GNG 2101

University of Ottawa: Faculty of Engineering

Project Deliverable D: Detailed Design, Prototype 1, and BOM

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Group Z-22

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Introduction

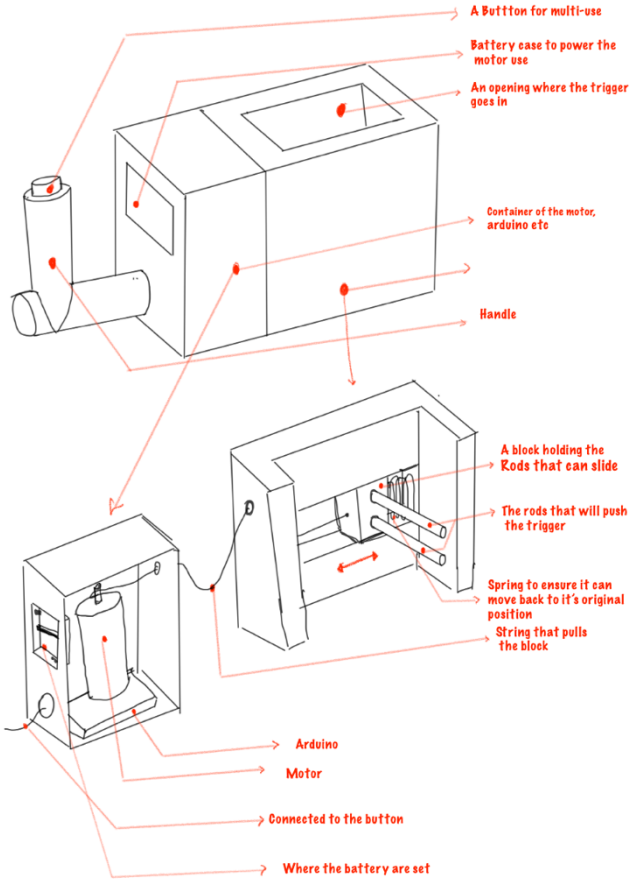
The objective of this deliverable is to provide detailed design concepts to build the first product prototype. Additionally, a summary of the feedback obtained during the second client meeting will be displayed in this deliverable, in order to update and progress our design according to the feedback acquired prototypes will be built by different subsystems of the power grabber to test the product's most critical functions and target specifications. The team will provide visual representations of the prototype which will include various subsystems such as a physical model and electrical wiring. Moreover, the team will provide its bill of materials that will be used to construct the final prototype.

Summary of Client Meeting

Proceeding the client meeting the feedback obtained from them was that our designs concepts that the team created were not what he was looking for. The design that was created was a fully automated power grabber, however due to miscommunication, this was not what our client wanted. The feedback obtained was to design a handle that would pull the trigger of the power grabber for the user. The idea the client provided was to have a "sleeve" that would fit over the handle and trigger. When the user presses the button, a mechanism would be signaled to pull the trigger back. Additionally, the team needed to design something to observe the force applied to the object. This could be done by either adding a way for the user to manually control the force or adding a force sensor to the device to automatically track it. Overall, the feedback acquired from our client was necessary to our progress, as we need to redesign a new device to perform the function.

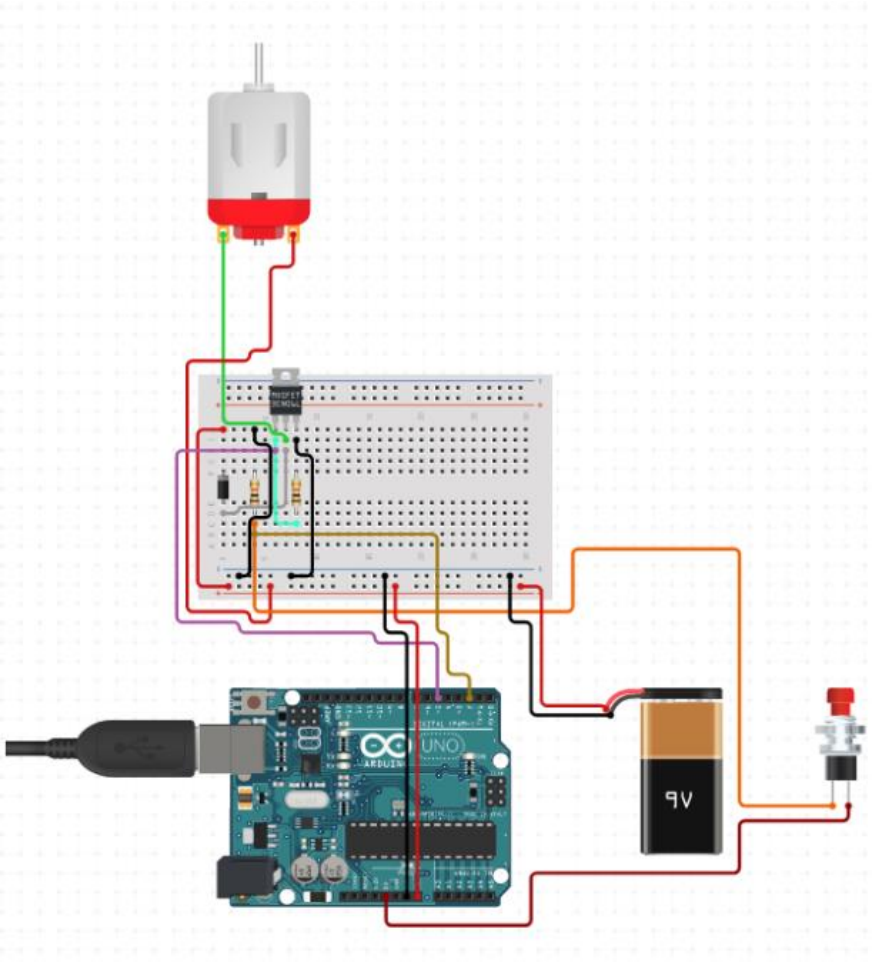
Detailed Design of the Concept

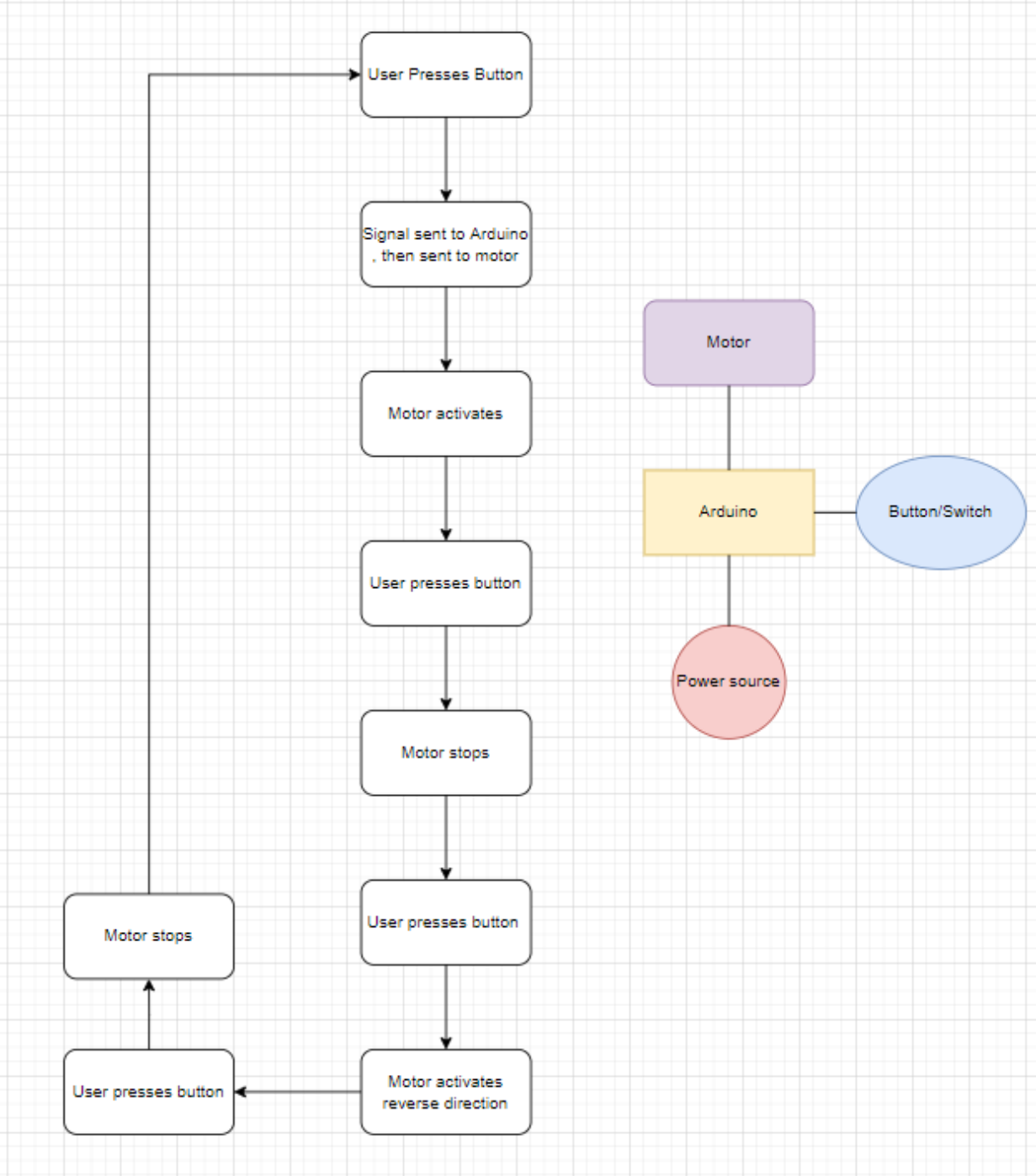
Physical design:



The device is controlled by a single button. The button sends a signal to the Arduino, which starts the battery-powered motor. A string would be connected to the motor's shaft as it began to spin. The string would be connected to two blocks, one on each side of the container, where the trigger would be placed. The string and the two blocks would be pulled as the motor spun. Two rods are connected to the blocks. As a result, as the blocks move, so does the rod that pushes the trigger. The user can press the button again to stop the shafts from moving back and the jaws will be held in place in the position when the button is pressed. When pressed again the motor is activated in the reverse direction, with the force of the springs, the blocks and shaft return to in original position.

Electrical design:





The electrical design consists of an Arduino UNO board powered by a 9V battery. There is an input button controlled by the user which allows for the Arduino board to start the motor. The button is then pressed again while the motor is on to lock the motor in place. The user picks up the object, then presses the button again to unlock the motor which slowly unravels the string back to its original position. Ideally, the motor is programmable to change its RPM as the team decides. This motor pulls the string, subsequently moving the slider which pulls the trigger.

Critical Product Assumptions

This power grabber is required to be safe, lightweight, grab objects in a manner such that the trigger does not need to be used and is rather pulled by a simpler process, and ergonomic. The grabber must be made in order to accommodate those with physical disabilities who have limited strength, finger dexterity and overall range of motion. The group's power grabber will be modelled for someone with arthrogryposis.

Knowing this, it is assumed that the user has poor grip and will need a motorized system to pull the trigger and keep it held down. It is assumed that the user will need the power handle grabber to grab the same objects a regular grabber would. Such as water bottles, wallets, pencils, keys, etc. Another assumption the group will be making is that the user will be able to lift back up the grabber to retrieve the item. They will not need to have a hand occupied by keeping the trigger squeezed during this process.

Table 1: Target Specifications

Metric #	Metric	Unit	Marginal	Target
1	Weight of the Handle	Pounds	0.8	0.4
2	Grip Force	Newtons	4	2
3	Force applied to object	Pounds	1	3
4	Object Weight	Pounds	1	3
5	Battery Life	Hours	5	8
6	Motor Speed	RPM	N/a	N/a
7	Cost	Canadian Dollars	150	100

Bill of Materials

Table 2: Bill of Materials

Item #	Name	Description	Qty	Cost	Total cost	Source
1	Outer case	Plastic 3D modeled box	2	11.08	22.16	3D print
2	spring	Plastic springs	2	19.38	38.76	mcmastercarr

3	Arduino	Arduino uno Rev3	1	29.99	29.99	arduino store
4	motor	DC Planetary Geared Motor with encoder Diameter 36mm - 6V 17.5RPM	1	35.88	35.88	robotshop
5	Battery case	To hold and connect the battery to the motor	3(only using 1)	13.99	4.66	amazon
6	AA batteries	Remote batteries	20 (only using 2)	20	2.26	Amazon
7	Handle	Plastic 3D modeled	1	6.33	6.33	3D print
8	String	String	1	14.20	14.20	amazon
9	Linear actuator	Linear actuator	1	23.77	23.77	amazon
Total project cost:					$178.01	

Documentation of Prototype I

In our first prototype, we are focusing on the ergonomics of the design, particularly the handle. The prototype is physical, focused, and of low fidelity. Because of the design's weight on the wrist, our new design would rely on the arm for additional support. This may mean that it takes longer to hold, but in our client's case, comfort is more important

Prototype Testing and Evaluation

This prototype will be used to communicate with the client what the handle will look like and whether this will be acceptable. The main objective was to know whether the handle design is functional. One main flaw is that we will be testing with able bodies, and we have nobody with arthrogryposis who can test it for us. However, the idea was to maximize the support and minimize the grip force. This way, the design should work for someone with arthrogryposis or a similar grip-weakening condition. The prototype will be vital as determining the handle ergonomics as acceptable is necessary before continuing with the rest of the project.

The prototype has low fidelity as it is merely made from cardboard and a CAD model. The final design is expected to be 3D printed. This prototype is both physical and analytical since it consists of a cardboard representation and a CAD model. It is focused on the handle grip and ergonomics.

Table 3: Target Specifications and Tested Results

Metric #	Metric	Unit	Marginal	Target	Test
1	Weight of the Handle	Pounds	0.8	0.4	n/a
2	Grip Force	Newtons	4	2	0.2

3	Force applied to object	Pounds	1	3	n/a
4	Object Weight	Pounds	1	3	n/a
5	Battery Life	Hours	5	8	n/a
6	Motor Speed	RPM	n/a	n/a	n/a
7	Cost	Canadian Dollars	150	100	$154.24

Preparation for Upcoming Client Meeting

For the next client meeting, the team plans to present a new design to our client as in the last meeting the client explained that our previous concepts did not fit the criteria of the product he wants. For this client meeting the design that will be proposed to our client is a new design to squeeze the trigger for the user with the press of a button. The information we would like to gather from the client is to obtain feedback on our new design concept that the team came up with. It will be crucial to know whether our design is feasible for somebody with arthrogryposis, as none of the group members have the condition or know someone with the condition.

Wrike

The team's plans moving forward have been scheduled on Wrike:

https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=rYDzNcYFDpc9058AIeekslma86CbOxBn%7CIE2DSNZVHA2DELSTGIYA

Conclusion

To conclude, the team has progressed with the new design concept generated after the previous client meeting. The team has created two detailed designs, one comprising of the electrical components and another for the mechanical components. Moreover, the basic sequence of the Arduino code is organized as well. Additionally, the bill of materials was constructed to obtain an idea of the materials needed to build the final prototype of the design concept. Furthermore, the team made a prototype to test the ergonomics and comfort of the power handle. It was tested to see if the handle is comfortable and supports the user's arm appropriately. The team evaluated the cardboard box prototype to test user comfortability. The prototype has proven to be comfortable, however, the prototype will be shown to the client and some users to test comfortability.