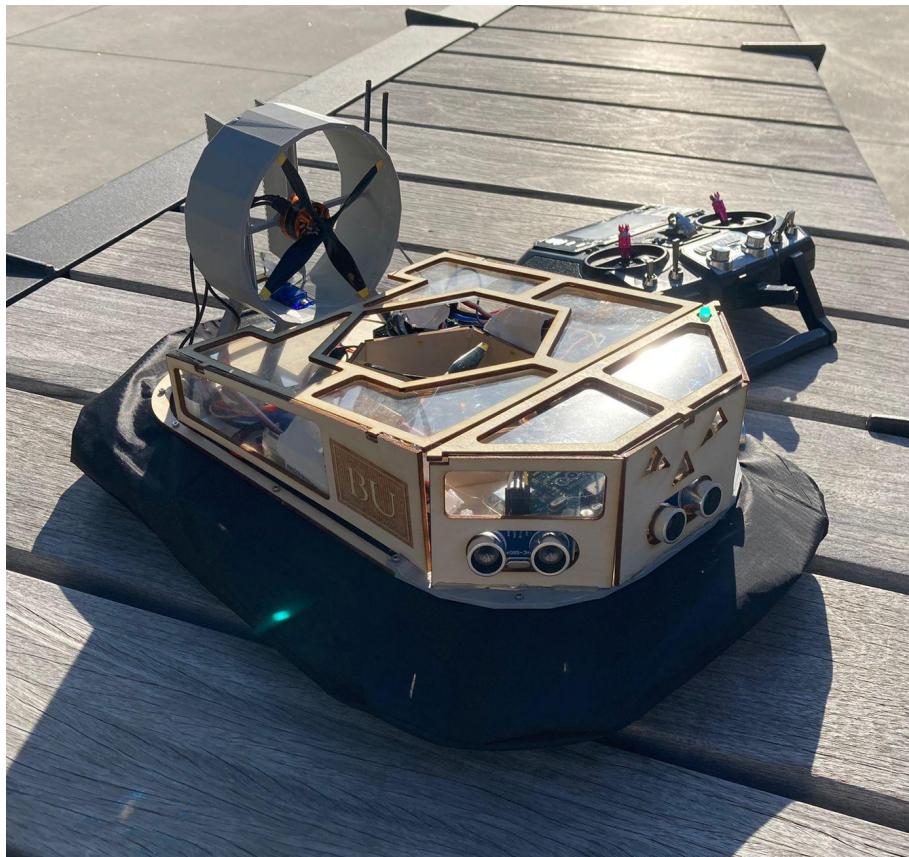


# Manufacture and Assembly Guide for Albert 2.0



**Boston University Department of Mechanical Engineering**

**ME461 Capstone Experience Section A1**

**Albert 2.0: Smart Mini-Hovercraft**

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# Introduction

This document serves as a start to finish guide for building your own RC hovercraft, Albert 2.0. This guide assumes that the builder has access to a laser cutter and a 3-D printer with beds of at least 12"x12" at their disposal.

Warning: Wear goggles and gloves while assembling the hovercraft! Stay the components away from fire and water. Don't let children under 12 years old get in touch of any of the components without an adult's supervision.

# Materials

The following table are the required materials for constructing your own albert 2.0. Included in the table are links to Amazon for purchase for applicable items, however these items can be obtained from anywhere so long as they are the same as the specified parts in the table.

Table 1: Summary of Required Materials for Albert 2.0

Item	Quantity	Amazon Link	Price per Unit
24x12 balsa wood sheets	1 set, or 12 sheets	<a href="https://smile.amazon.com/dp/B07CHX1GTD/?coliid=I22AO7SUSGLP4E&amp;colid=24OCX7GALXU9S&amp;pse=1&amp;ref_=lv_ov_lig_dp_it">https://smile.amazon.com/dp/B07CHX1GTD/?coliid=I22AO7SUSGLP4E&amp;colid=24OCX7GALXU9S&amp;pse=1&amp;ref_=lv_ov_lig_dp_it</a>	19.45
M2 nut and bolt set	1 set	<a href="https://www.amazon.com/dp/B01N1WDUK0/?coliid=IEXGOAPXI1LCV&amp;colid=24OCX7GALXU9S&amp;pse=1&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B01N1WDUK0/?coliid=IEXGOAPXI1LCV&amp;colid=24OCX7GALXU9S&amp;pse=1&amp;ref_=lv_ov_lig_dp_it</a>	10.99
M1 nut and bolt set	1 set	<a href="https://www.amazon.com/dp/B07QB2LWN8?psc=1&amp;ref=ppx_yo2_dt_b_product_details">https://www.amazon.com/dp/B07QB2LWN8?psc=1&amp;ref=ppx_yo2_dt_b_product_details</a>	13.99
Ripstop Nylon Sheeting	1 set	<a href="https://www.amazon.com/dp/B00ZR81X56/?coliid=I3TI7GRT6SCWD3&amp;colid=24OCX7GALXU9S&amp;pse=1&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B00ZR81X56/?coliid=I3TI7GRT6SCWD3&amp;colid=24OCX7GALXU9S&amp;pse=1&amp;ref_=lv_ov_lig_dp_it</a>	8.95
BYS 2300 KV brushless motor	2*	<a href="https://www.amazon.com/dp/B076H261PX/?coliid=I2CGFSZ37MC3C9&amp;colid=24OCX7GALXU9S&amp;pse=0&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B076H261PX/?coliid=I2CGFSZ37MC3C9&amp;colid=24OCX7GALXU9S&amp;pse=0&amp;ref_=lv_ov_lig_dp_it</a>	14.99
30A esc	2*	<a href="https://smile.amazon.com/gp/product/B071GRSFBD/ref=ppx_yo_d">https://smile.amazon.com/gp/product/B071GRSFBD/ref=ppx_yo_d</a>	16.49

		t_b_asin_title_o01_s00?ie=UTF8&psc=1	
Tattu 1300 mAh LiPo battery	2*	<a href="https://smile.amazon.com/dp/B013I9SYC0/?coliid=I1QVS6PCQGE1K8&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it">https://smile.amazon.com/dp/B013I9SYC0/?coliid=I1QVS6PCQGE1K8&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it</a>	18.99
4 blade propellers	2*	<a href="https://smile.amazon.com/gp/product/B007AFYNZG/ref=ppx_yo_dt_b_asin_title_o05_s00?ie=UTF8&amp;psc=1">https://smile.amazon.com/gp/product/B007AFYNZG/ref=ppx_yo_dt_b_asin_title_o05_s00?ie=UTF8&amp;psc=1</a>	7.79
Gorilla glue	1	<a href="https://www.amazon.com/dp/B082XGL21J/?coliid=I3TJF1PBHX79BW&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B082XGL21J/?coliid=I3TJF1PBHX79BW&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it</a>	7.99
Wood glue	1	<a href="https://www.amazon.com/dp/B07LGKHW5R/?coliid=I1SRQEQMKKXOUU&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B07LGKHW5R/?coliid=I1SRQEQMKKXOUU&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it</a>	10.99
Jumper cable set	1 set	<a href="https://www.amazon.com/EDGEL-EC-Breadboard-Optional-Assorted-Multicolored/dp/B07GD2BWPY/ref=sr_1_3?dchild=1&amp;keywords=wire+connectors+jumper+cables&amp;qid=1620232987&amp;sr=8-3">https://www.amazon.com/EDGEL-EC-Breadboard-Optional-Assorted-Multicolored/dp/B07GD2BWPY/ref=sr_1_3?dchild=1&amp;keywords=wire+connectors+jumper+cables&amp;qid=1620232987&amp;sr=8-3</a>	5.99
Arduino UNO	1	<a href="https://www.amazon.com/Arduino-A000066-ARDUINO-UNO-R3/dp/B008GRTSV6/ref=sr_1_3?dchild=1&amp;keywords=arduino&amp;qid=1620232916&amp;sr=8-3">https://www.amazon.com/Arduino-A000066-ARDUINO-UNO-R3/dp/B008GRTSV6/ref=sr_1_3?dchild=1&amp;keywords=arduino&amp;qid=1620232916&amp;sr=8-3</a>	20.26
Ultrasonic sensor	3	<a href="https://www.amazon.com/dp/B01JG09DCK/?coliid=IPMXI52BKFNO1&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B01JG09DCK/?coliid=IPMXI52BKFNO1&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it</a>	9.99
Flysky FS-i6 controller and receiver	1	<a href="https://smile.amazon.com/dp/B0744DPPL8/?coliid=IWBNXLHRHATY0&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it">https://smile.amazon.com/dp/B0744DPPL8/?coliid=IWBNXLHRHATY0&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it</a>	55.99

100mm long 2mm diameter stainless steel axles	2	<a href="https://www.amazon.com/Yeeco-100Pcs-Stainless-100mmx2mm-Helicopter/dp/B07232VWLT/ref=sr_1_1?dchild=1&amp;keywords=100mm+2mm+axle&amp;qid=1620233018&amp;sr=8-1">https://www.amazon.com/Yeeco-100Pcs-Stainless-100mmx2mm-Helicopter/dp/B07232VWLT/ref=sr_1_1?dchild=1&amp;keywords=100mm+2mm+axle&amp;qid=1620233018&amp;sr=8-1</a>	12.99
RGB LED light	1		
Small zip ties	1 pack	<a href="https://www.amazon.com/dp/B01018DB2E/?coliid=I8ONHVAPNUL3P&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B01018DB2E/?coliid=I8ONHVAPNUL3P&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it</a>	\$4.99
Electrical Tape	1 roll	<a href="https://www.amazon.com/dp/B07ZWC2VLX/?coliid=I3HG3T4U7PLXZM&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B07ZWC2VLX/?coliid=I3HG3T4U7PLXZM&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it</a>	4.99
Double Sided Tape	1 roll	<a href="https://www.amazon.com/dp/B009NP1OBC/?coliid=I26LFOR3WLXO8S&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B009NP1OBC/?coliid=I26LFOR3WLXO8S&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it</a>	9.88
Breadboard	1	<a href="https://www.amazon.com/dp/B07PCJP9DY/?coliid=I201DWWXD M6WE1&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B07PCJP9DY/?coliid=I201DWWXD M6WE1&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it</a>	5.99
Plastic Sheeting	1 pack	<a href="https://www.amazon.com/dp/B07MQTDF4R/?coliid=I3J2RH79OD0D19&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it">https://www.amazon.com/dp/B07MQTDF4R/?coliid=I3J2RH79OD0D19&amp;colid=24OCX7GALXU9S&amp;psc=1&amp;ref_=lv_ov_lig_dp_it</a>	9.45

\* We recommend purchasing one additional unit of these materials, as they can be damaged or broken easily.

## **Tools and Required Accessories**

There are several required tools to complete the Albert Build outlined in the table below. It is recommended you acquire all the means to build albert before you begin Construction

Table 2: Summary of Required Tools to build Albert 2.0

<b>Tool</b>
1.5mm Allen Key
X-Acto Knife
Rough Grit Sandpaper (courser than #100)
Needle Nose Pliers
Heat Sealer
LiPo Battery Charger
Laser Cutter (Bed at least 12"x12")
3-D Printer (Bed at least 12"x12")
Needle, or substitute sharp point (for poking holes in Ripstop Nylon sheet)
Q-tip (for applying glue)
Hand protection (Rubber or Nitrile Gloves recommended)
Cutting surface
Set of precision phillips head screwdrivers

## **Instructions**

### **Lasercut Balsa Wood Parts**

The first step to creating your own Albert 2.0 is laser cutting the required parts for assembly. The parts required are listed and the lasercut file linked in the table below. The files attached are to scale .pdf files without dimensions.

1. Open the PDF laser cutting files in the system viewer in EPIC, and remove any curves you will not cut/engrave. Change the sheet size to 12x24 inch to match the machine's dimensions for more accurate placement.
2. Change the width of curves to cut to “**Hairline**”. Any curve/shape that is not hairline will be engraved and not cut.
3. Go to “print” and change the printer settings to suit Balsa wood (see figure 0), then click OK. Click “Print”.

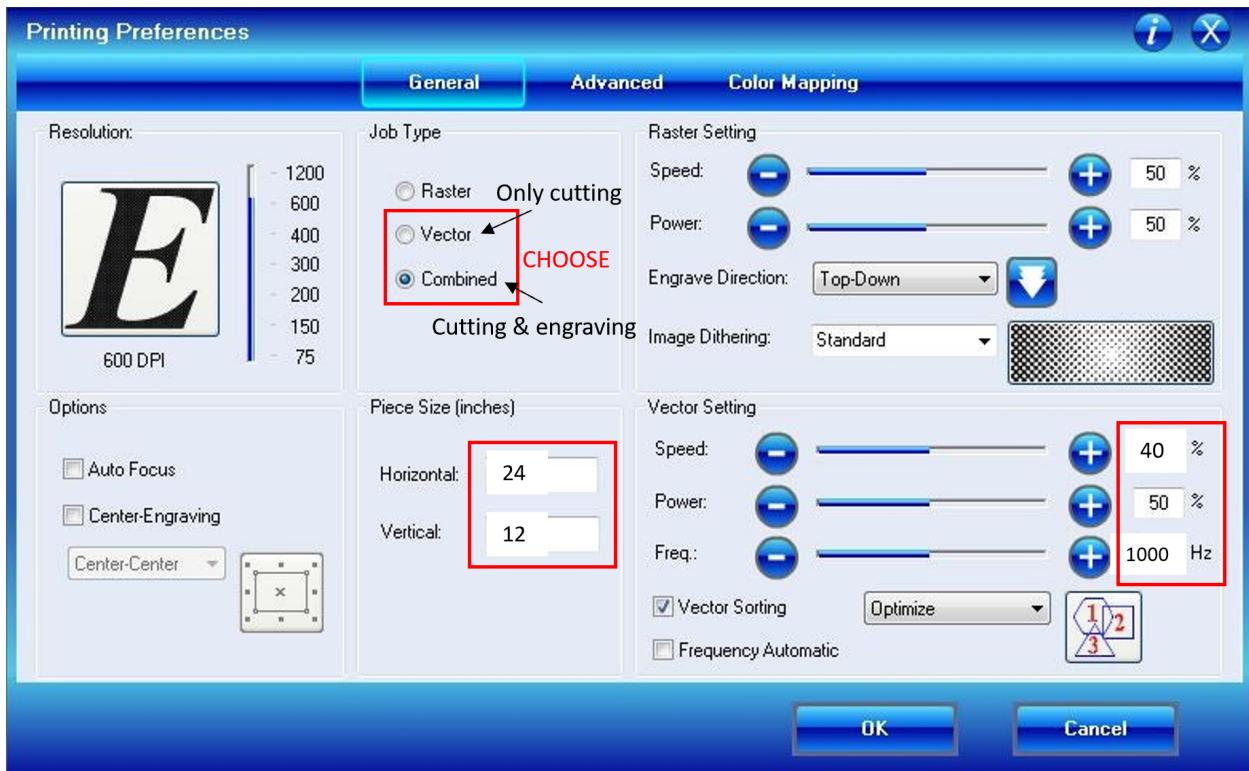


Figure 0: Printer Setting Screenshot

4. Remember to turn on all the vents, focus the laser, and position your balsa wood sheets properly in the machine. OPTIONAL: press “Go” while the lid is open to preview the cutting process.
5. Close the lid and press “Go”. When finished, do not move the wood and press “Go” again for a second run. This will ensure that the wood is cut all the way.

Part	Quantity	File
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Main Body	1	<a href="https://drive.google.com/file/d/1MBv_5VV67zqkZ2FeD9ElwsnyQUMjml6K/view?usp=sharing">https://drive.google.com/file/d/1MBv_5VV67zqkZ2FeD9ElwsnyQUMjml6K/view?usp=sharing</a>
Lift Motor Panel	5	<a href="https://drive.google.com/file/d/1EBiSr_xsbK0bz3hGNTUfPoN15-SWmiUe/view?usp=sharing">https://drive.google.com/file/d/1EBiSr_xsbK0bz3hGNTUfPoN15-SWmiUe/view?usp=sharing</a>
Lift Motor Panel with cutout	1	<a href="https://drive.google.com/file/d/1aU_dEPdGERkZ1P680kUvdoe7g4hzG0R5/view?usp=sharing">https://drive.google.com/file/d/1aU_dEPdGERkZ1P680kUvdoe7g4hzG0R5/view?usp=sharing</a>
Skirt Bottom Ring	1	<a href="https://drive.google.com/file/d/1MB2WwVDcPHp429eissvs2H0vYfaMOGyP/view?usp=sharing">https://drive.google.com/file/d/1MB2WwVDcPHp429eissvs2H0vYfaMOGyP/view?usp=sharing</a>
Top Ring Rear Half	1	<a href="https://drive.google.com/file/d/1Q7PJGIVpE_zWsDohwFHFk9_g10j_02th/view?usp=sharing">https://drive.google.com/file/d/1Q7PJGIVpE_zWsDohwFHFk9_g10j_02th/view?usp=sharing</a>
Skirt Holder Ring	2	<a href="https://drive.google.com/file/d/1TRxz1e8YTrTNZqDzi86S4YXgwCO2UTr0/view?usp=sharing">https://drive.google.com/file/d/1TRxz1e8YTrTNZqDzi86S4YXgwCO2UTr0/view?usp=sharing</a>
Skirt holder supports	8	<a href="https://drive.google.com/file/d/1ABkaEslzzXYEJX2uRiEk56n1Pc5lHol0/view?usp=sharing">https://drive.google.com/file/d/1ABkaEslzzXYEJX2uRiEk56n1Pc5lHol0/view?usp=sharing</a>
Outer housing front panel	1	<a href="https://drive.google.com/file/d/1Jod1EIrLYcYwiLEZk9-XRmb02U0PKjum/view?usp=sharing">https://drive.google.com/file/d/1Jod1EIrLYcYwiLEZk9-XRmb02U0PKjum/view?usp=sharing</a>
Outer housing 45 degree panel	2	<a href="https://drive.google.com/file/d/1a9hNmLhwrBXvEPmHTYUGgRUpLFr1zJM/view?usp=sharing">https://drive.google.com/file/d/1a9hNmLhwrBXvEPmHTYUGgRUpLFr1zJM/view?usp=sharing</a>
Outer housing side panel	2	<a href="https://drive.google.com/file/d/1K6OBSZIEaF0cofz-C0LleCVnlayaRm1/view?usp=sharing">https://drive.google.com/file/d/1K6OBSZIEaF0cofz-C0LleCVnlayaRm1/view?usp=sharing</a>
Outer housing front top panel	1	<a href="https://drive.google.com/file/d/17Us8pH0QcfNjRGzDxv6HIO4LVvLldRLP/view?usp=sharing">https://drive.google.com/file/d/17Us8pH0QcfNjRGzDxv6HIO4LVvLldRLP/view?usp=sharing</a>
Outer housing rear top panel	1	<a href="https://drive.google.com/file/d/1u5OSpphn0FORz1-xtgCVKJt6TDNEX1zK/view?usp=sharing">https://drive.google.com/file/d/1u5OSpphn0FORz1-xtgCVKJt6TDNEX1zK/view?usp=sharing</a>
linkage	1	<a href="https://drive.google.com/file/d/1qP6AIIRIVzrgC4tUNQHdpVm3">https://drive.google.com/file/d/1qP6AIIRIVzrgC4tUNQHdpVm3</a>

		<a href="https://WEoRtNUi/view?usp=sharing">WEoRtNUi/view?usp=sharing</a>
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## 3-D Print Parts

The rear propulsion mount and the front sensor mount have complex geometries and thus necessitate the use of 3-D printing for manufacture. The .3mf files can be found below. In addition, the entire CAD repository is linked in Appendix B in case modifications are required.

Table 3: Summary of 3-D Print Parts

Part	Quantity	.3mf file
Prop Mount	1	<a href="https://drive.google.com/file/d/148FS8WYcL_FZT-v0HaYFnMqTrta2iIz/view?usp=sharing">https://drive.google.com/file/d/148FS8WYcL_FZT-v0HaYFnMqTrta2iIz/view?usp=sharing</a>
Sensor Mount	1	<a href="https://drive.google.com/file/d/1wu6PPgROJ8nhvSkKHzH46SNjDBsz0o/view?usp=sharing">https://drive.google.com/file/d/1wu6PPgROJ8nhvSkKHzH46SNjDBsz0o/view?usp=sharing</a>
Rudder	2	<a href="https://drive.google.com/file/d/10C6OWlraCYoXAqFRwxUi3_knaYEf7oZW/view?usp=sharing">https://drive.google.com/file/d/10C6OWlraCYoXAqFRwxUi3_knaYEf7oZW/view?usp=sharing</a>

## Chassis Assembly

**Required parts:** 1x Main body, 5x Lift Motor Panel, 1x Lift Motor Panel w/ cutout, 2x Skirt Holder Ring, 8x Skirt Holder Supports

**Required Tools:** Wood Glue

1. Assemble Craft Base

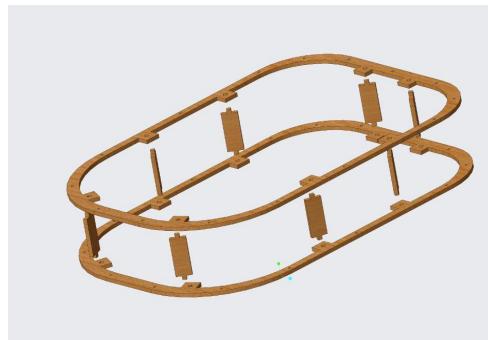
The main base consists of the Main Body, 5x of the Lift Motor Panel and 1x of the Lift Motor Panel with Cutout. The slots cut into the base correspond with the rectangular protrusions on the cutouts. Apply a generous amount of wood glue to the protrusions of the cutouts and slide into place (Figure 1)



*Figure 1: Exploded View of Craft Base Assembly*

## 2. Assemble skirt holder

The skirt holder for albert 2.0 consists of two skirt holder rings and 8 skirt holder supports that fit together as seen in figure 2. The struts fit neatly in the holes on the rings to create the part shown in figure 3.



*Figure 2: Exploded view of skirt holder assembly*

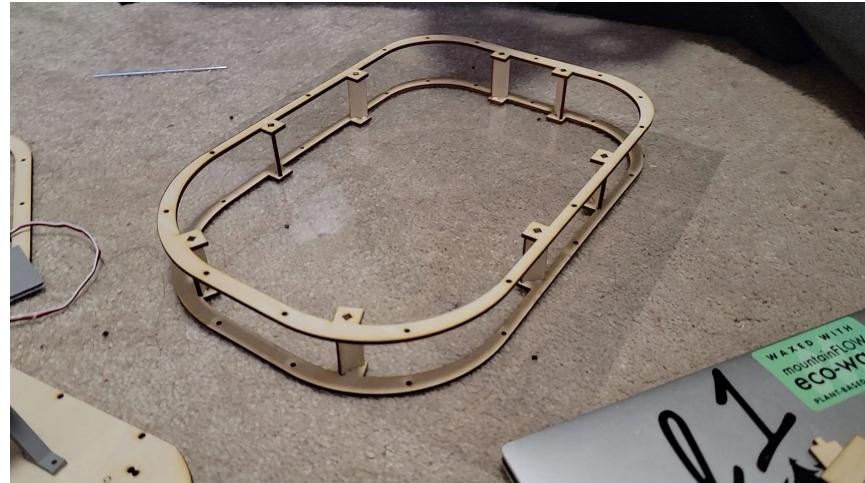


Figure 3: Finished Skirt assembly

3. Attach (glue) skirt holder to flight frame and line up the holes (figure 4)



Figure 4: Placement of base assembly on skirt holder assembly

## Creating and Assembling Skirt

**Required Parts:** 1x Skirt Bottom Ring, Nylon Sheet, 1x Craft Chassis, 1x Top Ring Rear Half, M2 15 mm bolts and nuts

**Required Tools:** X-Acto Knife, Heat Sealer, 1.5 mm Allan head Screwdriver, safe workspace for work with cutting tools, ruler

1. Use ring as guide to cut two skirt pieces as illustrated in figure 5



Figure 5: Skirt Cutting Diagram

2. Place both pieces on top of each other and heat-seal the outside edge (Figure 6)



Figure 6: Heat Sealing Diagram

3. Flip the skirt inside out and place it over the frame (Figure 7)



*Figure 7: Skirt placement on frame*

4. Add skirt holder rings and screw them over the skirt to attach it. Use a sharp object such as a pen or a screwdriver to make holes in the skirt (Figure 8)



*Figure 8: Poking holes and screwing in skirt*

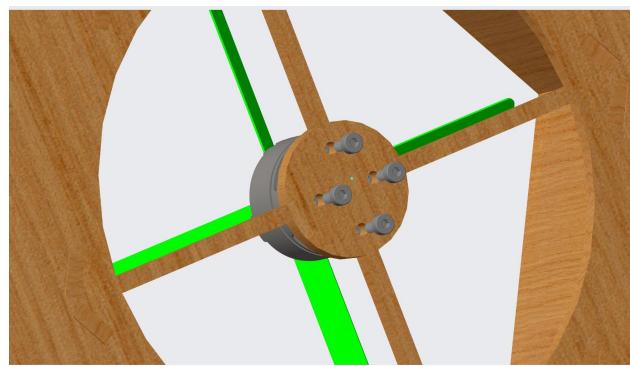
5. Trim excess fabric.

## Attaching Propellers to Motors

**Required parts:** 2x 2300 KV brushless motors, 2x 4 blade propellers, M2 5mm bolts

**Required Tools:** sandpaper, gorilla glue, safe working surface for gorilla glue, gloves

1. Attach propellers to motor
  - i. Sand axle
  - ii. Apply generous gorilla glue to shaft
  - iii. Press fit propeller onto shaft
  - iv. Let cure for 10 minutes upside down, this is important so excess glue does not drip into the motor coils
2. Attach Lift Motor to Craft base (Figure 9)



*Figure 9: Lift motor assembly*

## Assembly and Installation of Rear Prop Mount

**Required parts:** Prop Mount, 9g Servo Motor with included screws, 2300 KV brushless motor w/ propeller attached, linkage, 2x stainless steel axle, 2x rudders, M2 5mm bolts

**Required Tools:** 1.5 mm allen key

1. Install Servo into its slot in the bottom of the mount and secure the servo arm to the servo (Figure 10)

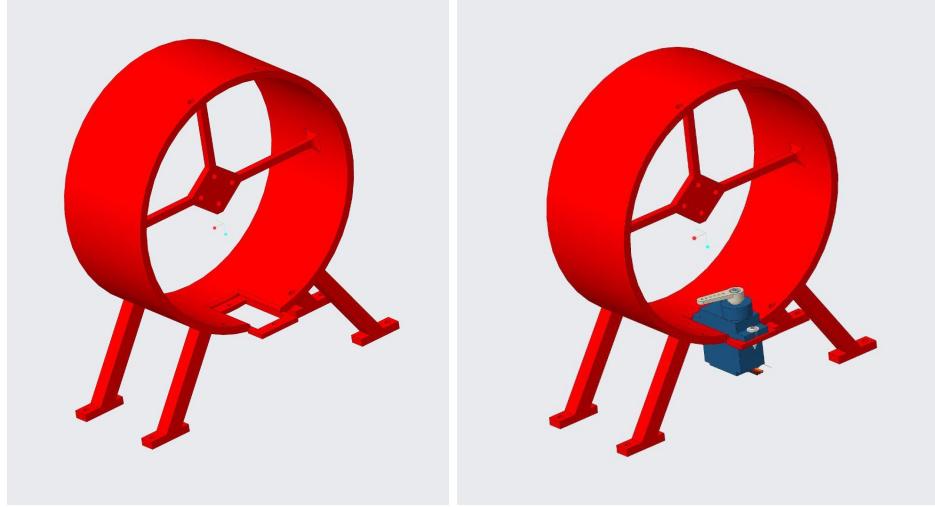


Figure 10: Propulsion Motor mount and Servo

2. Screw the remaining Brushless motor and prop assembly into the center of the mount (Figure 11)

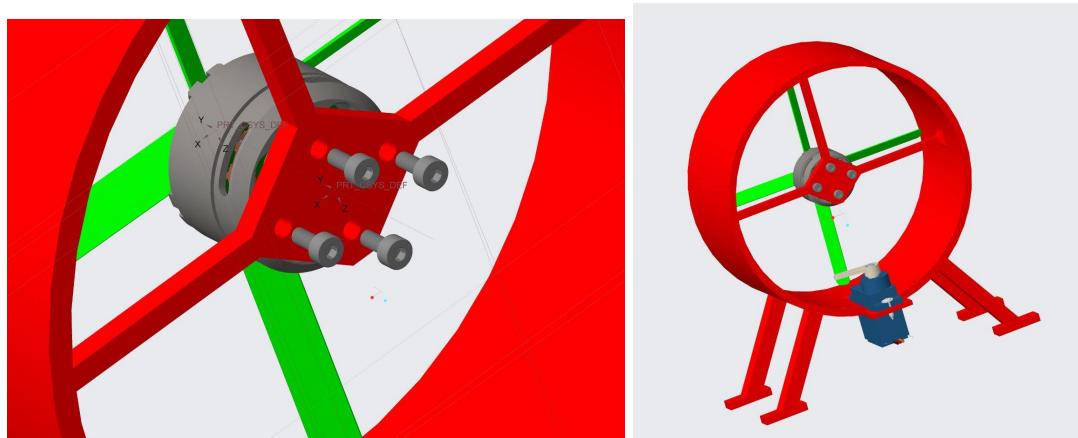


Figure 11: Brushless motor and Propeller assembly and Propulsion Motor Mount

3. Sand axles
4. Slide axles into the axle holes on the mount (Figure 12)

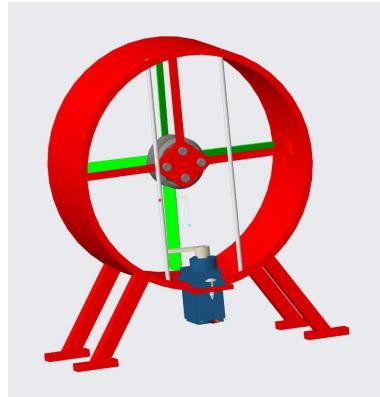


Figure 12: Axles and Propulsion Motor Mount

5. Apply gorilla glue to the open slots on the rudders
6. Press rudders onto the axles, making sure the side of the rudders with the holes are on the bottom and that the rudders are centered along the span of the axle (Figure 13)

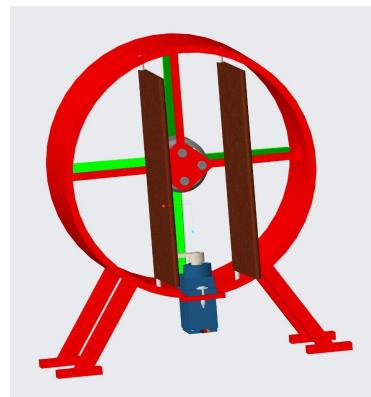


Figure 13: Rudders and Propulsion Motor Mount

7. Screw linkage piece into each rudder (Figure 14)

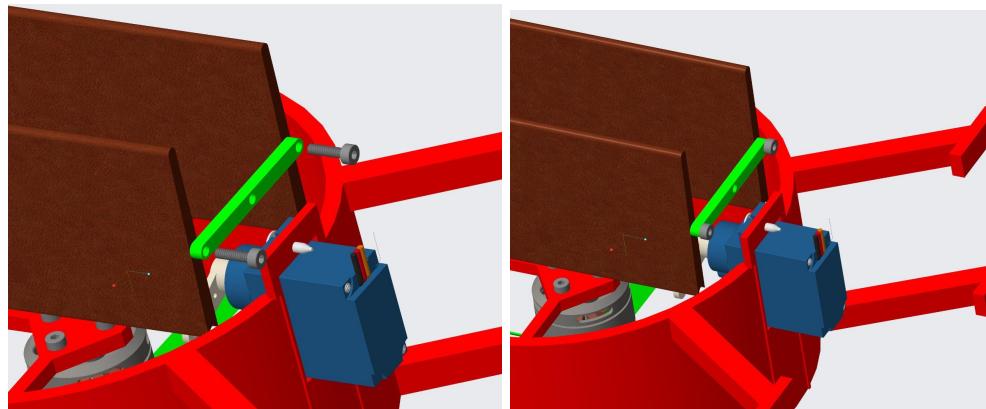
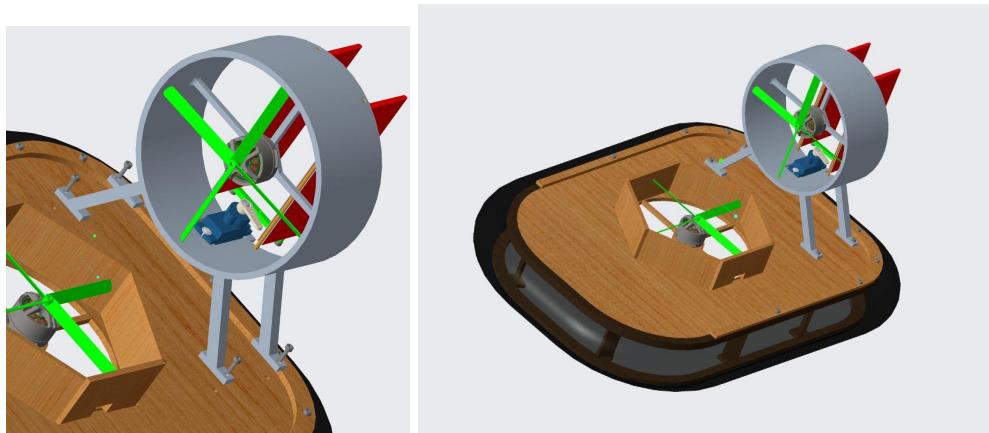


Figure 14: Linkage and Propulsion Motor Mount

8. Attach linkage to servo
9. Attach Rear prop assembly to the main flight body (Figure 15)



*Figure 15: Propulsion Motor Assembly and Craft Base Assembly*

## Assembling Electronic Components

**Required parts:** RGB LED, three Ultrasonic sensors, Arduino UNO, 2.4GHz Receiver, Servo, two ESCs, two 1500 mAh LiPo batteries, a set of jumper wires, USB cable Type A to Type B, a M2 nut and bolt set, M1 nut and bolt set

### Required Tools:

## Software

1. Connect Arduino UNO to a computer using USB cable Type A to Type B
2. Open Arduino IDE, in the Menu -> Tool -> Board -> choose Arduino UNO (See figure 16)

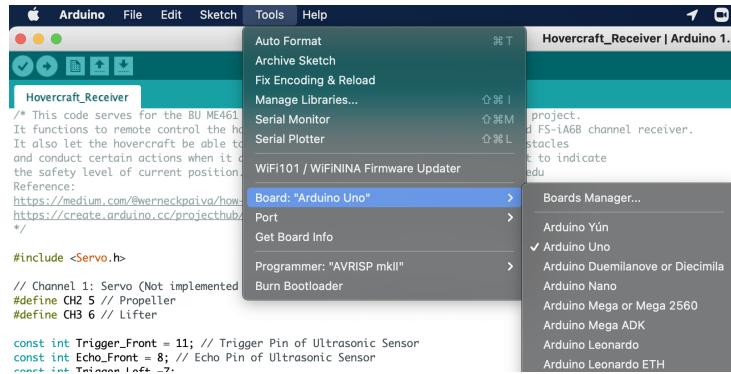


Figure 16: Arduino Board Selection

3. Find the correct port for Arduino: Menu -> Tool -> Port -> choose “COM6 (Arduino/Genuino Uno)” (See figure 17)



Figure 17: Arduino Port Selection

4. Create a new script in the IDE
5. Copy and paste the Arduino code in the appendix A into the new script
6. Upload the Arduino code to the Arduino UNO
7. Unplug the USB cable between Arduino and the computer

## Electronic Hardware

1. Take the breadboard, following figure 18, take off the bus strip part (circled in red) (Figure 18)

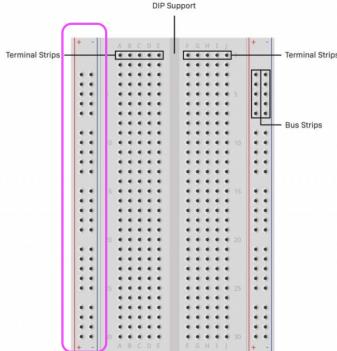


Figure 18: Breadboard Separation Instruction

2. Prepare the following items: RGB LED, three Ultrasonic sensors, Arduino UNO, 2.4GHz Receiver, Servo, two ESCs, two 1500 mAh LiPo batteries, and a set of jumper wires
3. Following figure 19, connect everything as indicated expect for the connection of LiPo batteries with ESCs (connect the batteries to ESCs when you want to operate the hovercraft, otherwise they should be unplugged)

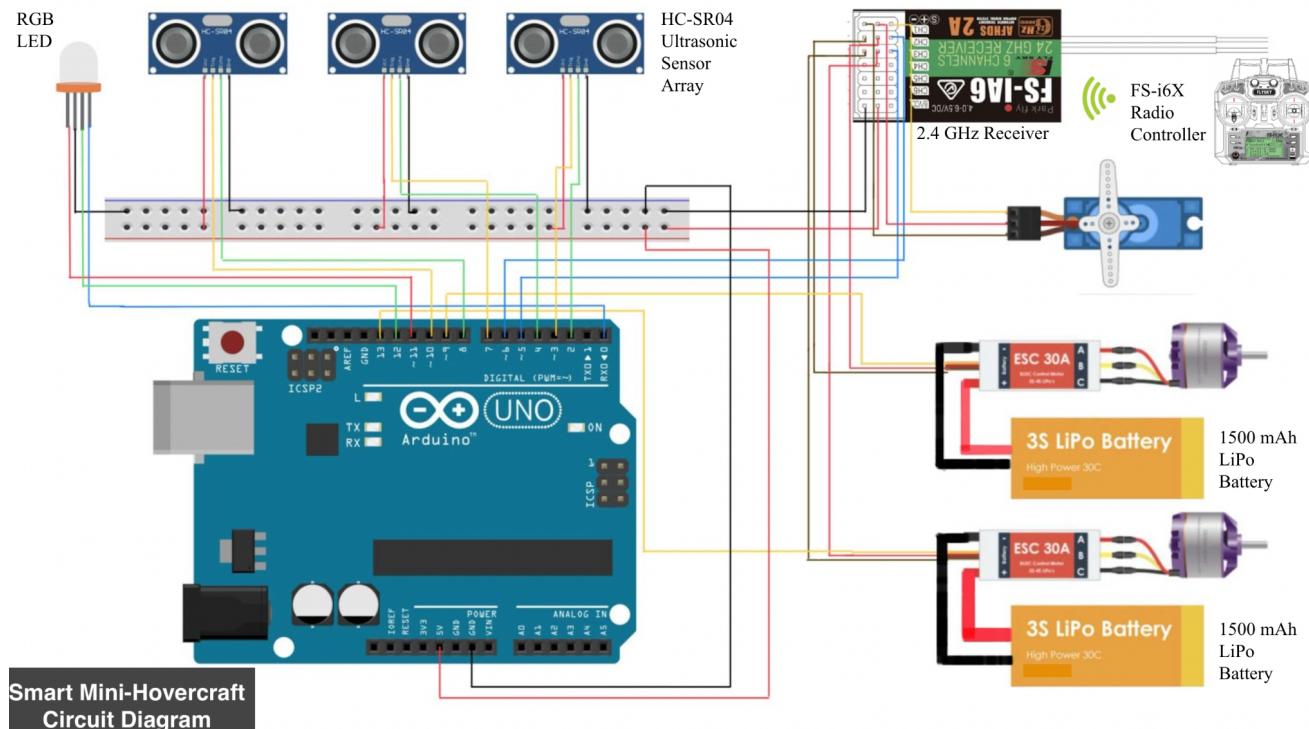
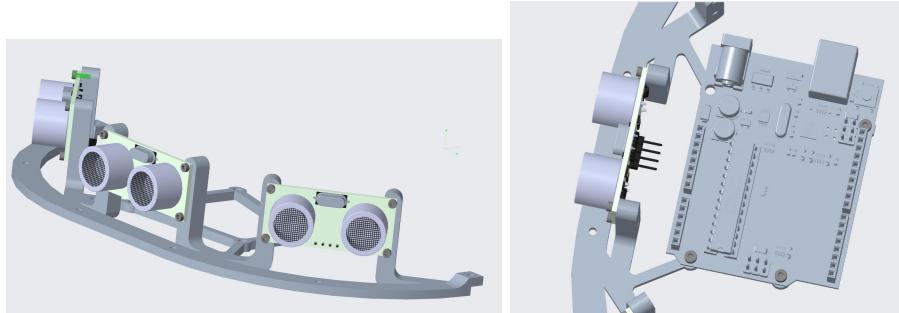
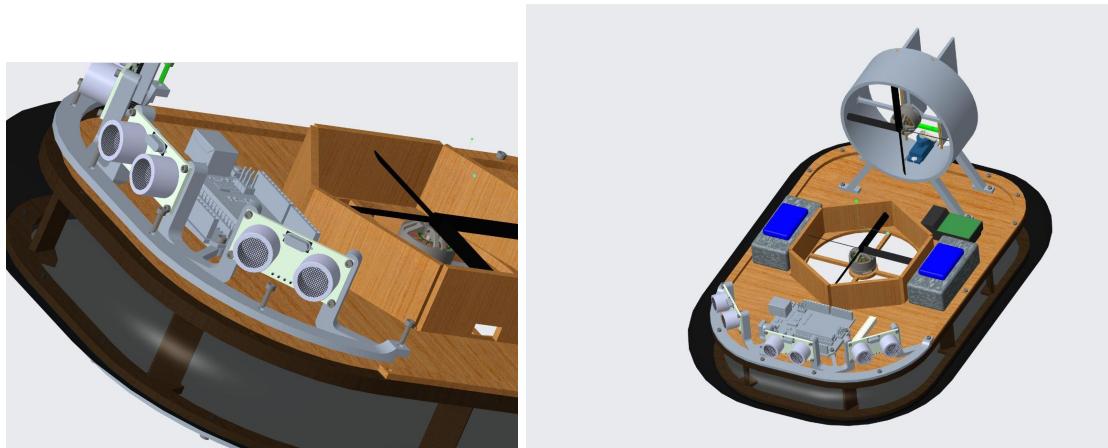


Figure 19: Circuit diagram of Albert 2.0

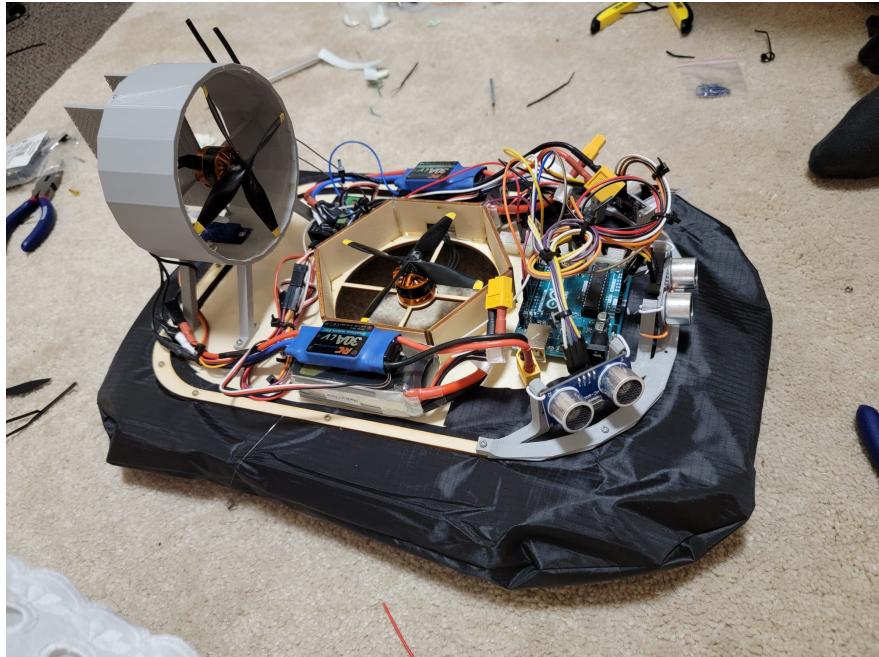
4. As indicated in figure X and X, using the M2 nut and bolt set, attach the sensor assembly and the Arduino onto the 3-D printed sensor mount while placing the other electronic components. (See figure 20, 21, and 22)



*Figure 20: Mounting of the ultrasonic sensor array*



*Figure 21: Placement of the electronic components*



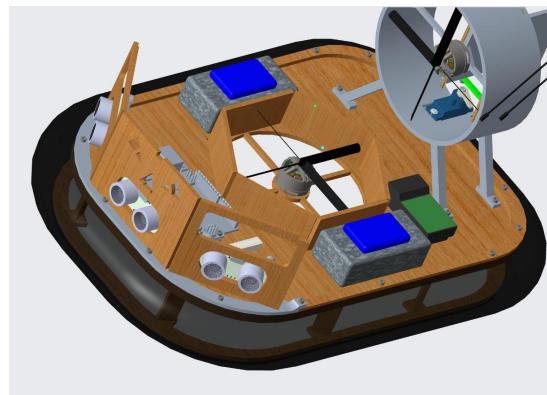
*Figure 22: Layout of electronic components - 2*

## Assembling and Installing Outer Housing

**Required parts:** Outer housing front panel, 2x Outer housing 45 degree panel, 2x Outer housing side panel, Outer housing front top panel, Outer housing rear top panel, Plastic Sheeting

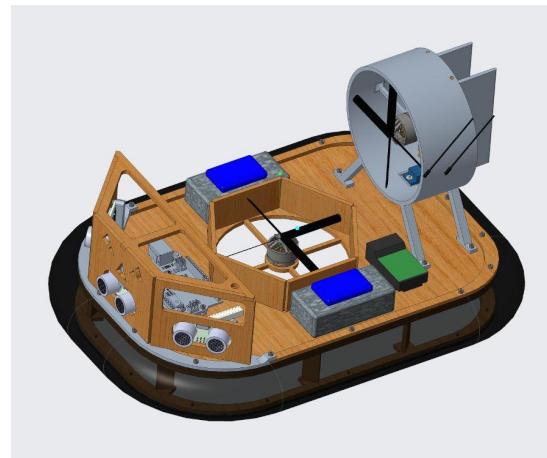
**Required Tools:** Gorilla Glue, Wood Glue

1. Bundle wiring using the small zip ties
2. Gorilla glue plastic sheeting to the backside of each panel, then cut around each part
3. Assemble Front End housing
  - i. Glue on front pieces (Figure 23)



*Figure 23: Front Panels on Craft Assembly*

- b. Slide on top piece (Figure 24)



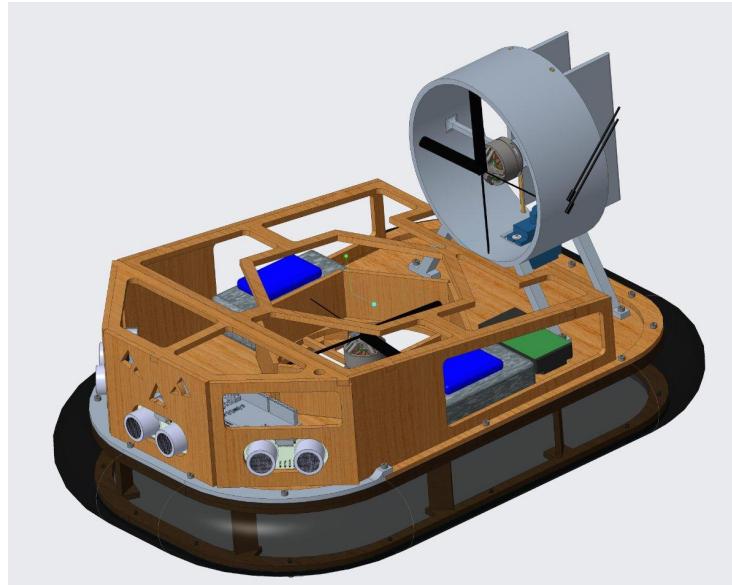
*Figure 24:Front Top Panel and Craft Assembly*

4. Assemble Rear housing (Figure 25)
  - i. Glue together rear housing



*Figure 25: Rear Housing Assembly*

5. Plug in motors to power
6. Attach rear housing to Albert (Figure 26)



*Figure 26: Final Appearance of Albert 2.0*

## Start playing the hovercraft

1. Connect the batteries to the ESCs
2. Turn on the Radio controller
3. Figure 27 indicates the operation of the Radio controller

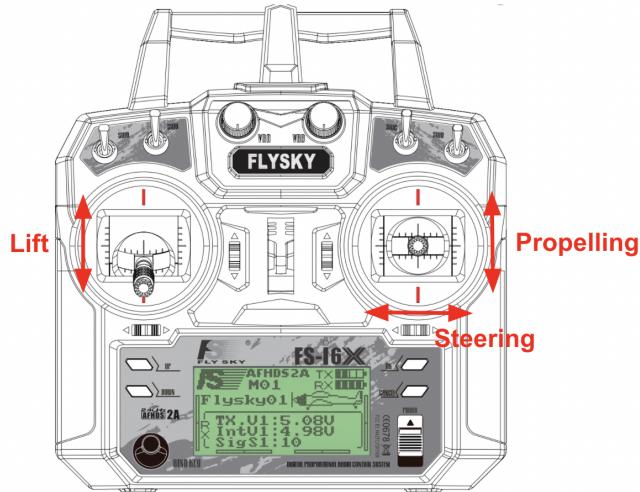


Figure 27: Operation of the Radio controller

4. Keep the function of the joysticks in mind and start having fun with Albert!

## Charging

Please refer to the manufacturer tutorial at the following link for charging:  
[https://www.youtube.com/watch?v=gsrMwu9A1DM&ab\\_channel=TenergyOfficial](https://www.youtube.com/watch?v=gsrMwu9A1DM&ab_channel=TenergyOfficial)

## Appendix

### Appendix A - Arduino Code

```
/* This code serves for the BU ME461 Team 11's Smart Mini-Hovercraft senior design project.
It functions to remote control the hovercraft with FS-i6X and remote controller and FS-iA6B channel
receiver.
It also let the hovercraft be able to use the ultrasonic sensor array to detect obstacles
and conduct certain actions when it detects obstacles. It also includes a RGB light to indicate
the safety level of the current position. Written by Chuwei Chen | 2021 | chenchuw@bu.edu
```

Reference:

<https://medium.com/@werneckpaiva/how-to-read-rc-receiver-signal-with-arduino-54e0447f6c3f>  
<https://create.arduino.cc/projecthub/muhammad-aqib/arduino-rgb-led-tutorial-fc003e>  
\*/

```
#include <Servo.h>

// Channel 1: Servo (Not implemented here), Channel 2: Propeller, Channel 3: Lifter
#define CH2 5 // Propeller
#define CH3 6 // Lifter

const int Trigger_Front = 11; // Trigger Pin of Ultrasonic Sensor
const int Echo_Front = 8; // Echo Pin of Ultrasonic Sensor
const int Trigger_Left = 7;
const int Echo_Left = 4;
const int Trigger_Right = 3;
const int Echo_Right = 2;

int red_light_pin = 10;
int green_light_pin = 12;
int blue_light_pin = 0;

Servo ESC_propeller;
Servo ESC_lifter; // Under construction!

// Read the number of a given channel and convert to the range provided.
// If the channel is off, return the default value
int readChannel(int channelInput, int minLimit, int maxLimit, int defaultValue){
    int ch = pulseIn(channelInput, HIGH, 30000);
    if (ch < 100) return defaultValue;
    return map(ch, 1000, 2000, minLimit, maxLimit);
}

void setup(){
    Serial.begin(115200);
    ESC_propeller.attach(9,1000,2000);
    ESC_lifter.attach(13,1000,2000);
    pinMode(CH2, INPUT);
    pinMode(CH3, INPUT);
}

int ch2Value, ch3Value, ch2speed, ch3speed;

void loop() {
```

```
// Sensors
long duration_front, cm_front, duration_left, cm_left, duration_right, cm_right;
// Front sensor
pinMode(Trigger_Front, OUTPUT);
digitalWrite(Trigger_Front, LOW);
delayMicroseconds(2);
digitalWrite(Trigger_Front, HIGH);
delayMicroseconds(10);
digitalWrite(Trigger_Front, LOW);
pinMode(Echo_Front, INPUT);
duration_front = pulseIn(Echo_Front, HIGH);
cm_front = ms_to_cm(duration_front);

// Left sensor
pinMode(Trigger_Left, OUTPUT);
digitalWrite(Trigger_Left, LOW);
delayMicroseconds(2);
digitalWrite(Trigger_Left, HIGH);
delayMicroseconds(10);
digitalWrite(Trigger_Left, LOW);
pinMode(Echo_Left, INPUT);
duration_left = pulseIn(Echo_Left, HIGH);
cm_left = ms_to_cm(duration_left);

// Right sensor
pinMode(Trigger_Right, OUTPUT);
digitalWrite(Trigger_Right, LOW);
delayMicroseconds(2);
digitalWrite(Trigger_Right, HIGH);
delayMicroseconds(10);
digitalWrite(Trigger_Right, LOW);
pinMode(Echo_Right, INPUT);
duration_right = pulseIn(Echo_Right, HIGH);
cm_right = ms_to_cm(duration_right);

Serial.print("Front sensor: ");
Serial.print(cm_front);
Serial.print("cm  ");
Serial.print("Left sensor: ");
Serial.print(cm_left);
Serial.print("cm  ");
Serial.print("Right sensor: ");
Serial.print(cm_right);
Serial.print("cm  ");
```

```

// ESCs
ch2Value = readChannel(CH2, 0, 100, 0);
ch3Value = readChannel(CH3, 0, 100, 0);
// if (ch2Value < 50)
//   ch2Value = 50;
ch2speed = map(ch2Value, 50, 100, 1000, 2000); // 50(middle joystick), 100 (top joystick), 1000 (0 speed), 2000 (max speed)
ch3speed = map(ch3Value, 0, 100, 1000, 2000); // 0(bottom joystick), 100(top joystick).

// Important variables here: cm_front,cm_left,cm_right, ESC_lifter, ESC_propeller

// Determine current situation: var=1 all green, var=2 one or more blue, var=3 one or more red.
// Green(safe): nothing ahead, Blue(careful): something in between 20-30cm, Red(warning): something in 20cm.
int varr = 0;
// Nothing around:
if (cm_front >= 30 and cm_left >= 30 and cm_right >= 30) varr = 1;
// Be careful:
else if (cm_front >= 20 && cm_left >= 20 && cm_right >= 20 && cm_front < 30) varr = 2;
else if (cm_front >= 20 && cm_left >= 20 && cm_right >= 20 && cm_left < 30) varr = 2;
else if (cm_front >= 20 && cm_left >= 20 && cm_right >= 20 && cm_right < 30) varr = 2;
else if (cm_front >= 20 && cm_left >= 20 && cm_right >= 20 && cm_front < 30 && cm_left < 30)
varr = 2;
else if (cm_front >= 20 && cm_left >= 20 && cm_right >= 20 && cm_front < 30 && cm_right < 30)
varr = 2;
else if (cm_front >= 20 && cm_left >= 20 && cm_right >= 20 && cm_right < 30 && cm_left < 30)
varr = 2;
else if (cm_front >= 20 && cm_left >= 20 && cm_right >= 20 && cm_right < 30 && cm_left < 30 && cm_front < 30) varr = 2;
// Too close:
else varr = 3;

// Obstacle-detected Decision Making && Remote Control
// Green: do nothing, Blue: do nothing, Red: brake and delay 1s for user lowering speed.
switch (varr) {
case 1:
  RGB_color(0,255,0);
  ESC_lifter.write(ch3speed);
  if(ch2speed > 990)
    ESC_propeller.write(ch2speed);
  break;
}

```

```

case 2:
    RGB_color(0,0,255);
    ESC_lifter.write(ch3speed);
    if(ch2speed > 990)
        ESC_propeller.write(ch2speed);
    break;

case 3:
    RGB_color(255,0,0);
    ESC_lifter.write(1000);
    if(ch2speed > 990)
        ESC_propeller.write(1000);
    delay(1000); // Delay 1second for user to lower the speed
    break;

default:
    ESC_lifter.write(ch3speed);
    if(ch2speed > 990)
        ESC_propeller.write(ch2speed);
    break;
}

Serial.print((int)varr);
Serial.print(" Ch2: ");
Serial.print(ch2Value);
Serial.print(" Propeller Speed: ");
Serial.print(ch2speed);
Serial.print(" Ch3: ");
Serial.print(ch3Value);
Serial.print(" Lifter Speed: ");
Serial.print(ch3speed);
Serial.print("\n");
delay(100);
}

long ms_to_cm(long microseconds) {
    return microseconds / 29 / 2;
}

void RGB_color(int red, int green, int blue)
{
    analogWrite(red_light_pin, red);
    analogWrite(green_light_pin, green);
    analogWrite(blue_light_pin, blue);
}

```

{}

## **Appendix B: CAD Link**

The following link contains every CAD file used in the design and manufacture of Albert 2.0:

[https://drive.google.com/drive/folders/1\\_Lm0IttWmEj1vA2xIQak3ergI1G2PtUT?usp=sharing](https://drive.google.com/drive/folders/1_Lm0IttWmEj1vA2xIQak3ergI1G2PtUT?usp=sharing)

CAD Models for Arduino UNO, Brushless Motor, Microservo 9G, Ultrasonic Sensor and 6 Terminal Receiver were obtained from outside sources and included in the references

## **Reference**

“FS-i6X.” *FlyskyRC*, www.flysky-cn.com/fsi6x.

“Free CAD Designs, Files & 3D Models: The GrabCAD Community Library.” *Free CAD Designs, Files & 3D Models | The GrabCAD Community Library*, grabcad.com/library/fs-ia6b-1.

“Free CAD Designs, Files & 3D Models: The GrabCAD Community Library.” *Free CAD Designs, Files & 3D Models | The GrabCAD Community Library*, grabcad.com/library/arduino-uno-r3-1.

“Free CAD Designs, Files & 3D Models: The GrabCAD Community Library.” *Free CAD Designs, Files & 3D Models | The GrabCAD Community Library*, grabcad.com/library/hc-sr04-9.

“Free CAD Designs, Files & 3D Models: The GrabCAD Community Library.” *Free CAD Designs, Files & 3D Models | The GrabCAD Community Library*, grabcad.com/library/flysky-ia6b-receiver-1.

