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% ENGR 130 Module 3.2 Report
% Section E
% October 13, 2023
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1) We concluded that an optimal voltage for detecting a knock is 0.15V. We came to this conclusion after constant testing and seeing how different peoples knocks were recorded. Most of our knocks were easily breaking the 0.5V mark, but there were some lighter knocks that wouldn't be detected at such a high threshold. Using this knowledge we gradually lowered our threshold until every knock was recorded and there were no false positives. A slight movement of the film could record a voltage of at most 0.1V, so we set our threshold to a value a safe distance away from this minimum. This happened to 0.15V.

2) The obvious use of a knock sensor is in a home security system. It would be useful to tell the owner of a house that there is someone knocking on your door and waiting for you to answer. This could go a step further and turn on a camera outside your front door only if there is someone knocking. This would save energy and prevent your camera from infringing on the privacy of people walking by. A knock sensor may also be useful in a lab, where strong, deliberate hits would interfere with the experiment currently taking place. Being able to detect knocks in this setting could reduce the chance for repeated trials, saving time in the long run.

3) As mentioned in module 1 of this lab, we can clearly see piezoelectric materials in musical instruments like electric guitars, where the vibrations of the strings are recorded and turned into a voltage that is converted to a sound. It is also very likely that piezoelectric materials can be/are used in some touch screen technology, where touching a screen with enough force is converted to an electric signal that corresponds to another part of a system.

4) Algorithm
    a) Designate a term to be the threshold value
    b) Look at the first voltage recorded
    c) If the first voltage recorded is greater than the threshold value record a knock
    d) Look at the next voltage recorded and call it the current voltage
    e) Look at the voltage reading directly before the current voltage reading
    f) If the current voltage reading is above the threshold value and the previous threshold value is below the threshold value, record a knock
    g) Repeat steps d-f for as many voltage readings were recorded
    h) Once the voltages have all been looked through, show the user how many total knocks were recorded

5) We detected knocks by analyzing each individual point in our vector containing the voltage readings. We looped through this vector, starting at an index of 2 and going to the end. In the loop, we assigned a current value variable the index of the voltage at the for loop index and a previous value variable the index before this. We then determined if a knock should be recorded by comparing these values with the threshold value. If the current value was above the threshold and the previous value was below the threshold, then a knock was recorded. This accounts for two back-to-back readings being above the threshold value. After the entire voltage vector had been looped through, we looked at the first value, as it was not fully analyzed by the loop. If the first voltage reading recorded was above the threshold, then a knock was recorded. This accounts for the code being run at the same time someone is knocking.

Engineering Design Process Sheet **Module 3**

Fill out this worksheet as you work through the design of your knock detecting spy device. You will submit this typed and completed worksheet as part of your module report.

Part A: Define Problem
Write a description of the problem in your own words.

The problem is to use the piezoelectric film as well as the arduino to build a sensor that is able to detect a knock.

Part B: Determine Specifications & Requirements
Ask at least two clarification questions.

1. **Will part of the project be hiding the device in something and if so is one of the criteria the size of the device?**

2. **Will we need to be able to analyze a wide variety of knock signals ranging from soft to loud knocks?**

Part C: Identify Design Decision Criteria
Thinking about what would be helpful for the intended user of your product, create a list of at least two criteria by which you will evaluate your design concepts. Indicate whether they are equally important or whether one should be weighted more heavily than the other. Explain why you chose these criteria.

1. **The sensitivity of the device. This is important for differentiating between accidental taps and purposeful knocks.**

2. **The size of the device, this is important because users may need/want a device of certain size specifications.**

Part D: Generate Design Concepts
List as many ideas as you can for designs and features.

- **Lighting up an LED to tell the user that there is someone knocking**
- **Sounding an alarm with active buzzer when there is someone knocking**
- **If there is a knock a message appears on a computer.**
- **Make a passive buzzer play a tone and have the user return a similar knock**
- **Make a motor vibrate if there is a knock.**
- **Place something on the top of the piezo to distribute the voltage**

Engineering Design Process Sheet **Module 3**

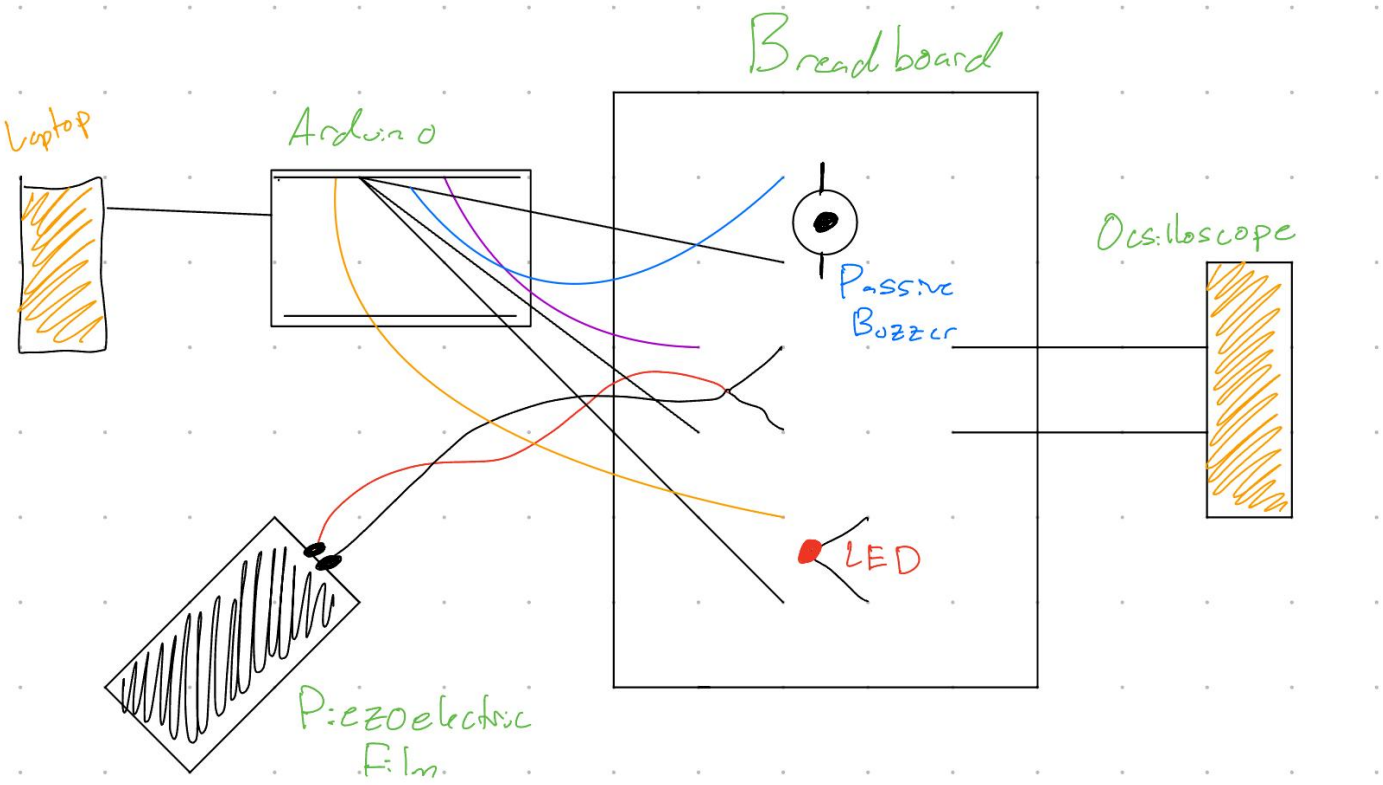
Part E: Choose Initial Design Features

Which of the ideas did you choose? Why? You must use the criteria developed earlier to justify your design choice.

- **Possibly place something above the piezo film to conceal it**
- **If there is a knock a message will appear**
- **We chose to play a sound as well as implement the LED idea.**
- **The response of a sound or a light is based on the strength of the knocks.**

Part F: Design a Solution

In the space below, create a rough description/sketch of your design as part of your preparation process. Include notes highlighting important features.



Our design utilizes the piezoelectric film to detect knocks and has the arduino decide if the knock recorded is high enough to make the LED blink and passive buzzer go off. The oscilloscope is not necessary for this design, but we plan to use it to make sure our piezoelectric film is working the right way and to determine the threshold voltages. Take note of how the LED and passive buzzer are not directly linked to anything but the arduino, as we want them to only go off if certain criteria are met.

Part G: Create and Test Prototype
Build your prototype and test its functionality. What potential improvements and/or enhancements come to mind? Continue to iterate your design as time permits, keeping track of the modifications in the space below.

- **Plezoelectric is left out in the open.**
- **Putting a charger on top of the piezoelectric film.**
- **Moving the piezoelectric film to the middle of a book.**
- **We finally moved the film to the top third of the book to get more consistent readings**
- **We made it so that the passive buzzer only went off if a second voltage threshold was hit, but the light would blink regardless**
- **We changed our code's threshold values multiple times, landing on 0.01V for the light, and 0.04V for the buzzer. These voltages are so low because of the muffled, yet still noticeable, readings from the book**
- **We changed the amount of time that the voltages were being recorded for ease of use in class**

Part H: Evaluate Design
As you share your design with others in the class and as you look at the designs of others, think about the following questions and then answer them as a group after the showcase.

What were the strengths of your design?

Our design was functional and worked as expected during the showcase. It was discrete and could still detect knocks while nested inside a book, and the buzzer was loud enough to be noticeable by us and other classmates. It would be valued by a spy company because they may use it to send critical information or alerts based on the urgency and frequency of knocks.

What changes would you make to the design in the next iteration of it?
If we were to make more modifications to our design, we would have made it so that our passive buzzer played different tones based on how many urgent knocks were recorded. We would have also made our threshold values more solid, and had the code work proactively instead of retroactively. This would entail having the code running at all times, and reporting information when something occurs. We could have also spent more time tuning our buzzer to be a more recognizable sound, and had the light and buzzer go off simultaneously, assuming the right voltages were collected. We would have also made our circuitry more discrete, disconnecting the oscilloscope and including something like a motor to alert the user of a knock in a more discrete fashion.

What were some of the most creative ideas you saw incorporated by other teams in the class?

The most creative idea we saw among the other groups was that they implemented a password system that flashes a green light if the user knocks the correct number of times and a red light if the number of knocks was incorrect. Another creative idea that we saw was using the device as a security system on a person's wrist. One group also based their system on Batman, where different numbers of knocks triggered a different response. One of the responses was a light, another was a message, and the last one was a sound that was played.

Team E1: Knockaroo, the Sensor with a Sense of Humor

Knock it and it will play a programmable sound for you!

Secret agents will love this because this system utilizes different signals based on the type of knock to alert the agent of what is going on.

	ENGR 130 Module Planning		Module	3	Section	E	Team	1	
			Scheduled		Actual				
#	Task	Deadline	Start	End	Start	End	Primary	Secondary	% Complete
1	Setup oscilloscope and check probe for Lab 1	10/3	10/3	10/3	10/3	10/3	Jonathan	n/a	100
2	Build LED circuit in Lab 1	10/3	10/3	10/3	10/3	10/3	Angel	Madhav	100
3	Double-check LED circuit of Lab 1	10/3	10/3	10/3	10/3	10/3	Madhav	n/a	100
4	Manipulate oscilloscope during Lab 1 circuit work	10/3	10/3	10/3	10/3	10/3	Jonathan	n/a	100
5	Type team's code for Lab 1	10/3	10/3	10/3	10/3	10/3	Trevor	Madhav	100
6	Discuss questions for Lab 1	10/3	10/3	10/3	10/3	10/3	All	n/a	100
7	Type team's answers to Lab 1 questions	10/9	10/3	10/3	10/3	10/3	Angel	Jonathan	100
8	Setup oscilloscope and check probe for Lab 2	10/5	10/5	10/5	10/5	10/5	Trevor	Madhav	100
9	Work with piezofilm in Lab 2	10/5	10/5	10/5	10/5	10/5	Angel	All	100
10	Manipulate oscilloscope during Lab 2	10/5	10/5	10/5	10/5	10/5	Trevor	Jonathan	100
11	Type team's code for Lab 2	10/5	10/5	10/5	10/5	10/5	Angel	n/a	100
12	Discuss questions for Lab 2	10/5	10/5	10/5	10/5	10/5	All	n/a	100
13	Type team's answers to Lab 2 questions	10/9	10/5	10/7	10/5	10/6	Jonathan	n/a	100
14	Assemble module report 3_1	10/9	10/5	10/7	10/6	10/6	Trevor	n/a	100
15	Proofread module report 3_1	10/9	10/5	10/7	10/6	10/6	All	n/a	100
16	Submit module report 3_1	10/9	10/5	10/7	10/6	10/6	Trevor	n/a	100
17	Build circuit for Lab 3	10/10	10/10	10/10	10/10	10/10	Trevor	Jonathan	100
18	Double-check circuit for Lab 3	10/10	10/10	10/10	10/10	10/10	Angel	n/a	100
19	Triple-check circuit for Lab 3	10/10	10/10	10/10	10/10	10/10	Madhav	n/a	100
20	Work with piezofilm in Lab 3	10/10	10/10	10/10	10/10	10/10	Angel	n/a	100
21	Type team's code for Lab 3	10/10	10/10	10/10	10/10	10/11	Madhav	Trevor	100
22	Read through design specs for Lab 4	10/10	10/10	10/10	10/10	10/10	All	n/a	100
23	Work through design worksheet	10/10	10/10	10/10	10/10	10/10	Jonathan	Angel	100
24	Type team's responses to design worksheet	10/10	10/10	10/10	10/10	10/10	Jonathan	n/a	100
25	Discuss questions for Lab 3	10/10	10/10	10/10	10/10	10/10	All	n/a	100
26	Type team's answers to Lab 3 questions	10/10	10/10	10/10	10/10	10/10	Trevor	n/a	100
27	Finalize purpose of gadget	10/12	10/12	10/12	10/12	10/10	All	n/a	100
28	Research potential components of gadget	10/12	10/12	10/12	10/12	10/10	All	n/a	100
29	Sketch initial concept for gadget hardware	10/12	10/12	10/12	10/12	10/10	Trevor	Jonathan	100
30	Write algorithm for gadget code	10/12	10/12	10/12	10/12	10/12	Jonathan	Madhav	100
31	Type initial version of gadget code	10/12	10/12	10/12	10/12	10/12	Trevor	n/a	100
32	Draft slide for gadget presentation	10/12	10/12	10/12	10/12	10/12	Jonathan	All	100
33	Assemble circuitry for gadget	10/12	10/12	10/12	10/12	10/12	Angel	n/a	100
34	Test logic of code for gadget	10/12	10/12	10/12	10/12	10/12	Madhav	n/a	100
35	Test gadget circuitry and code together	10/12	10/12	10/12	10/12	10/12	Jonathan	n/a	100
36	Improve gadget	10/12	10/12	10/12	10/12	10/12	Trevor	n/a	100
37	Finalize slide for gadget presentation	10/12	10/12	10/12	10/12	10/12	All	n/a	100
38	Present gadget for first half of sharing time	10/12	10/12	10/12	10/12	10/12	Trevor	Madhav	100
39	Present gadget for second half of sharing time	10/12	10/12	10/12	10/12	10/12	Jonathan	Angel	100
40	Discuss questions for Lab 4/ remainder of worksheet	10/12	10/12	10/12	10/12	10/12	All	n/a	100
41	Type team's answers to Lab 4 questions/worksheet	10/12	10/12	10/12	10/12	10/12	All	n/a	100
42	Assemble module report 3_2	10/16	10/12	10/15	10/12	10/13	Trevor	Madhav	100
43	Proofread module report 3_2	10/16	10/12	10/15	10/12	10/13	All	n/a	100
44	Submit module report 3_2	10/16	10/12	10/15	10/12	10/13	Trevor	n/a	100
	Last updated	10/13/2023							
	updated by	Trevor							