Automatic Chessboard

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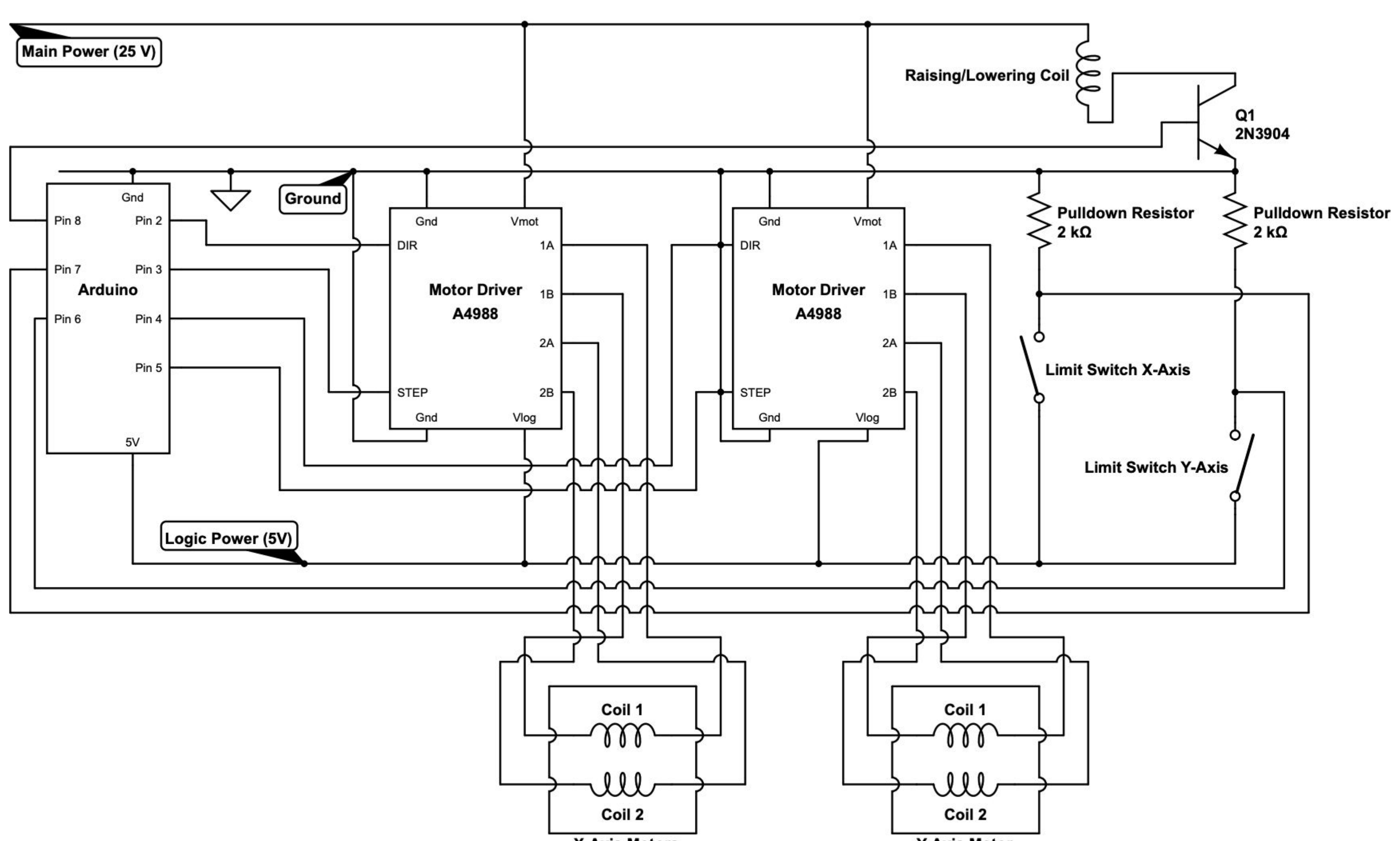
Abstract

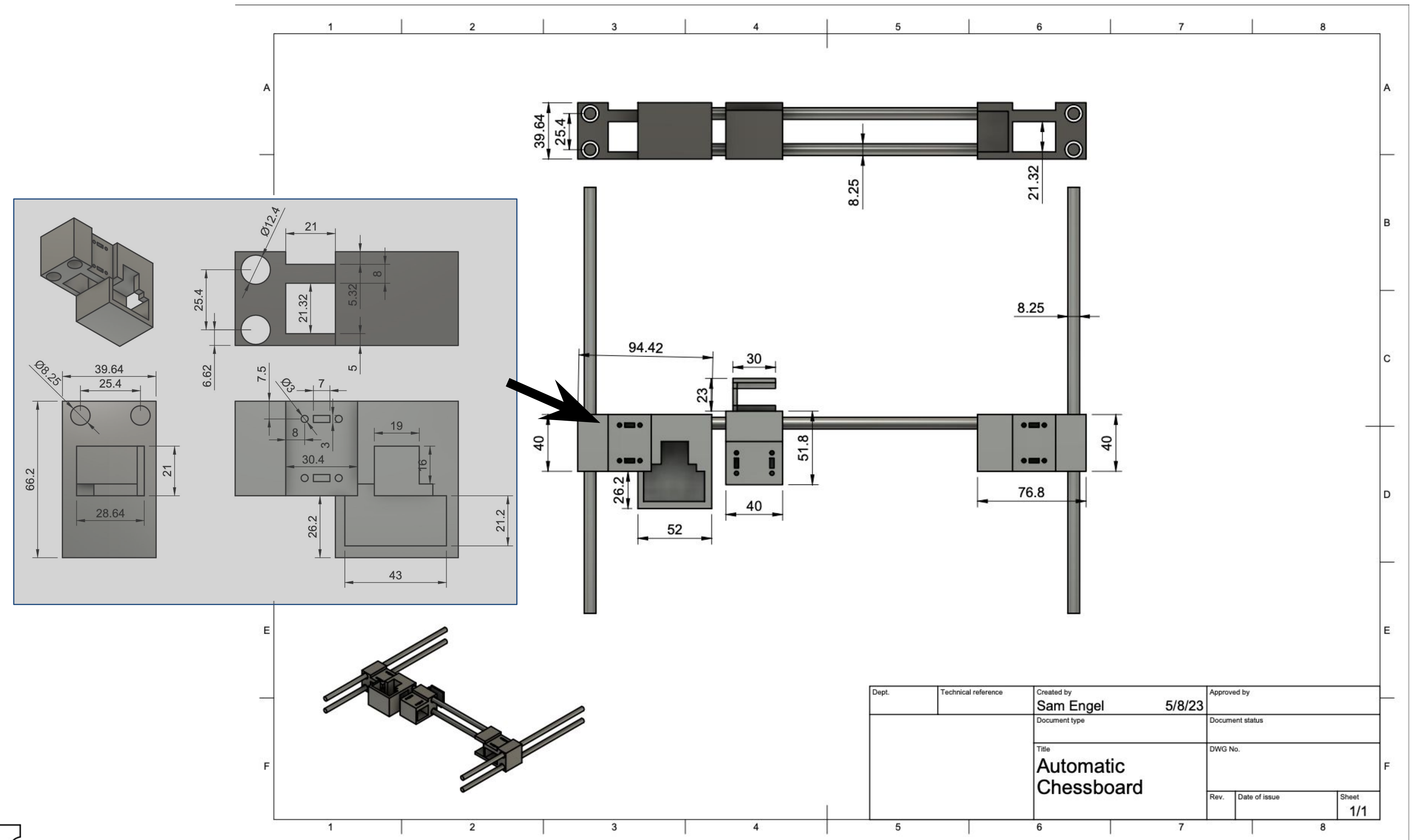
An automatic chess board was designed and built to move magnetic chess pieces between the squares. The initial goal was to coordinate these moves with a Chess engine, either pre-built or custom made, so that users could play chess with an AI over a physical board; however, due to time constraints, the board currently just moves individual pieces. A 3d-printer-like mechanism controlled by an Arduino is employed to position a solenoid with a magnet attached to the top, which can move pieces from beneath the board's cover. Two motors turn belts that slide the entire mechanism along the X-axis (up and down in the CAD diagram), and within this mechanism a single motor moves the solenoid along the Y-axis (left and right in the CAD diagram). The solenoid can be raised and lowered, effectively engaging and disengaging its magnet from the pieces above. The stepper motor drivers that run the motors are finicky and easily broken; however, when these work, the project can smoothly move pieces from one square to another on the board.

Circuit Diagram

The following circuit diagram represents all the electronics that run the chessboard. Note that the stepper motor and driver pair on the right hand side is, in practice, two motors and drivers set to move together.

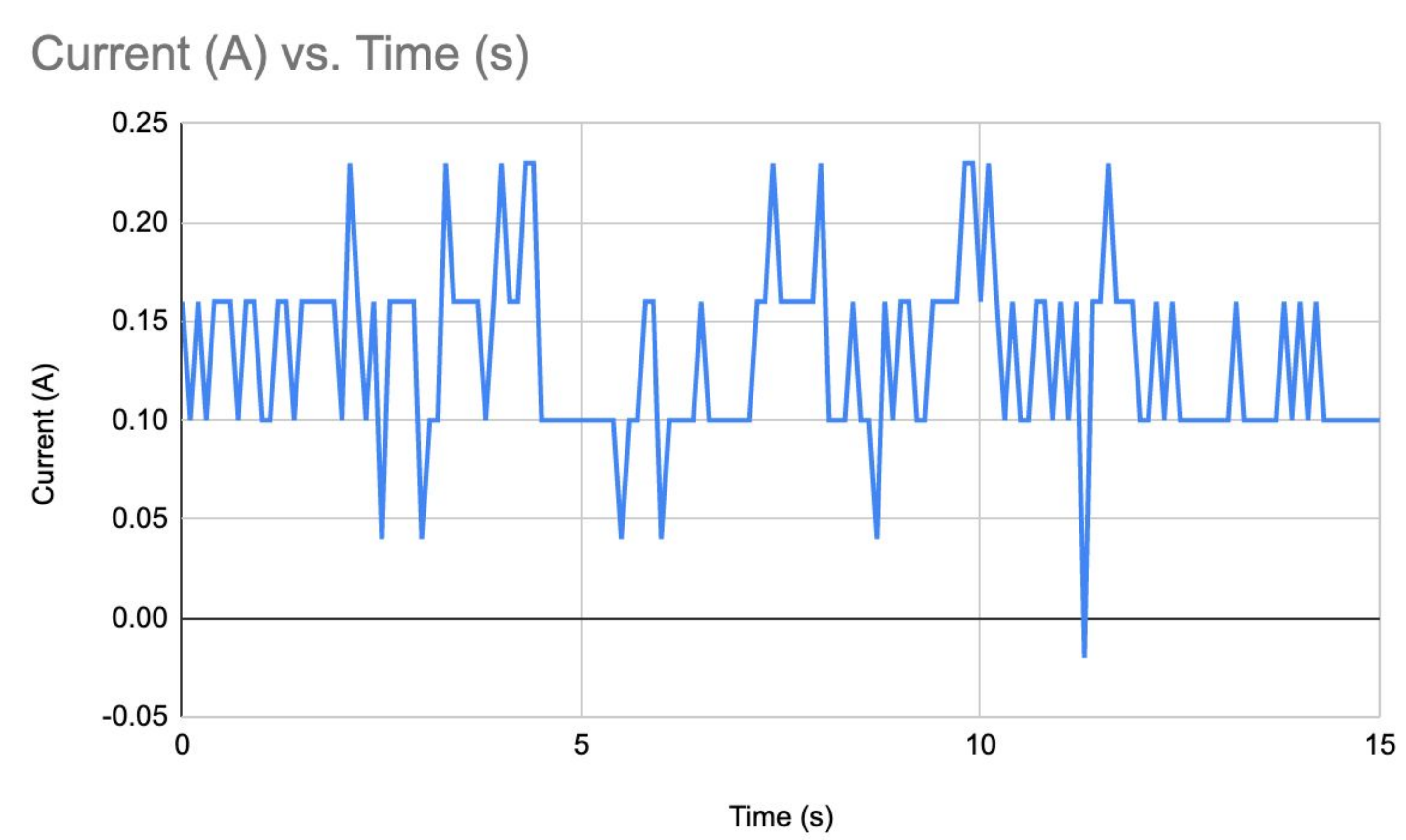


CAD Diagram



Results

Below is a graph of Current Drawn (A) vs. Time (s) over the range of motion in the Y-direction (shown in the above diagram as horizontal). Note that the magnet holder started at one end of its range of motion, moved to the other end, and then came back to its starting point in the 15 second time span below. A 0.1 ohm resistor was connected in series with the motor power supply in the circuit, and the voltage was measured across the resistor as a proxy to the current load.



Conclusion

In conclusion, the board as it is now is a successful proof of concept for the full automatic chessboard. It can move individual pieces as long as the pieces remain separated, and it can sense when the solenoid reaches the edges of its motion. The mechanism can also raise and lower a permanent magnet attached using a solenoid to engage and stop engaging pieces on the board. To test the movement system, the current load over the range of motion in the Y-direction was measured to find points of high friction. This measured current mainly hovered between 0.10 A and 0.15 A; however, it fluctuates too much to draw any reasonable conclusions about points of high friction. One possible explanation is that the bars on which the mechanism slides are not consistent along their length, so the motor experiences significantly varying friction through its range of motion. A secondary cause might be the inaccuracy or inconsistency of the Vernier measuring device, which only takes measurements every 0.1 seconds: note that, at around 11 seconds, the current spikes below 0 A.

Next Steps

To complete the functionalities of an automatic chessboard, the first step is to focus the magnetic field so that a piece can be moved precisely next to other pieces without affecting those other pieces. Putting a hollow cylinder of aluminum around the magnet might narrow its field; also, using a differently shaped magnet could help. Once pieces could move around each other, the code could easily be linked to a chess engine such as Stockfish so that full games of chess could be played on the board.

References

[1] *Control Stepper Motor with A4988 Driver Module & Arduino*, Last Minute Engineers