Team A4 - BeatLock

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Problem

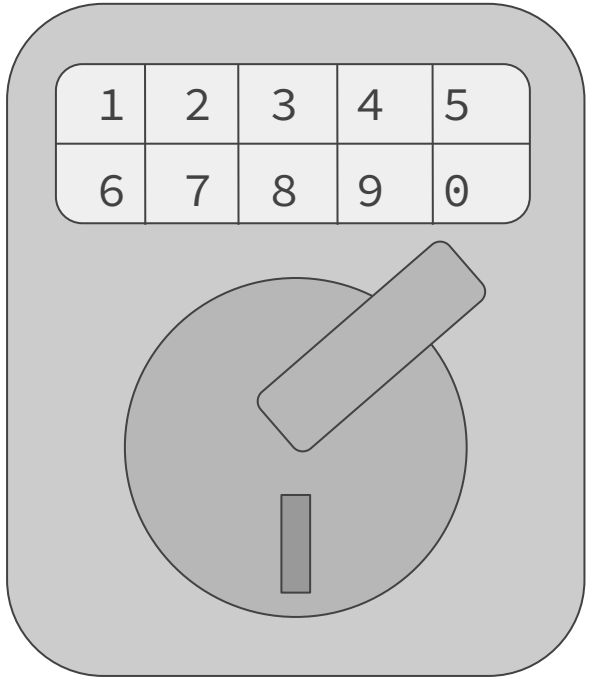
Current door unlocking systems:

Physical key or keycard

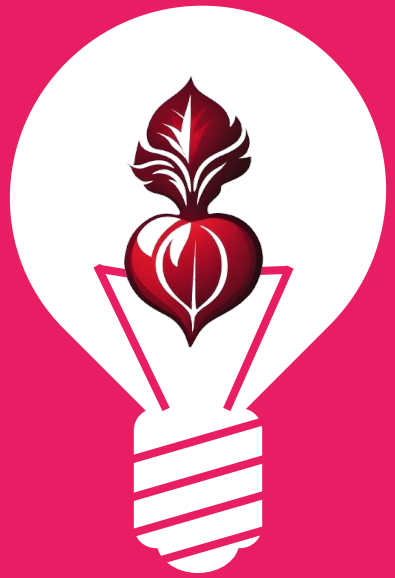
- Forgetting or losing keys prevents you from unlocking door
- Copies of keys can be forged

Number pad

- Limited security due to short passcodes



Use Case



- Security
- Fun and engaging
- Durable
- Relatively quick entry time
- Unique key for each user
- Reliability and repeatability

Areas: Software, Hardware, Circuits

Use Case Requirements

Requirement	Rationale
Two-factor authentication via phone app	Provides an additional layer of security
Minimum of 10 dance steps per dance	Greater security than a traditional keypad ($12^{10} > 10^6$), can be as short as ~5 seconds
Ability to add different dances/songs	Unique dance for each person
Backup PIN	When the user's phone is inaccessible, they can use a PIN pad to activate the mat
Differentiate between standing and stepping	Need to determine when to begin checking the dance sequence

Security Hardware/Software Manufacturing

Use Case Requirements

Requirement	Rationale
Communication between the phone, the mat, and the lock	Needs to interact with mat and phone to unlock door
Reliability	Correct dances must unlock door every time
Robust speaker array	Need to clearly hear song playing for accurate dancing
Robust materials and design	Door mat will experience wear and tear from daily use
Function as a traditional doormat	If it replaces someone's standard doormat, it should perform the same function

Security Hardware/Software Manufacturing

Technical Challenges - Software

Application Integration

- App must communicate seamlessly with mat
  - Zero delay for quality user experience

Wireless Security

- Authentication app must be secure

Correctness Algorithm

- The algorithm must give leeway for imperfect timing
  - Balance between security and user experience

Technical Challenges - Hardware

Step Detection and Reliability

- Finetune hardware to differentiate between stepping and standing
- Correct dances must grant access every time

Locking Mechanism

- Have a reliable locking mechanism with a functional keypad to select songs as a backup for if the user's phone is unavailable

Durability

- Chosen materials and final product design must withstand daily use and environmental factors

Long Term Power

- The mat needs to maintain functionality for extended periods of time to prevent the user from having to constantly replace the battery

Solution Approach

Software

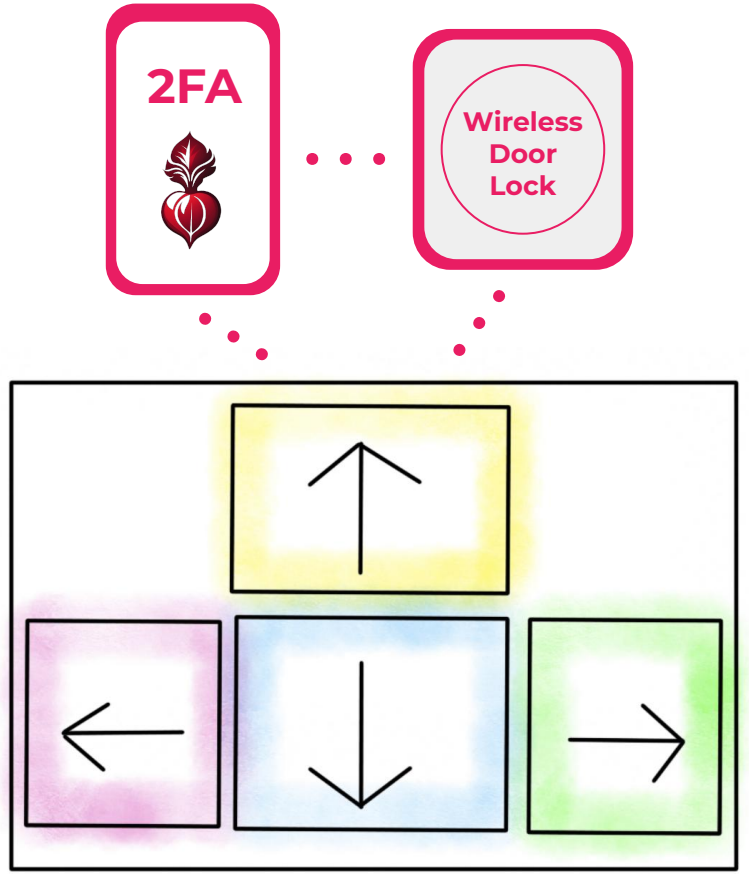
- Arduino IDE for Sensor Integration
- Swift for Authentication App

Hardware

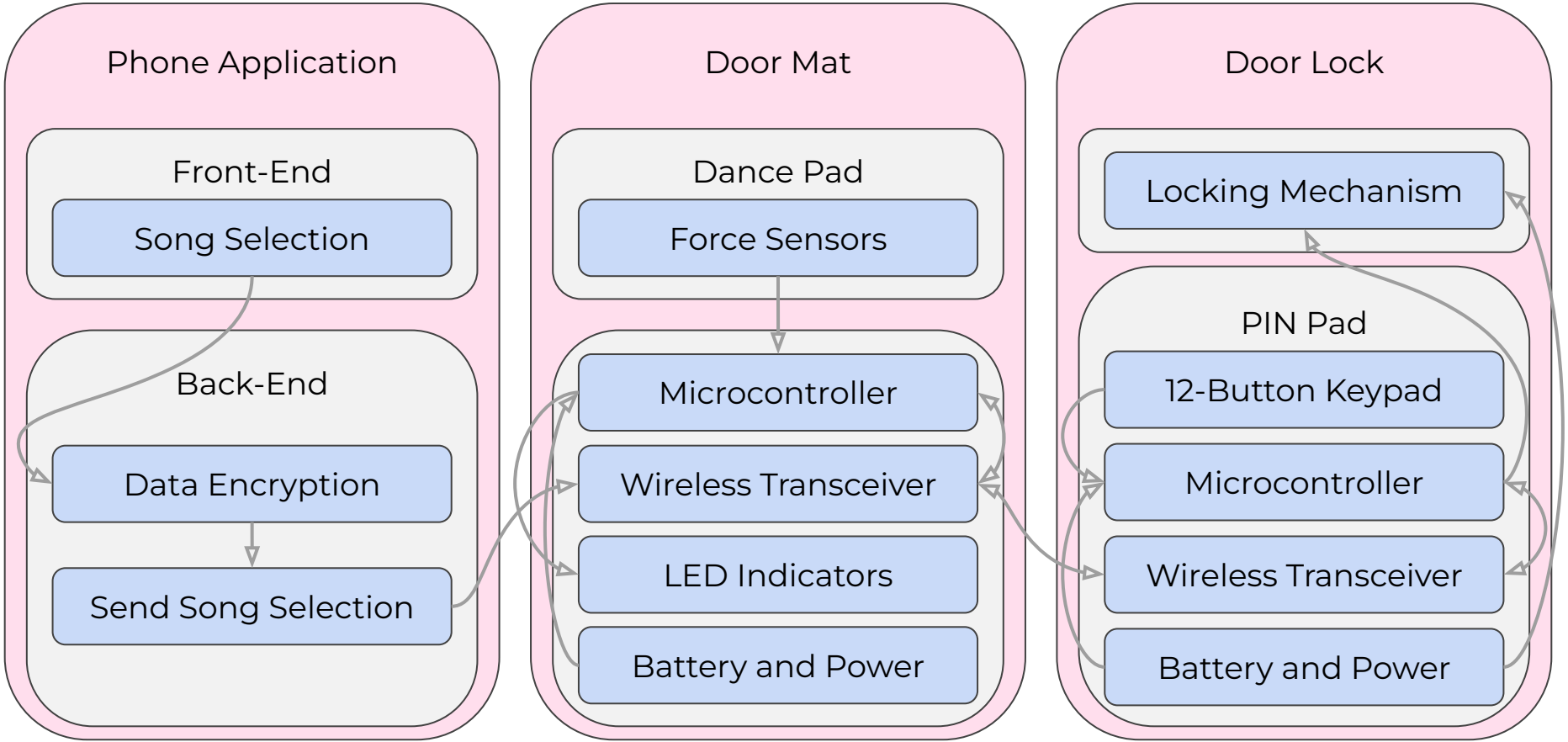
- Custom PCB
- Microcontroller for Mat and Door Lock
- Force-Sensing Resistors
- Midrange Speakers

Manufacturing

- 3D Printing
- Laser Cutting



Solution Approach



Testing, Verification, and Metrics

Functional testing

- Ensure mat, hardware, app, and lock all work as intended from the user's perspective

Usability testing

- Get feedback from others about user experience

Reliability testing

- Use stress testing and long-duration testing to find potential reliability issues

Tasks and Division of Labor

JADA: Hardware

- PCB Design
- Door Lock Design
- Manufacturing
- Hardware Testing

ZOE: Software

- App Development
- Firmware
- Wiring
- Software Testing

BROOKE: Hardware

- Sensor Integration
- Door Mat Design
- Manufacturing
- Hardware Testing

Schedule

Display week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
Planning and design				
Finish proposal presentation		50%	1/29/2024	2/4/2024
Compile materials list		50%	2/4/2024	2/18/2024
Sensor testing	Jada	0%	2/18/2024	2/25/2024
Flowcharts	Brooke	20%	2/18/2024	2/25/2024
PCB Schematic	Zoe	0%	2/18/2024	2/25/2024
MVP				
PCB Design	Jada	0%	2/25/2024	3/3/2024
Firmware	Zoe	0%	2/25/2024	3/3/2024
Build and wire mat	Jada & Brooke	0%	3/3/2024	3/10/2024
3D print foot pads	Brooke	0%	2/25/2024	3/3/2024
Create mobile app	Zoe	0%	3/3/2024	3/10/2024
Final product development				
Add songs	Jada	0%	3/10/2024	3/17/2024
LIDAR	Brooke & Zoe	0%	3/24/2024	3/31/2024
Wire lock	Zoe	0%	3/17/2024	3/24/2024
Build lock	Brooke & Jada	0%	3/10/2024	3/17/2024
Slack		0%	4/7/2024	4/21/2024
Testing and verification				
Functional testing	Jada	0%	3/31/2024	4/7/2024
Usability testing	Zoe	0%	3/31/2024	4/7/2024
Reliability testing	Brooke	20%	3/31/2024	4/7/2024