Project Deliverable H

Team A07

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Abstract:

The objective of this document is to showcase the fabrication of our third prototype and to receive customer feedback to improve it

Introduction

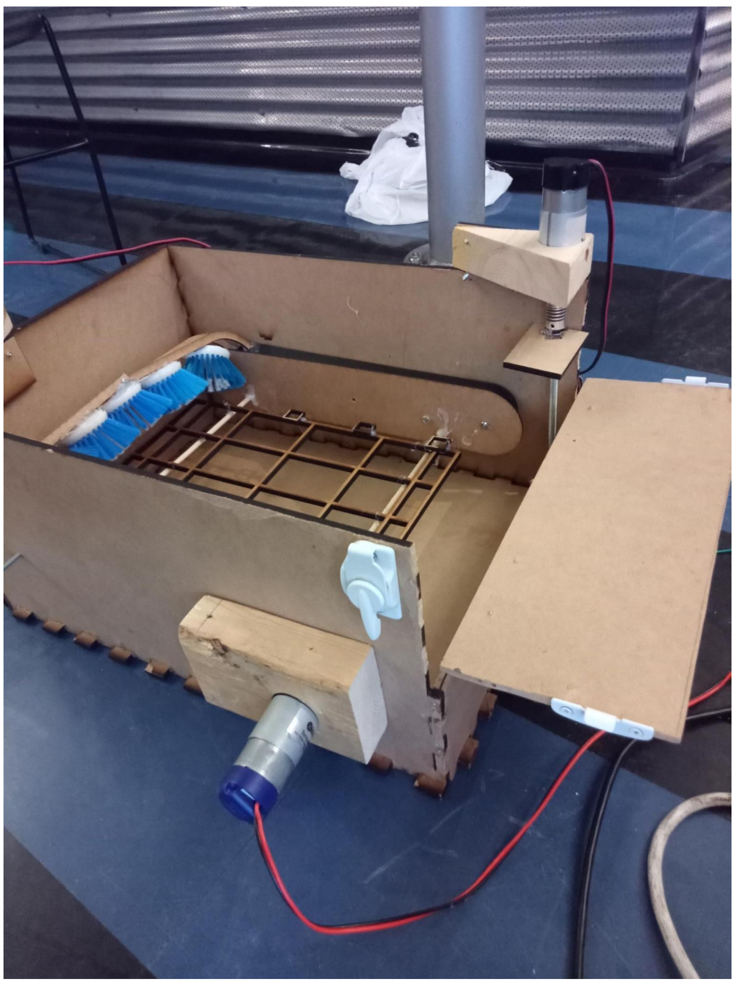
Our team has been tasked with designing a hydroponic system to clean algae that 1) is automated and time efficient, 2) has an easy user interface, 3) cleans all areas of the board including contours, and 4) fits in the designated area. In this document, we showcase our third Prototype by putting it to the test with an elaborated test plan and by providing a simple but efficient analysis of its critical component(s). Although compared to the two last Prototypes, this one serves as a complete analysis of all of the subsystems. On the other hand, this document also reserves a spot for an update regarding the BOM and the List of Equipment, a gathering of feedback received from users and an analysis of the results of this Prototype.

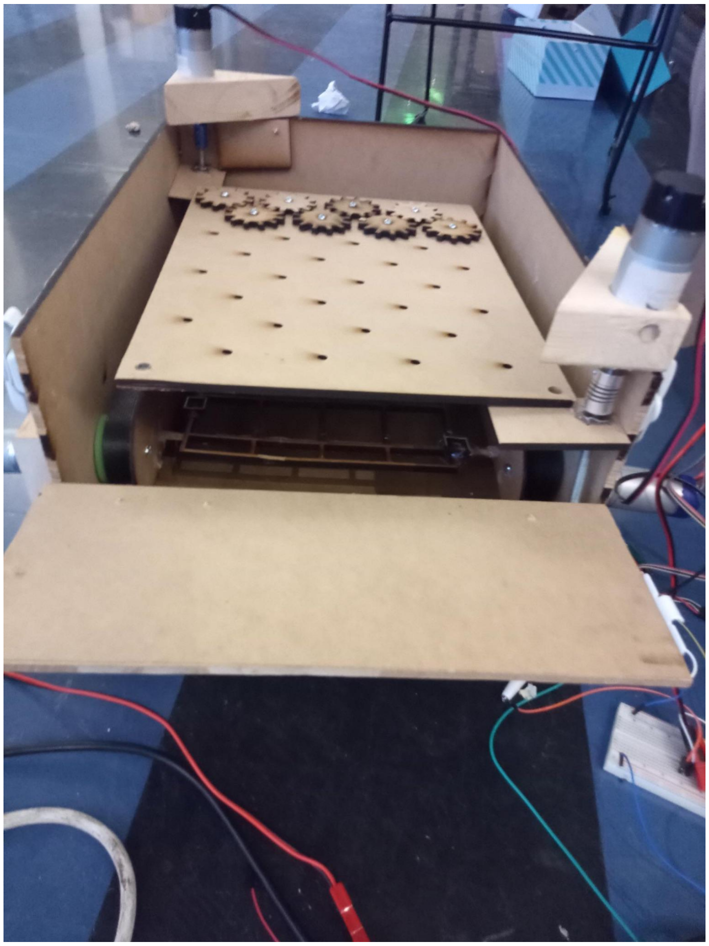
As a pretext, the results of Prototype I showed us that the whole cleaning process was very feasible, automated or not. It covered all the board (except the left and right sides), cleaned the holes, and exceeded time expectations. For Prototype II, we concentrated specifically on the box that will hold both the frame and the brushes, as we illustrated how the board will be inserted and taken out, how the door will be held in place when cleaning the board, and what will happen to the excess water. It has to be noted that the box we came up with (this critical subsystem) will be the exact one we'll use for prototype III, with of course all of the cleaning products and others that we'll have to work on. After having actually constructed Prototype II, it was clear that this box was perfect. We had found a way to open the door and insert the board (the locks), a way to hold the board using a laser cut grid and a way to drain the water once we're done with it.

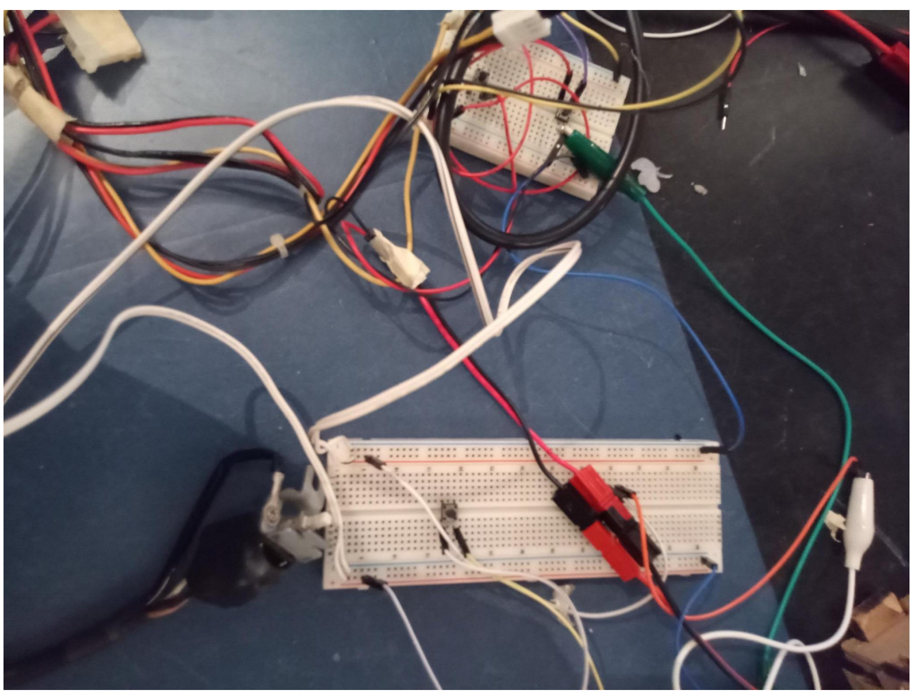
To finish, the Final Prototype we assembled is a mix of the two lasts. It regroups all of the 3 subsystems, as we use the exact box we came up with for Prototype II and base ourselves on the cleaning process of Prototype I. Although, this time we improve on this last by making it automated (both the cleaning of the board and the cleaning of its holes).

I. Prototype III - Documentation

In this section, you'll find pictures of the actual physical Prototype, and a representative description.







This prototype is a mix of the two previous ones. We used the exact same box/exterior established in Prototype II, and based our cleaning process on Prototype II. This time, we laser cut some sort of base for the conveyor belt you can find on the left and right side of the prototype, to which we glued the ends of a stick to which are collated 6 brushes. We then connected 2 DC motors which gave the brushes the opportunity to go all around the board by pushing a button.

On the two corners of the prototype, you can see that we attached 2 stepper motors to some sort of rectangular platform, which permits it to go up and down with the pressing of a button. On this platform, holes have been formed (the same distance as the holes of the board) where nails (serving as thin brushes) have been imposed. Each of those nails fit inside of a laser cut gear, which permits the nail to rotate. Once one of them rotates, all of the others rotate at the same time. Unfortunately, we did not manage to make this part automated (with a button).

All of the cables, motors and breadboards are connected to a portable power supply.

II. Results

In this section, you'll find the results of this Prototype. We use the test plan we came up with during the last Project Deliverable to compare the actual results with the ones that were expected.

Test ID	*Test Objective (Why)*	*Description of Prototype used and of Basic Test Method (What)*	*Description of Results to be Recorded and how these results will be used (How)*	*Estimated Test duration and planned start date (When)*	*Results Yielded (Actual Results)*
1	*Determine a*	*Physical model*	*Record the*	*Testing these*	*The brushes*

	method to spin each brush of the cleaning subsystem at a fast enough speed to clean the board.	*with higher fidelity (important test) of brushes hooked up to dc motors.*	*speed of each brush to find the average speed of all brushes. Also note any brushes that do not spin. This will help us determine the type of brushes, motors and axles needed.*	*brushes may take a long amount of time as the brushes need to spin for a long time to measure cleaning performance.*	*unfortunately do not spin because the DC motors we used do not permit making the brushes go all around and spin at the same time*
2	*Figure out if there are any compatibility issues between the three subsystems.*	*Physical models of the cleaning (lower fidelity), holes and frame subsystems that are wired up to a controller to allow movement.*	*Results of the prototype include any collision between subsystems and the lengths of subsystems that are too big for the frame.*	*Once subsystems are assembled testing for compatibility won't take long.*	*All of the subsystems are compatible to one another: the cleaning of the holes do not compromise the cleaning of the board*
3	*Test for the amount of water that can drain from the box.*	*Using the medium fidelity physical model from prototype 2 combined with a testing device containing water.*	*Measure an amount of water in liters and add it to the prototype. Then measure the amount of water that leaves the prototype to record the amount of water drained.*	*Since it will only require a slight modification to the model from prototype 2 little time will be spent testing this.*	*We ended up not using water, as it was mentioned that it wasn't allowed for Design Day. If we were to use some, we would use the drainage established during the last prototype*
4	*Test for percentage of the board*	*Analytical model with high fidelity. Calculations for*	*Results will be the percentage of the board*	*Will take a while to take into account*	*We achieved a total cleanliness percentage of*

	cleaned (related to brush speed and coverage).	*how much algae will remain after a given time of the brushes running.*	*cleaned of algae. Used to determine the performance of the entire project.*	*all parts of the prototype in the calculations. All forces must be accounted for.*	*86.18% by calculating the flat area of each surface of the board (top, bottom…) and assuming that most of the sides would get cleaned except for most of the left and right sides. This brought us to a 90% cleanliness, and we divided that by the total area of the surface. It has to be noted that this is only an estimate.*

III. User Feedback

Feedback from general users

[Unfortunately, we did not manage to receive feedback from users regarding this Prototype.]

IV. Bill of Material and List of Equipment

The materials and equipment with their respective descriptions and others that are in red represent the updated list. The materials in bold are the ones we already bought, meaning that we'll come to the next lab session with their receipts, and the ones that are highlighted in yellow are the materials we thought we needed, but that we never bought (turns out we got no use for them).

BOM

Item name	Description	Units of measure	Quantity	Unit cost	Extended cost	Link
Strong glue	160	ml	1	$6.67	$7.67 (with tax)	https://www.amazon.ca/gp/product/B00P94NRDE/ref=ox_sc_act_image_1?smid=A3DWYIK6Y9EEQB&psc=1
Scisors	IKEA	N/A	1	$0 (provided at home)	$0	N/A
Pencil	HB 2	N/A	1	$0 (provided at home)	$0	N/A
Tape	32.9 x 0.019	m	1	$0 (provided at home)	$0	N/A
Plastic wire (to represent power wire)	20	cm	2	$0 (provided at home)	$0	N/A
Screws	12 x M3	mm	15	$0.10	$1.5	https://edu-makerlab.odoo.com/shop/product/socket-head-screw-metric-70?search=screw#attr=376,370
Wood	Scraps from members'work	N/A	N/A	N/A	N/A	N/A
Aluminium	Scraps from lab	N/A	N/A	N/A	N/A	N/A
Breadboard	8.5 x 5.5	cm	1	$2.50	$2.50	https://edu-makerlab.odoo.com/shop/product/breadboard-53?search=breadboard#attr=58
Tactile button (to start/end process)	12 x 12	mm	1	$0.20	0.20	https://edu-makerlab.odoo.com/shop/product/tactile-button-37?search=breadboard#attr=39
USB cable	A-B	N/A	1	$7	$7	https://edu-makerlab.odoo.com/shop/product/usb-cable-68?page=4#attr=80
Jumper wire	Male-Male	N/A	5	$0.10	$0.50	https://edu-makerlab.odoo.com/shop/product/jumper-wires-44?page=2#attr=46
Jumper wire	Female-Female	N/A	5	$0.10	$0.50	https://edu-makerlab.odoo.com/shop/product/jumper-wires-44?page=2#attr=46
Jumper wire	Male-Female	N/A	5	$0.10	$0.50	https://edu-makerlab.odoo.com/shop/product/jumper-wires-44?page=2#attr=46
Brushes	Circular and Linear	N/A	4 and 3	$0 (provided at member's work)	$0	N/A
DC Motor and FeatherWing add-on	2-bipolar stepper and 4 brushed motors	N/A	1	$32	$32	https://makerstore.ca/shop/ols/products/dc-motor-stepper-featherwing-add-on-for-all-feather-boards
Metallic Grid	Thin (Scraps from member's work)	N/A	1	$0	$0	N/A
Wooden sticks	Long (Scraps from member's work)	N/A	4	$0	$0	N/A
MDF wooden planks	24 x 18 (width: 1/4)	in.	5	$4	$20	https://makerstore.ca/shop/ols/products/mdf/v/M003-1-4-18-NCH
Locks	N/A	N/A	2	$4.50	$9	Home Depot
Hinges	N/A	N/A	2	$6.22	$12.44	Home Depot
MDF wooden planks	**24 x 12 (width: 1/4)**	**in.**	**2**	**$3.50**	**$7**	**https://makerstore.ca/shop/ols/products/mdf/v/M003-1-4-12-NCH**
Tee nuts	**N/A**	**N/A**	**4**	**$0.67**	**$2.68**	**Home Depot**
Threaded rod	**01-Apr**	**in.**	**1**	**$6**	**$6**	**Home Depot**
MDF wooden planks	**24 x 12 (width: 1/8)**	**in.**	**2**	**$2.50**	**$5**	**https://makerstore.ca/shop/ols/products/mdf/v/M003-1-4-12-NCH**
Brushes	**N/A**	**N/A**	**6**	**$2.26**	**$13.56**	**Home Depot**
Threaded metal pole	**N/A**	**N/A**	**1**	**$7.69**	**$7.69**	**Home Depot**
Shelf Liner	**For conveyer belt**	**N/A**	**1**	**$4.52**	**$4.52**	**Home Depot**
Tee nuts	**N/A**	**N/A**	**4**	**$0.67**	**$2.68**	**Home Depot**
MDF wooden planks	**24 x 18 (width: 1/4)**	**in.**	**4**	**$4**	**$16**	**https://makerstore.ca/shop/ols/products/mdf/v/M003-1-4-18-NCH**

LIST OF EQUIPMENT

Item name	Description	Type	Prototype #	Source
Onshape (CAD)	To design our concept	Online Software	1	https://www.onshape.com/en/
Breadboard	To test circuits	Hardware - Temporary	2	MakerLab
Arduino	To create a code in order to test circuit	Software	2, 3	Arduino App / MakerLab
Drill press	To drill holes in prototype	Hardware	2, 3	Brusfield
Hot glue	To stick the various parts together	Hardware	2, 3	Brusfield
ArcSite	To design our concept	Software	1, 2, 3	App Store
3D Printer	To construct the frame	Hardware	1	MakerLab
Laser Cutter	To create the "Lego" type dent on the borders of the box	Hardware	2	MakerLab

It has to be noted that all of the electric components (power supply, cables, breadboards and motors) do not have a cost, as they all come from equipment used by one of our team members for previous robotics projects.

Conclusion

To conclude, this prototype has elevated both the cleaning of the holes subsystem and the cleaning of the board subsystem: by managing to automate all of these last, we were able to make the prototype as user friendly as possible.