

IOWA STATE UNIVERSITY

Road Safe Phone Case

Team Number: sddec19-05

Client: Christine Shea-Hunt

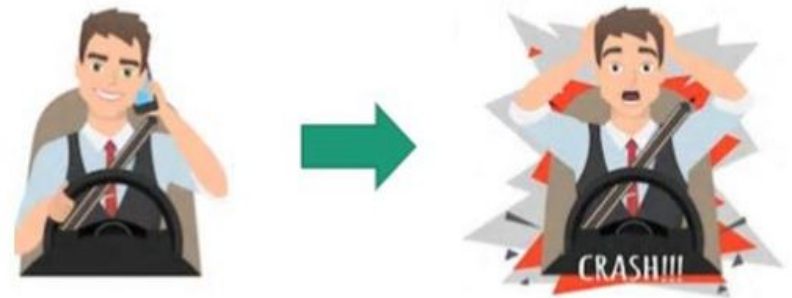
Advisers: Dr. Rover

Team Members: Sarah Baratta, Kedan Xin, Yue Chen,
Zixiao Lu, Yifei Wang

Team Website: <http://sddec19-05.sd.ece.iastate.edu/>

Problem Statement

- Phones are great for communication, entertainment, and more
- **Problem:** Phones lead to distracted driving, which can be fatal for drivers and others on the road
- **Solution:** A two-sided case that will enclose the phone while driving to ensure it will not become a distraction



Functional Requirements

- Case should prevent the driver from accessing phone while driving
- The system should identify the phone and car key of the driver only, not other passengers
- A locking mechanism should restrict access to either the phone or car key at all times
- There should be a method for the driver to have access to both their phone and car key in an emergency situation
- Case should send a notification to a designated person, such as a parent, when driver has access to both phone and car key
- The system should be able to communicate using the phone to send messages

Non-Functional Requirements

- Components will rely on a 9V battery supply
- Sensors should be stable so that lock works properly
- Case should lock within seconds of correctly triggering sensors
- Case should be able to withstand a drop from five feet

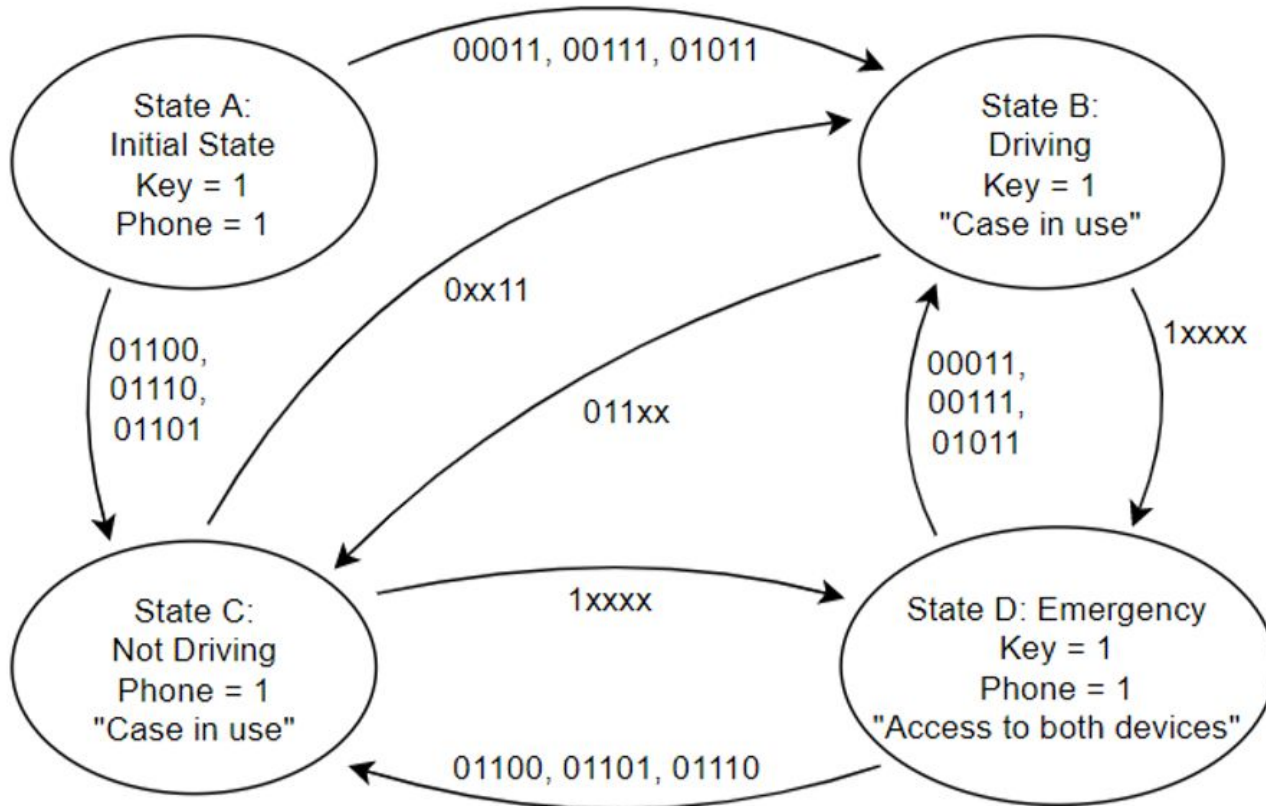
Operating Environment:

- Driver should only have one phone
- Driver should have a designated person to receive notifications
- Case should remain indoors and should endure various temperatures from within a car
- Case should fit in a spot within the car where it will remain stationary

Market Survey



Functional Decomposition



(inputs in the order: **abcde**)

- a** - Emergency (button)
- b** - Car key lid is closed (Magnet)
- c** - Car key in case (RFID)
- d** - Cell phone lid is closed (Magnet)
- e** - Cell phone in case (RFID)

Constraints and Considerations

Engineering Constraints:

- Case must be small enough to comply with campus 3D printing restrictions and to be carried in one hand
- Case must be large enough to fit smaller Android phones
- System should operate for five hours from the battery supply

Design Considerations:

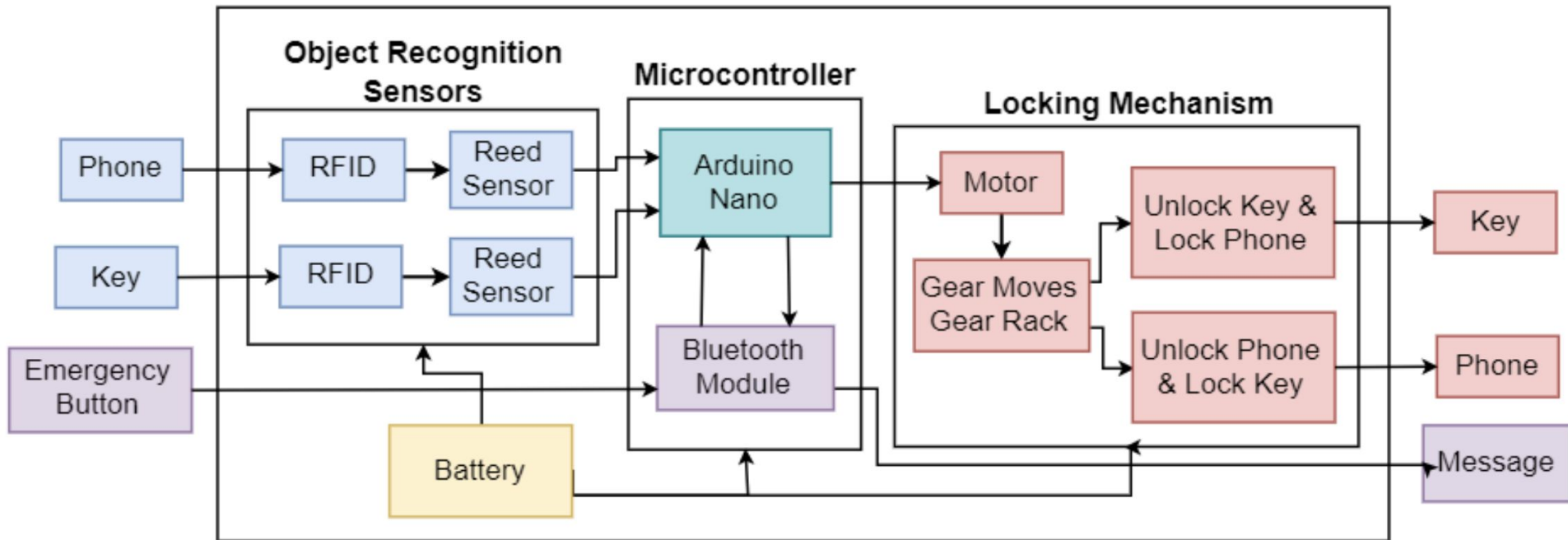
- Whether to take a hardware vs. software-based approach
- What features will make the product more marketable
- How to design for many types of phones and keys

Risk Identification & Mitigation

- User safety → Confidence in team's work
- User mischief → Foolproof design
- Product marketability → Lower cost components

System Diagram

Road Safe Phone Case



System Design

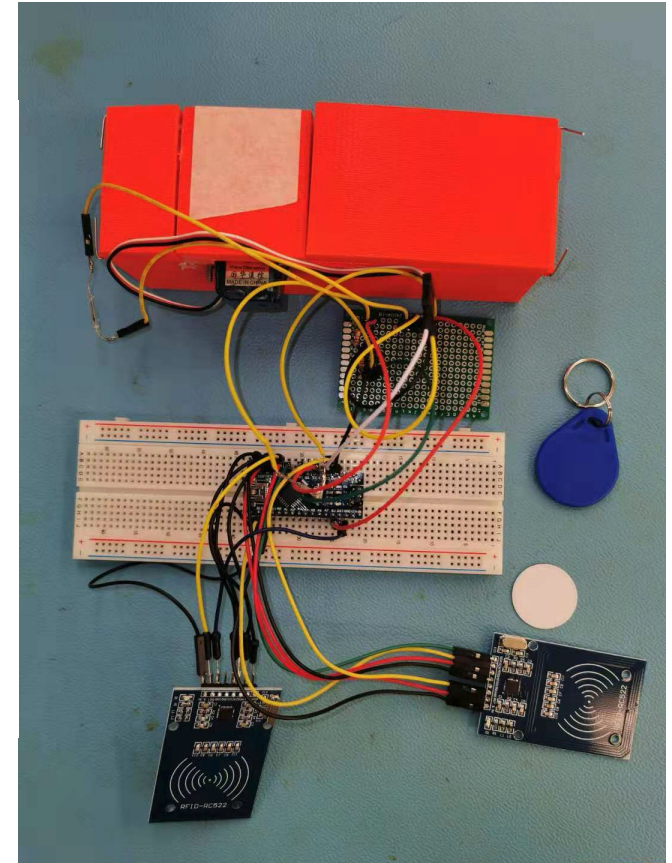
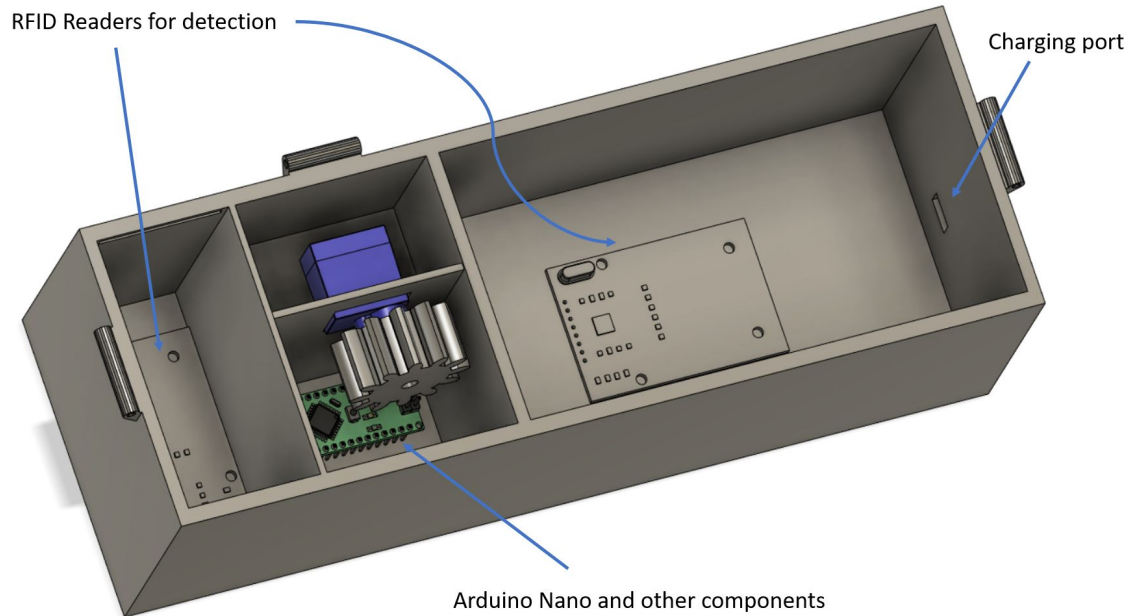
Hardware Used:

- Servomotor
- RFID Card/Reader
- Reed Switch
- Arduino Nano
- Bluetooth Module

Software Used:

- Android Studio
- Autodesk Fusion 360
- Google FireBase
- GitHub

Detailed Design: Prototype

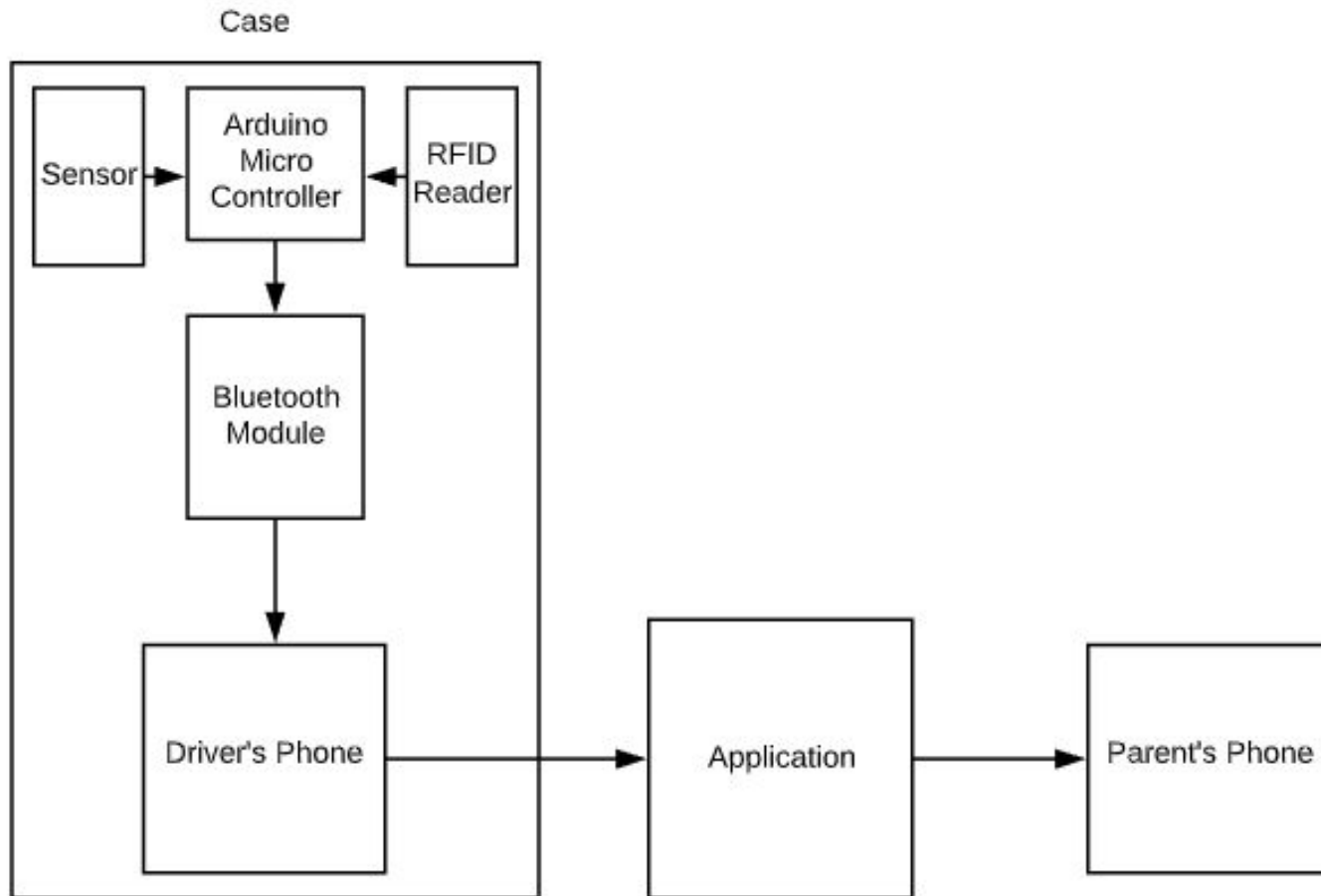


Resources

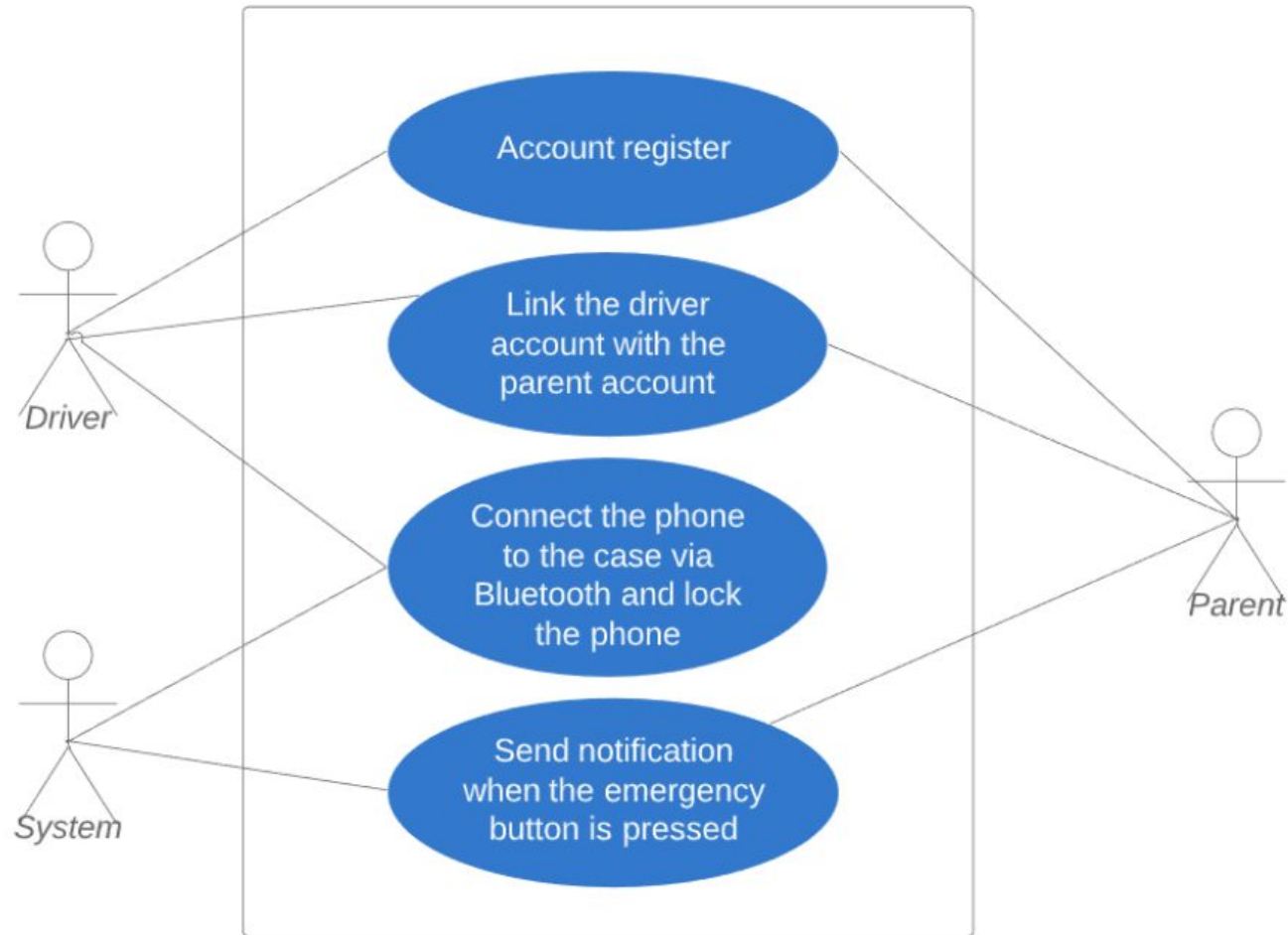
- Total cost of case is estimated to be around \$40

Part Name	Description	Quantity	Cost per Each	Lowest Cost
Arduino Nano	LAFVIN Nano V3.0, Nano Board ATmega328P (Amazon)	1	4.66	2.00
RFID reader	RC522 RFID RF IC Card Sensor Module (eBay)	2	1.46	1.00
RFID anti-metal sticker	YARONGTECH 8 x NFC sticker RFID anti-metal (Amazon)	2	0.87	0.75
3D Printed case	Lids, compartments, locking mechanism. Case weight = 300g of material = \$6 Charge for using campus printer = \$remainder	1	25.00+	\$6-10
Circuit components	2 resistors, many wires, emergency push button (free from ETG)	1	0.00	0.25
Servo Motor	Organizer 5 Pcs SG90 9G Micro Servo Motor Kit (Amazon)	1	1.80	1.70
Reed sensor	Reed sensor pack of 20 (Amazon)	2	0.45	0.28
Magnet	To activate reed sensor (Amazon)	2	0.05	0.05
Battery	Non-rechargeable 9V Alkaline battery	1	0.66	0.60

Messaging Data-flow Diagram

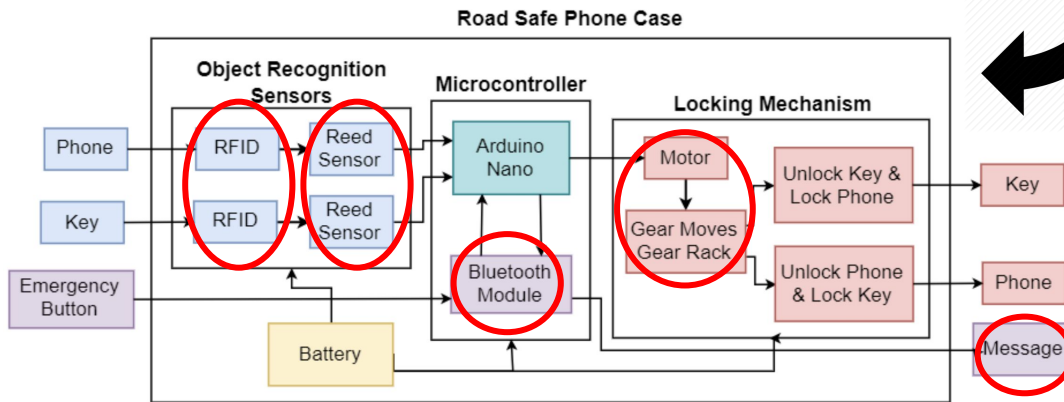


Mobile App Use Case Diagram

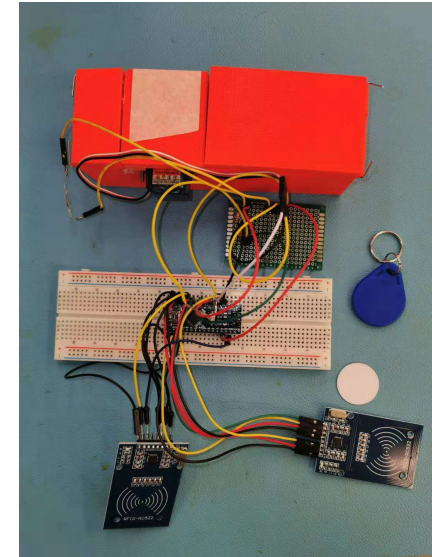


Test Plan

Component Testing:



Integration Testing:



Engineering Prototype:



Test Results: Mobile App

User Sign Up:

Authentication

Users Sign-in method Templates Usage

Search by email address, phone number, or user UID Add user ↻ ⋮

Identifier	Providers	Created	Signed In	User UID ↑
test1@gmail.com	✉	Dec 10, 2019	Dec 10, 2019	dXbkZJJ719bTBwG6MKzwEdpM19p...
seniordesign@gmail.com	✉	Dec 10, 2019	Dec 10, 2019	ihyfcyYkugT1bYxkKvWUnGLmyr2
test@gmail.com	✉	Dec 10, 2019	Dec 10, 2019	rY0cQriWZBYqsVJnsHijCm6PIRE3

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login

test1@gmail.com

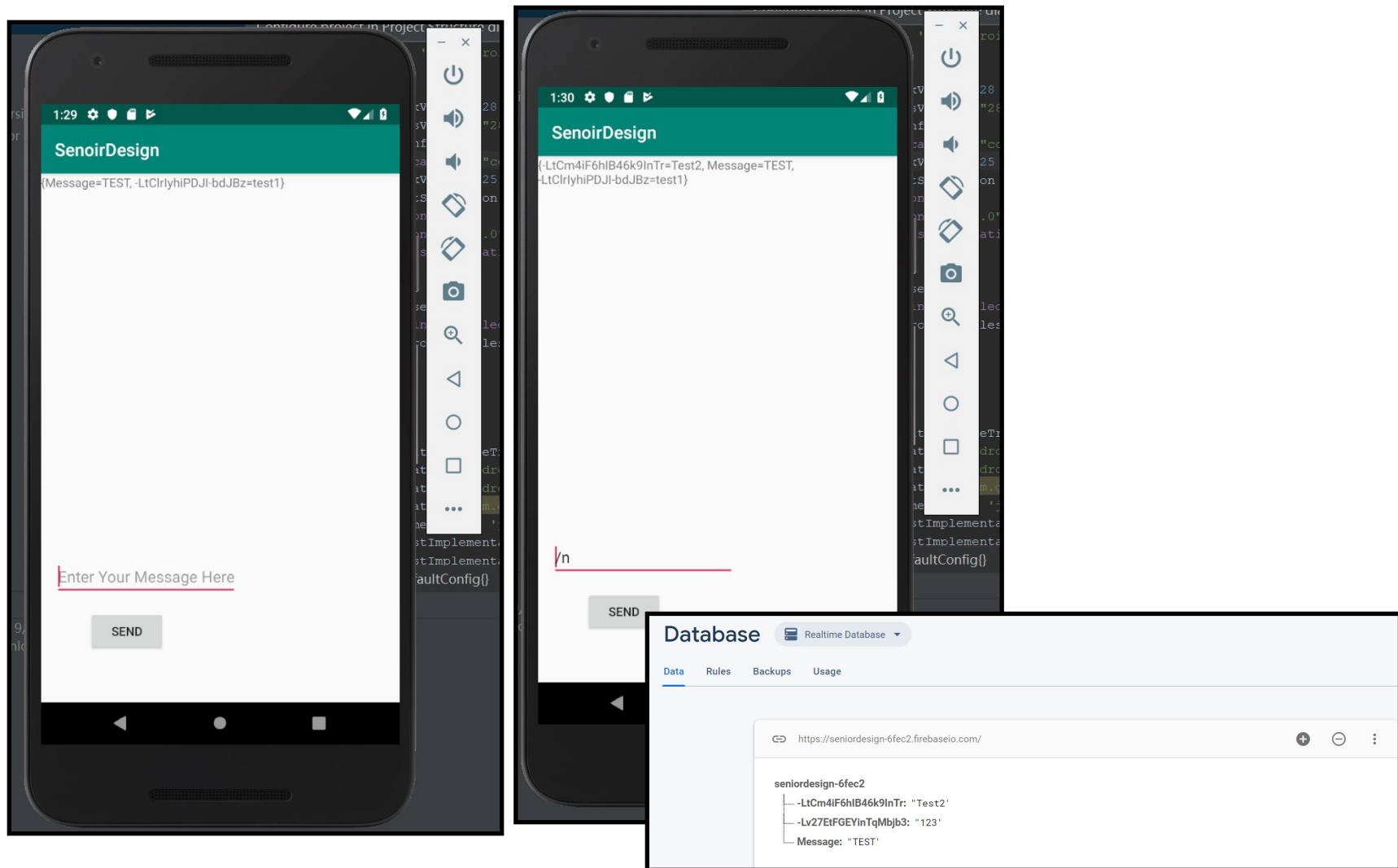
123456

BUTTON

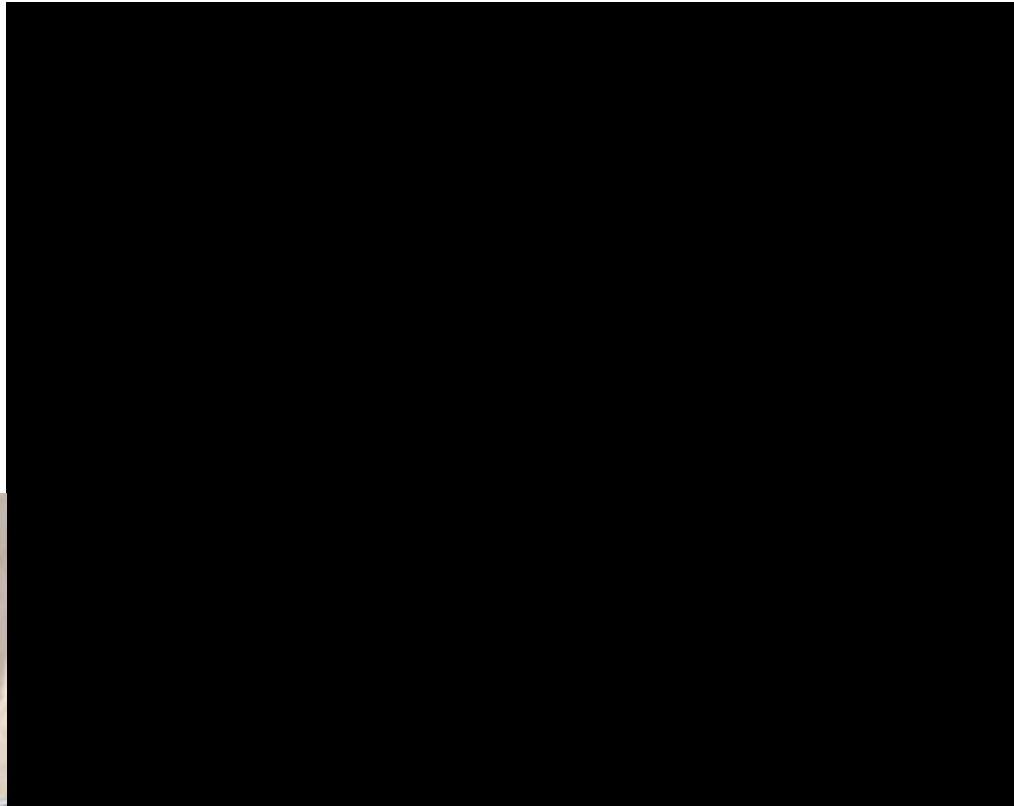
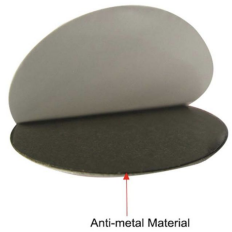
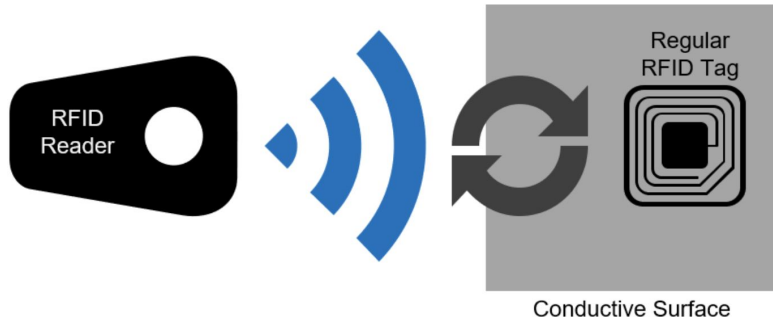
LOG IN

Successfully Register

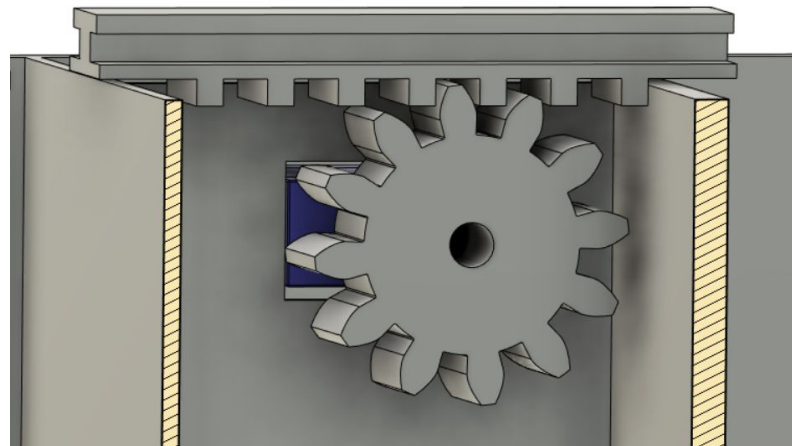
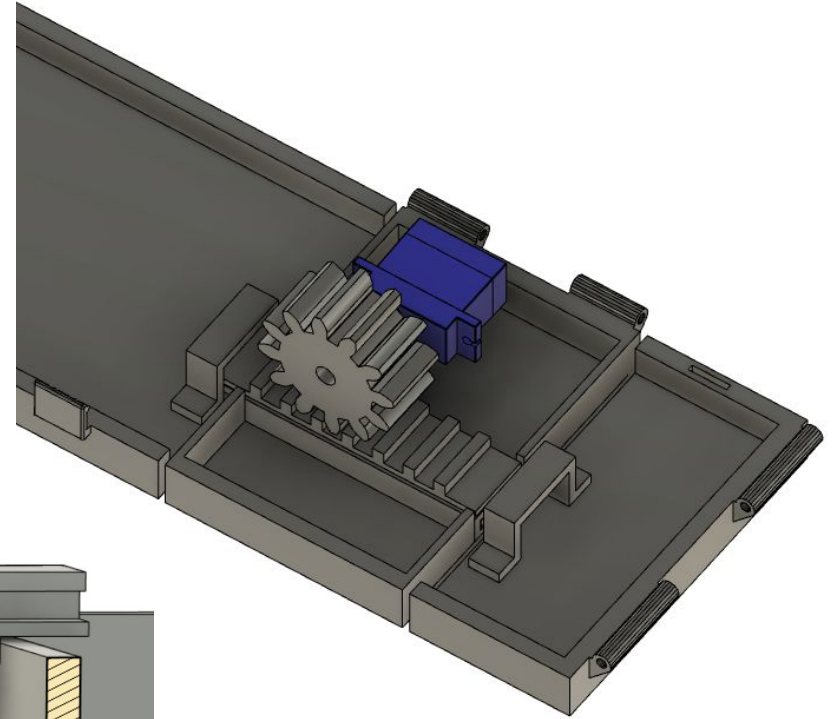
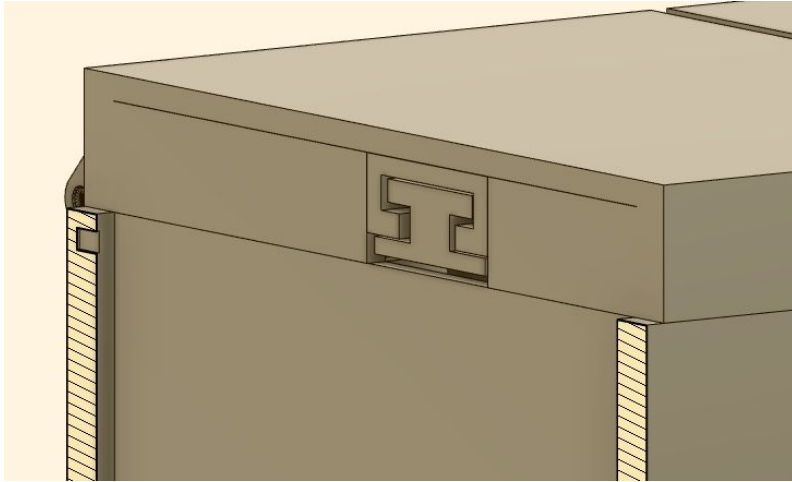
Test Results: Notification



Test Results: Object Detection



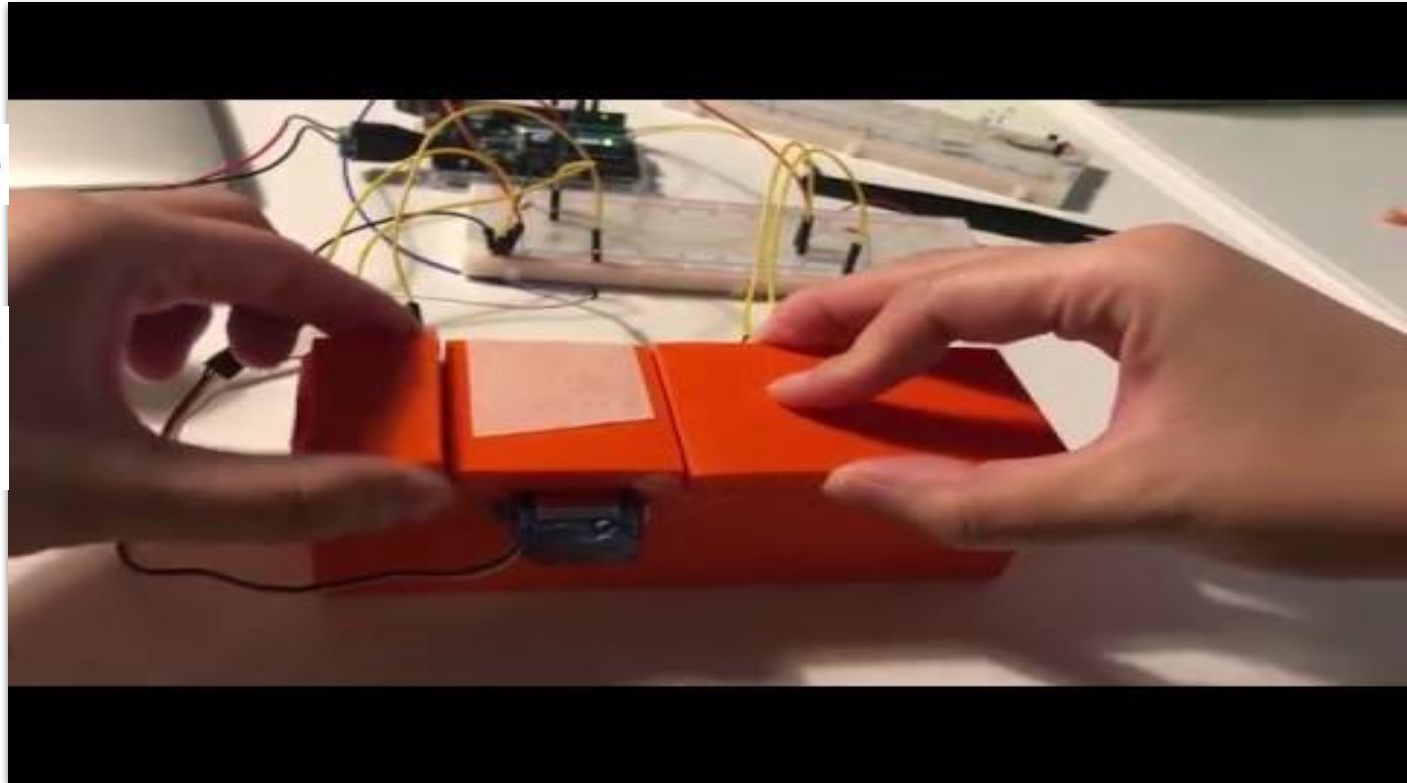
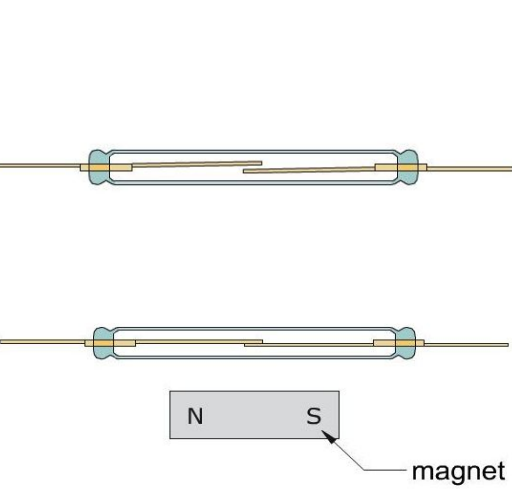
Test Results: Locking Mechanism



Test Results: Locking Mechanism

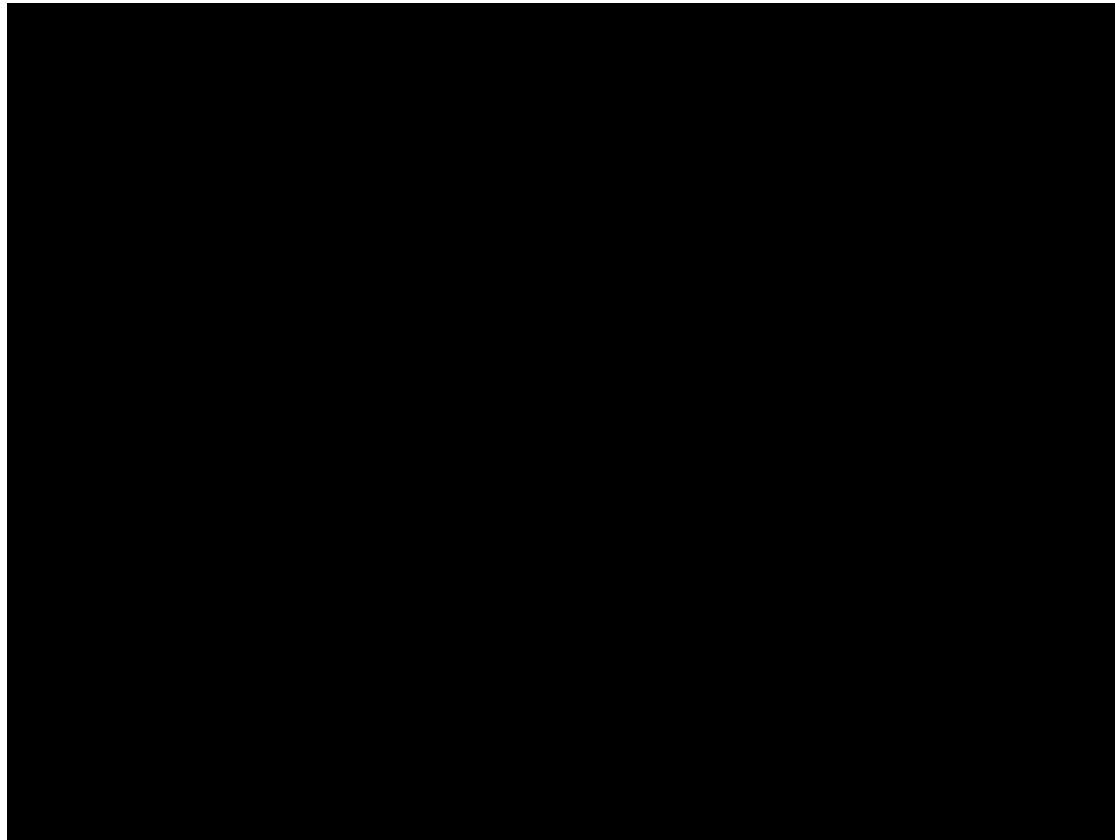


Test Results: Reed Switch

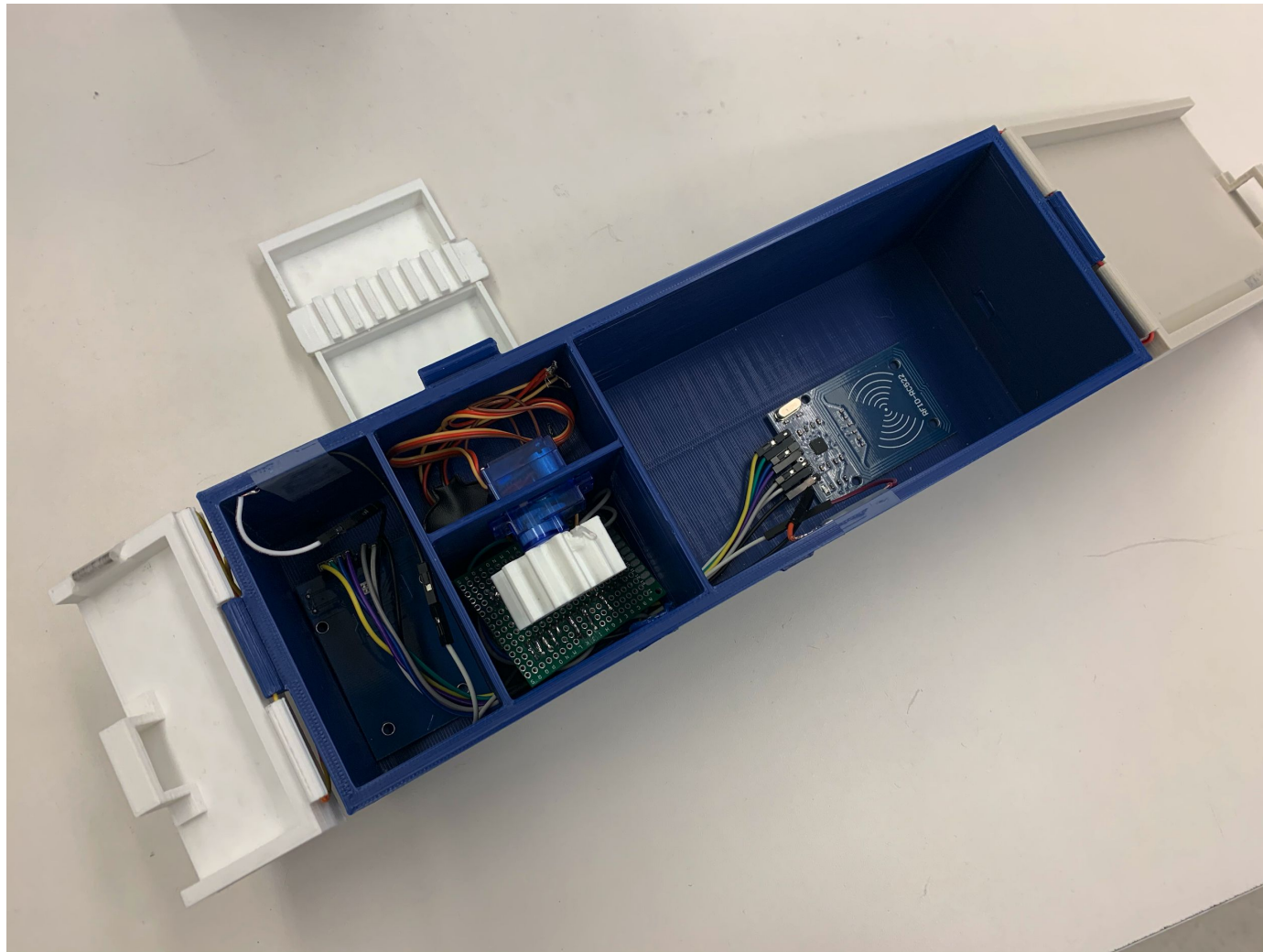


Test Results: Integration

- Components assembled together after each has been tested separately



Test Results: Engineering Prototype



Current Project Status

Achieved Functionalities:

- Locking mechanism
- Phone/key detection
- Cover open/close detection
- Emergency unlock

Unfinished Functionalities:

- Emergency message system
- Full integration of software and hardware

Future Work

- Foundation for a future senior design project
- Client's decision to pursue further development
- Potential for use in future vehicles

Lessons Learned

- Project had interdisciplinary prospects that we did not consider, such as manufacturing for test
- Obstacles could have been avoided by thoroughly researching components
- The team gained experience working with a client over a long period of time
- The team learned how to use “Design Thinking” to evaluate solutions other than what was proposed

Conclusion

- Overall, the client satisfies with the project design and progress made
- This project provided the opportunity to use our engineering knowledge to solve the real-world problem while attending to budgets, demands, and deadlines
- The team member gained experience in project management, team-based designing skills, and problem-solving ability

Questions?