected after unlock is preformed

OPERATIONAL FLOWCHART

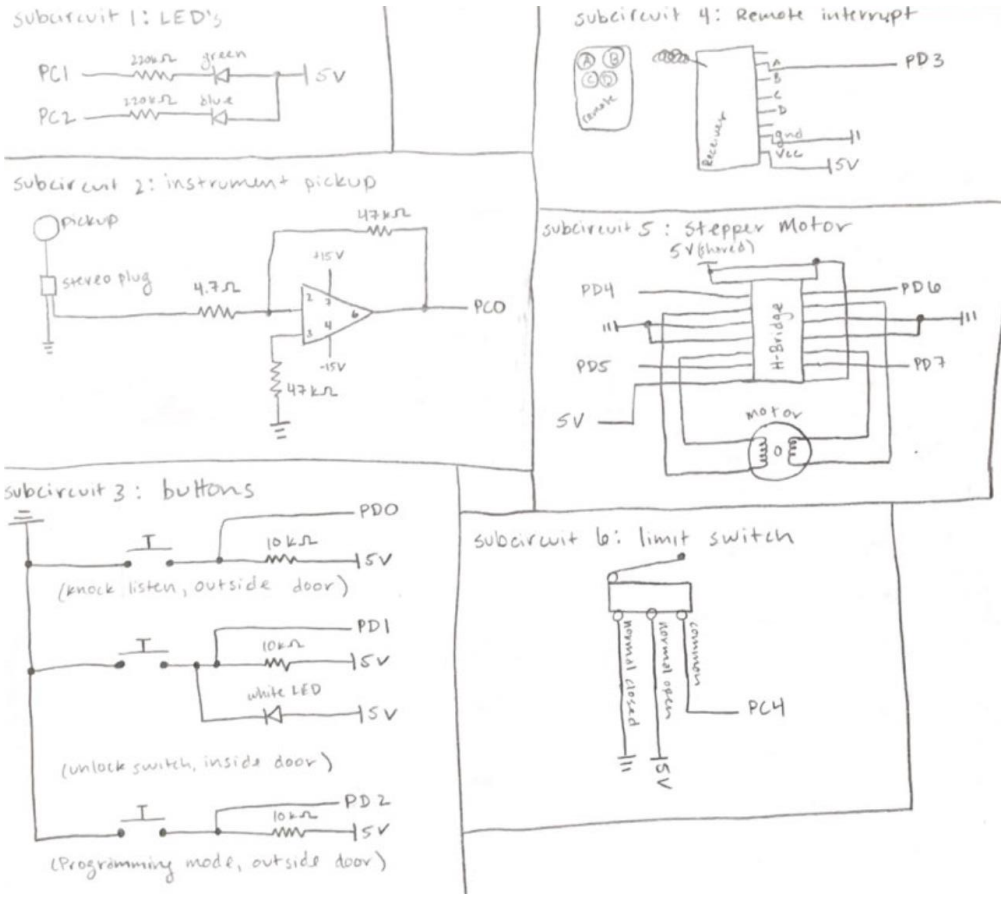


ELECTRICAL CIRCUIT SCHEMATICS

Main Circuit



Sub-circuits



LIST OF HARDWARE

- DC Motor (5in lb estimated) https://www.pololu.com/product/1472
- Gears (3D printed, see CAD model)
- Mechanical Limit Switch https://www.mcmaster.com/7090k38
- Mounting hardware (MakerSpace screws)
- Door supplies
    - 2x4, Qty: 3
    - Plywood (base and door)
    - Door hinge, Qty: 2 https://www.mcmaster.com/1603a2
    - Deadbolt https://www.homedepot.com/p/Defiant-Single-Cylinder-Stainless-Steel-Deadbolt-DL61-RQLBGS/205489284
- Key FOB
- Musical instrument pickup (provided by group member)
- Stereo Plug (Adafruit)
- Buttons with LEDs (Adafruit)

LIST OF TASKS COMPLETED

1. Solidworks design
    a. Tyler Clark
2. 3D printing of gears
    a. Tyler Clark, Zachary Yoder
3. Door construction
    a. Zachary Yoder, Tyler Clark
4. Signal processing
    a. Jamie Laughlin
5. Circuit construction
    a. Jamie Laughlin
6. Code
    a. Jamie Laughlin
7. Testing & data collection
    a. Zachary Yoder
8. Op-amp design
    a. Zachary Yoder, Jamie Laughlin

TEST PLAN

1. Knock functionality
    a. Programming mode effectively changes the required pattern
        i. Blinks correct pattern back to user

    b. Knocking the correct pattern unlocks the deadbolt
        i. LED blinks green
        ii. Knocking incorrect pattern does not unlock door
2. Manual unlock button
    a. Pressing the manual unlock button automatically unlocks the deadbolt
    b. LED blinks white
3. Re-locking
    a. Closing the door automatically causes the deadbolt to re-lock
    b. If deadbolt in unlocked and door is not opened for 4 seconds, deadbolt relocks
4. Wireless control
    a. Unlock button unlocks deadbolt
    b. Unlock button interrupts all other functionality
        i. Functionality continues as normal after door is unlocked
5. Other functionality
    a. Deadbolt can be turned manually without damaging the system