ChessMate
Initial Design Review

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Philip Lo
Alex Babicz
Jason Dahn
Product Description

ChessMate is an interactive, LED illuminated chess board that enhances a player’s experience by providing various digital board augmentations. These include multicolor LEDs that automatically light up valid moves when a player picks up a piece, a touchscreen display that passively times each player as moves are made while displaying pertinent game information.
ChessMate Development Team

- Jeremiah Schultz (Leader): LCD interfacing and addressing, user interface design
- Philip Lo: Embedded software integration, board-logic
- Alex Babicz: LED and IR proximity sensor interfacing
- Jason Dahn: Board assembly, peripheral interfacing, software board memory
- All: PCB design, embedded development, enclosure assembly
Application & Usage

- Designed to help visualize chess moves on the playing surface
  - “Middle-man” between player’s thought-process and game-board
- Applicable to players of all skill levels
  - Assist new players in learning possible moves for each piece
  - Complement experienced user’s knowledge with visual representation
  - Toggle LED illuminations to practice/play without visualized moves enabled
- Simple touch LCD interface to combine simplicity and accessibility
  - Easily start/restart a new game with 1-button press
  - Track pieces that have been taken
  - Display last move made by each player
Block Diagram

- **IR Proximity Tile Sensors**
  - Vishay TCRT1010

- **Controller**
  - LPC4088
  - (Cortex-M4)

- **Multi-Color LED Strip**
  - LPD8806

- **Game Board Surface**

Connections:
- Analog connection between IR Proximity Tile Sensors and Controller
- RGB/I^2^C connection between LCD Touchscreen Display and Controller
- I^2^C connection between Controller and Multi-Color LED Strip

Key:
- No electrical connection
Initial Specifications

- **Game Surface and Enclosure**
  - Wooden box board enclosure to house entire unit
  - Indent on side panel of enclosure to mount LCD on the board

- **Sensors**
  - IR Proximity sensor: detects when a piece is picked from the board and moved to a new/same location on the game surface

- **Multi-color LEDs**
  - Visual representation of possible moves based on which piece is being used
  - Place beneath each game tile to illuminate specific squares

- **LCD Touchscreen**
  - User interface to start a new game
  - Displays passively timed clock for the game and player turns
  - Displays moves and pieces that have been taken
Processor - LPC4088 (with Cortex-M4 CPU)

- Memory: 512 kB flash, 96 kB RAM, 4k EEPROM
- Max clock speed: 120Mhz
  - Expected to operate at max speed
- Power: 2.4V - 3.6V supply voltage
  - 1.5W power dissipation
- Serial Interfaces: 5 UART, 3 I²C, 3 SPI
  - Peripherals used require I²C
- Analog peripherals: 12-bit ADC & 10-bit DAC
- Temp Range: -40 to +85 °C
IR Proximity Sensor - Vishay TCRT1010

- Analog output
  - Convert to digital for simplicity
- Detection distance 1 - 10mm
  - Detect when piece has been picked up from surface
  - Daylight blocking filter
- 4 wires per sensor
  - 2 unique wires for each individual sensor
  - Common signals for 2 wires across all sensors
- Supply: 5V input voltage
  - 200 mW total power dissipation
- Average output current 0.5 mA
LED Strip - Adafruit Digital RGB LED Strip

- **Connection via 4-pin JST SM connector**
  - 8 connectors total for each row of tiles

- **Digital I²C interface**
  - Individually control each LED
  - Cut strip into 8-LED increments

- **Power: 5V Supply voltage**
  - Max 5V @ 120 mA across one segment
    - One segment = 2 LEDs/1 LPD chip

- **16.5mm wide, 4mm thick**
  - Sized to fit under each game tiles
  - 8x8 matrix of LED segment strips
NewHaven LCD Touchscreen - NHD-7.0-800480EF

- TFT 24-bit parallel RGB, Capacitive I²C interface
- 16.7M colors
- 7” screen, 800 x 480 resolution
- Wide Viewing Angles (75°)
- TFT Power supply:
  - Vdd = 3.3V
  - Backlight Anode = 10 mA @ 9.6V
- Capacitive Touch Panel Power supply:
  - Vdd = 3.0 V
- Wide Temp Range: -20 to +70 °C
# Current Bill of Materials

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<thead>
<tr>
<th>Manufacturer Part #</th>
<th>Description</th>
<th>Price</th>
<th>Distributor</th>
<th>Distributor Part #</th>
<th>Quantity</th>
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<tr>
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<td>LED Strip (32 LEDs)</td>
<td>$30.00</td>
<td>Adafruit</td>
<td>306</td>
<td>3</td>
<td>$90.00</td>
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# Development Plan

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<th>Milestone</th>
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<th>End Date</th>
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<th>Person Responsible</th>
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<tr>
<td>Initial Design Review</td>
<td>10/12/2015</td>
<td>10/25/2015</td>
<td>Create powerpoint for system level design, including parts</td>
<td>Everyone</td>
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<td>Collect Datasheets</td>
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<td>Low level hardware implementation</td>
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<td>Provide proof that the job can be done</td>
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Technology Reuse

- **LCD Display**
  - Used in previous capstone projects (different size but same interface)
  - Drivers supplied by manufacturer
  - Processor has built-in LCD driver
- **Multi-colored LED strip**
  - Tutorials provided by Adafruit for implementation
  - Arduino experimentation and previous experience addressing LEDs individually
Critical Elements

● Smooth sensor interfacing for each individual tile & piece
  ○ Accurate IR proximity reading for when a player has removed a piece from the playing surface
    ■ Must recognize individual tiles and pieces separately to uniquely identify each game-tile

● Software logic to monitor and maintain piece locations in memory
  ○ Must track every piece’s movement and store its current location in memory to determine possible moves
    ■ Intuitive solution: All pieces start in the same position at the beginning of every game. Based on which sensor detects movement first, use that position as a basis for where that piece has moved and which pieces do not detect any objects above them to identify vacant tiles.

● LCD Interfacing and GUI Design
  ○ Simple and efficient display - Navigate between several displays