– DIY Guide–

# Intelligent Chess Board

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# Introduction

One of the oldest board games is chess, its origins can be traced back to the 8th century. In modern times many people have moved the ancient board game to an online platform such as chess.com and Lichess, those are great mediums they are no replacement for the physical form. This guide's goal is to enable players to create their own intelligent chess set to aid skill progression while keeping the physical game pure. The Intelligent chess set is broken down into four main categories: Chassis, Movement, Sensing, and Code. Each of these categories or subsystems will be discussed separately followed by the combination of the subsystems. A description of functionality and the science behind each component can be found in the appendix. For more help please visit our website https://joshuaaduarte.github.io/Gambit.io/ for frequently asked questions, common issues, and CAD files.

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# Materials

**Tools**

1. Tables Saw
2. CNC (Router is possible)
3. Soldering Iron
4. Measuring tape
5. Drill
6. Drill Bits
7. 3-D Printer
8. Computer
9. Hot glue gun
10. Hot glue
11. Superglue
12. Multimeter
13. Bread Board

**Movement**

1. 2 STEPPERONLINE Nema 17 Stepper Motor Bipolar 2A (https://www.amazon.com/STEPPERONLINE-Stepper-Bipolar-Connector-compatible/dp/B00PNEQKC0/ref=pd_lpo_1?pd_rd_i=B00PNEQKC0&psc=1)
2. KeeYees 5M GT2 Timing Belt (https://www.amazon.com/KeeYees-Timing-Tensioner-Torsion-Printer/dp/B07JKT5BZQ/ref=rtpb_2/146-6600754-2834064?pd_rd_w=cOkuM&pf_rd_p=d12edb90-0e5b-498c-816a-9ba65872c34f&pf_rd_r=BQZJN3RBWHCFSC7JWPVM&pd_rd_r=6a3886b5-61d9-4222-b04c-aa203a6b4137&pd_rd_wg=boUdB&pd_rd_i=B07JKT5BZQ&psc=1)
3. 1/4in aluminum 24in rods (Onlinemetal.com is a good vendor)
4. Linear Motion Rod Shaft Guide with 4 PCS Ball Bearing (https://www.amazon.com/dp/B09MTNXP26?ref=ppx_pop_mob_ap_share)
5. Electromagnet (https://www.amazon.com/uxcell-Electric-Lifting-Electromagnet-Solenoid/dp/B01N5OPUEC/ref=sr_1_5?crid=370ECQ55CQRZG&keywords=electromagnet&qid=1643917223&sprefix=electromagnet%2Caps%2C129&sr=8-5)
6. Corner Bracket, Nickel-Plated Steel
7. 82 Degree Countersink, 2-56 Thread, ¼” Long
8. 1” Aluminum Square Bar 6061 - T6511 - Extruded
9. 0.25” Aluminum Round Bar 6063 - T52 - Extruded
10. Linear Motion Rod Shaft Guide Set

**Sensing**

1. 4 BIQU Endstop Mechanical Limit Switches (https://www.amazon.com/dp/B01FX8SR8A?ref=ppx_pop_mob_ap_share)
2. 64 plastic reed switches (https://www.amazon.com/Gebildet-Normally-Induction-2-5mm%C3%9714mm-Multi-Use/dp/B07YFBQ4HS/ref=sr_1_3?crid=IS8NDC8SLLPI&keywords=Gebildet%2B10%2Bpcs%2BPlastic%2BReed%2BSwitch&qid=1642816594&sprefix=gebildet%2B10%2Bpcs%2Bplastic%2Breed%2Bswitch%2Caps%2C115&sr=8-3&th=1)
3. Arduino Mega 2560 Rev3 (https://store-usa.arduino.cc/collections/boards/products/arduino-mega-2560-rev3)
4. Silicon 30 Gauge Copper Wire ~ 27 ft
5. Solder ~ 20 ft
6. Large solderless breadboard
7. 64 diodes - 1N4148
8. 8 resistors - 10 Ω
9. LCD Screen
10. Transistor IRF - 520
11. Diode IN4007
12. Resistor - 330 Ω
13. Resistor - 2.2 kΩ

**Chassis**

1. ⅕ in x 4 ft x 8 ft Hardwood Plywood Panel
2. ¼ in x 4 ft x 8 ft Birch Plywood https://www.homedepot.com/p/Columbia-Forest-Products-1-4-in-x-4-ft-x-8-ft-PureBond-Birch-Plywood-165891/100092485
3. Alloy Steel Cup-Point Set Screw
4. 18-8 Stainless Steel Shoulder Screw 18 mm Long Shoulder
5. 18-8 Stainless Steel Shoulder Screw 10 mm Shoulder Length
6. OPTIX 18in x 24 in x 0.22 in Acrylic Sheet https://www.homedepot.com/p/OPTIX-18-in-x-24-in-x-220-in-Acrylic-Sheet-MC-21/202038050

## Chassis Subsystem

Beginning with the 4 x 8 ft panel. Split the panel into two 4ft x 4 ft sections. Then cut following the cut pattern shown below in Figure 1. Being sure to cut a hole for the LCD on the front side panel.

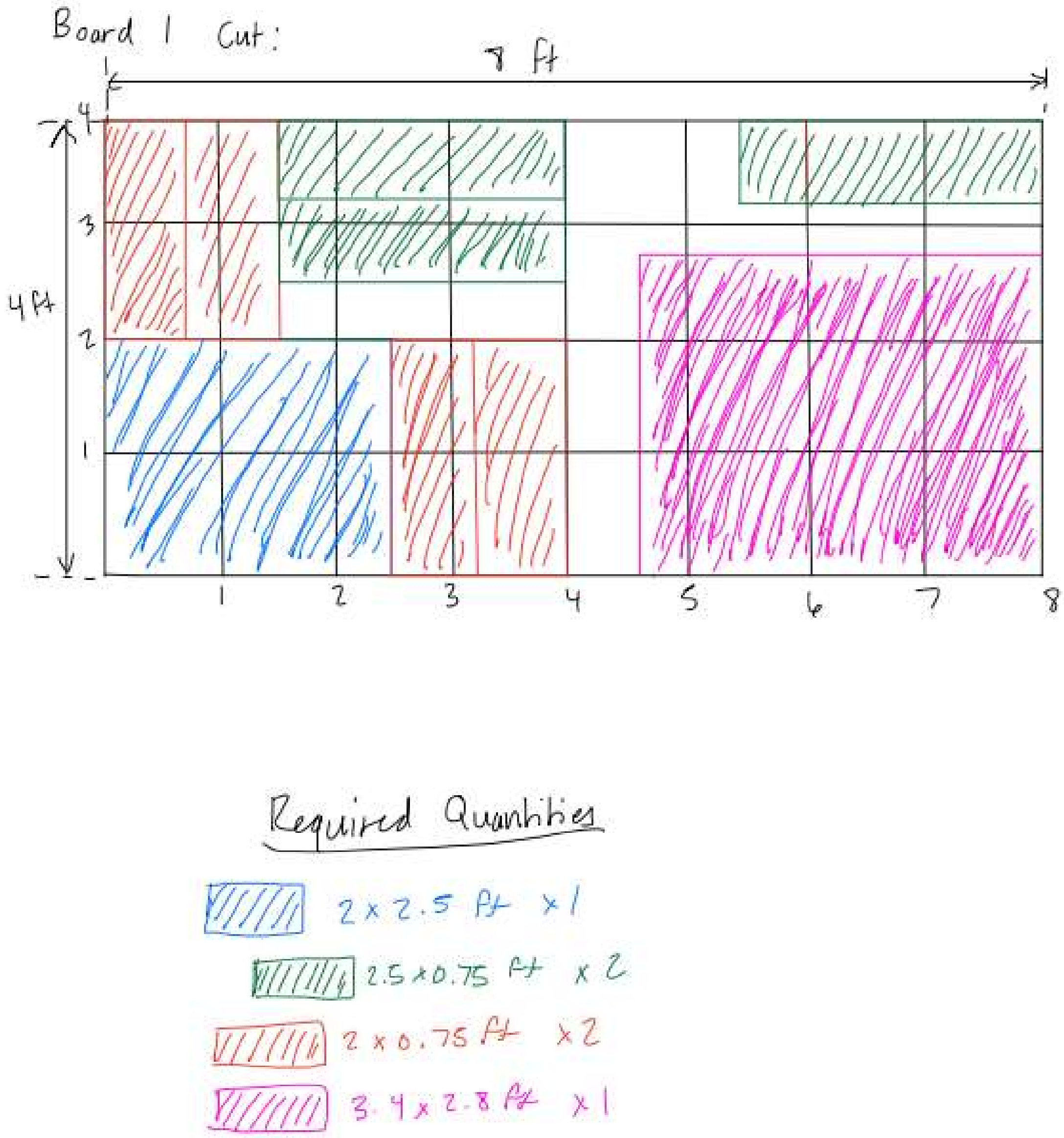



Figure1. 1/4in x 4ft x 8ft plywood cut list.

After each panel is cut, change the miter angle of the table saw to 20 degrees and trim edges to hold the angle. Using small scrap section of 1in x 2in will allow for easy and scure mounting. Cut these scrap peicse to the dimension shown in figure 3 Cutting an angle on the panels will eliminate the need for edge banding and allow for the top panel to sit flush. Next using a CNC or a handheld router cut the pattern found in figure 2 below or the CAD file on the website.

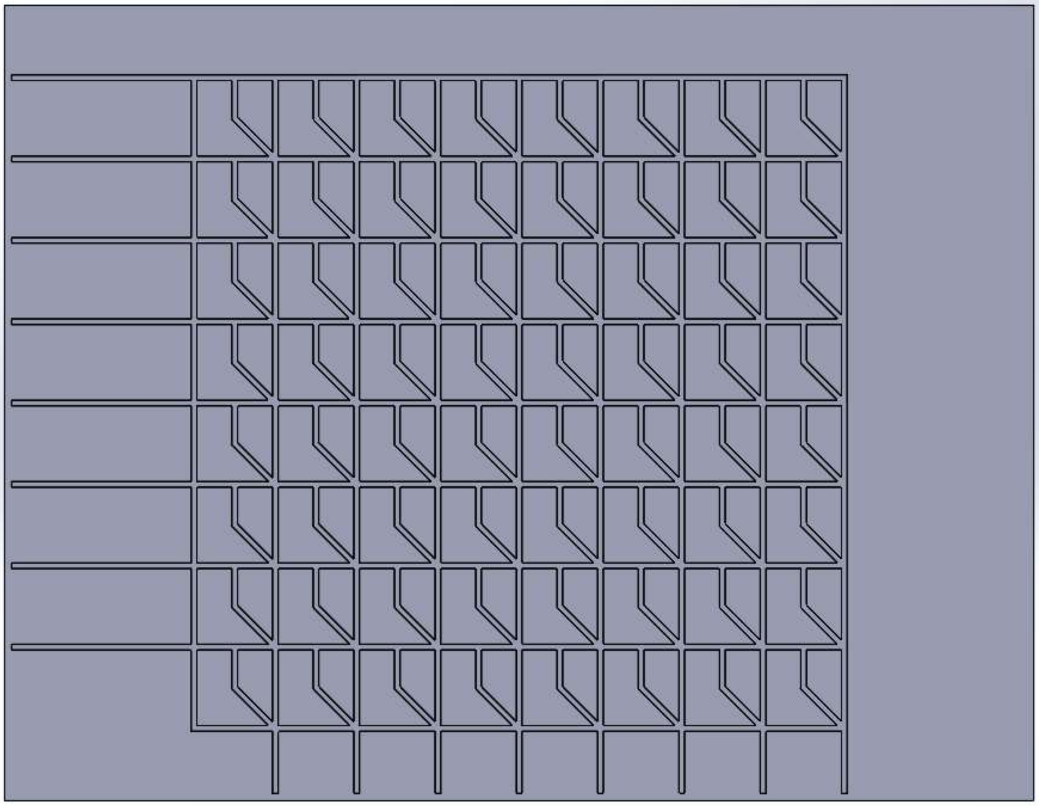


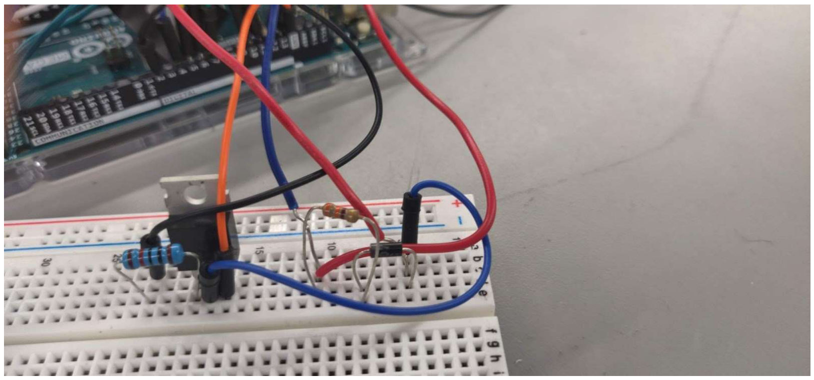
Figure 2. ReedSwitch and Diode top panel inlay

# Movement Subsystem

Starting with the bottom panel cut in the last section, take the linear sliders and mount them parallel to the short side of the board spaced from the edge by 2.54in. Follow the mounting position of the linear sliders as shown below in figure 3.

Next take the 3d printed parts named XXXX (CAD files found on the website) and secure them to the linear sliders using superglue ensuring they are centered on the slider. Afterward, place cut both of the 1/4in x 24in aluminum rods to 22.20in and place one end into the linear sliders as shown below. Once inserted slide on the y slider to the aluminum rods, then slide the rods into the opposing linear slider. At this stage, the subsystem should look like the photo below. Using hot glue attach the electromagnet to the y slider centering on the slider and connect the wires to the terminals on the arduino shown in figure 4.

To wire up the electromagnet, a circuit needs to be completed in order to allow the component to turn on and off. It is important that the electromagnet turns off when not in use because it runs the risk of overheating and burning out. The input pins on the arduino do not supply enough voltage to power the electromagnet, so an external power supply is needed to run it at full capacity. A transistor is a key component in order to boost this power. Wire up the electromagnet circuit as shown below in figure 5.



Next place the NEMA 17 stepper motors in two of the corners next to each other as shown in figure 6. Once motors have been secured using 4 SCREWS and 3d printed motor mounts attach the end brackets to the linear slider mounts opposing the motors. Place the pulleys and route the belt in the configuration shown in figure 6. Using the wires from the NEMA 17 stepper motors and a bread board wire the motors in the configuration shown below and attach it to the arduino.

# Sensing Subsystem

The sensing subsystem is centered around the plastic reed switches. The reed switches, diodes, resistors, and wires need to be soldered in the configuration displayed in figure 2. The reed switches need to be oriented approximately 45 degrees away from the diode which allows most effective sensing.  When a magnet is placed above the reed switch and diode pair, the system will send a signal back to the arduino, changing the “0” to a “1”, indicating that there is a chess piece on that particular square. Additionally, resistors and ground wires need to be soldered into the side of the matrix to complete the circuit. Once the full 8 x 8 reed switch matrix has been completely soldered and the top panel found in figure 2 has been routed, place the matrix in the top panel as seen in figure 3 use either hot glue or electrical tape to secure the matrix in place. To ensure that the system is functioning properly use the multimeter and a magnet at each solder point to test continuity voltage and resistance across each reed switch. Using the arduino and the 16 wires coming out of the top panel, attach each wire to the terminals on the arduino. See figure 4 for reference.

# Code

The code aspect of the board is extremely vital as the subsystems have no way of interacting with one another unless the code is written appropriately.

Throughout the construction of the initial prototype, the code was discovered to have been able to be broken down into numerous parts. These are the chess engine, the sensing script, movement code, and

I have zero Idea what happened in this system right now

# Subsystem Integration

At this point, The movement system should be mounted on the bottom panel, the sensing system should be mounted on the top panel and connected to the arduino, and the side panels cut if all 3 of these things are not true complete each step then return here.

Place the piece of scrap wood that was cut the dimension shown in figure 3, place two on each side of the board and secure them in place with wood screws ensuring the tip is flush with the edge of the bottom panel. (insert figure)

Next applying wood glue on exposed surfaces place the side panels inplace adding clamps along the way.

Once the glue dries the arduino and breadboards can be placed in BOTTOM LEFT SIDE of the board using double sided tape to secure in place.

Lastly place the top panel on top of the side panels and use the LCD display interface.

# References


- https://joshuaaduarte.github.io/Gambit.io/
- Where we took the chess engine from


# Appendix