ECE 445 Senior Design Laboratory

Project Proposal

Blitz Board

Team #66: Owen Shin, Nick Bingenheimer, James Tang

TA: Hanyin Shao

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1 Introduction

1.1 Objective and Background

1.1.1 Goals

- The blitz board enables playing chess against a remote player or bot with a new design.
- The current solution uses a two-axis motor system to move pieces underneath the board.
- Multi-axis based solution is slow for "takes" when a single electromagnet must move two pieces, which is unfavorable for fast-paced games.

1.1.2 Functions

- The blitz board connects to chess.com or other online chess bot with an API.
- The robots within the board move the pieces around with electromagnets.

1.1.3 Benefits and Features

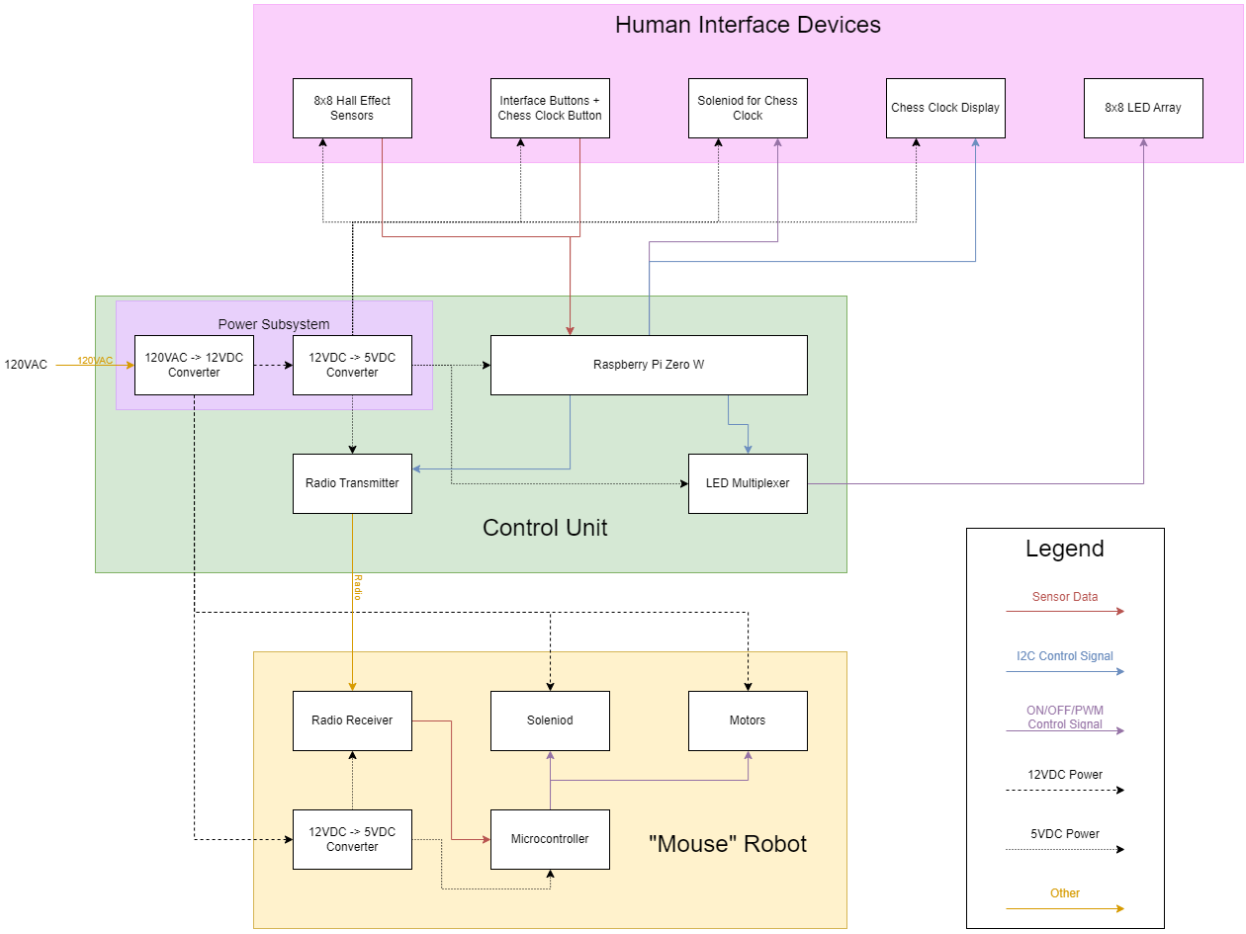
- The users can play against a bot or millions of remote players around the world.
- The reduced waiting time for the moving and discarding of pieces improves the user experience.
- The faster movement on the behalf of the computer opponent allows a greater variety of game modes such as blitz chess.

1.2 High-Level Requirements

- The in board robots should be able to perform movement of and discard of taken pieces faster than other boards on the market (Square off averages 1s/square of distance on the board for normal moves and up to 10s per take of pieces)
- The Robot will be able to perform/meet the following criteria
    - Be able to utilize the space in between pieces for moving a chess piece
    - Be able to take taken pieces to the “parking lot”
    - Return to the center of the board or other specified spot after each move is complete, and remain until the human player completes their turn
- A working chess-clock that allows for timing of moves along with chess rules. Robot will effectively hit its clock at the end of its turn, as well as begin moving at the hit of the player’s clock.

2 Design

2.1 Block Diagram



2.2 Block Descriptions

2.2.1 Power Unit

The power unit supplies power to the entire system, including the microprocessors in the control unit, the microcontroller in the robot unit, the chess-clock displaying the user interface unit, etc. The power unit is connected to the rest of the other units, and it consists of a power converter.

Converter

The converter circuit will most likely consist of an off the shelf AC/DC power converter that takes 120VAC in and outputs 12VDC. Individual units will further utilize a 12V/5V DC/DC converter to be compatible with components such as a raspberry pi or small DC motors.

2.2.2 Control Unit

The control unit focuses on processing data from sensors, sending that data through the web with an API and then retrieving chess moves from an online chess bot. It will then turn these moves into functional directions for the robot under the board so that it can maneuver to displace pieces on the board. In addition, it will also control the use of the chess clock on the board's behalf and be able to light up LEDs on the board to indicate different information to the player during gameplay.

Converter

This will be an intermittent DC/DC, 12V/5V converter that will step down power from the main power module and make it compatible with most of our devices.

Microprocessor

The microprocessor, most likely a Raspberry PI Zero W, has several tasks. First, it interprets the data from the sensors to determine the position of the chess pieces. Second, it utilizes an API to connect to chess.com or other online chess bot and translate the moves received from the online chess bots into physical directions for the under-board robots. Third, it sends the position data and the data from the bots to the transmitter. It also sends data to the chess clock solenoid and HEX display for keeping time.

Sensors

The Hall effect sensors underneath the board floor report the position of chess pieces to the microprocessor. They detect the presence of the magnetic field generated by the magnets on the base of the pieces, and their output voltages are directly proportional to the strength of the magnetic field. A possible model is the A3144/OH3144/AH3144E, which are found on amazon at a price of $8/20pcs. These will not affect the use of the electromagnet for moving pieces as they won't be sensing during the robots work.

Transmitter

The transmitter obtains the position data from the microprocessor and sends the data to the receiver in the robot unit.

2.2.3 Robot Unit

The in-board robots will be similar to small rc bumper cars. They will receive power through metal "antennas" that make contact with a copper "ceiling". It is important to use copper as it won't affect use of electromagnets to grab pieces. They will navigate using small DC motors and have electromagnets mounted on top. A small digital processing unit will be used to drive the motors and provide a switch for the electromagnet.

Converter

A separate unit will be used to step down power to about 5V, similar to the manner described in section 2.2.2 under "Converter"

Microcontroller

A small digital processing unit will be used to take in signals from the radio receiver on the robot, and provide directions for the robot. These directions will mostly consist of which motor to drive, and when to activate the electromagnet.

Motor

Small DC motor will be used to drive axles with wheels mounted on them, and be placed at each side of the robot. They will be the only way for the robot to move about under the board and be able to be driven separately in order to execute turns.

Receiver

The receiver obtains data from the transmitter in the control unit and sends the data to the microcontroller on the robot. This data will already be formatted so that the information of which motor to drive and when to activate the electromagnet will require little computational effort on behalf of the robot's microcontroller.

2.2.4 User Interface

The user interface allows users to interact with the board in several ways. It is connected to the control unit, and it consists of the led display, chess-clock components, and several buttons. We hope to be able to have some sort of On/Off switch, a button to operate the chess clock on the user side, HEX displays to denote time on the clock, and LEDs to provide extra information to the user during gameplay.

LED Display

LEDs embedded in the board will display the most recent move by highlighting the moved piece's current and previous positions. They will be driven by an off the shelf multiplexer.

Chess-clock Display

The display on the side of the board will reflect the time limits for both players according to chess.com. The clock's display will be seven-segment LCDs and will have the see-saw switch often seen on chess clocks.

Chess-clock Solenoid

In order for the board to play against a human opponent, it will need to be able to operate the chess clock remotely. We plan to accomplish this task by using a small plunger-and-solenoid activated switch that, at the call of a digital signal, will push the clock switch and transfer control of the clock to the human opponent. It will be a short impulse function of current in the solenoid that drives the plunger forward, and will allow it to immediately retract so that the human opponent/player can transfer control of the clock back to the board as soon as the player would like to.

Further on the Chess-clock and Interface Buttons

The user pressing the switch will finalize a move, allowing it to be sent to chess.com. A solenoid under the switch will press the switch when the computer's move is made or to reverse the switch in case

the user makes an illegal move. Note, when an illegal move is made, the LEDs will all light up RED and the board will automatically undo the move. The API and microcontroller will check if moves are legal.

2.3 Risk Analysis

The part that poses the greatest difficulty or risk to implement is the robot unit. Specifically, getting it to move consistently, precisely, and reliably. A possible risk is that during movement, the robot could experience a disconnect from its power source and stop working momentarily. We plan to circumvent this issue by ensuring that the metal contacts between the robot and the power ceiling is spring-loaded and that the contact uses a brush-like contact surface similar to a brush motor with a commutator.

Another aspect that can be risky, and also pertains to the robot, is ensuring that the electromagnet is strong enough to attract pieces, but also weak enough to cause harm to players or other parts of the board in any way.

3 Ethics and Safety

3.1 Ethics

Our project has little ethical aspects to it. It is merely a board meant for playing a game chess. However, games can often be taken too far, or the boards they are played on incite annoyance and anger. While we consider our project to be safe to play with and use, it may not be best for mental health and safety. For users that struggle with interaction, loneliness, depression or other mental health issues, this board may not be healthy to play on as it lacks human interaction and cannot provide emotional support like a true human companion and chessmate can provide.

Additionally, it is our responsibility to provide users with a board that works and will not cause issues to upset the user, and we are aware of and adhere to point 3 of the IEEE Code of Ethics: “ to avoid real or perceived conflicts of interest whenever possible…” [1]. This would ultimately hurt the development of and sale of this board were it to hit the free market. Ultimately though, the goal is to provide the average chess player with a chance to challenge themselves against the processing power of computers in a physical location in their home that is both safe and fun to use when you lack the ability to play with another.

3.2 Safety

Our project has few safety concerns. One of the safety concerns is that children or animals may accidentally swallow chess pieces. Swallowing foreign objects can be harmful, especially when multiple magnets are ingested. The magnets can attract to each other, causing severe problems such as bowel puncture or blockage. According to point 1 of the IEEE Code of Ethics: "to hold paramount the safety, health, and welfare of the public…" [1], we will notify the users to keep the chess pieces out of the kids' and animals' reach.

The magnetic field of magnets and electromagnets poses the other safety concern. Magnets are attached to the chess base, and electromagnets are on top of the robot. There is a slight possibility that the

field can interfere with electronic implants such as pacemakers and implantable cardioverter-defibrillators. Conforming to point 1 of the IEEE Code of Ethics: "to hold paramount the safety, health, and welfare of the public…" [1], we will have a warning on the outer packaging to ensure the users are aware of the magnets in the product.

References

[1] "IEEE code of Ethics," *IEEE*. [Online]. Available: https://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: 09-Feb-2023].