

A chessboard with white and clear pieces on a wooden surface. The board is set up with pieces in their starting positions. The background is a warm, golden-brown color.

Smart Chess Board

Group 10

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Motivation

- To create a remake of a classical game that could inspire more people to play by adding features that'll make it more fun and creative.
- A smaller version of the wizard's chess from Harry Potter.



Objectives

- Autonomous, Voice-Controlled Chess Board
 - Players use voice commands to move pieces.
- Electromagnet
 - Moves the physical piece to desired location.
- Player vs. Player



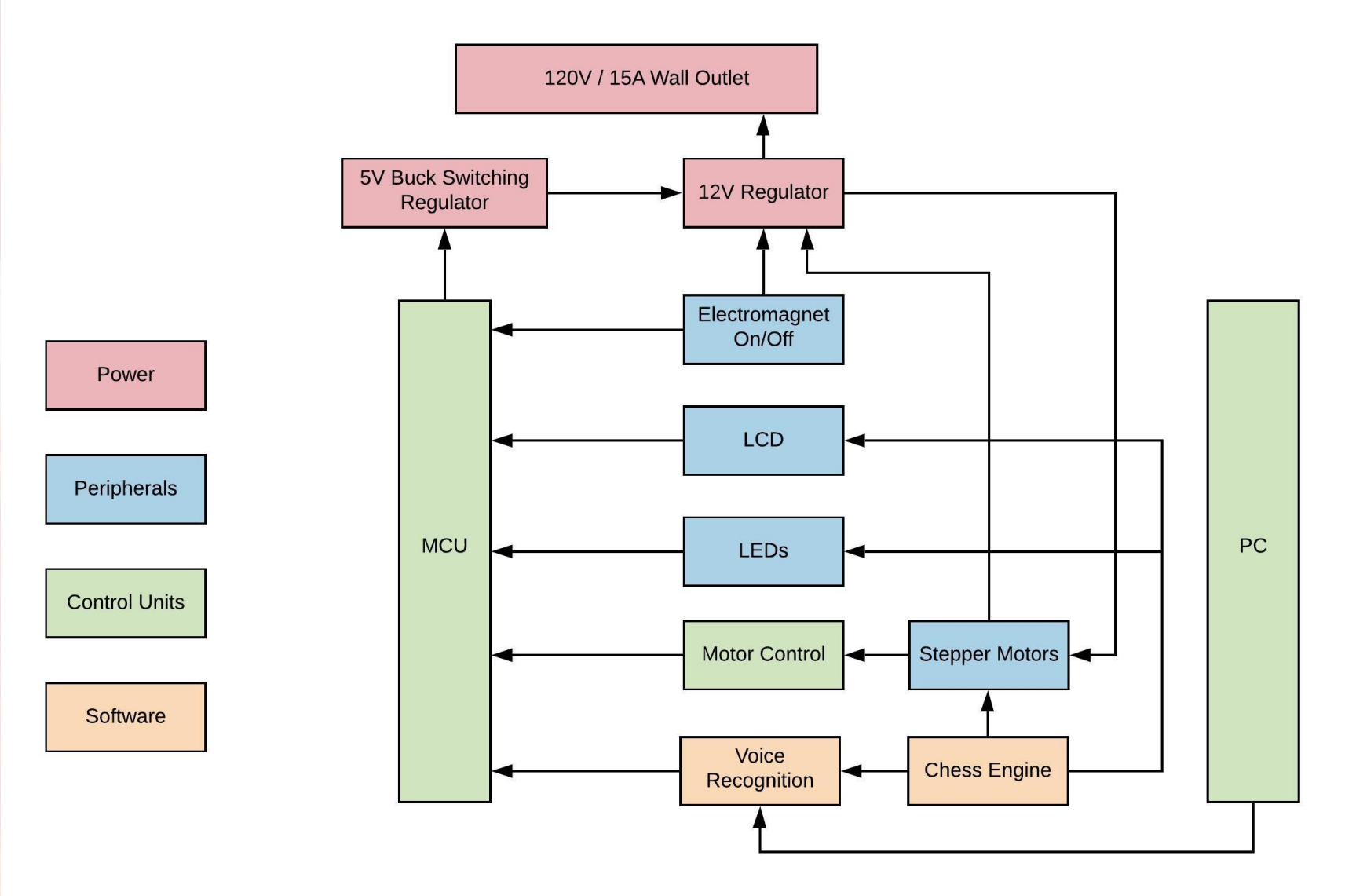
Requirements

- The project design approach and parts selected were chosen so that they comply with these requirements.

			Engineering Requirements				
			Dimensions	Processing Time	Weight	Power Consumption	Production Cost
			(-)	(-)	(-)	(-)	(-)
Marketing Requirements	Durable	(+)	↓				
	Easy to Use	(+)	↑	↑	↑		
	Portable	(+)	↑		↑	↑	
	Easy to Maintain	(+)	↑		↑		
	Reliable	(+)				↑	
	Cost	(-)	↑	↓	↓		↑↑
			< 62x62x20 cm	< 5 seconds	< 30 pounds	< 1000 Watts	< \$800

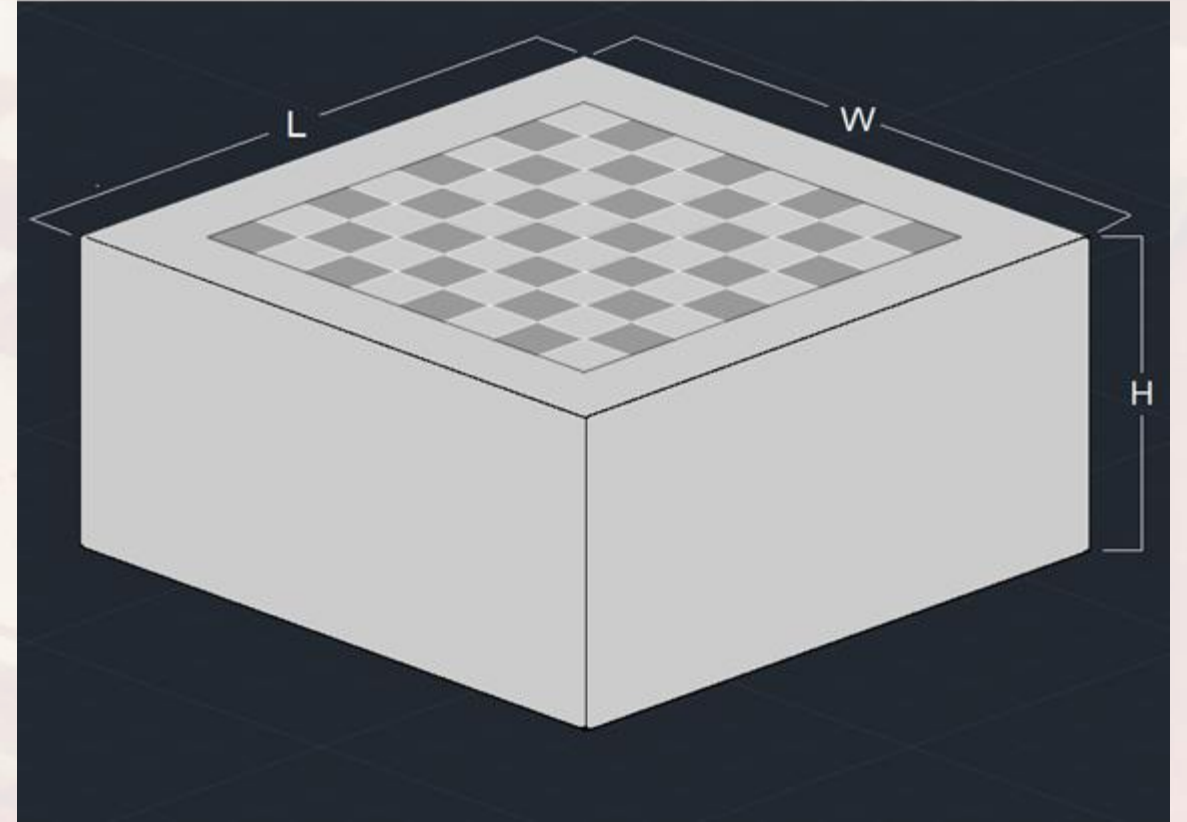
Strong positive correlation	↑↑
Positive correlation	↑
Negative Correlation	↓
Strong negative correlation	↓↓
Positive polarity	(+)
Negative polarity	(-)

Project Block Diagram



Chess Board Housing

- Length x Width x Height :
 - 650mm x 650mm x 200mm
- Volume :
 - 84,500 cm³
- Weight
 - Enclosure – 12 lbs
 - Playing Surface – 3 lbs
 - Total – 15 lbs



Chess Board Enclosure

- Sande Plywood
 - 4x8 sheet
 - Marine plywood
 - water resistant
 - Strong and light weight
- The enclosure houses all of the hardware and electrical components



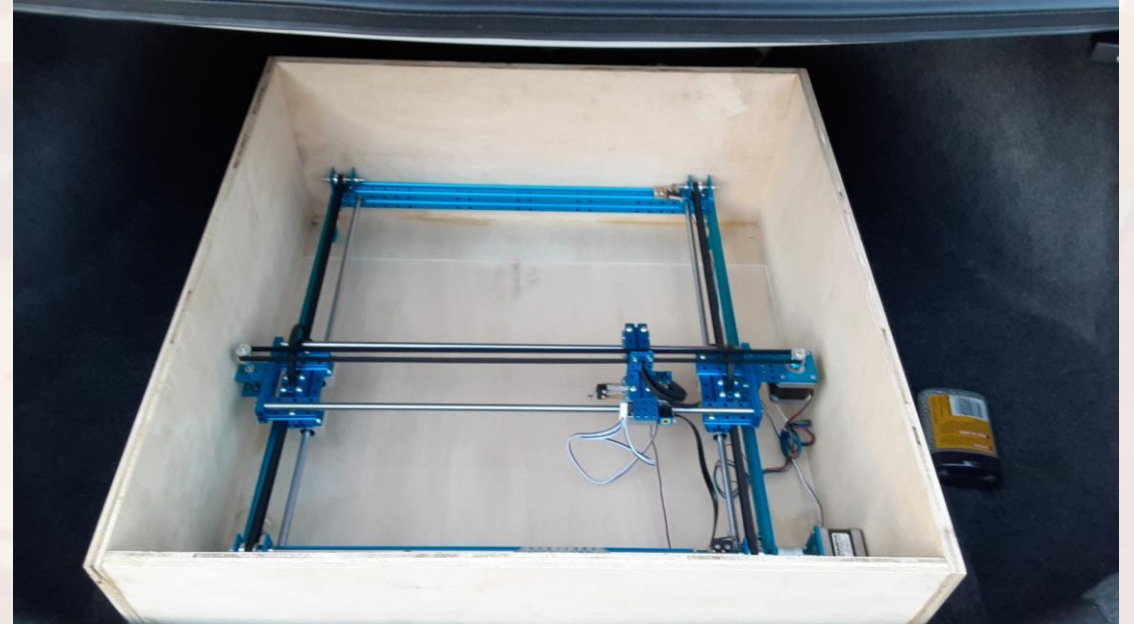
Chess Board Playing Surface

A photograph of a chess board with pieces on a wooden surface. The board is partially obscured by a semi-transparent white text box that contains the title and a list of specifications. The chess pieces are arranged in their starting positions, and the board's alternating light and dark squares are visible.

- The playing surface consist of a plexiglass chess board surrounded by a wooden boarder.
 - The plexiglass sheet chosen is a thickness of 2mm allowing for the electromagnet to grab each piece with ease while also not compromising the structural integrity of the chess board.
- Playing Surface
 - 300 x 300 mm
- Border
 - 175 mm

XY-Plotter Location and Position

- Location
 - Within the chess board enclosure
 - Brackets used to mount XY-Plotter towards top
- Position
 - Positioned upside down with respect to designed orientation
 - Electromagnet facing up towards the playing surface



Chess Piece Specifications

- Chess consists of 32 playing pieces in a complete set
 - 16 Chess pieces for each side

Piece	Height (mm)	Diameter (mm)	Weight/Piece (g)
King (2)	32.5	12.7	70.8
Queen (2)	31.75	12.7	62.5
Bishop (4)	26.98	12.7	50.0
Knight (4)	23.8	12.7	41.6
Rook (4)	20.64	12.7	37.5
Pawn (16)	19.8	12.7	33.3

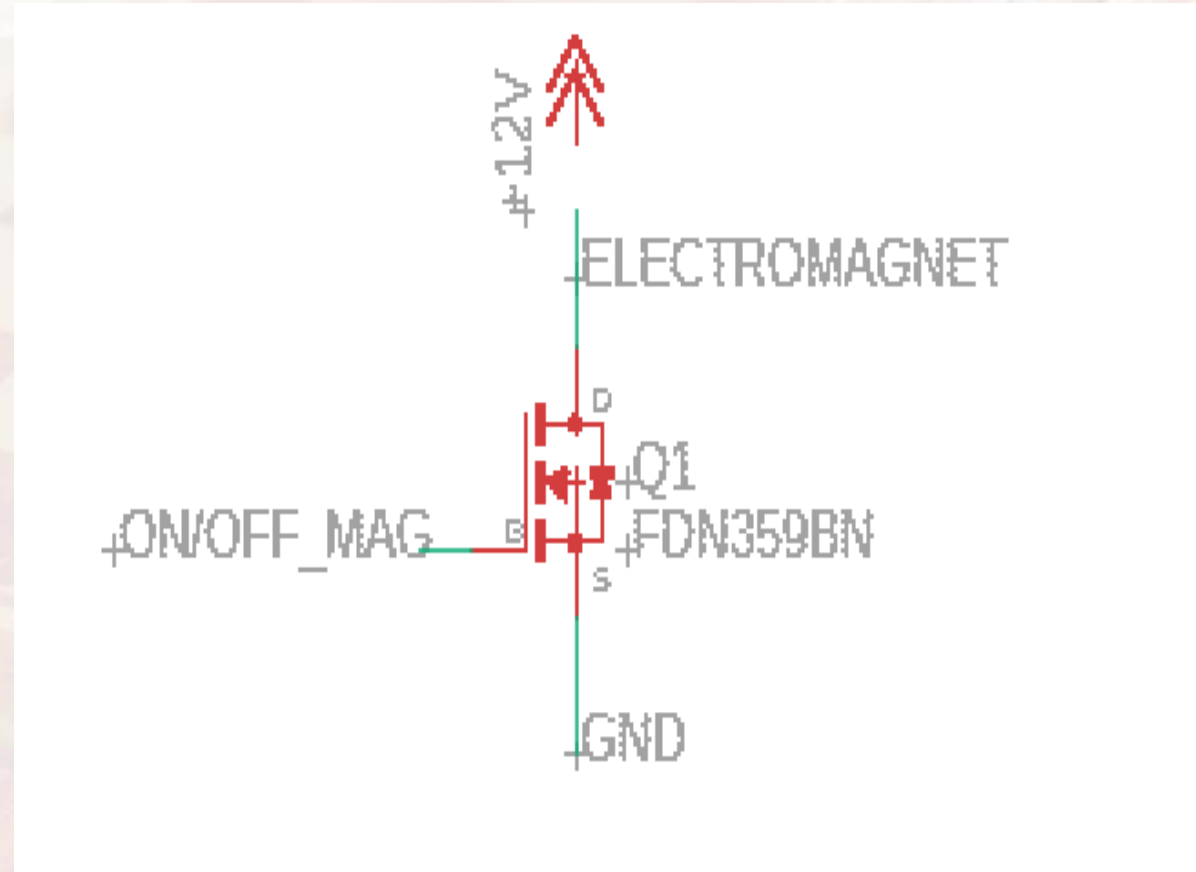
Chess Piece Magnetization

- Since the chess pieces are wooden, metal needs to be implemented into them to make them attract to the electromagnet.
- Each chess piece has a circular hole located at the base.
- Small metal BBs will be glued inside the pieces.
- This allows the electromagnet to attract the pieces.

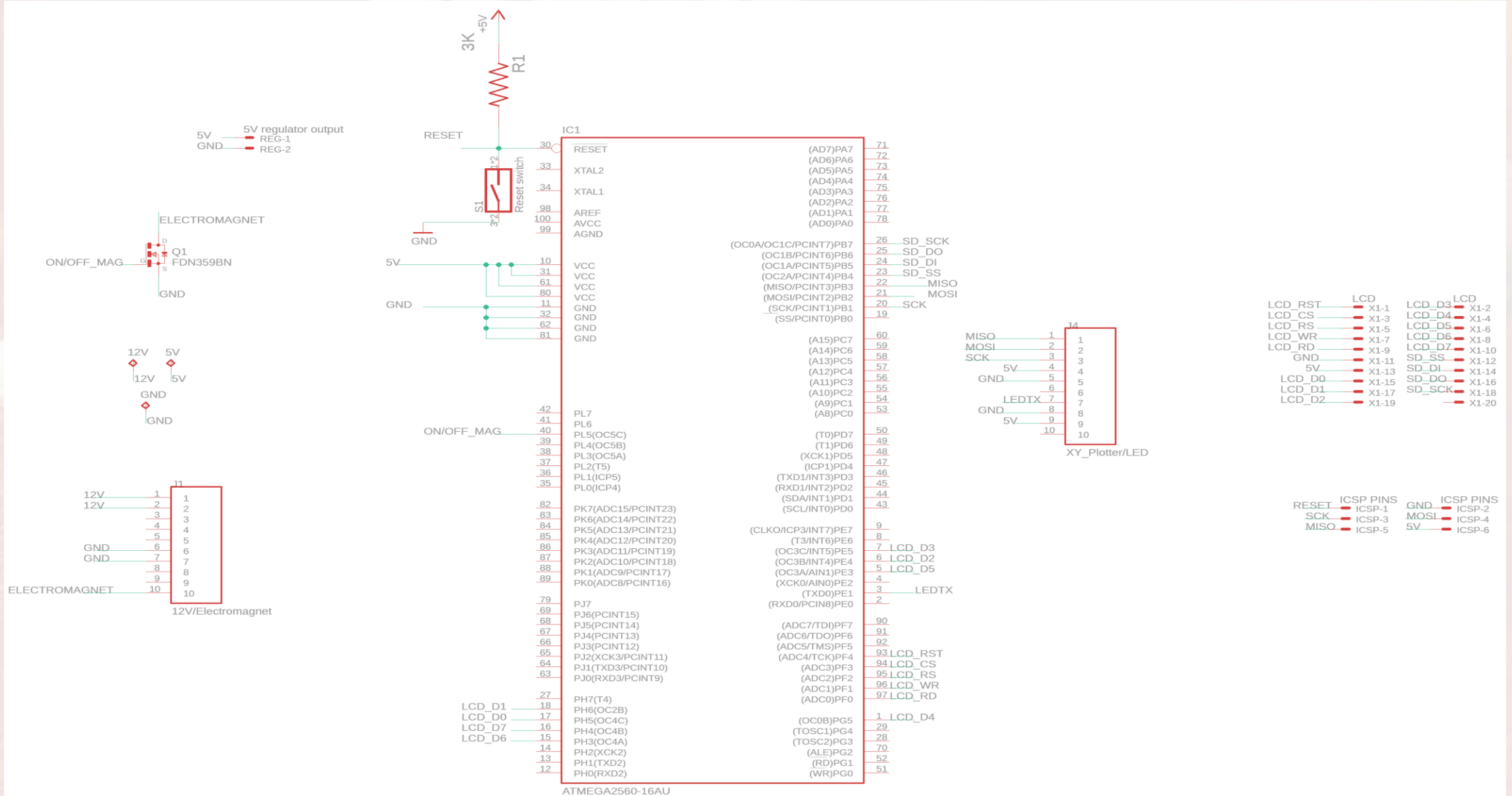


Electromagnet Specifications

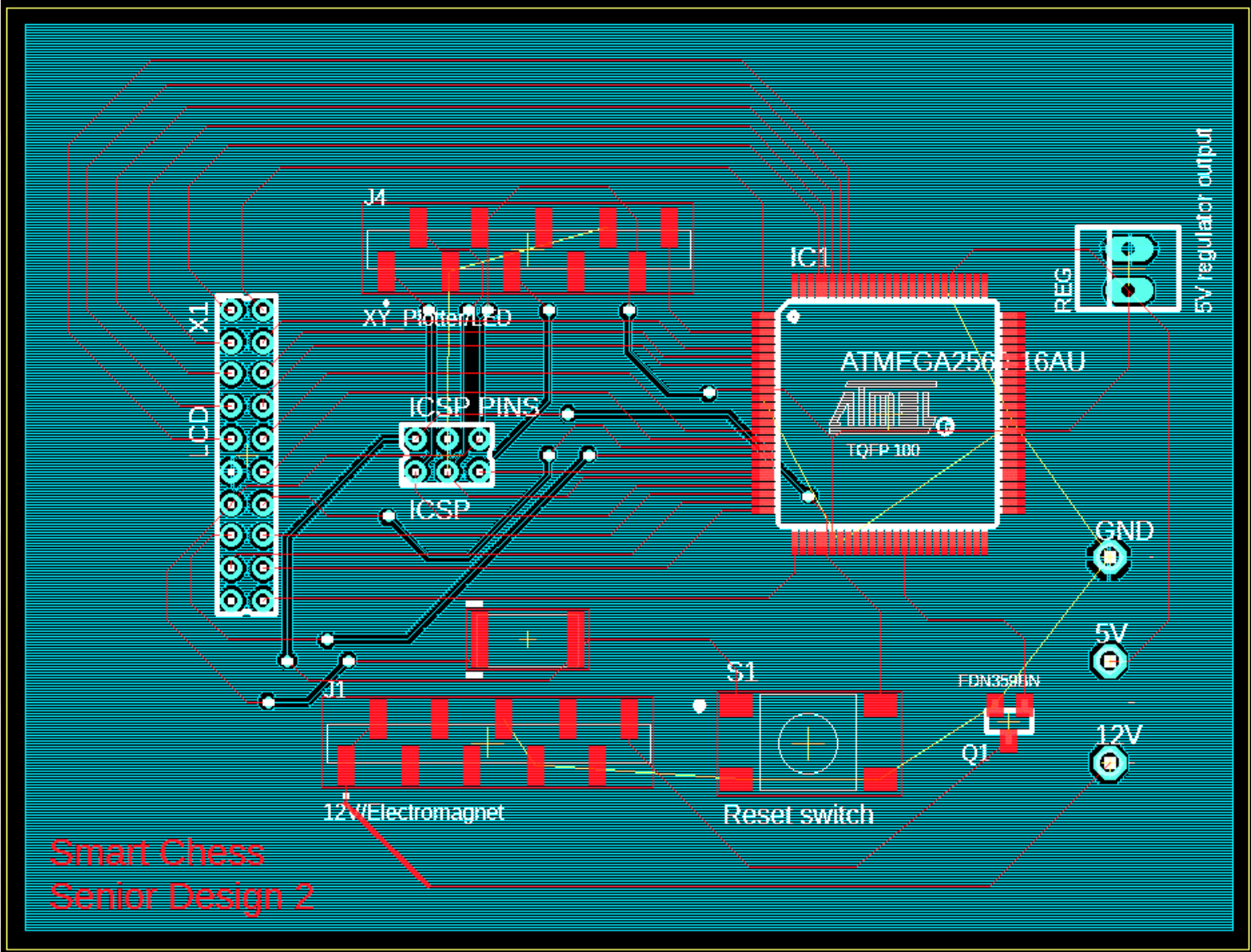
- 12V electromagnet
180N lifting force magnet
- Used in conjunction with a MOSFET in order to easily switch the electromagnet on and off
- N-channel Power MOSFET capable handling a Drain-Source voltage of 30V , and a current of 2.7A



Schematic



PCB



Testing

Electro-magnet and piece testing

- Voltage:12V Peak Force: 50N
- Overall Size : 25*20mm/1*0.8inch
- 12V DC ; Peak Force :500N
- Overall Size : 50 x 27 mm /1.97 x 1.06 in.
- 12V DC ; Peak Force :180N
- Overall Size : 34 x 18 mm / 0.7 x 1inch



Power System

- A 120V AC wall outlet will be used to power the project
- An adapter will convert the 120V AC into 12V DC
- A buck regulator drops the 12V down to 5V
- A 12 V power rail will power components such as the Electromagnet
- A 5V source will be provided from the regulator to power other components such as the microcontroller, LCD and the LEDs

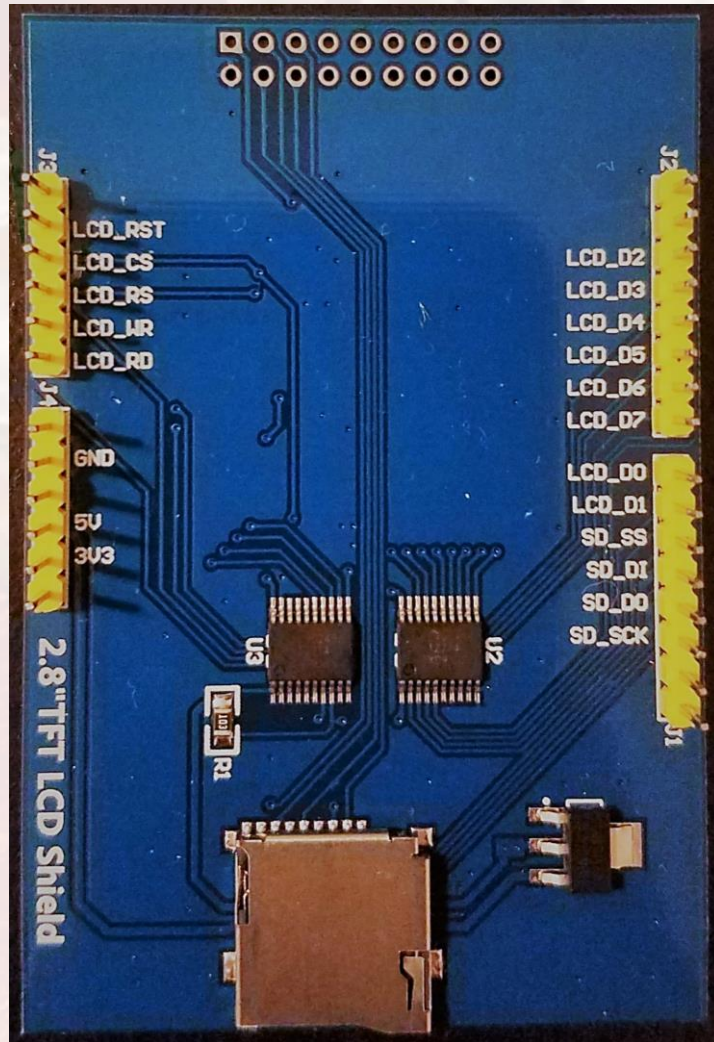
LCD

- ELEGOO Uno R3 (ATmega2560 Compatible).
- To be informed, visually, what the software is saying.



Specifications	Description	Units
Display Type	2.8 inch TFT LCD Module	-
Glass Type	TFT	-
Display Resolutions	240 x 320	Pixels
Backlight	4 chip Highlight white LEDs	-
Control IC	ILI9341	-
Interface	8 Bit Parallel Interface	-
PCB Module Size	78.22 x 52.7	Millimeters
LCD Area (W x H x T)	50 x 69.2 x 2.5	Millimeters
Active Area (W x H)	43.2 x 57.6	Millimeters
Module Weight	1.67	Ounces
Power Voltage	5	Voltage Direct Current
Current Consumption	120	Milliamperes

LCD Interface Definition



LCD Pins	Arduino 2560 Pin	Instruction
LCD_RST	A4	Reset Signal
LCD_CS	A3	Chip Select
LCD_RS	A2	Command/Data Select
LCD_WR	A1	Write Signal
LCD_RD	A0	Read Signal
GND	GND	Power GND
5V	5V	Power VCC
3V3	3.3V/NC	Not Connected
LCD_D0	8	LCD Data Bit0
LCD_D1	9	LCD Data Bit1
LCD_D2	2	LCD Data Bit2
LCD_D3	3	LCD Data Bit3
LCD_D4	4	LCD Data Bit4
LCD_D5	5	LCD Data Bit5
LCD_D6	6	LCD Data Bit6
LCD_D7	7	LCD Data Bit7
SD_SS	10	SD-Card Chip Select Signal
SD_DI	11	SD-Card SPI Bus MOSI Signal
SD_DO	12	SD-Card SPI Bus MISO Signal
SD_SCK	13	SD-Card SPI Bus SCLK Signal

LEDs

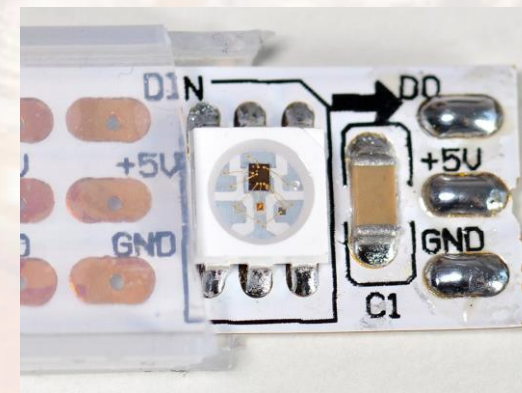
- For aesthetics and more entertaining game.
- When pieces are killed or promoted, or when the game is starting or ending, the LEDs will go off.



LEDs

- NeoPixel by Adafruit
- Each LED chip can be addressed and controlled individually.
- Low power consumption, bright, flexible, and low temperature.

Specifications	Description	Units
Model	WS2812 Strip 5050 RGB Chip	-
Input Voltage	5	VDC
LED Quantity	60 Piece RGB SMD 5050	Per Meter
Wavelength	R: 650 ; G: 520 ; B: 460	Millicandela
Product Dimension (L x W x H)	1000 x 10 x 3	Millimeters
Lifespan	>50,000	Hours



Microcontroller Specifications

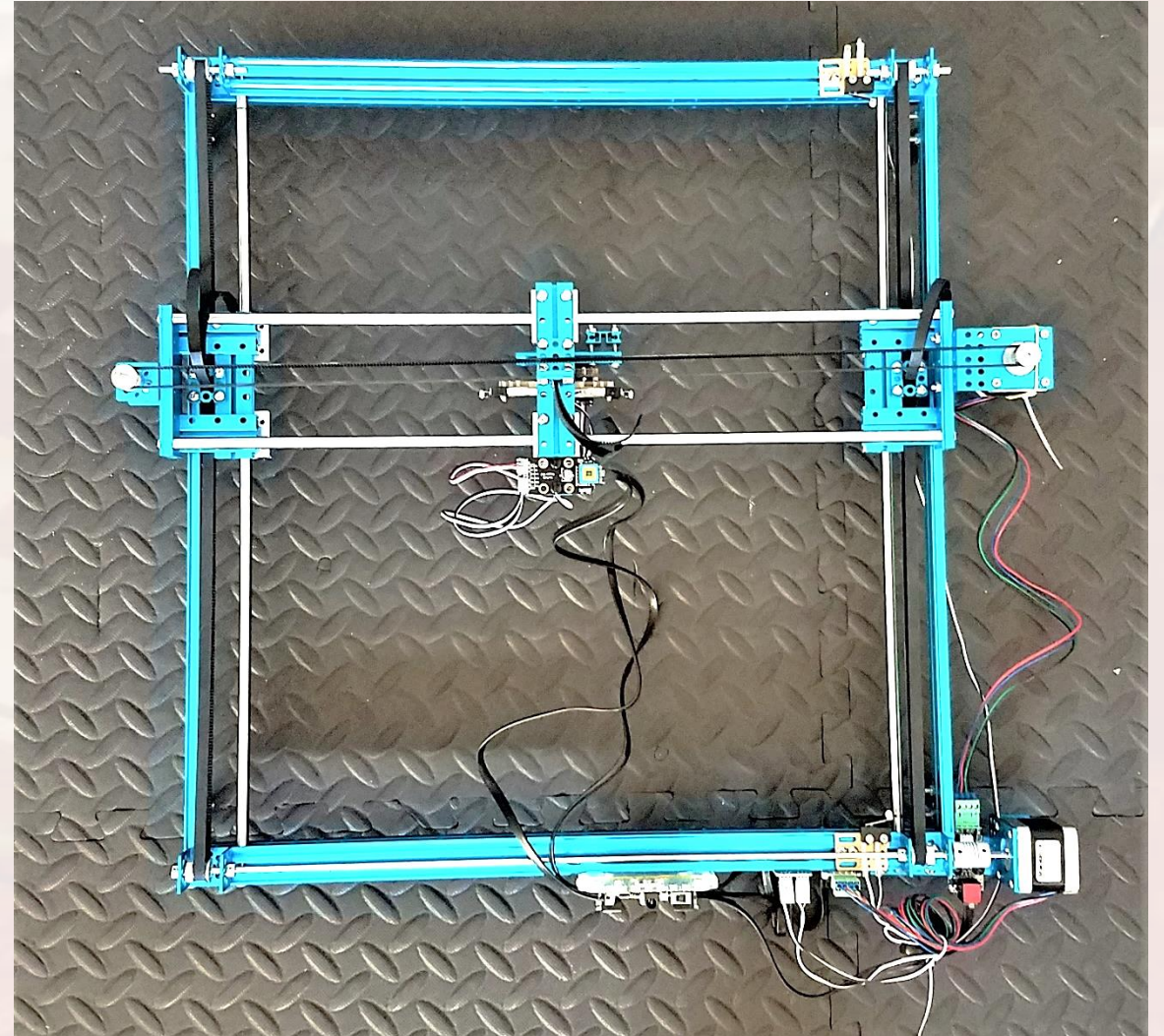
- ATmega2560-16au
- Low power 8-bit microcontroller
- Executes powerful instructions in a single clock cycle
- Achieves throughputs approaching 1 MIPS per MHz

Microcontroller Information

CPU speed	16MHz
Program Memory Size	256KB
RAM Memory Size	8KB
Number of I/O's	86
Embedded interface	I2C, SPI, USART
Supply Voltage Max	5.5V
Supply Voltage Min	4.5V

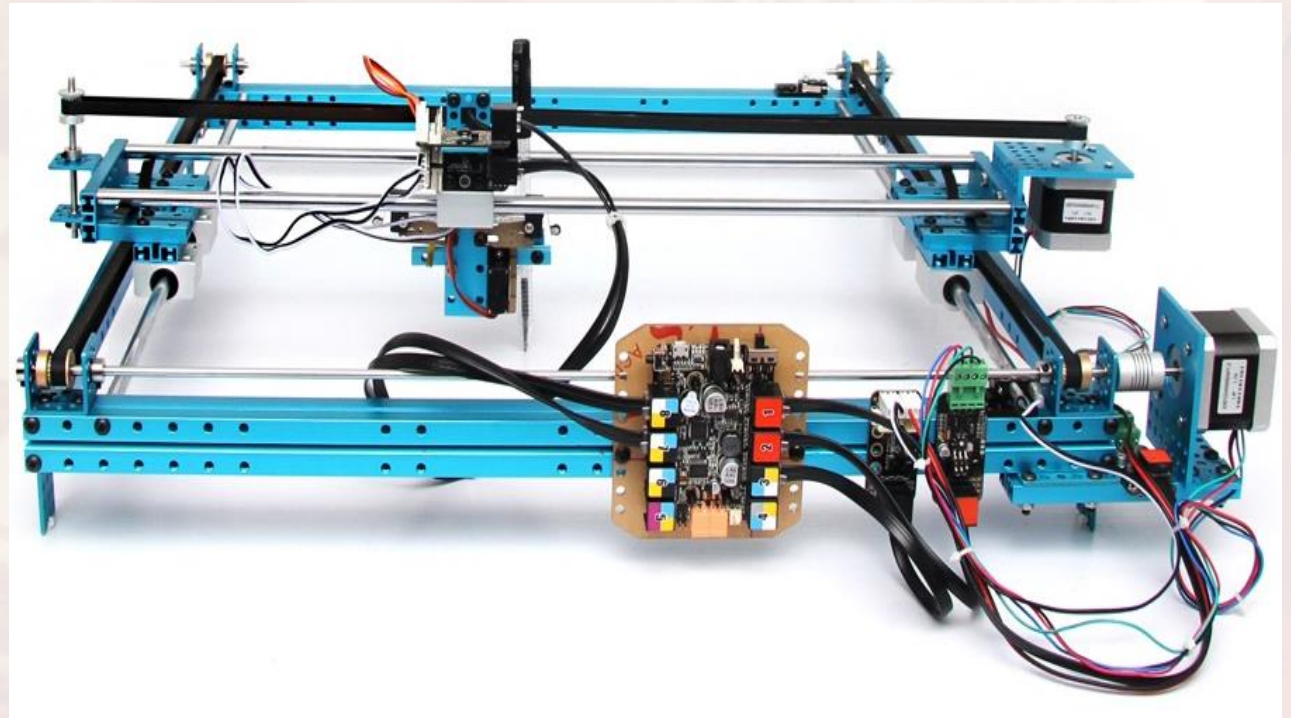
XY-Plotter Robot Kit V2.0

- The XY-plotter is used to move the pieces across the board.
- An XY-plotter is used to draw images from a bitmap; there is a clamp that holds a writing utensil.
- An electromagnet will be attached instead and be used to move the pieces across the board.



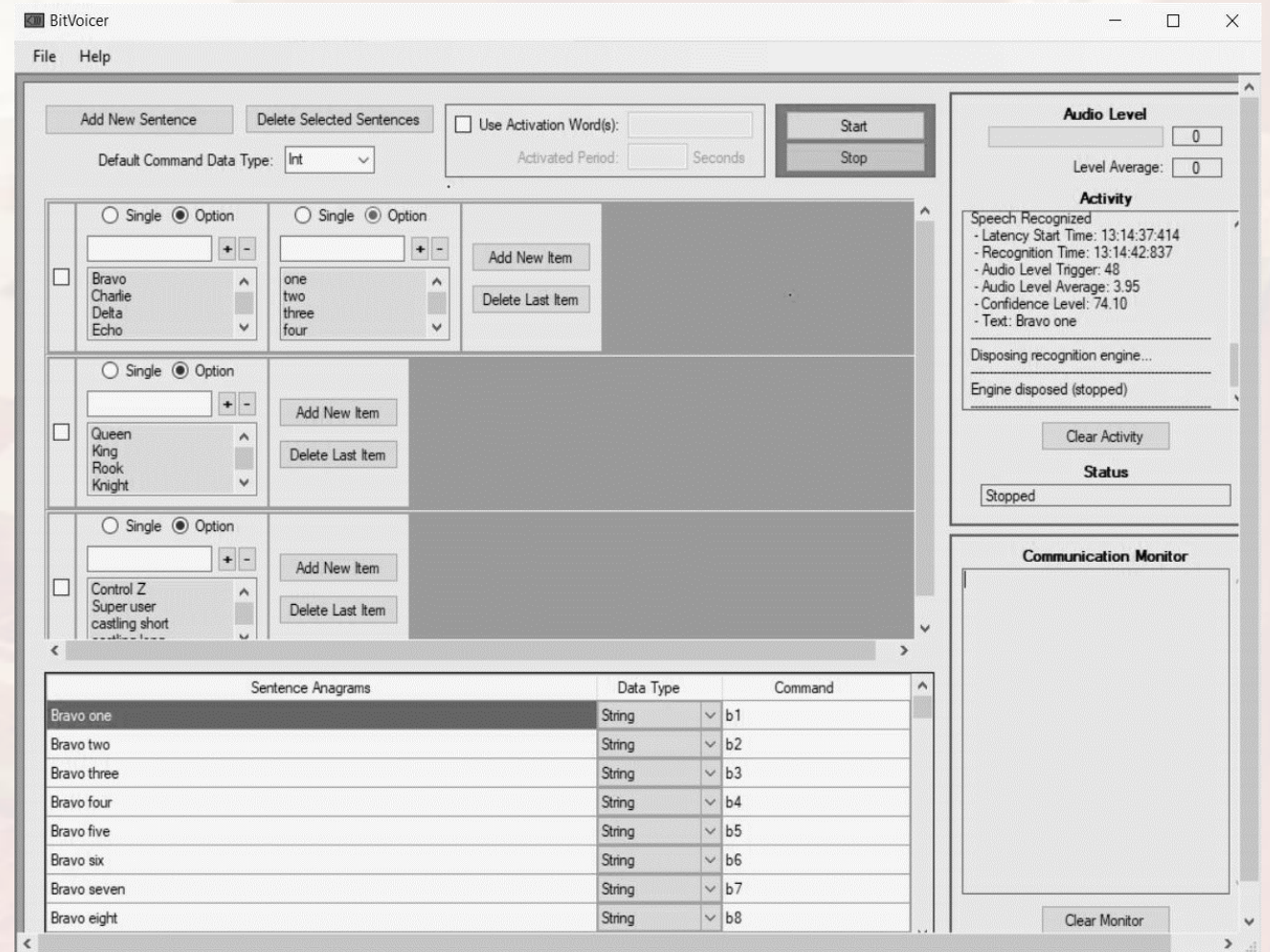
XY-Plotter Robot Kit V2.0

- The plotter is controlled via G-code, typically used for CNC.
- A coordinate grid will be created of the chess playing surface and a script will be written that converts the voice commands to G-code instructions.
- This will cause the stepper motors to move the electromagnet appropriately.



Voice Recognition Software

- BitVoicer is an app that analyzes audio streams and identifies words or sentences.
- Only relevant words are recognized.
- Audio is compared to the library of relevant words and the closest sounding sentence is chosen.



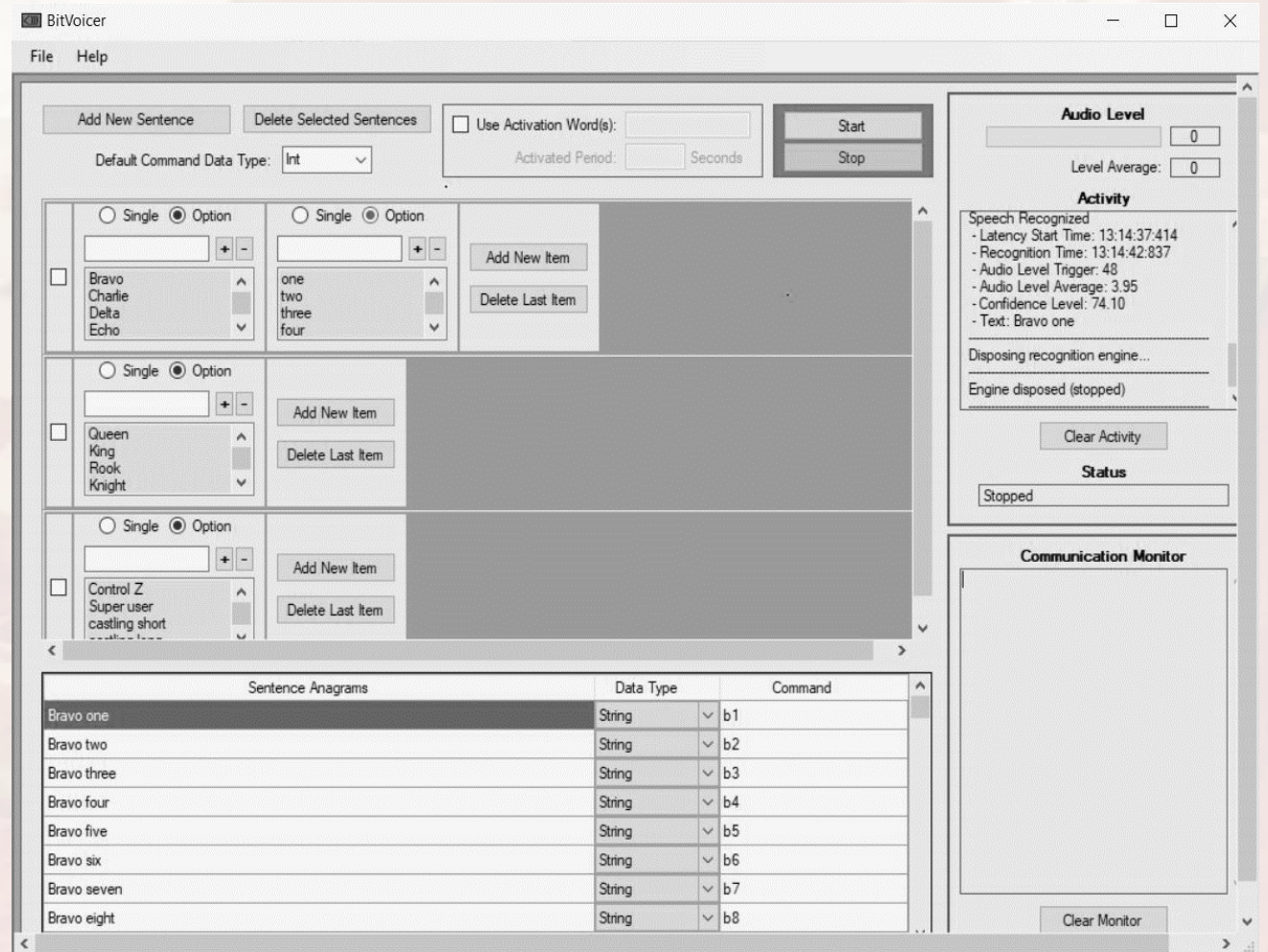
Voice Recognition Software cont.

- The NATO Phonetic Alphabet is used to disambiguate letters that sound similar
- i.e. B, C, D, E, G
- This improves accuracy

Latin Alphabet	NATO Phonetic Alphabet	Phonetic Pronunciation
A	Alfa	(AL-FAH)
B	Bravo	(BRAH-VOH)
C	Charlie	(CHAR-LEE)
D	Delta	(DEL-TAH)
E	Echo	(ECK-OH)
F	Foxtrot	(FOKS-TROT)
G	Golf	(GOLF)
H	Hotel	(HOH-TEL)

Voice Recognition Software cont.

- Recognized words are converted to commands and sent to a microcontroller.
- The commands are then run through a chess engine which analyzes move legality.



Chess Engine

- A chess engine is a program that analyzes chess positions and generates a move or list of moves that it considers as strongest.
- The engine shown in the image stores pieces using a mailbox array.
- All chess engines function based on a set of algorithms including minimax and alpha-beta pruning.

```
tscp> d
8  r n b q k b n r
7  p p p p p p p p
6  . . . . . . . .
5  . . . . . . . .
4  . . . . . . . .
3  . . . . . . . .
2  P P P P P P P P
1  R N B Q K B N R

   a b c d e f g h
```

```
tscp> a2a4
tscp> d
8  r n b q k b n r
7  p p p p p p p p
6  . . . . . . . .
5  . . . . . . . .
4  P . . . . . . .
3  . . . . . . . .
2  . P P P P P P P
1  R N B Q K B N R

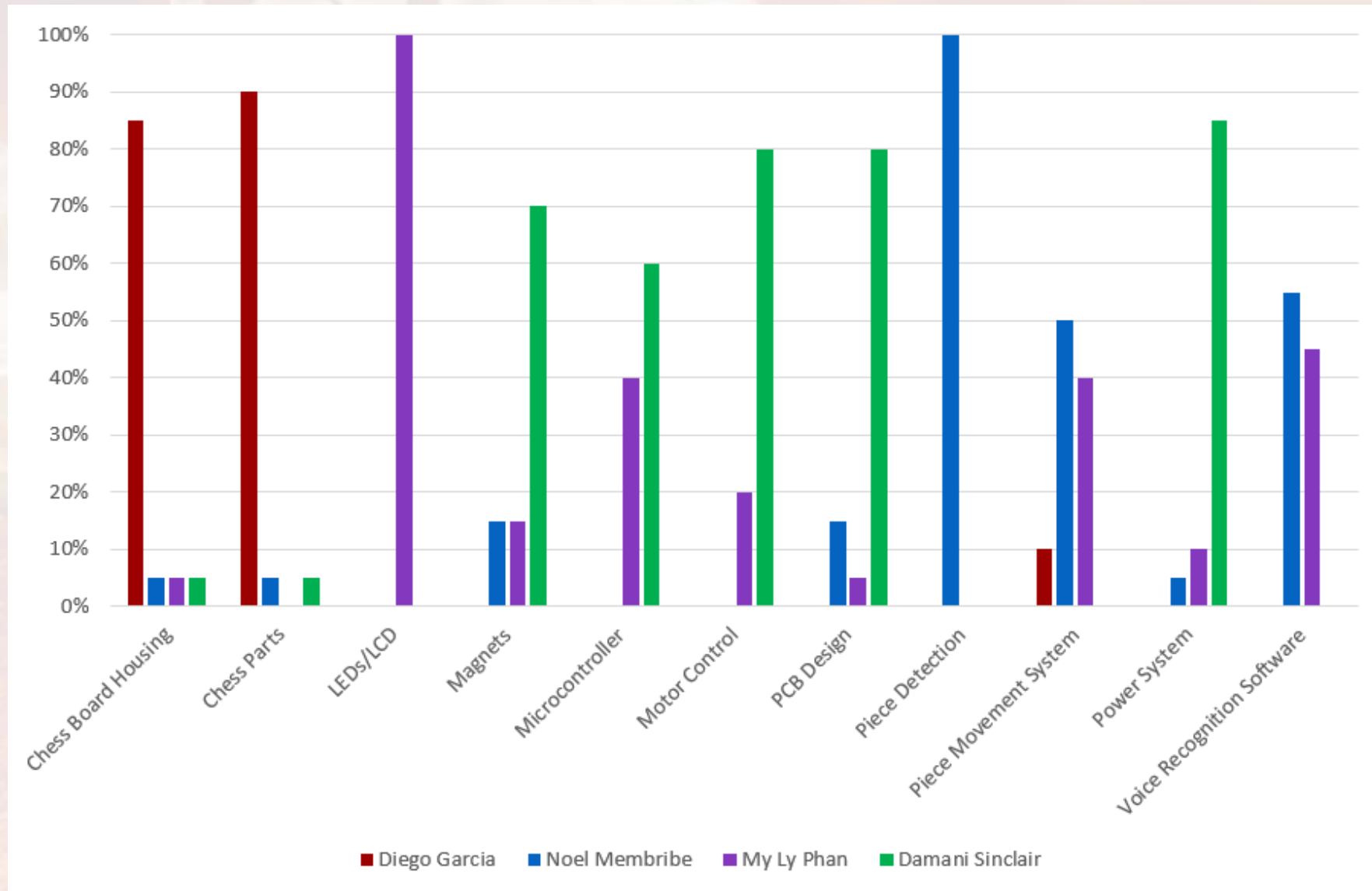
   a b c d e f g h
```

```
tscp> a8a7
Illegal move.
```

Quick Recap of Software

- Voice recognition software takes voice commands from player.
- Commands are converted to instructions and sent to microcontroller.
- Microcontroller is running chess engine program on it, takes in instructions as an input.
- If the move is legal, then a G-code instruction is generated and sent to the XY-plotter.
- XY-plotter executes the code and the chess move that the player requested is performed.

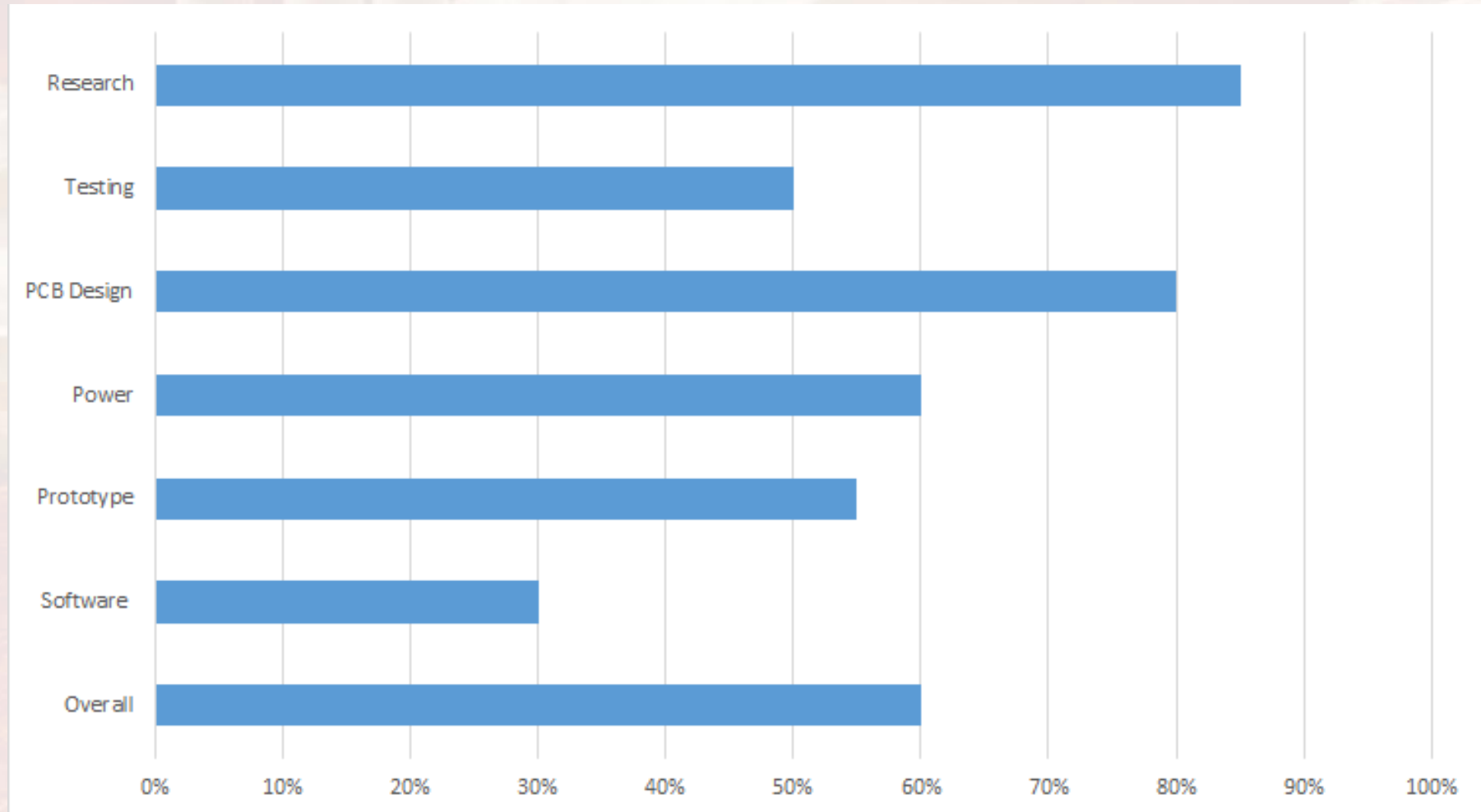
Project Management



Project Budget and Financing

Item	Price	Quantity	Tax & Shipping	Subtotal
Plywood	\$35.95	1	\$2.52	\$38.47
Plexiglass	\$29.78	1	\$2.08	\$31.86
Chess Piece Set	\$15.00	1	-	\$15.00
ATmega 2560 Microcontroller	\$10.24	3	\$8.99	\$19.23
Generic Sunfounder Development Board	\$13.99	1	-	\$13.99
XY-Plotter	\$299.99	1	-	\$299.99
Electromagnet	\$12.00	1	-	\$12.00
Voltage Regulator	\$2.20	1	\$4.81	\$7.01
Standard Power Outlet	\$6.86	1	-	\$6.86
PCB Manufacturing	\$35.45	1	-	\$35.45
LEDs/Cosmetic Lights	\$24.95	1	-	\$24.95
LCD Screen	\$15.99	1	-	\$15.99
Microphone	\$5.49	1	-	\$5.49
Speakers	\$11.99	1	-	\$11.99
Miscellaneous	\$14.70	-	\$1.03	\$15.73
Total				\$554.01

Progress



Project Difficulties



- How to make the Bit voicer, Microcontroller and the XY- plotter to work in unison
- How to communicate between the computer and XY-plotter
- How to get the LCD and LEDs to work with Bitvoicer and the chess engine.

A photograph of a chess set on a wooden board. The chess pieces are arranged in their starting positions. The board is a standard 8x8 checkered pattern. The pieces are made of a light-colored material, possibly wood or plastic. The word "Questions?" is overlaid in the center of the board in a large, black, sans-serif font. The background is a dark, textured surface, likely a wooden table.

Questions?