Knock-Turn Lock

Electrical & Computer Engineering

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Team Introduction

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Focuses: PCB Design, Actuator and Power Circuitry

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Knock, knock.

Who's there?
Doris.

Doris who?
Doris locked, that's why I'm knocking!
Project Objective

How do we maintain access to a space without a physical token? Consider AirBnB rental use case. There should be a secondary information token.
**Problem:**

It is very common to lose access to a space due to lack of physical token -- losing or not bringing a key. Current solutions are either clearly insecure, such as hiding a key, or convey an unsightly and obvious second path of entry, such as keypad lock.
Introducing the Knock-Turn Lock

An auxiliary combination lock based on door knocks and doorknob turns that offers a secure and convenient secondary access alternative.

Hiding the circuit within the door simultaneously maintains the aesthetic and conceals the existence of the secondary combination lock.
Video Demonstration
Hardware Design

Getting a handle of things
Original Design

- Microcontroller is the central hub
- Sensors are input
- Actuator is the only output
Revised Design:

- LED added for debugging
- Programming header removed
- IC socket added for microcontroller
- Software debouncing
Circuit - Actuator

PCB Final Lock Relay Circuit

- MOSFET relay
- Flyback diode
Actuator Simulation

LTSpice Simulation

• Lock modeled as inductor
• Generic NMOS
Actuator Simulation

Control Voltage
Current through lock
Circuit - Power

Power Design

- High tolerance for DC stepdown
- Low power use in standby
High Tolerance

- 1.8-5.5V for microcontroller
- Power of 60mW for microcontroller, 2.525mW for sensors

Low Standby Power

- Voltage drop on lock unlocking
- Low standby due to lock being active on low
Software Flow

Twists and Turns
Overview

Setup:
1. Configure pins
2. Set initial combination

Main Loop
Main Loop

Input?

- No user input for 5 seconds
  - Yes: Clear input array
  - No: LOCK

< N inputs detected?

- No: No
  - Yes: Input -> input array

Correct combination?

- No: No
  - Yes: Set combination

Programming mode

- Yes: Right button held for 1 second within 3 seconds

N inputs detected?

- No: No
  - Yes: Yes
Program Size

Program is efficiently written and fits well within the 8kB requirement

```
Sketch uses 2028 bytes (24%) of program storage space. Maximum is 8192 bytes.
Global variables use 35 bytes of dynamic memory.
```
Final Build

Knock on Wood
Annotated Electronics

- Single Piezo Sensor
- Contact wire on door handle
- Debug LED
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- Single Piezo Sensor
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Moving Forward

One door closes ...
Additional Features

• Rhythmic knock sequence
• Variable sequence length
• Advanced door handle design
  • Integrated contact pads
  • Integrated key fail safe
• Piezo sensor array
• Audio user feedback
Conclusions

Locking in a final design
Lessons Learned

• Simulate Circuit Conditions
• Test, test, test!
• Module testing through program hot-swapping
• Understand datasheets (RESET active low)
• Add test points to PCB

Design Improvements

• Hollow Door
• Lower threshold for knocks
Questions?

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