Team 10

MagiChess

Jack Deguglielmo, Samantha Klein, Weishan Li, Sai Thuta Kyaw

Advisor: Shira Epstein
Meet the team

Sai Thuta Kyaw
Electrical Engineer

Samantha Klein
Electrical Engineer

Jack Deguglielmo
Computer Engineer

Weishan Li
Computer Engineer

Shira Epstein
Faculty Team Advisor
Problem Statement

For centuries, the game of chess has been played by two players sitting across a chessboard. The advent of digital technology in the last decades has brought virtual chess to computers and mobile phones and for the first time, this has allowed players to be anywhere across the world.

Digital chess lacks:

- A physical aspect/satisfaction of seeing and moving your own pieces

Physical chess lacks:

- Ability to play from anywhere and with anyone
We’ve decided to close the gap between physical and digital chess. To do this, we plan to create a chess board that allows users to play with an AI or a remote human opponent.

Our board will:

- Move pieces replicating an opponent
- Include a display for user interface
- Include a speaker for audio feedback
- Have internet connectivity for remote games
Preliminary System Specifications (Design-agnostic)

- Mechanically move a piece to destination cell
- Remove/replace a piece to/from game board
- Provide visual feedback
  - Game setup
  - Game announcements
  - Where pieces can move after picked up
- Provide audio feedback
  - Notification alerts
- Play versus remote opponent or AI opponent, or learn how to play chess.
- Playback previous games
- Includes buffer zone to store captured pieces
Preliminary System Specifications (Quantitative)

- Total system dimensions: no larger than 26in x 26in x 6in (65cm*65cm*15cm)
- Speed of XY plotter: 4-5 cm/s
  - Max time for a move: 15s, x2 for capture and transport
  - Average time for a piece to move: 7.5s
- Weight: Under 25lbs
Competing Solutions in Marketplace

Commercial Solutions and Products

- **Square Off ($399 - 450)**
  - Globally connected, autonomous chess board
  - Capabilities:
    - Autonomy, Chess.com integration, PvP and PvB modes, move speed
  - Differences:
    - no native display, limited auditory feedback

- **DGT Chess ($400 - 900)**
  - Chess “E-Boards”
  - Capabilities:
    - piece detection, portability, integration with various chess engines
  - Differences:
    - no autonomously moved pieces
Chess automation and connectivity is a topic of many university and recreational projects. Square Off and other commercial solutions have influenced the design of new chess automation capabilities.

**IoT Connected Chess Boards from SparkFun!**
SparkFun’s solution using LEDs to indicate positions of pieces

**James Stanley’s Project**
Project built by James Stanley on Youtube. Interfaces with Lichess via API calls on Linux-based system
Method 1:
Use multiplexed RFID antennas across 64 cells.

Method 2:
Use six different strength magnets with different poles to identify pieces.

Method 3:
Use magnets to sense occupied cells and single RFID reader to identify.
A game has started, piece locations have been scanned and verified

Physical user makes move

After confirmation and preliminary validation, the user’s move is sent to the server

Invalid move message sent back to board. System prompts user to make a different move

Opponent’s move message sent to board. System gantry moves opponent’s piece to destination cell using path planning algorithm.
Path Planning the Chess Pieces

Why A* Search?
1. Completeness
2. Optimality
3. Best-First Search
4. Allows for diagonal movements

Heuristic Function:
- number of moves from solution

\[ f(n) = g(n) + h(n) \]
Significant Custom Hardware Design

- Provides power to all subsystems
- Microcontroller for communication with Pi and Motor Controllers for moving chess pieces
- Microcontroller for communication with ADC and RFID reader for chess pieces mapping and sensing
- H bridge to control electromagnet
- Includes pin headers for easy debugging and programming
Proposed MDR Deliverables

- LiChess integration with Raspberry Pi (initiate games, execute moves, etc.)
- GUI prototype for Raspberry Pi touch display
- Raspberry Pi outputting digital communication protocols
- Assembly and movement of XY plotter (gantry)
- Results from RFID multiplexing / Hall Effect sensor testing
  - Decision on which sensing technique to use
## Cost Estimates

### Scenario #1: RFID

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<thead>
<tr>
<th>Component</th>
<th>Est. Cost</th>
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<tr>
<td>Gantry</td>
<td>$121</td>
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<tr>
<td>Raspberry Pi</td>
<td>$35</td>
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<tr>
<td>Touch Screen Display</td>
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<td>Motor Drivers</td>
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<td>Chess Pieces</td>
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<td>Electromagnet</td>
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<td>RFID Test</td>
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<td><strong>Total</strong></td>
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### Scenario #2/3: Hall Sensor or Hybrid

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<th>Component</th>
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Technical Responsibilities

Jack
- LiChess Server + Pi Integration
- Software interface between GUI/API
- XY Plotter (Gantry) Assembly and test
- Altium Lead

Weishan
- Touch GUI Prototype for Pi
- Software interface between GUI/API
- XY Plotter (Gantry) Assembly and test

Sam
- RFID Antenna Multiplexing testing
- Multiplexing Analog Signals for Hall Sensor input
- Budget Manager

Sai
- Hall Sensor test w/ diff. Magnets
- RFID on system testing
- XY plotter (Gantry) assembly and test
- Team Coordinator
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<td>Sensing</td>
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Thanks for watching!!