The Digital Doorman

ECE 511, Group 5

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The Digital Doorman

*Never again be locked out of your home!*

- Allows user to unlock a door with a special "knock rhythm."
- Keeps door locked otherwise.
- System is invisible from the outside.
- Alerts on failed entry attempts.

- Inside:
  - Microphone detects knocks
  - Solenoid deadbolt secures door
  - Button allows override
Block Diagram

- Condenser Microphone
- USB connection to PC Serial Terminal
- Signal Level Conditioner
- MSP430 microcontroller
  - ADC
  - GPIO
- Battery
- Voltage Regulator
- Switch
- Override (Lock/Unlock)
- Reset
- Buzzer
- Green LED
- Red LED
- MSP-FET430UIF
- USB connection
- Software UART 9600 Baud
- Darlington Driver Array
- Lock Solenoid
- Solenoid plunger acts as deadbolt
- Lock Switch
# Component List

<table>
<thead>
<tr>
<th>Name</th>
<th>Part Number</th>
<th>Hardware Interface</th>
<th>Software Interface</th>
<th>Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solenoid</td>
<td>690-C24-261012DC-AP 12VDC PUSH</td>
<td>Darlington Driver</td>
<td>GPIO Control</td>
<td>Ordered/Received/Tested</td>
</tr>
<tr>
<td>Microphone</td>
<td>AOM-4544P-2-R</td>
<td>OPAMP Gain Stage Low Pass Filter OPAMP Buffer ADC pin 1.7</td>
<td>Threshold Detection</td>
<td>Tested</td>
</tr>
<tr>
<td>Toggle Switch</td>
<td>100SP1T2B4VS2RE</td>
<td>GPIO</td>
<td>GPIO Monitor</td>
<td>Ordered/Received/Tested</td>
</tr>
<tr>
<td>LED</td>
<td>HLMP-3680</td>
<td>GPIO</td>
<td>GPIO Control</td>
<td>Ordered/Received/Tested</td>
</tr>
<tr>
<td>Buzzer</td>
<td>DBX-01PN</td>
<td>Darlington Driver</td>
<td>GPIO Control</td>
<td>Ordered/Received</td>
</tr>
</tbody>
</table>
Firmware

- Written in C
- Detection algorithm
  - Receives ADC interrupts with microphone voltage samples at a constant frequency
  - Determines when an actual knock has occurred
  - Notifies recognition algorithm of each knock and its timing
- Recognition algorithm
  - Determines if each detected knock matches the knock pattern, within tolerance
  - Provides feedback outputs (pattern acceptance or rejection)
  - Provides lock control outputs
DETECTION

uint16_t ctr;

ctr = 0;

Get A/D sample

ctr++;

Analyze signal

Knock Detected?

Yes

Report ctr value to Recognition

No

RECOGNITION

idx = 0;

Wait for knock event from Detection

ALARM (flash red LED)

Wait for 3 seconds silence

Matches key?

Yes

idx++;

End of key?

No

abs(ctr - key[idx]) <= tol?

Yes

idx == key_len?

End of key?

No

UNLOCK

uint8_t idx;
const uint8_t tol = ...;
const uint8_t key[] = ...;
const uint16_t key_len = ...;
const int key[] = {10, 5, 5, 10, 20, 10}

"Key" pattern is pre-programmed in memory

Legend:
- "Key" knock event
- Observed knock event
- "Accepted Region" (+/- tolerance)

Rejected! knock event falls outside accepted region

Accepted! all knock events fall within accepted regions
# Timeline & Status

<table>
<thead>
<tr>
<th>Task</th>
<th>Responsibility</th>
<th>Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component selection</td>
<td>Russell</td>
<td>10/11/2011</td>
</tr>
<tr>
<td>Board fabrication/interfacing circuitry</td>
<td>Russell</td>
<td>11/01/2011</td>
</tr>
<tr>
<td>Recognition firmware</td>
<td>Doug</td>
<td>11/15/2011</td>
</tr>
<tr>
<td>Detection firmware</td>
<td>Mahmoud</td>
<td>11/15/2011</td>
</tr>
<tr>
<td>Debug/UART firmware</td>
<td>Jeremy</td>
<td>11/15/2011</td>
</tr>
<tr>
<td>Test/debug firmware</td>
<td>Group</td>
<td>11/22/2011</td>
</tr>
<tr>
<td>Final testing</td>
<td>Group</td>
<td>11/25/2011</td>
</tr>
<tr>
<td>Project demonstration (miniature door with mounted solenoid and project enclosure)</td>
<td>Group</td>
<td>12/06/2011</td>
</tr>
</tbody>
</table>

- Component investigation and selection
  - Tested each component separately to verify functionality and behavior
- Basic firmware for different components
  - ADC knock detection and recognition
- UART for debugging
  - Printed characters to PC terminal
- Initial testing for hardware and firmware