MaGomoku Design Doc

Design Review
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Problem Statement & Use Case

A physical, **networked, automated Gomoku set made for:**

- Gomoku Lovers who want to level-up their experience
- Want to enjoy the physical game with online friends
- Elderly Users who are not familiar with online Gomoku games
- Tech enthusiast who want to try out magnetic levitation devices
- Interesting game that can kill time and bored

Design Requirements & Metrics

Use Case	Requirements
Detection & Board Integrity	● Distinction between black and white piece (aim for 95%) ● Detection of piece presence on the board (aim for 95%) ● Use sensors and software to ensure board integrity
Movement	● Stable magnetic levitation pick-up of piece (90% success) ● Stable piece transportation (90% success) ● Accurate piece landing (within 5mm of the center) ● Fast feeding and movement (within 13s)
User Experience	● Easy setup (game setup done in app only) ● Easy to play (only need to deal with his/her own piece) ● Low latency (maximum latency of 1 second)

Implementation (Detection & Locking)

- A matrix of Hall Effect sensors to detect pieces

- Small fixed position permanent magnets for locking
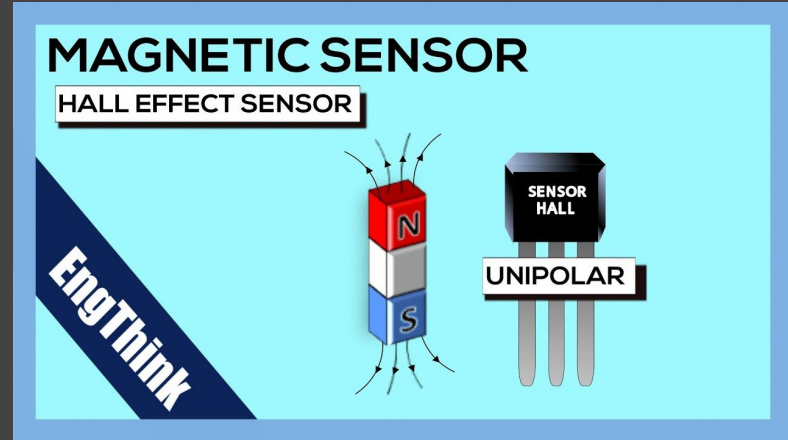
Implementation (Go Piece Movement)

- Use an xyz-gantry system powered by stepper motors and a magnetic levitation kit to hold and drag a piece from point A to point B. (Point A is the position where the opponent's piece is fed from the feeding system and point B is the location on the board).

https://www.etsy.com/listing/1538486129/magnetic-levitation-module-diy-core-kit
https://openbuildspartstore.com/v-slot-nema-17-linear-actuator-bundle-lead-screw/
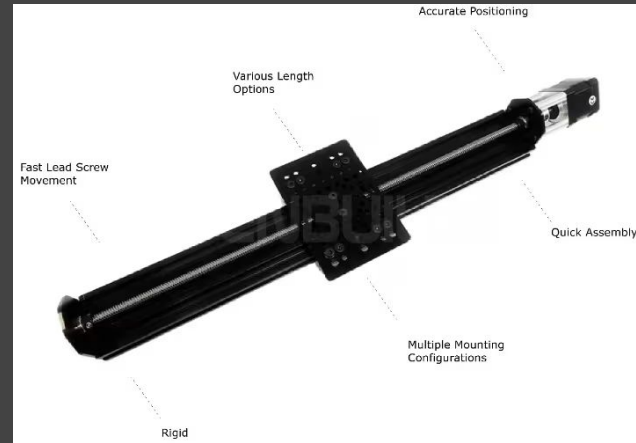
Implementation (Go Piece Feeding)

- Use a spring loaded magazine integrated into the Go board where the pieces with magnets are stacked vertically inside

- Use a stepper motor flag to physically push the pieces out of the opening of the magazine

https://www.printables.com/model/230486-stepper-motor-flag-nema-17-5mm-shaft
https://www.amazon.com/Neodymium-Magnets-Kitchen-Science-Industrial/dp/B09MDX9GWD
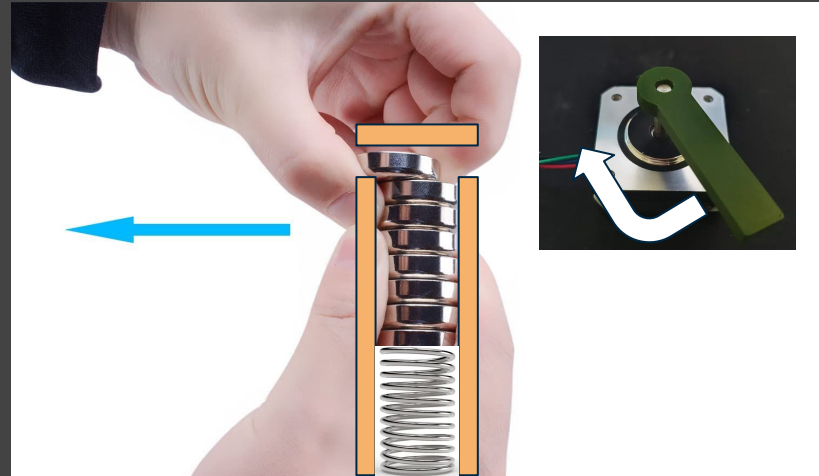
Implementation (Software Interface)

- Use Django(python) as the backend and html/css as the frontend to achieve the game state control and communication with the online gomoku platform.
- Django will also kickstart a new process (app) for communication with the arduino via PySerial package.
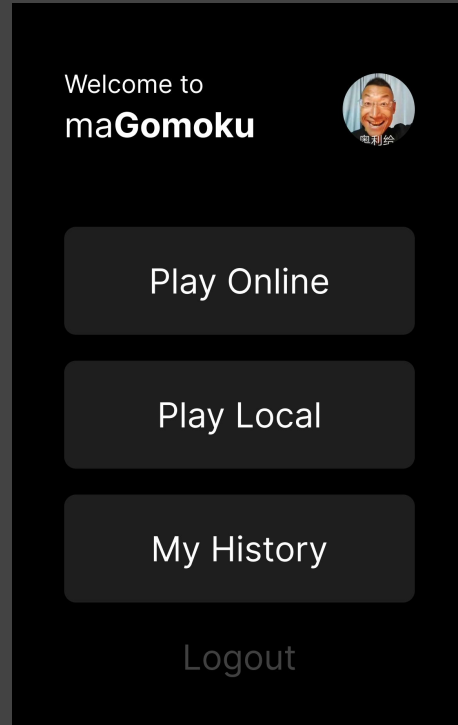
Solution Approach Block Diagram
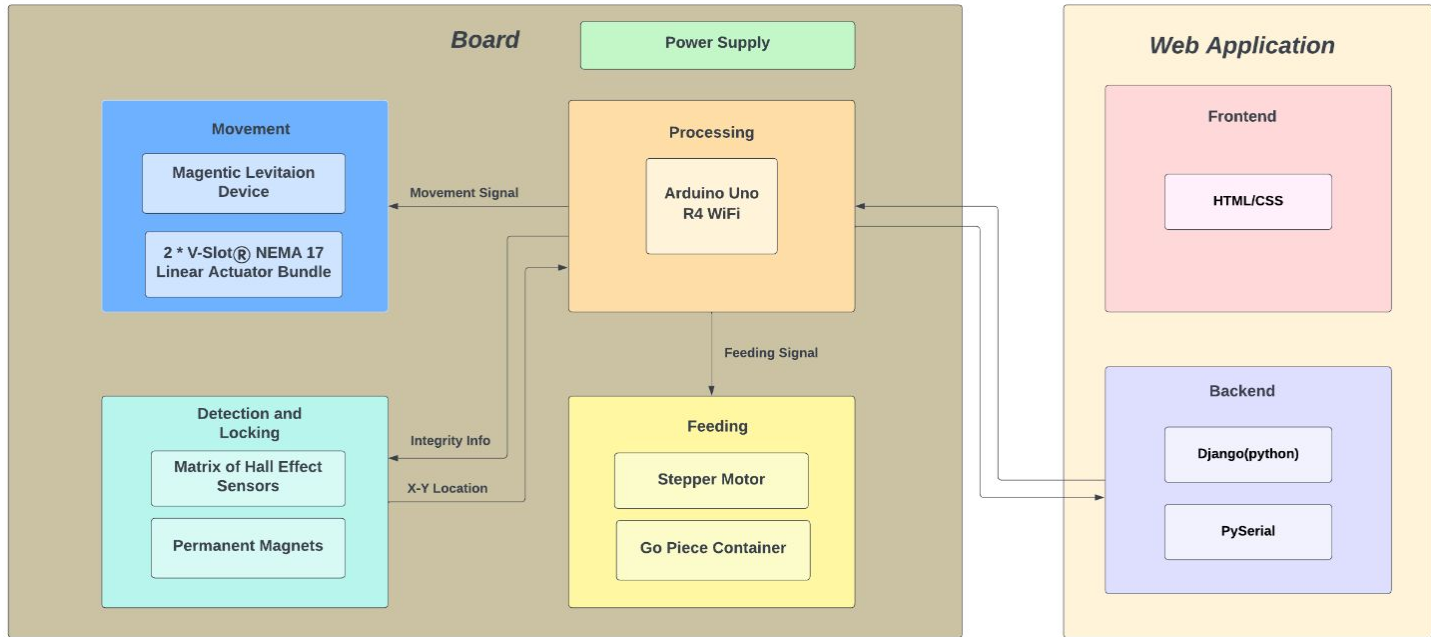
Testing, Verification, and Metrics

Test	Method	Target	Mitigation
Go Piece Black and White Detection	Compare detection result between white and black pieces	≥ 96%	Increase magnetic difference between different pieces
Board State Hardware Detection	Compare physical board state to detection output	≥ 90%	Adjust magnet size or board size
Board Integrity Software Detection	Perform different kinds of illegal moves and look for software detection	≥ 96%	Adjust baud rate accordingly
Board State Analysis Latency	Perform illegal moves and test for time delay till raised warning	≤ 50ms	Adjust baud rate accordingly

Testing, Verification, and Metrics

Test	Method	Target	Mitigation
Locking Range (Interference)	Test for distance where Go piece can be locked without external force	≤ 5mm	Decrease piece magnets / Increase board size
Feeding Speed	Test for time delay between signal received and piece in-place	≤ 2s	Adjust padding between pieces
Feeding Accuracy	Test for average distance between feeded piece position and target position	≤ 5mm	Adjust Physical magazine shape and stepper motor speed
Interference to Maglev Movement	Test for distance where Maglev movement success rate drops below 60%	≤ 15mm	Increase Physical Board Size

Testing, Verification, and Metrics

Test	Method	Target	Mitigation
Maglev Movement Accuracy	Test for average distance between feeded piece position and target position	≤ 5mm	Decrease Maglev Move speed
Maglev Movement Speed	Test for time delay between signal received and piece in-place for longest possible path	≤ 10s	Decrease Board size
Maglev Movement Robustness	Test for success rate when maglev system is exposed to tremor or magnetic interference in transport	≥ 90%	Decrease Maglev Move speed
Total Automatic Turn Speed	Test for time delay between a move is played on software to the piece is actually placed	≤ 13s	Adjust Board Size, Maglev move speed, or feeding speed

Project Management

		Feb 2024			Mar 2024						Apr 2024			
	Item	3-9	10-16	17-23	24-1	2-8	9-15	16-22	23-29	30-5	6-12	13-19	20-26	27
1	Gantry Research	5 days-Gantry Research												
2	Detection Research	5 days-Detection Research												
3	Feeding Research & Design	5 days-Feeding Research & Design												
4	Maglev Feasibility Testing	9 days	Maglev Feasibility Testing											
5	Order (Detection)	1 day-Order (Detection)												
6	Order (Gantry)		6 days	Order (Gantry)										
7	Order (Feeding)		5 days-Order (Feeding)											
8	Design Presentation PowerPoint			1 day-Design Presentation PowerPoint										
9	5x5 Hall-effect Unit Testing		5 days-5x5 Hall-effect Unit Testing											
10	Locking Research		5 days-Locking Research											
11	Maglev Control Testing			10 days	Maglev Control Testing									
12	Gantry Assemble and Programming			7 days	Gantry Assemble and Programming									
13	Web app Test Version UI			5 days-Web app Test Version UI										
14	Locking and Detection Test			5 days-Locking and Detection Test										
15	Feeding system Assemble and testi...			12 days	Feeding system Assemble and testing									
16	Integration (w/ maglev)				5 days-Integration (w/ maglev)									
17	Integration w/ detection				5 days-Integration w/ detection									
18	Web App Board communication				5 days-Web App Board communication									
19	Design Review Report				1 day-Design Review Report									
20	Spring Break				9 days	Spring Break								
21	Network game feature dev					5 days-Network game feature dev								
22	Integration							Integration	14 days					
23	Interim Demo								1 day-Interim Demo					
24	Slack Time									Slack Time	14 days			
25	Final Due										1 day-Final Due			