Team BO: Seamless Autonotator

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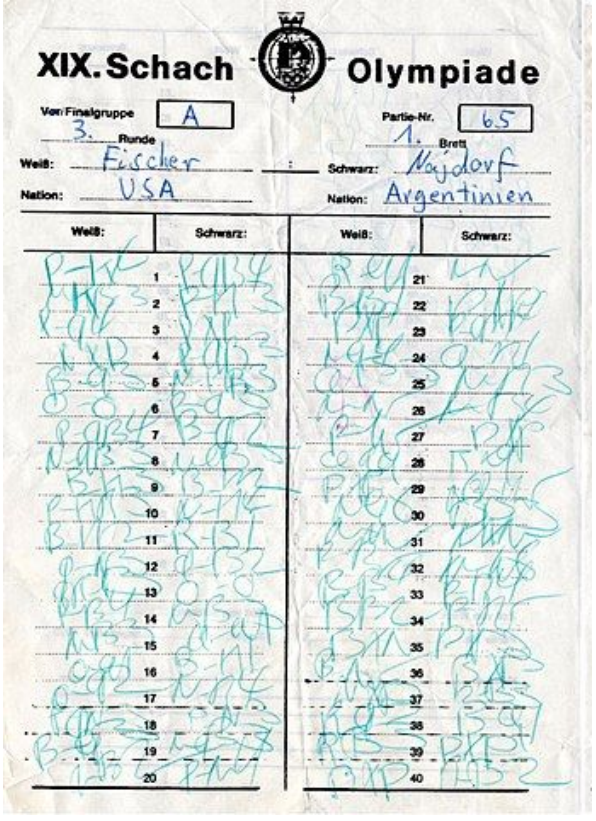
Problem Statement/Use Case

- Notation is the way chess moves are recorded

  (Nc3, Bxf6)

- Notation is useful
- Possibility of errors and time-consuming
  - Handwriting
  - Forgetting to notate
- Solution: Create a system that makes it easier for chess players to notate

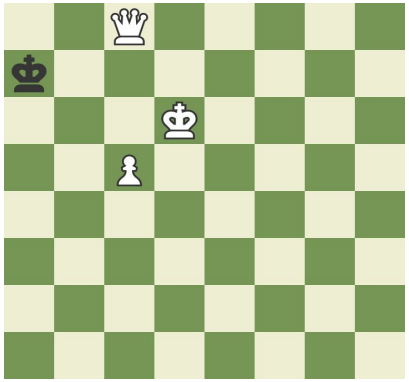


Requirements Revisited

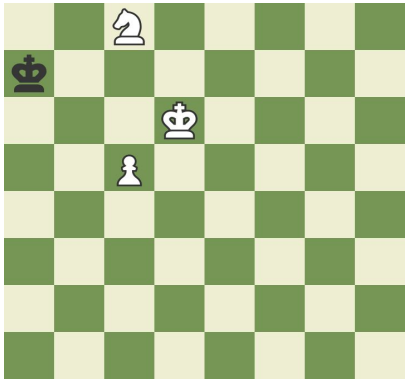
- Record notation with **100% accuracy**
- Report move legality in **300ms** or less
- Provide **10 hours** of battery life
- Access previous **10 games** through website
- Provide exportable PGNs through website for analysis on Chess.com

Revisiting Piece Detection

- Planned to distinguish between black and white
- Overlooked one situation - pawn promotion
- Pawn can promote to a Knight, Bishop, Rook, or Queen
- Sensors should be able to distinguish between them, but MVP will remain white vs. black



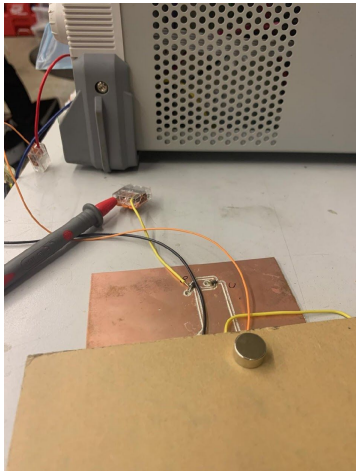
Stalemate!

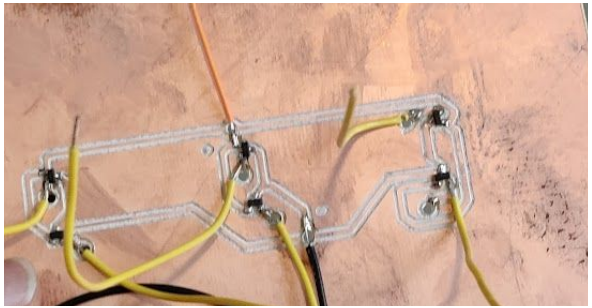


Game continues, white should win

Solution-Custom Board and Pieces

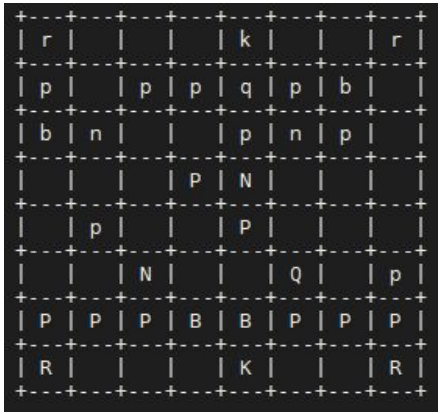
- Chess board made from acrylic
- Plastic pieces
  - Magnets in the hollow bottoms of pieces
- PCB with hall-effect sensors directly under the board
  - Bipolar sensors for simplification
  - One sensor per square, multiplex into ADC
- Power
  - Integrated batteries under board
  - 5V and 3.3V Regulators
- Connects to Raspberry Pi

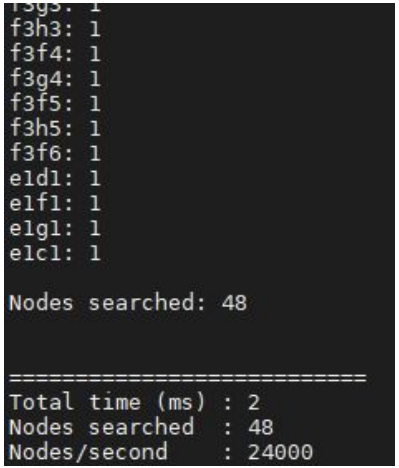




Solution-Legality Check

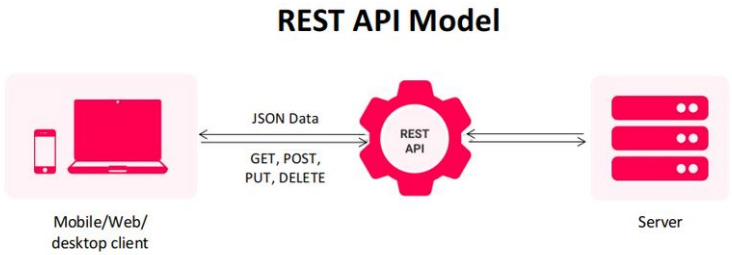
- C++ program reads sensor output and determines the source and destination of the moved piece.
    - Compares new board state to previous board state.
- Compares move against legal move list and returns result via green/red LEDs on board.
    - Legal move list is generated by Stockfish move generation.
    - Fast enough (<10 ms) and has low memory usage.
- Updates board state if move was legal, back to previous state if illegal.



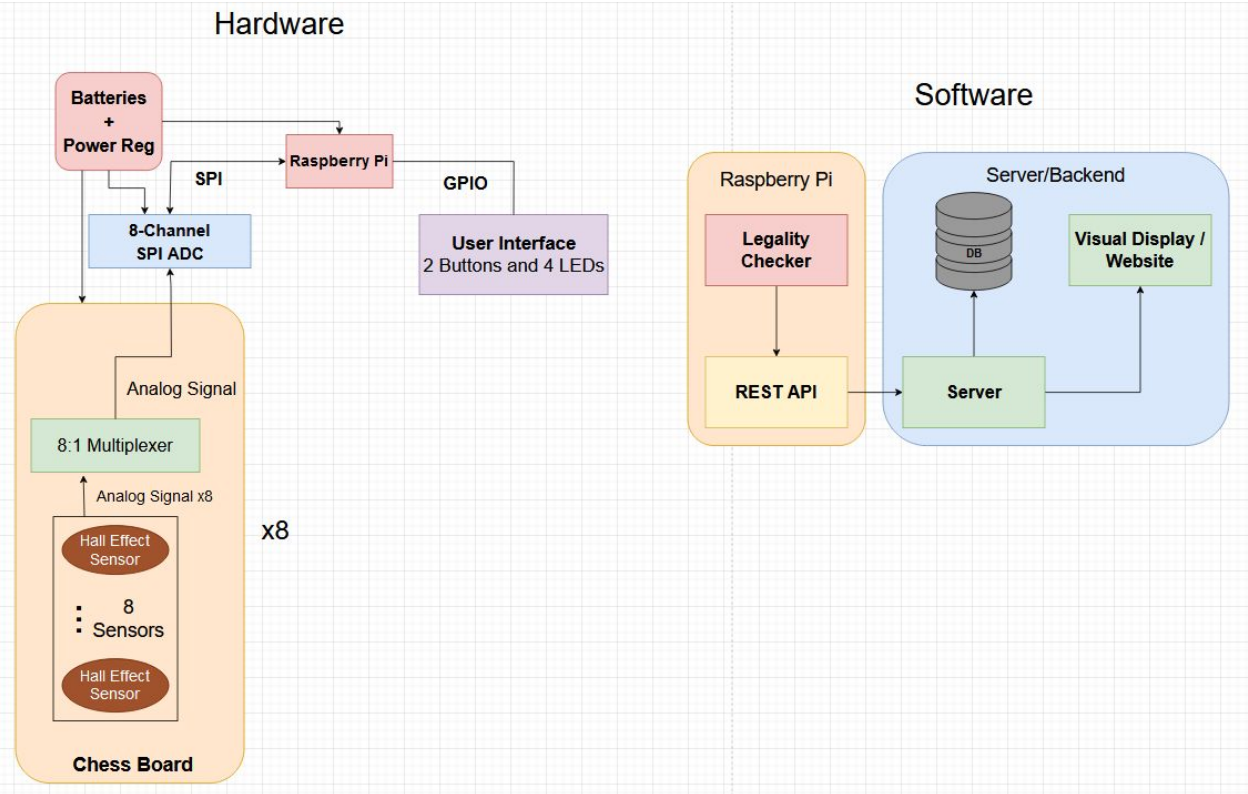


Solution-Database/Website

- Use Django (Python) to write the server backend
- Use the built in sqlite database (hosted locally) to store games (MVP)
    - Expand to a SQL Database hosted on AWS
- REST API for interactions between Pi and server



Block Diagram



Implementation

	Off-the-shelf	Designing

Hardware	• Sensors
	• Magnets
	• PCB Components
	• Raspberry Pi
		• Chess Board PCB
		  ○ Sensing Circuits
		  ○ User Interface Circuits
		  ○ Power Regulation Circuits
		  ○ Interface with RPi
		• Mechanical Board

	Tech Stack	Uses
Software	• Django (Python) • HTML/CSS • C++ (Stockfish) • SQLLite / SQL	Website / Backend Frontend Legality Checker Database

Testing, Verification, Metrics

Requirement	Test	Mitigation of Failure
Accuracy of Piece Detection	• Move pieces at playing speed and test for accuracy of notation	Explore different magnet options to make sensing more robust
Latency	• Data collection, user input to visual output and website update	Identify latency bottleneck(s) with targeted testing.
Power use	• Power draw at idle and at peak computation	Determine if power use can be lowered, add batteries.

Schedule


Task
Start of Week
8/29/2022
9/5/2022
9/12/2022
9/19/2022
9/26/2022
10/3/2022
10/10/2022
10/17/2022
10/24/2022
10/31/2022
11/7/2022
11/14/2022
11/21/2022
11/28/2022
12/5/2022
Chess Board (Circuits and Hardware)
Sensor Research and Validation
PCB Schematic
PCB Layout and Ordering
PCB Assembly
PCB Hardware Tests and Validation
Making/Modifying Physical Board
Firmware and State Logic
Legal Move Generation
Legality Check
Notation Legality Check
Interface with Hardware
Interface with Software
Output State Logic
Software and Web
Creating Chess Class and Object Oriented Structure
Test Python vs C++ Latency Requirements
Create Website
Create Autonotater and interface Autonotater with Website
Allow Website to Read and Write from Database
Allow Website to export notation to chess.com
Create basic analysis tools within website (past games)
Integration
Test Data Collection with PCB
Testing Interface with RPi
Testing Web Interface
Validating Final Product
Hardware Testing-Power, Accuracy, Latency
User Testing
Slack

Conclusion

Our Solution

- Custom Chess Board
- Senses moves with magnets in pieces
- Raspberry Pi to take in sensor data and determine legality
- Pi communicates with server to maintain game database
- Server actively updates website to show notation
- Users can access previous games in database