PiezoBot

Brayden Riggs and Monqiue Parrish

December 1, 2023

Table of Contents

Introduction

Brayden Riggs - Team Lead: Responsibilities include managing due dates, mainly coding the project, and meeting with the client bi-weekly.

Monique Parrish - Treasurer: Responsibilities include managing the budget for the project, filling out purchase orders, 3D printing, and Web design.

This project is an improvement to the Kilobots created at Harvard. Dr. Cunha has challenged us to construct a small, low budget robot. Instead of incorporating a bulky vibration motor, we are trying to cut down on that weight with a piezo disk. Applications for these robots can be applied in search and rescue, collective transport, and cleaning oil spills. However, this is an early stage prototype for these robots that still have a lot of potential and work to be done to get them to that point.

Statement of Needs:

In this Section, we will analyze the client's needs for the project. We will compare and weigh them using a matrix and objective tree.

Marketing Requirements

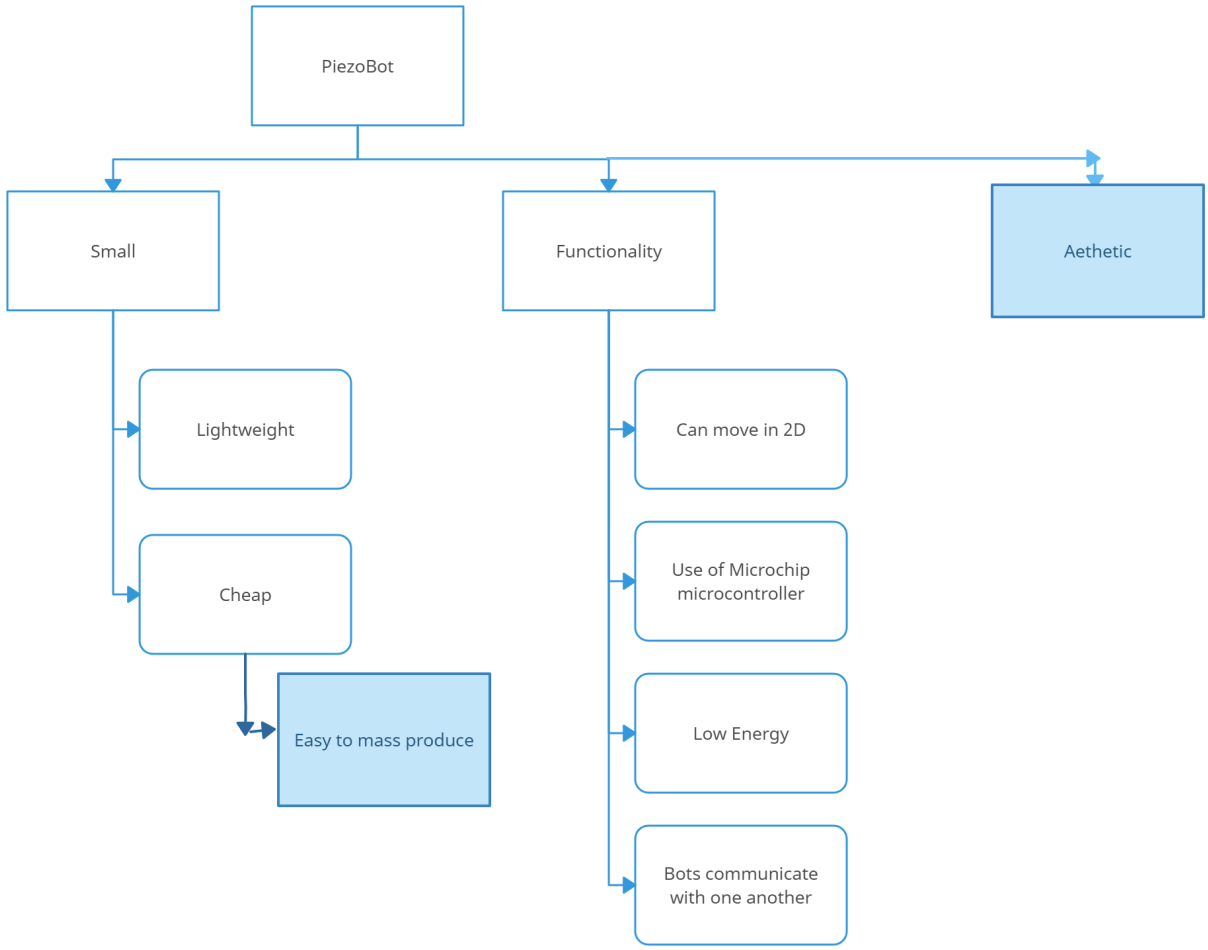
- Small as possible
- Light weight
- Easy to manufacture/mass produce.
- Use Microchip microcontroller since they are sponsoring the project
- AVR 128 nano Board
- Low energy
- Use piezo disk

Additional Optional Customer Wants

- Bots are be able to communicate, i.e. with light or sound, not Bluetooth
- Multiple bots as deliverable to demonstrate communication

\

Diagram and Matrices:



	Small	Performance	Aesthetic	Sum	Weight
Small	1	0.25	4	5.25	0.31
Performance	4	1	5	10	0.6
Aesthetic	0.25	0.2	1	1.45	0.09
				16.7	

	2D	Energy	Communication	Light	Cheap	Sum	Weight
2D	1	5	4	3	3	16	0.413544
Energy	0.2	1	3	2	0.5	6.7	0.173171
Communication	0.25	0.33	1	2	0.25	3.83	0.098992
Light	0.33	0.5	0.5	1	0.5	2.83	0.073146
Cheap	0.33	2	4	2	1	9.33	0.241148
						38.69	1

Statement of Objectives

By the end of the semester, we want to start getting to the point where we are designing and have all our equipment this semester. In this fall semester, we want to get as far as we can and at least to a point where we are hands-on. Have our recommendations for equipment by the end of December. Come to a point where we are designing and getting to a point where we are using Blender or some type of

3D programming and where we are almost testing to satisfy the “hands-on” part where we wish to be by December.

Get some type of movement by the end of the semester on an X-Y plane. Hopefully, we can have the robot moving so that we can start 3D designing and testing our piezobot and come to a point where we can move on to the next state of communicating with other piezobots and hopefully more than one bot by the end of the spring semester.

By the end of the fall semester, we want to have the deliverable, where the bot is moving and the goal moving on an X-Y plane. By January or the beginning of February, we want to have the robot functioning and begin working on the communication between the bots and we are leaning towards light sensors and some types of sensors, which are still being researched.

System Requirements

Technical:

- Low Energy
- Small as possible
- 2D Movement (at least “3 Feet”)
- Low cost
- Bots Communicate

Hardware and Software:

- Use MPLAB X software
- Use Microchip microcontroller (AVR128DB48-C Nano)
- Incorporate sensors as communication system between bots

Trade-Off Matrices:

Comm. = Communication	Move = Good Movement
Perform. = Performance	Manufac. = Manufacturability
Green = Higher/Good	Red = Lower/Bad
(-)= Negative Correlation	(+)= Good Correlation

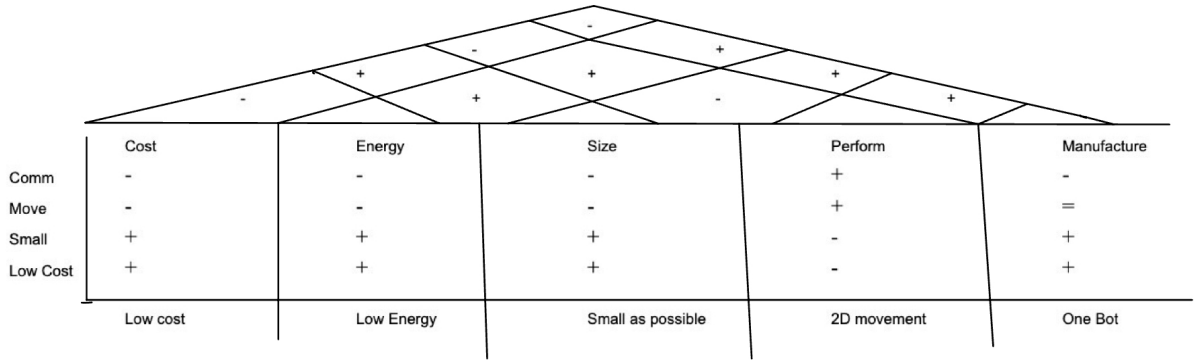
	Cost	Energy	Size	Perform.	Manfuc.
Comm.	-	-	-	+	-
Move	-	-	-	+	=
Small	+	+	+	-	+
Low Cost	+	+	+	-	+

Here in this matrix, “-” means negative correlation, and “+” means positive correlation. The green and red mean higher/good and lower/bad respectively. So for example having the robot be small is good and has a positive correlation with cost since we want a lower cost. This helps make it clear how our engineering requirements impact our client's requirements.

	Cost	Energy	Size	Perform.	Manufac.
Cost		-	+	-	+
Energy			+	+	+
Size				-	+
Perform.					-
Manufac.					

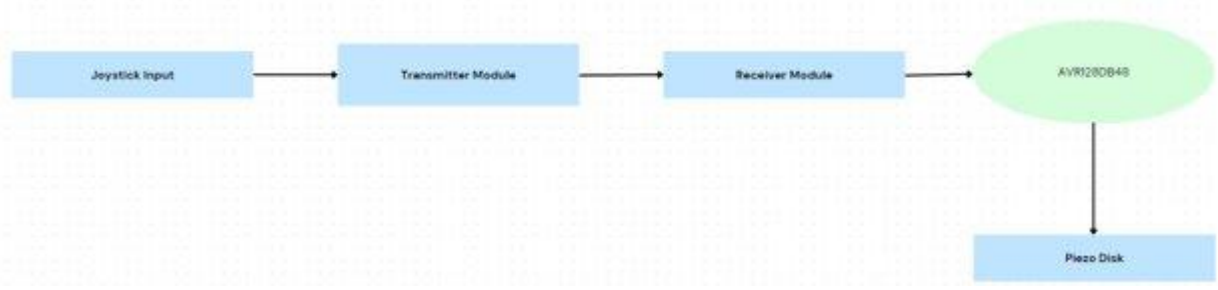
In this matrix, we compared the engineering trade-offs. Again, “-” means poor correlation, and “+” means good correlation. So cost and size both lower when the other lowers. This helps us understand the relationship between our given requirements.

House-of-Quality



This is the house of quality which was made based on the matrices. The requirements are very vague because at the moment we only have the goals of our robot and so we have to go off our budget of $500 to get accurate requirements for what we are aiming for.

Functional & Behavioral Analysis



After setting up an AC square wave signal using a timer, sending a differential voltage to the disk will create a certain flex in the disk that can create 2D movement to achieve a minimum of 3 feet of movement. Future plans will incorporate a joystick for demonstration of movement.

Conclusion

Next semester will focus on completing the side-to-side movement of the piezo bot. Cleaning up the website to be more presentable and adding the poster to the website.