Flexy Board

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Overview of project

Idea and Drive:
Bring the physical experience of board games online.

What:
A table which can move pieces magnetically so a single player can play with a physical board against an online player.

How:

- A magnet mechanically moved underneath the table moves pieces.
- CV with camera above to match game state with opponent.

Full Idea:
2 boards able to be played wirelessly with each other.

MVP:
1 board with opponent on software.

Use-Case Requirements

- User is someone who wants physical play with a long-distance friend:
    - Enjoys the action of playing with physical pieces versus playing on a screen
    - Wireless/online with minimal lag so games can be played as if in-person
    - Easy and intuitive function: Not worth it if the experience is difficult
- User is aware of alternatives:
    - Must have a tangible benefit over current competition.

Similar Products

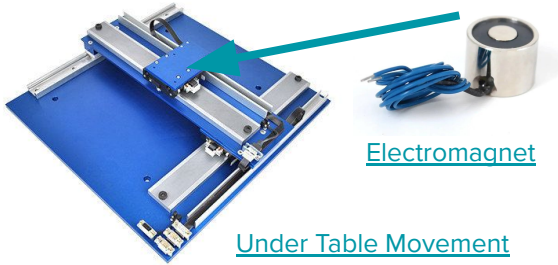
- Square-Off Robotic Chessboard - $599.95
- Chessnut EVO AI Chessboard - $899.99
- Competitor projects only support one game
- Flexy Board is compatible with more games at a lower price point

Components and Cost

1. **Table:** Modify or/and laser cut
2. **Camera**
3. **Motors/servo under-table movement:** x, y translation
4. **Magnet and solenoid or electromagnet:** To move pieces from under the table
5. **Microcontrollers:** Raspberry Pi (CV, camera, wireless) and Arduino (motors)
6. **Miscellaneous:** Magnets under pieces, installation components, camera arm

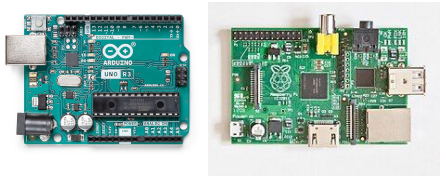
Camera

Chess

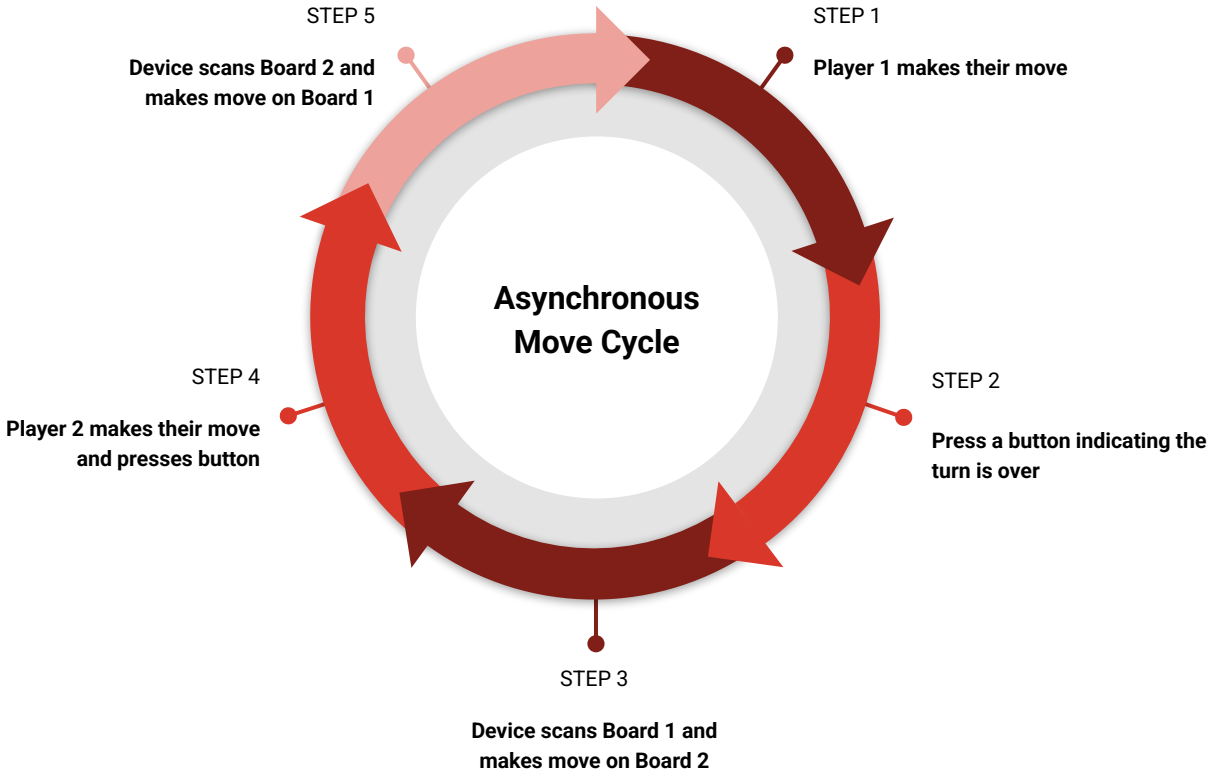


Electromagnet

Under Table Movement

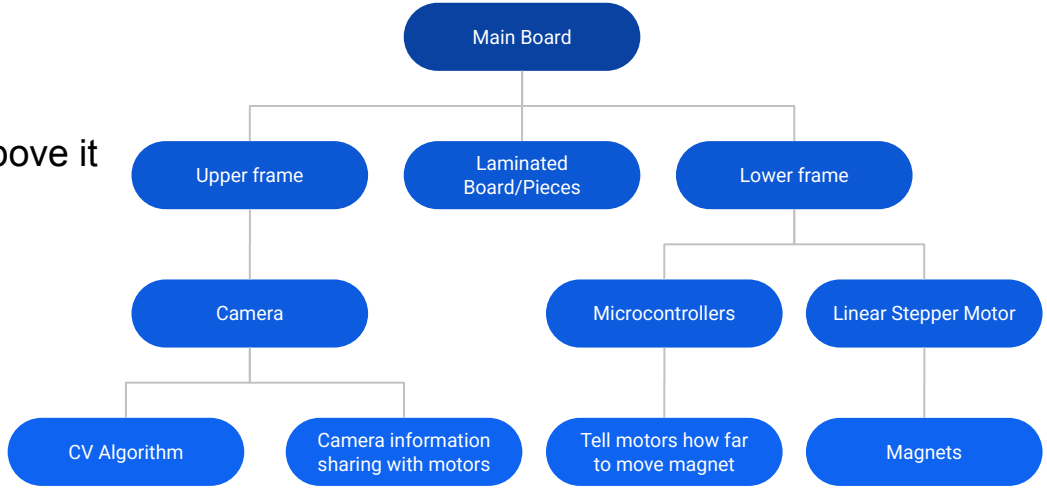


Arduino + Raspberry Pi


Asynchronous
Move Cycle
STEP 1
Player 1 makes their move
STEP 2
Press a button indicating the turn is over
STEP 3
Device scans Board 1 and makes move on Board 2
STEP 4
Player 2 makes their move and presses button
STEP 5
Device scans Board 2 and makes move on Board 1

Approach to Solution

- **Physical design:**
  - Square Board
  - Frame for stability for Camera above it
  - Under board:
    - Magnet, controller, motors
  - Laminated board (any game)



- **Software approach:**
  - CV Camera that detects changes in positions when end-turn button is pressed
  - Sends position differences to a microcontroller
  - Controls motors to move magnet from underneath pieces relocating them

Technical Challenges

Computer Vision:
Converting change in image to movement sent to stepper motors.

- Color tops of pieces
- CV tracking differences between start-of-turn and end-of-turn photos
- Algorithms to indicate taking a piece and “jumping” over pieces

Hardware Challenges:

- Calibrating gantry/magnet to correct x/y position
- Ensuring magnet engages/disengages appropriately
- Moving pieces over/across other pieces
    - e.g knight in chess

Our Testing Plan

- **Measure latency**
  - Between player having made the digital move on the app (or other physical board) to how long until it is completed on the board (less than a human seeing the move)
  - Aim for <5 Seconds for one move (based on chess study of estimated human time to translate: ~2s)
- **Test against multiple games (Chess, Checkers, Monopoly)**
  - Record Accuracy across all games should be >95%
  - Magnet doesn’t move other pieces
  - Corrections can be made by the physical user if move is obviously wrong

Testing Verification Metrics

- User study on enjoyability and function compared with fully physical and fully online board game experiences (is the flow nice or buggy?).
- Accuracy of movement (where it should be - where it is)
- Chance of error / malfunction
- Time for each move from initial move to fully being on the board

Division of Labor

Chris: Software integration, software algorithms
Iniyaa: Hardware integration, physical design
Harrison: Hardware integration, software integration

We will all be helping each other with everything at the end of the day.

Timeline of Project

Design

Finalize Design and order components

CV Board Mapping

Preliminary code based on theoretical board measurements

Hardware Build

Assemble gantry and hardware components

Integration

Connect CV to motor control logic

Testing

Goes along with refinement. Test product against metrics previously set.

Refinement

Fix any errors found in testing. Add in additional features if time allows for it