TEAM 21: ROBOCHESS

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Project Description

Our project aims to solve the problem of limited accessibility to real-time chess matches with human opponents. As chess is a popular game with cognitive and educational benefits, it's important to find ways to make it more accessible. Our solution is to create a device that allows for physical chess matches between two players, even when they are not in the same location. The device consists of a chessboard with hall-effect sensors placed underneath. Player 1 will move physical chess pieces on the board, while Player 2 interacts through a website. The sensors underneath the board detect Player 1's moves and convey them to Player 2, who can then respond by moving a digital piece on the website. A robot arm at the opposite end of the board then makes the move on the physical board. The website displays the chessboard and the positions of the physical pieces, as well as important details such as time, player turn, and connection status. An LCD display on the physical board also conveys this same information to Player 1. Information between the arm and the website will be conveyed through a Raspberry Pi. 5V and 4A will be supplied to the entire board to ensure all the capabilities of the electrical components are met. Through the implementation of all this, our project allows players to feel like their opponent is in the room with them without being physically present, eliminating the accessibility issue that plagues the game of chess.

PSSCs

1. PSSC #1 (Hardware): An ability to utilize hall effect sensors to accurately detect and continuously monitor the positions of chess pieces on a chess board.

2. PSSC #2 (Hardware): An ability to establish communication between a microcontroller and website through the use of a Raspberry Pi to transmit and receive chess piece location information via serial communication.

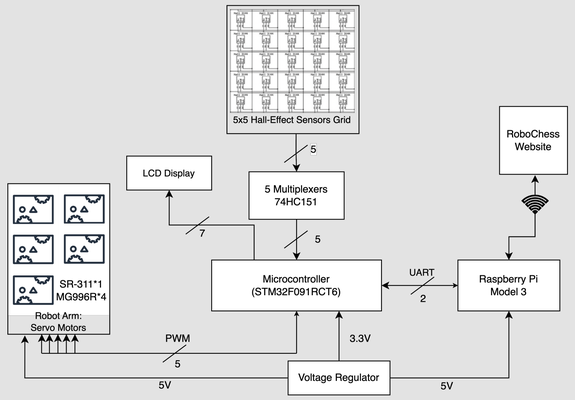
3. PSSC #3 (Hardware): The ability to display real-time important game information on an LCD through the use of a microcontroller and an SPI bus for data transfer. LCD will have important information such as time, player turn, connection status, etc.

4. PSSC #4 (Software): An ability to use PWM to precisely control servo motors within a robot arm in order to pick up a chess piece and move it to a specific square on the chessboard.

5. PSSC #5 (Software): An ability to display a graphical chess board on a remote website and update the corresponding chess pieces as players move a chess board both physically and virtually.

Block Diagram

Figure 1: Block Diagram



What is Gardner's Chess?

Gardner's Chess is variant of Chess played with regular chess pieces and standard rules, but on a smaller board. The motivation for these variants is to make the game simpler and shorter than standard chess. The game was largely played in Italy (including by correspondence) and opening theory was developed. We chose (add text here)

References

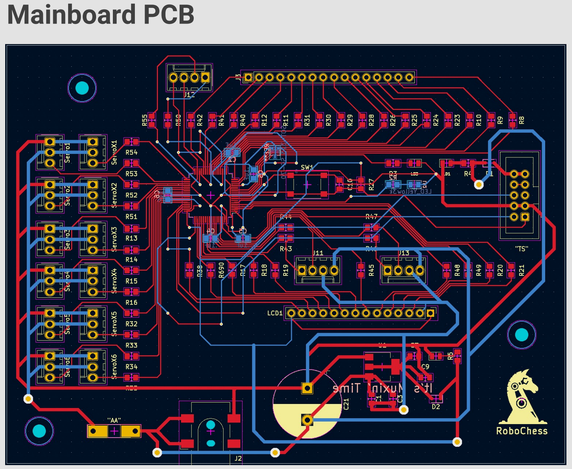
[1] R. Smith, "A Chess-Playing Robot Utilizing a Hall Effect Sensor and STM32 Microcontroller," in Proceedings of the 2022 IEEE International Conference on Robotics and Automation, May 2022.

[2] M. Johnson and S. Lee, "Design and Implementation of a Robot Arm Control System," in Proceedings of the 2023 IEEE International Conference on Robotics and Automation, May 2023.

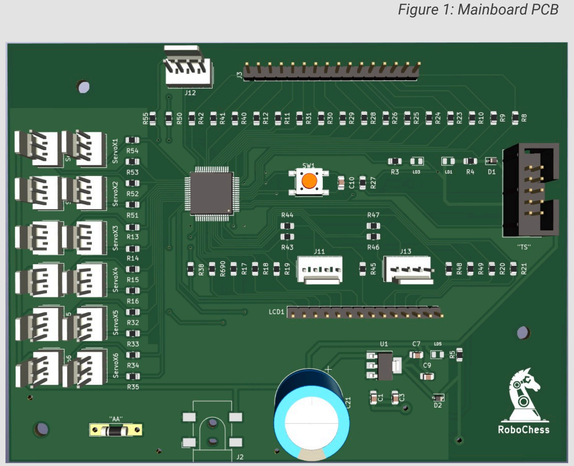
[3] K. Park and J. Kim, "Development of a Hall Effect Sensor-Based Detection using STM32 Microcontroller," in Proceedings of the 2022 IEEE Sensors Applications Symposium, April 2022.

Mainboard PCB

Figure 1: Mainboard PCB



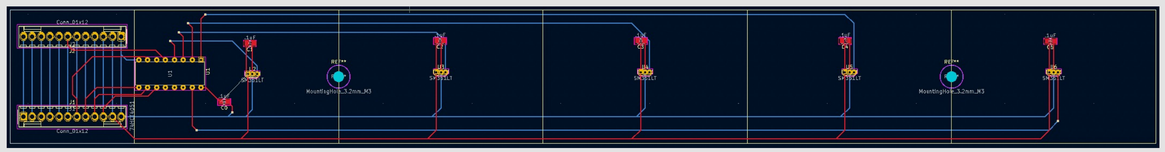
PCB Layout



PCB 3D Render

Hall Effect Strips PCB

Figure 3: Hall-Effect PCB



Hall-Effect Strips PCB Layout

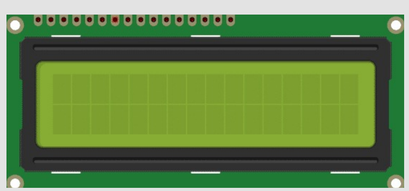
Hall-Effect Strips PCB 3D Render

Robot Arm

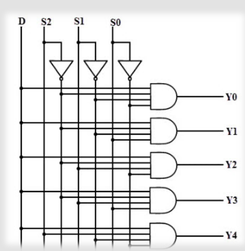
A 5-DOF (degree of freedom) robot arm uses servo motors to control the movement of each joint. The robot arm is programmed with the coordinates of each chess piece and the corresponding movements needed to pick them up. The servo motors move the arm to the appropriate position and orientation to pick up the piece, and then move it to the desired location on the board.

LCD

An LCD (Liquid Crystal Display) is a type of flat panel display used in electronic devices to display images and text.



5-1 Multiplexer



A 5-1 mux is a digital circuit that selects one of five input signals and transmits it to a single output based on a selection signal. It can be used in combination with hall effect sensors to detect the presence of magnetic chess pieces on a board by selecting the signal from the sensor under the square where the piece is placed based on a binary selection signal.

Hall-Effect Sensors

A Hall-Effect sensor (or simply Hall sensor) is a type of sensor which detects the presence and magnitude of a magnetic field using the Hall effect. The output voltage of a Hall sensor is directly proportional to the strength of the field. It is named for the American physicist Edwin Hall.