EE476C – Project Design Procedures	
Problem Statement	
White Board Robot	
Group: ***Smart Board***	
Term/Year: Fall 2022	*Date*: 10/14/2022

Statement of Needs

Many professors have a need for whiteboards in their offices, however, keeping track of what is on the board, erasing content and adding notes can be difficult. This project is about combining a traditional whiteboard with a new type of smart whiteboard that pushes the physical boundaries of a traditional whiteboard and gives it many digital whiteboard features.

Statement of Objectives

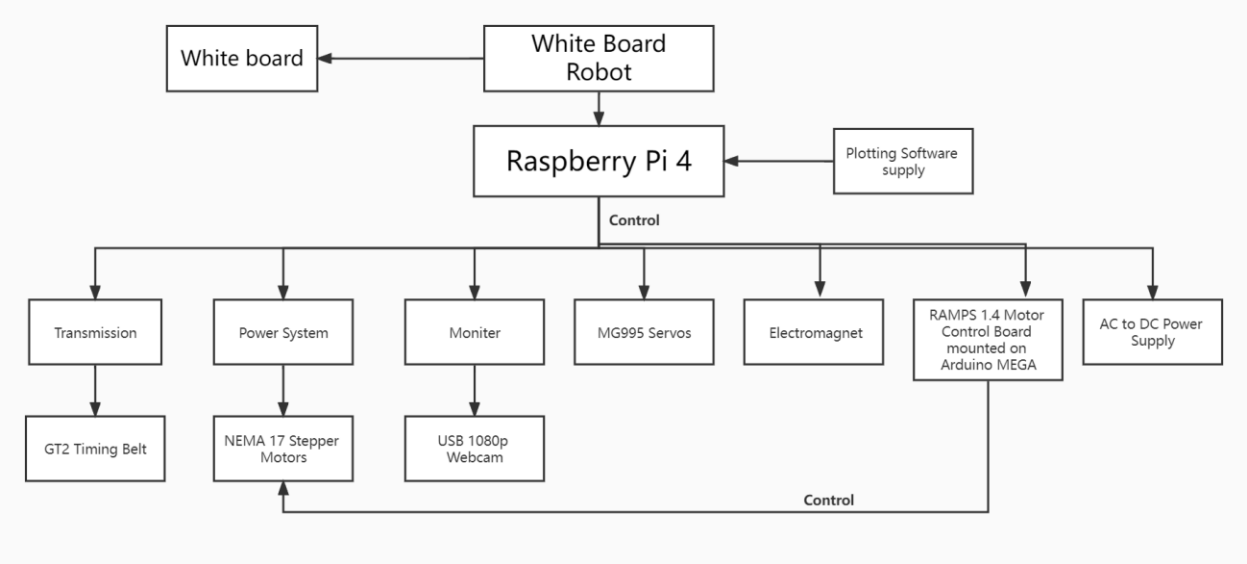
1.Digitally record what is currently on the white board in a private and non-invasive manner.(meaning, a camera on the other side of the room will not do the job)

2.Erase parts of the white board as directed through a hardware and software interface.

3."Write " new notes or drawings on the white board through a remote, internet enabled interface.

4.Something like an app, or a website that could be loaded on a tablet, or maybe even a “send a picture and have it sketch” feature.

Objective Tree



Literature Research

Some websites about our projects：

1:https://www.instructables.com/XY-Plotter-Drawing-Robot-Arduino-Polargraph/

2:https://www.maslowcnc.com/

3:https://youtu.be/gYv5TzKNsK4

4:https://eltra-encoder.eu/news/quadrature-encoder

Some references for our project：

[1] J. Wan, Z. Wang, B. Zi, D. Wang and Z. Cao, "Kinematics Modeling and Analysis of a Novel Five-DoF Spraying Robot," 2019 IEEE International Conference on Mechatronics and Automation (ICMA), 2019, pp. 524-529, doi: 10.1109/ICMA.2019.8816253.

[2] Z. Pei, M. Zhao and D. Liu, "Spraying robot kinematics analysis based on BP neural

network," 2015 IEEE International Conference on Information and Automation, 2015, pp. 2744-2748, doi: 10.1109/ICInfA.2015.7279751.

[3] S. Pieskä, J. Kaarela and J. Mäkelä, "Simulation and programming experiences of collaborative robots for small-scale manufacturing," 2018 2nd International Symposium on Small-scale Intelligent Manufacturing Systems (SIMS), 2018, pp. 1-4, doi: 10.1109/SIMS.2018.8355303.

The House of Quality has been made as shown in the following figure. It has developed by using the customer requirements and engineering requirements. As the customer requirements have listed on the left side of the table and engineering requirements have listed on the top of the table.

House of Quality (HOQ)

Customer Requirement	Weight	Engineering Requirement	WiFi Operation	Accuracy	High Speed Motor	High Resolution Camera	Database Capacity	Durable	Two Dimensional	Cursor Movement Reading
Write on whiteboard	9		3	3	1			1	3	3
Erase on whiteboard	9		3	3	1			1	3	3
Remotely Use Robot	9		3			1				
Online Portal	3		3			1				
Images on whiteboard	3		3				9			
Scanning board	3			1		9				3
Cost within budget	3		1	1	1	1		3	1	1
Durable and Robust Design	1				1	1		3		1
Reliable Design	1				1	1		3		1
Absolute Technical Importance (ATI)			102	60	23	44	27	33	57	68
Relative Technical Importance (RTI)			35%	21%	8%	15%	9%	11%	20%	24%
Target ER values			24 hours	1 cm		100 rp	108MP	100GE	2200 M	-	1 cm
Tolerances of Ers			5 min	0.01 cm		10 rpm	10 MP	10GB	200 Mp	-	0.01 cm

The relation of each customer requirement with the engineering requirement has listed with the marks given in the corresponding box and the table has generated the priority list of engineering requirements according to which the most important requirement is Wi-Fi operation, that needs to be active for full time a day so anyone can access the robot at any time. The next most important requirement is cursor reading as it can easily locate the exact point where the cursor is present. And the next important requirement is two-dimensional movement of the cursor to move the cursor for writing and cleaning purposes in both horizontal and vertical direction and the least important is motor speed as the cursor writing and erasing has to be done with a specific speed and doesn't require any high-speed motor. Hence house of quality plays a great role in determining which engineering requirement is most important and which is least important.

Functional Analysis

1. Functional Decomposition

Our project is a whiteboard robot with many functions. We use three stepper motors to control the polar plotter so that the marker can move, rise and fall to draw and write on the whiteboard.The position of the marker on the whiteboard is controlled by a servo, the position of the eraser is controlled by a solenoid embedded in the eraser, and the three stepper motors are operated by a Ramps 1.4 motor control board controlled by a Raspberry Pi. A polar plotter software is installed on the Raspberry Pi so that commands can be sent to the polar plotter for drawing operations. A webcam is placed on top of the whiteboard and activated when needed.

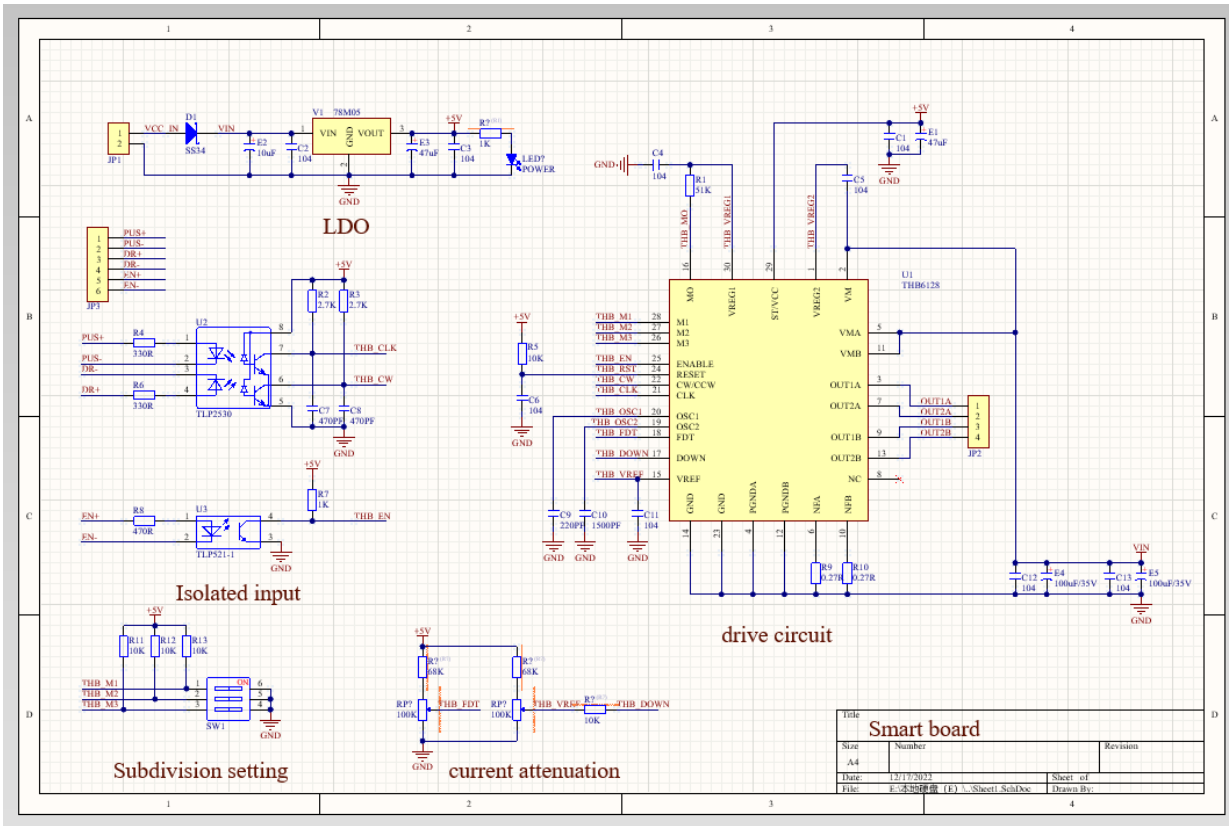
Function:

- Write on whiteboard
- Draw on whiteboard
- Erase on whiteboard
- Operate remotely on whiteboard
- View whiteboard remotely
- Scan the whiteboard

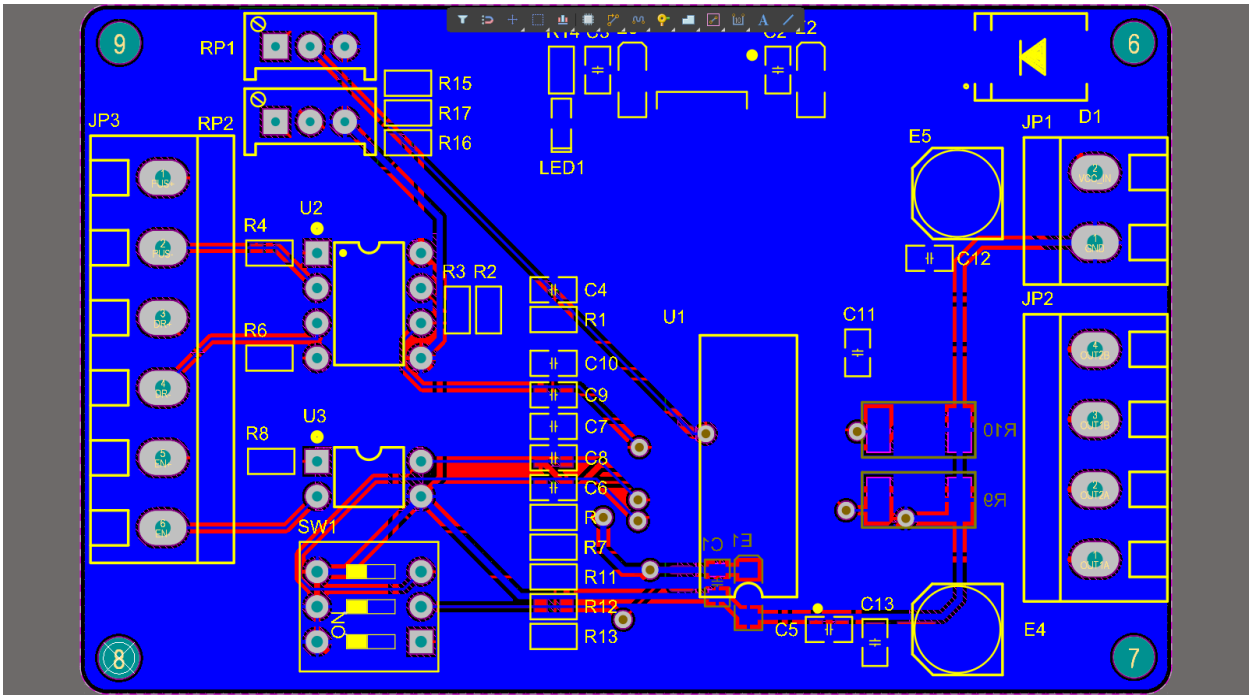
2. Bottom-up & Top-down approaches

We use a top-down approach to decompose the project by first analyzing the requirements and then developing a general design for the project based on the requirements. Then analyze the breakdown one by one. After that, design some circuit diagrams and simulate them on the computer.

Testing matrix for prototype



Stepper Motor Control Principle diagram



PCB schematic diagram

test case:	amplifier		date:	2022/12/15		
			time:	22:00		
setup:	apply DC input, wait 1s and measure DC output with voltmeter.					
test	Vi	expected output		obtained	pass	fail
1	0V	0V		0V	√	
2	0.1V	1.5V		1.487V	√	
3	0.2V	3V		2.341V		√
4	0.3V	4.5V		4.514V	√	
			overall test result:		√	

Testing matrix

WBS (Work Breakdown Structure)