

FAB CHALLENGE 2019

GOVT ENGINEERING COLLEGE THRISSUR

Planning And Discussion

We were notified about the competition and a group was formed. The group consists of

Group Mentor : Ajay James
 Fab Lab Manager
 Govt Engg college Thrissur

Group members:

- 1) Cherian Francis
- 2) Athul
- 3) Joel James
- 4) Arjun Sankar
- 5) Sebin

Two of the group members had good background with FAB equipment, one was proficient in machine learning and two others were really good with electronics.

Out of the three given topics of the competition, we chose the beach cleaning as our problem statement after a very long discussion. We made different opinions and ideas to tackle the problem.

AIM : Machine learning equipped beach cleaning robot with drone mapping.

SUMMARY : The idea was to utilize a drone to identify the regions where wastes got accumulated within a beach and then use the drone map output sent to a robot on ground to clean the beach in the least time possible. The trained data sets are to be used for recognition of objects and the objects Gps location is input to ground bot to reach there and collect the waste.

The entire plan was formulated and then a table indicating the weekly plan was made showing the feats of achievements and progress our group was bound to make with the limited time we had.

The table is as shown below

SL NO:	Task Set	PLAN
1)	Task 1	<ol style="list-style-type: none"> 1) Make the basic design of the drone 2) Make the basic design of Cleaner Bot
2)	2	<ol style="list-style-type: none"> 1) Purchase of electronic components and modules

		<ol style="list-style-type: none">2) Testing of electronic components and modules3) Assembly
3)	3	<ol style="list-style-type: none">1) Using shopbot CNC milling equipment to create a wax mould for tyre grip2) Designing the negative of a tyre grip using CAM in Autodesk fusion 3603) Using laser cutter to cut out the drone frame
4)	4	<ol style="list-style-type: none">1) Moulding and Casting of tyre grip using liquid rubber and mould wax2) 3d printing tyres of cleaner bot
5)	5	<ol style="list-style-type: none">1) Assembly of the components of drone after calibration2) PCB milling of a power distribution system in shopbot for drone
6)	6	<ol style="list-style-type: none">1) Assembly of components of Drone and Ground robot.
7)	7	<ol style="list-style-type: none">1) Testing and improving

DAY 1

The entire project consists of the construction of a drone and a cleaner robot. The designated fund for the challenge was 20,000 and we decided to make designs of both so that the entire costs lies below the designated fund.

Today we decided to begin with the design of drone. Functionality of drone in the project was to capture the top view images of beach and then identify the gps locations of wastes in it and then to transmit the information to a cleaner robot below making cleaning much more efficient and easier for the robot.

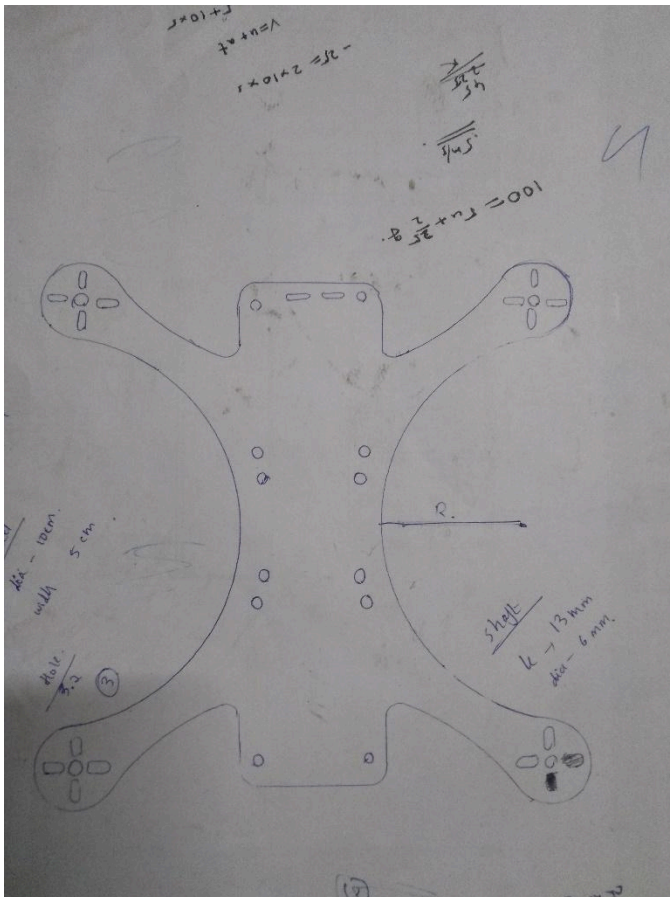
The main challenges for drone design were the following

1. Cost of the drone : We had to make a drone with the limited funds we had
2. Teaching the drone : The next major challenge was to teach the drone to identify wastes.
3. Transmission of captured images : Transmission of images was a challenge. FPV system was discussed but we dropped the idea as it was very costly. We decided to transmit information of GPS coordinates of location of wastes through a common Wi Fi.
4. Material of construction of FRAME : Material must be strong enough so that it doesn't break and light enough so as to decrease the NET weight of the drone. So we decided to choose ACRYLIC as our material of construction
5. The design : Design of the drone must be such that it has the minimum weight (so that we can reduce power consumption) and also it must be designed such that it can cruise through the air resisting the tidal winds.

Keeping all the above challenges in mind, we started the first stage of our project, "Design of drone".

DAY 2

Today, a few ideas for drone design were discussed. We decided to choose the design given below.



This design was small and had a lesser surface area which is why it would reduce the power consumption and air resistance.

The design of drone frame was made in Autodesk Fusion 360. The stl file from fusion is given below.

DESIGNING DRONE IN FUSION 360

Step1: open fusion 360

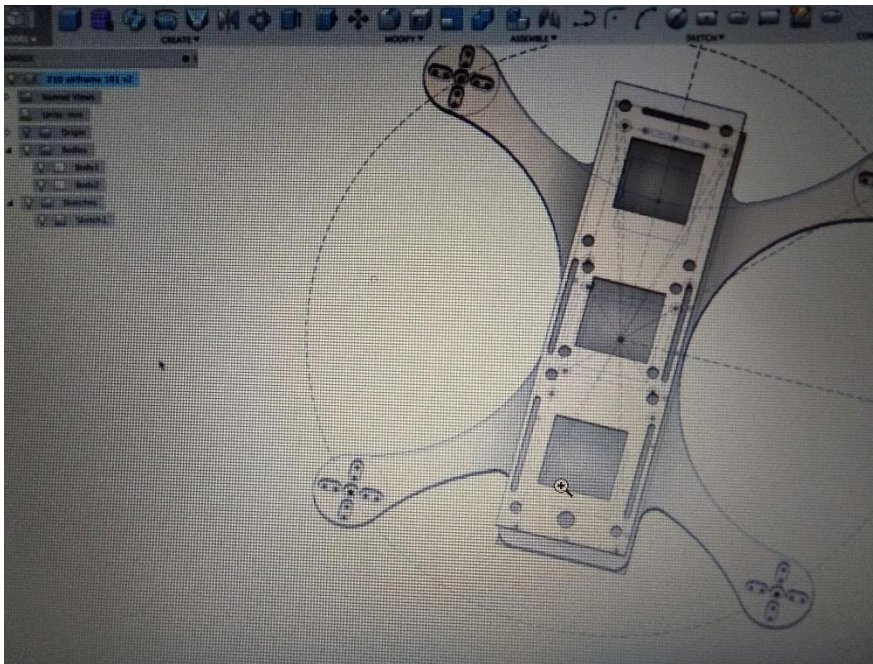
Step2: select plane and create sketch

Step3: draw model

Step4: The model is designed considering aerodynamic concepts

1. Maximum weight reduction by introducing holes and spaces
2. Considering spacers for joining top plate and bottom
3. The body designed to withstand the weight (weight of body weight of components)
4. The borders are designed in curved shape

(curved borders, circular holes introduced instead sharp and corners because considering the condition of stress concentration and breakage due to stress accumulation at a point)



DAY 3

We decided to make the frame by laser cutting. Since laser cutter accepts 2D image file and not a 3D file, conversion of the stl file into the required format was important.

Problem : The best file extension for Laser cutter is DXF. So we converted the 3D stl file into DXF. This was a major problem that we faced as fusion had no built in export to DXF option.

Solution : So we had to download an external ADD IN from Autodesk store. The name of ADD IN is “DXF FILE FOR LASER CUTTER”.

ADD IN LINK :

https://drive.google.com/file/d/1dIYVqfx7d7aumU4UOKh_agI5MmYCktnt/view?usp=sharing

(We followed this youtube video on link)

<https://www.instructables.com/id/Exporting-a-dxf-File-From-Fusion-360-for-Laser-Wat/>

So we converted all the three planes (XY, YX and ZX) into 2D DXF files for laser cutting using the ADD IN.

Now the frame is all set for laser cutting. File is saved for cutting.

We decided to cut it at any later point of time because of possible changes in design in the future and to avoid material wastage.

2D COREL DRAW FILES LINKS :

https://drive.google.com/drive/folders/1eifnpYWehle_UXMnenJ0slbRqd6QmkG1?usp=sharing

1. Drone body 1 & 2
2. Spacers (joints between 1&2)

DAY 4

Now that the design of the drone is complete, we decided to begin with the DESIGN of the BOT.

Discussions carried out on design of cleaner bot

The major challenges we faced during the construction of cleaner bot were the following

1. Waste collecting mechanism : After a long discussion on possible methods, we decided to use a belt mechanism to collect the wastes
2. Wheel : Since sand is fine it has every tendency to cause slip. So we decided to make wider wheels with higher surface area for the wheels.
3. Wheel Grip : Grip is an important factor in beach bot wheels. We decided to make grip similar to a tractor wheel. Grips were decided to be made using Mould Liquid rubber after casting from wax mould.
4. Body : Body was decided to be designed in fusion360 and cut out using a laser cutter by converting into DXF file using the ADD IN “ DXF for laser cutter”
5. Rollers: Rollers are required to drive the conveyor belt which is the designated part of the bot to carry wastes.
6. Waste storage mechanism : Wastes must be stored in some container after collection.

DAY 5

We designed a basic design for the BOT.

The design was made in AUTODESK FUSION 360.

The design is given below.

2D COREL DRAW LINKS

<https://drive.google.com/drive/folders/13uTJV2b4j5ZefQsHgEUr-IYGV3dX-OBz?usp=sharing>

STEPS OF DESIGN

Design aspects

1. A waste collection system on back side
2. A conveyor belt to direct waste to collection basket
3. A directional rotor to direct waste to conveyer belt

DAY 6

Now as the design for both the cleaner bot and drone were complete, we decided to begin with our work.

We decided to start with the construction of drone first. The materials required in making drone were listed down along with their function and source

NAME	PURPOSE	OBTAINED BY
● FRAME	The body of the drone	LASER CUTTING
● 4 BLDC MOTORS	For the rotation of the propellers	PURCHASING
● 4 PROPELLERS	For giving the upthrust for drone lift	3D PRINTING
● 4 ESC (Electronic speed controllers)	Speed controllers	PURCHASING
● STRIP TAGS	Holding battery, ardupilot and pi tightly to the frame	PURCHASING
● LITHIUM POLYMER BATTERY	For powering the drone	PURCHASING
● ELECTRONICS WORKBENCH	For assembly, testing and completing circuitry	FAB LAB WORKBENCH
● PCB	PCB for a power divider system	CNC MILLING IN SHOPBOT
● ARDUPILOT	Flight controller	PURCHASING
● JUMPER WIRES	Establish connections	FAB LAB
● MULTIMETER	Testing	FAB LAB

DAY 7

All the electronic components required in building the drone were purchased.

Each of the components was tested for its working.

The steps involved in Testing each components is elaborated below

(copied from internet)

1) TESTING OF BLDC:

- Testing BLDC for Short Circuits:

If any two of the wires are shorted together, we will experience resistance as we try to spin the motor by hand. If we separate all the wires, the motor must have no problem spinning when hand-propelled.

If we separate all the wires of the motor and it still resists spinning, we can assume it to have an internal short circuit

- Dry Test of BLDC :

Step One: Disconnect the motor from the Electronic Speed Controller (ESC) and wind it up with a variable-speed battery-operated drill, holding the stationary part and the three lead wires isolated. Run it at full speed for a couple of minutes. If the motor makes a strange noise or something inside the motor gets hot, you have a shorted winding or a loose magnet is hitting the stator within the motor.

Step Two: Label the three motor wires, making sure to continue to isolate them from one another, as 1, 2 and 3. Now connect your voltmeter to an AC range and connect two of the wires to terminals 1 and 2. Wind the drill at full speed again and note the AC voltage. Repeat this process with terminals 2 and 3 and 1 and 3. If all three readings are not about the same, you have a problem with your motor wires.

Step Three: Check for short circuits between the stator and the windings. Look for any connection between the windings and the motor stator laminations. You will need to find bare metal on the stator for one connection to the meter and the meter windings for the other. If you cannot find one, create one by poking through the coating of the steel laminations. If the meter doesn't read an open circuit, your motor is probably shot.

Step Four: If your motor passes all of these tests, it should be good to go. However, before putting it back into operation, you may want to check the no-load current of the motor and compare it with the specs provided by the manufacturer. This will allow you to identify a shorted turn in the motor or a winding that has shorted out. If you have a shorted turn, you cannot use the motor. It will generate very high

temperatures, causing the motor to fail and possibly do damage to your ESC.



2) Testing of ESC.

ESC can be tested by connecting ESC, motor and the flight controller and checking it



3) Testing of LiPO battery :

- Charge the LiPo battery pack in the usual way until fully charged. Remove the battery pack from the charger once charged.
- Look on the label on the LiPo battery pack. You need to find out the output voltage and mAh rating.
- The voltage figure is always a multiple of 3.7 and the mAh always a multiple of 2,100. For example, a LiPo battery pack using three cells have a voltage of 11.1 and mAh of 2200. The figures on the label are the figures you can expect to get when you test the battery using the multimeter.
- Set the multimeter to read voltage. Check the two terminals on the battery pack to determine which is positive and which is negative. They are labeled "+" and "-" respectively.
- Place the metal sensor attached to the end of the red wire that extends from the multimeter onto the positive LiPo battery terminal. Place the metal sensor attached to the end of the black wire extending from the multimeter onto the negative battery terminal.
- Read the voltage output on the multimeter display. It reads the same as on the battery pack label. If the voltage is more than five percent less then it's likely the battery is losing charge quickly as you have only just charged it.
- Set the multimeter to measure mAh. Place the two sensors on the battery terminals as before. Read the mAh on the multimeter display. It is the same as the label on the LiPo battery.
- If the mAh is more than five percent below the figure on the label it's likely you have a problem with your battery pack as it should not lose energy after just getting charged.
- Leave the LiPo battery overnight. Do not use it as you need to see if it loses charge while not in use. A good battery pack has the same readings the next day. Repeat the voltage and mAh test using the multimeter in the same way as before.

- The readings are identical if the LiPo battery pack is in good condition. If either the voltage or the mAh readings have reduced by more than 5 percent, then you need to consider getting your LiPo pack refurbished or replaced as you will find it gradually gets worse.

4) TESTING OF FLIGHT CONTROLLER

- With Mission Planner connected, move the flight controller board and you should see the artificial horizon move accordingly.
- The map will also show your current position using the GPS sensor if you have a GPS module connected, are outside and have GPS lock.

(Testing Procedures obtained from EC department faculties and internet)

DAY 8

Next day, as we began with the building of drone we faced a few problems. The problems we faced and its solution is elaborated below

- 1) Firmware couldn't be flashed in MISSION PLANNER (a configuration utility for ARDUPILOT (The flight controller)).

We were not able to flash firmwares in MISSION PLANNER. So we used APM (ArduPilot Mega) which is a professional quality IMU autopilot based on the Arduino Mega platform. When we used APM we could easily flash the firmwares.

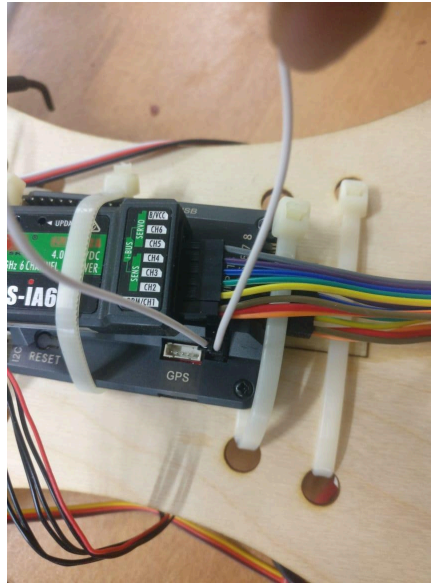
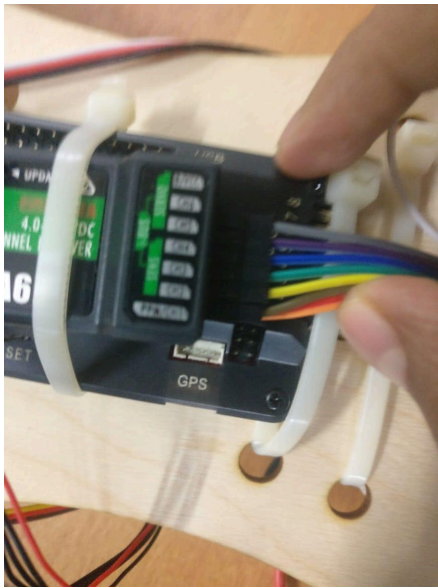
- 2) Calibration not working

The calibration of the flight controller was not working. This was because we didn't enable the built in compass of ARDUPILOT.

The built in compass can be enabled if we short the first two pins of the ARDUPILOT. This will give the necessary voltage to the compass and hence activating it for calibration.

STEPS TO SHORT THE COMPASS IN ARDUPILOT:

- First look for these two pins near the GPS (fig 1)
- Then connect a jumper wire (Female to Female) between the two pins. (fig 2)
- Now the compass is shorted.



3) ESC burnt out during testing

We were testing ESC by connecting it to motor and flight controller. But unfortunately it instantly burnt out.

Reason for this electronic damage was insufficient cooling. We were testing ESC with a high voltage LiPO battery for a long time. ESC can easily get damaged if it has

- Insufficient cooling
- High voltage input
- High Current input

We changed our LiPO battery to 2200maH, 11.1 V and now it works absolutely fine.

DAY 9

This day we decided to take the laser cut of the already designed frame of the drone.

We cut the frame in cardboard first to check its size by assembling the different components.

We cut the drone in cardboard by using EPILOG MINI LASER 40W



Steps for Cutting the Frame of Drone

- We import the 2D design of the frame in DXF format to CORELDRAW.
- The document size in CORELDRAW is set to 600 x 300 (in mm) which is the exact size of the honeycomb mesh of our laser cutter.
- Now we align our 2D sketch in the document properly.
- In the next step we introduce a 600 x 300 mm cardboard into the laser cutter for test cutting
- After keeping the 3mm , 600 x 300 mm cardboard we set the focus of laser cutter.
- We set the focus of the laser by adjusting the Z axis.
- We switch ON the laser cutter followed by the blower.
- Now we give the print command
- In the print settings we set the frequency , speed , power

Power – Speed – Frequency (Obtained from Test cutting shapes at various values)

Material	Power	Speed	Frequency
1. Cardboard (thickness = 3mm)	91	29	5000
2. Acrylic Sheet (thickness = 3mm)	95	15	5000
3. Wood westply (thickness = 3mm)	94	22	5000

From Kerf cutting ;

The obtained kerf of Laser cutter (using) is found to be = 0.23 (average)

Obtained cut size = given cut size + Kerf Value

Have to be implemented in areas where a strong fit (positive-negative fit) is needed.

Problem : Auto focus not working (Board issue)

Solution : There is a small door on front which can be opened. There is a belt. By moving the belt the z axis can be set to position

Problem: On importing DXF, there were multiple lines present. These multiple lines resulted in laser moving through an already cut section multiple number of times which caused a lot of time and also multiple passing resulted in burning of the end.

(multiple lines can be identified by zooming out – multiple lines will be a bit thicker)

Solution 1 : For simple shapes or less number of multilines – Delete the line and redraw using Bezier tool in corel draw

Solution 2 : The problem is mainly viewed on corel draw 2012 (old version – installed on fab lab computer)

Step1: install corel Draw X7 on another computer

Step2: import dxf file (multiple lines will be automatically removed)

Step3: save as pdf (X7 .cdr file not supported on 2012 version)

Step4: open pdf in corel draw 2012. The multiple lines eliminated.

After taking a sample cardboard frame cut, we assembled the components to check if it was fitting properly. The shortcomings were discussed.



VIDEO LINK:

https://drive.google.com/file/d/12ZpoTI--KhNZGBaWzX0WKM8RN_Yd8nmP/view?usp=sharing

DAY 10

We decided to cut the frame of the drone in acrylic which was our chosen frame material.

Machine : Epilog Mini 24 Laser 40W

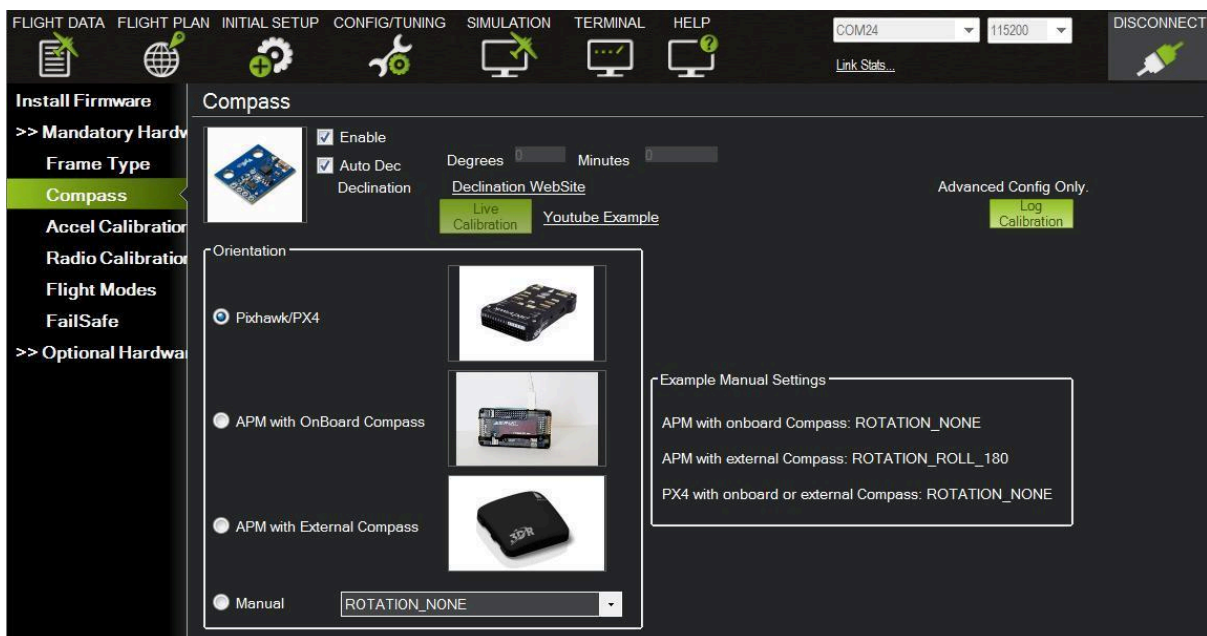


We assembled the components of the drone in the acrylic frame and tested working of the four motors and four ESC.

DAY 11

Today we decided to do complete calibration of ARDUPILOT (The flight controller of drones).

The steps of Calibration of ARDUPILOT using APM are elaborated below



DAY 12

Leaving the drone aside to be assembled later in the week, we decided to begin with the making of our cleaner bot.

The major components required for making the bot were noted down and are elaborated in the table below.

NAME	PURPOSE	OBTAINED BY
1)BODY	The body of the bot	Laser Cutting
2)Wheels	For bot mobility	3D Printing

3)Wheel Grip	For Grip on Wheels during movement	Moulding and Casting
4) Gear Motor	For driving the bot	Purchasing
5)Rollers	For the conveyer belt	3D Printing
6)Motor Driver	Required for Gear Motor	Purchasing
7)ARDUINO	Microcontroller	Purchasing

DAY 13

We decided to begin with design and printing of the wheels.

Wheels were designed in Autodesk fusion360.

Steps in the design of the wheel is elaborated below.



(provision for grip also designed)

3D Model of tyre with Grip

<https://drive.google.com/file/d/1D0LLBfIJ-SkIXPh9YLvpe2PEVT-zLy7l/view?usp=sharing>

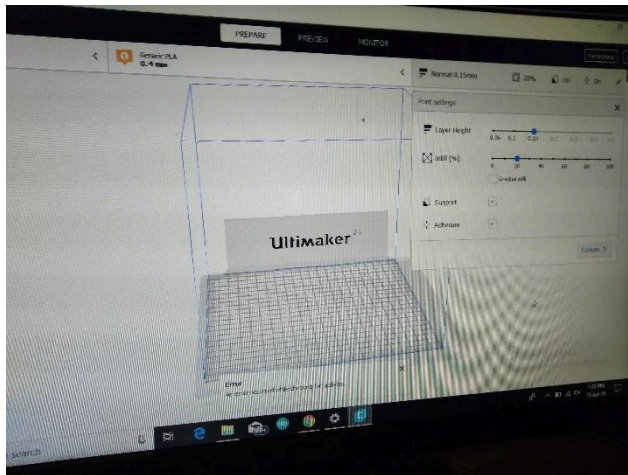
The final stl file from fusion has to be 3D Printed now.

So we imported the stl file to CURA. CURA is a powerful and user friendly 3D Printing software.

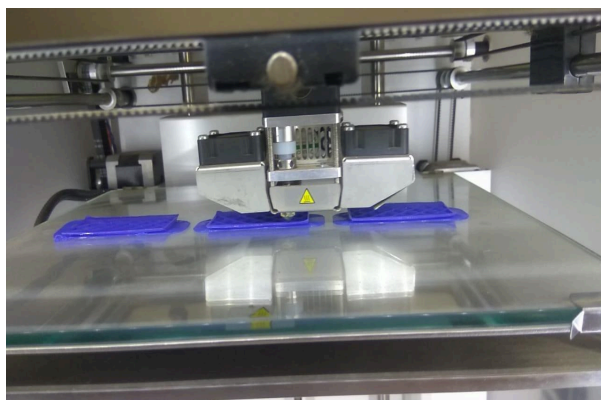
We decided to initially print a single wheel and test its quality. The file was converted to g code and copied to the memory card.

- The layer height , quality – normal , as default values used
- The nozzle used is 0.4 mm
- The bed size of printer 20 * 20 cm and height = 20 cm

Steps for converting stl file to g code is elaborated below



Now we inserted the memory card to the 3D printer and gave the print command .



It took hours before it got printed.

The first wheel was printed well and the material we chose for printing was PLA (Poly Lactic Acid)

This day we decided to print the rest of the wheels together so that it would save our time as we could allow the printer to print it overnight.

We assembled the 3 wheels together in CURA and saved the file as gcode.

We followed similar steps as mentioned above.

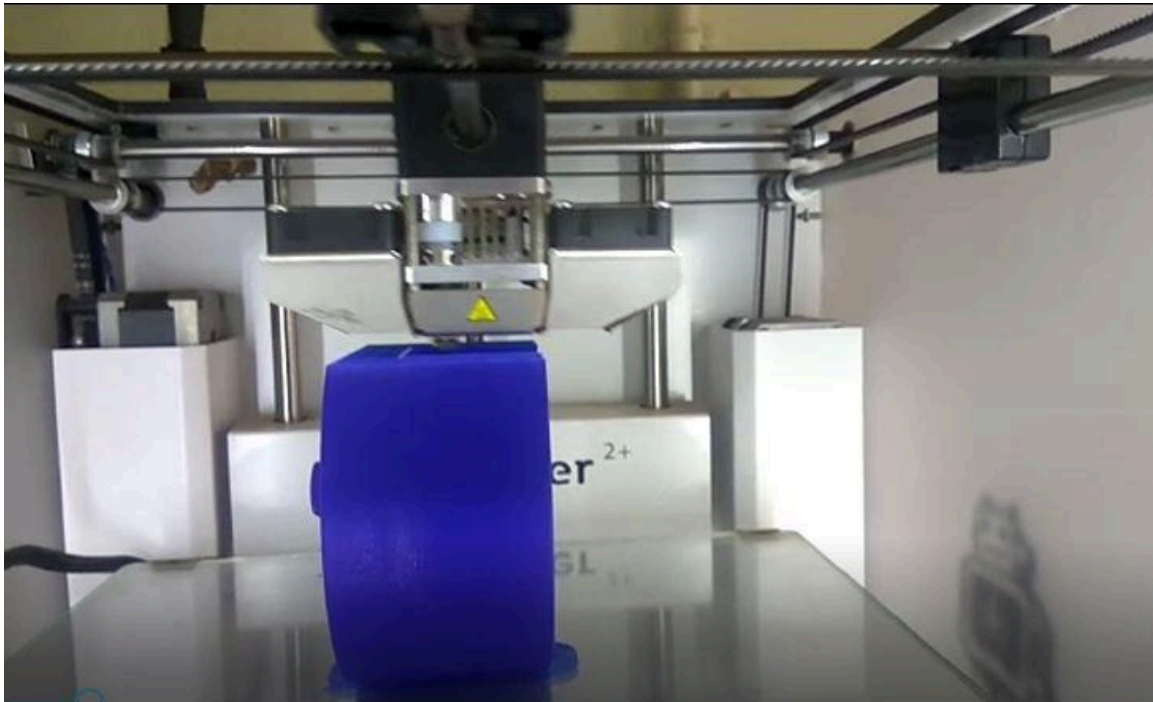
But our print wasn't successful and it turned out to be as shown below.



We were disappointed from the outcome and the loss of the material. We rechecked on why such a misshapen happened and concluded that the pointer of the printer would have brushed past one

wheel after the other during printing. The printer was trying to print the three wheels together because of which the wheels got misaligned and print went all wrong.

In order to avoid such a mishap again, we decided to print all the wheels separately.



VIDEO LINK :

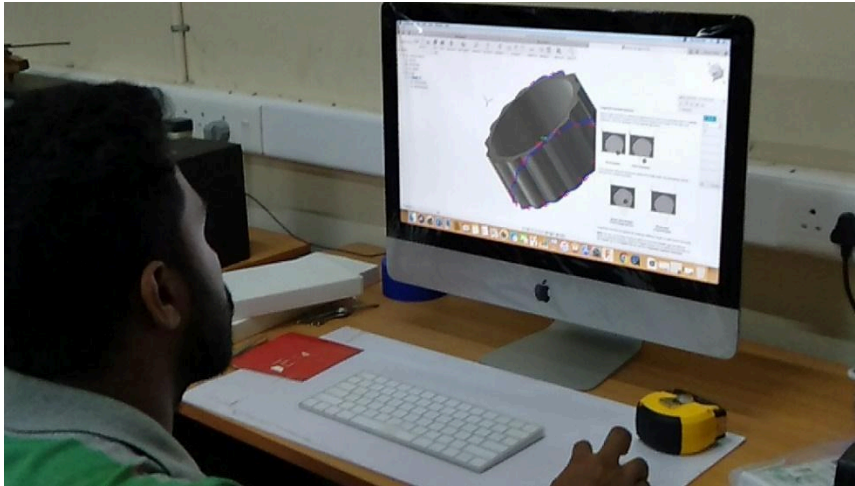
https://drive.google.com/file/d/1mgWiR3zozgsvkMw4oBRhbiFXGGpYf_PF/view?usp=sharing

DAY 15

Today we decided to make the wheel grip. Wheel grips could be readily purchased from market but we decided to make our own by using the FAB equipment and facilities. We thought of making a negative of tyre grip on wax mould and making the tyre grip we need by adding LIQUID RUBBER (Mold rubber) into the wax mould.

So the first step for the same was making the negative of the wheel grip on wax. The negative can be made by milling the wax on shopbot.

We first started with a design for the wheel grip.



The design was done in Autodesk fusion360. The steps in designing the wheel grip is elaborated below.

Problem 1 : we faced a small problem here regarding converting stl file to shopbot g code.

Vcarve installed in our system doesn't allow to import 3d files or any other

solution : Using fab modes : The values for carving in CNC for wax obtained from fab academy website (

http://fabacademy.org/2018/docs/FabAcademy-Tutorials/week7_computer_controlled_machining/cnc_tips.html).

The values are input as given

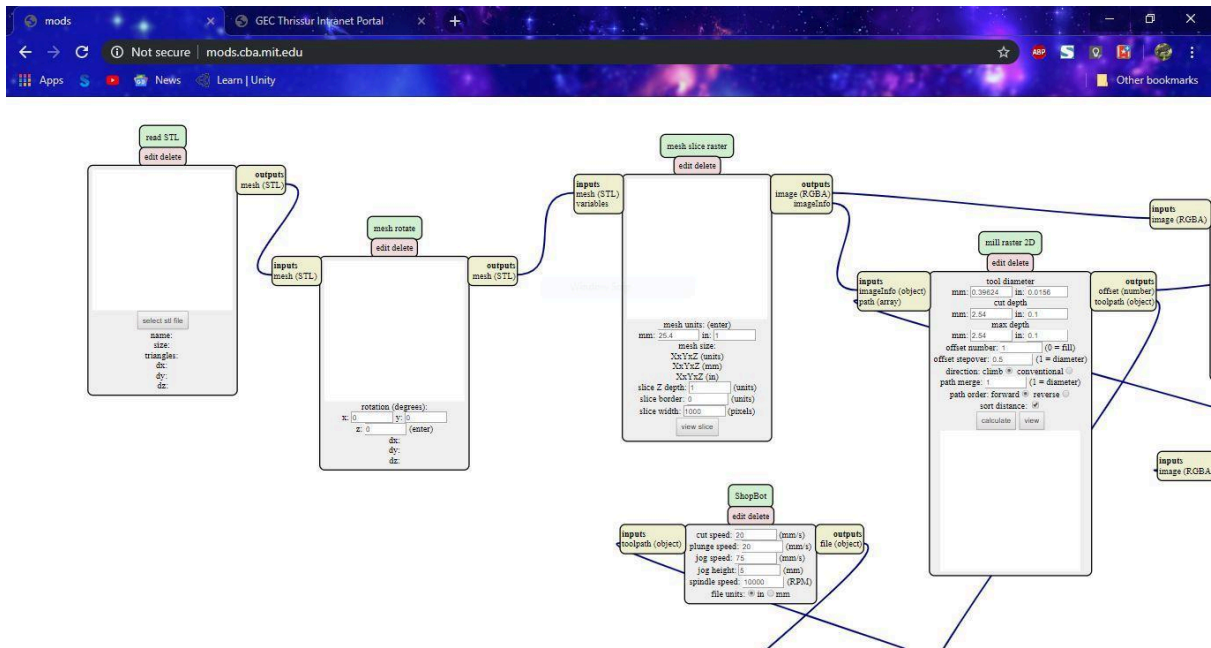
2 Flutes Up cut

- 10000rpm
- Feed rate 120 inch/min
- Plunge rate 30 inch/min
- Step down 65

Using fab mods : <http://mods.cba.mit.edu/>

Step 1 : right click >> click – open server program >> in (Shopbot section) click – mill 2D stl\

Step2: input stl file (stl file must be saved as top view as the circular part because milling will be XY to Z



Step 3 : select file>> (orient image as you want) >> set z depth >> give tool characteristics >> give cut speed, plunge speed , jog speed, spindle speed as the tested and recommended values for wax

Step4: click calculate

Step 5: file will be saved as Shopbot cnc g code (.sbp file)

- We used bit 1/8 inch diameter, two flute ball nose
- Given values suggested by fab academy website
- Since our bite was not long , we could only give z depth upto 2.5 cm.
- Wheel depth or thickness was 5 cm, so two grips of 2.5 cm each together consists of grip for 1 wheel
- The unit is defined in inch was convenience

DAY 16

After successfully converting the stl file to sbp, we decided to make the mould from wax.

Steps in using CNC miller for creating Wax Mould is elaborated below.

- 1) We chose a big enough piece of wax to be carved. (150 * 150 * 80 mm)
- 2) The wax was fixed onto the shopbot base using double sided tapes.
- 3) The origin was set at the corner of the wax.

Steps to set origin is elaborated below

- First we must launch the shopbot software application installed on system
- Then we will be able to find an interface where in we can see XYZ at one point

(it is the default xyz stored – Do not click – chance of hitting of ram at the machine bordered with a high force and hence the possibility of damage to machine – due the chance of storage of incorrect out of border values)

- Move the bit of the shopbot using the arrow key controls or mouse and take it to the desired location of the origin,
- After it reaches the desired point, we must set x and y to zero.
- Now we must set z to zero
- For this we use the help of the alligator plate. The alligator plate is fixed to the top surface of our feed wax as shown in the figure below. The alligator plate clip have to be connected to the bit

(image of alligator plate)

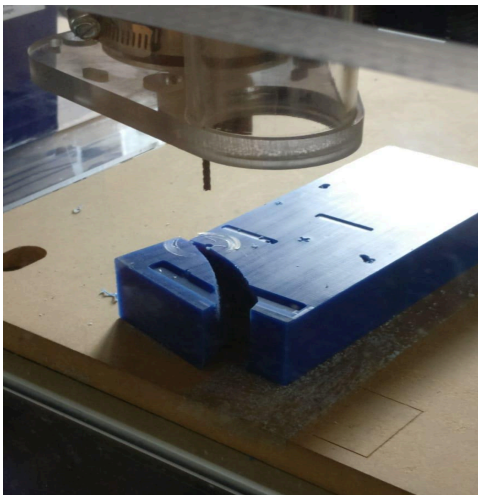
- Now we click on the Z option and the CNC miller will automatically set the zero for z axis.
- 4) After setting the origin we clicked on cut part and imported our file (.sbp file)
 - 5) The cutting was done using 1/8 bit.

ATTEMPT 1 :

Problem : The sbp file created was subjected to test cut on small piece. The Ram gone up and came down with a high thrust breaking wax into 2 pieces. **EMERGENCY switch pressed for shutdown.**

Inference : Unit defined in g code was in inch and in shopbot software as in mm.

Result : failed

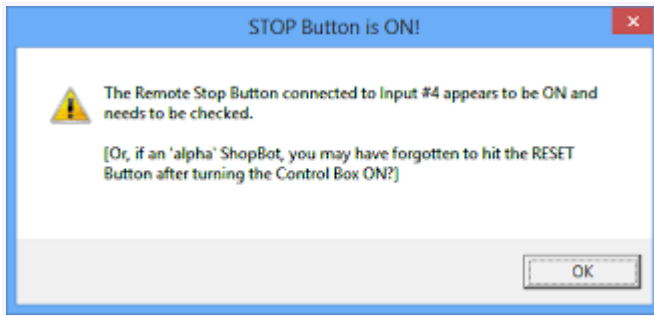


ATTEMPT 2 :

Problem : Error showing “ Parameter value below range for VS. Setting to lower limit . Checked the internet for solution cannot find one.

Inference : error related to file. Enter ok multiple times error gone. But the next error showed the following:

Problem : warning message



inference : some button is pressed on control box while trying to solve error. Reset, on buttons clicked, problem not solved .

ATTEMPT 3 :

We tried to reset the software (obtained from machine manual)

1. Click ' ? ' icon on software
2. Click reset and click ok
3. (Window pop up asking load tool settings) click ok
4. Then select PRS Alpha file from ' prs shopbot ' folder

Inference : after reset and loading tools settings the error is no more on starting.

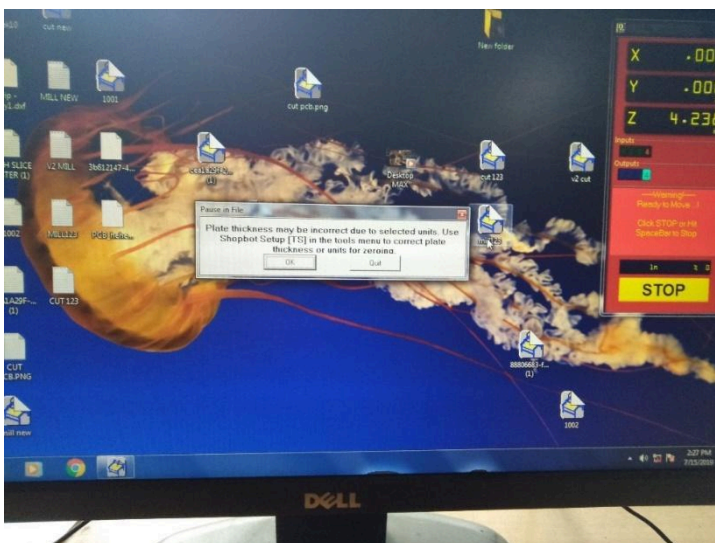
ATTEMPT 4 :

To match file unit and shopbot unit

Changed settings in shopbot mm to inch

Step : shopbot full >> tools menu >> shopbot settings >> (opening windows click next then upcoming window will have option to change unit

Problem : on setting Z an error showing “ plate thickness may be incorrect due to selected units



Inference : in inch the z cannot be set automatically due to software stored values issue.

DAY 17

ATTEMPT 5:

Trying to set z in mm and after setting change unit to inch.
Given input to cut the previously made .sbp file. **The Ram gone up and moved left border and hit the machine border with a high force. EMERGENCY switch pressed.**

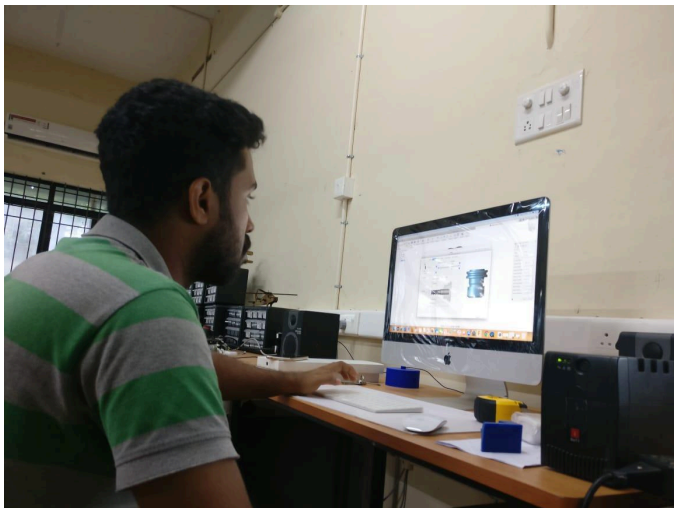
ATTEMPT 6:

We recognised that we couldn't create a proper gcode file with fab mods. We searched for alternate ways to create a gcode.

Finally we found one. Create gcode using fusion 360 cam.

<https://www.youtube.com/watch?v=whGKwsEY4Vo> (youtube link)

inference : created sbp file using the youtube video on fusion 360 cam



ATTEMPT 7:

We just set a random z in air. Input cut file gcode. Successfully we got tool path on air.

ATTEMPT 8:

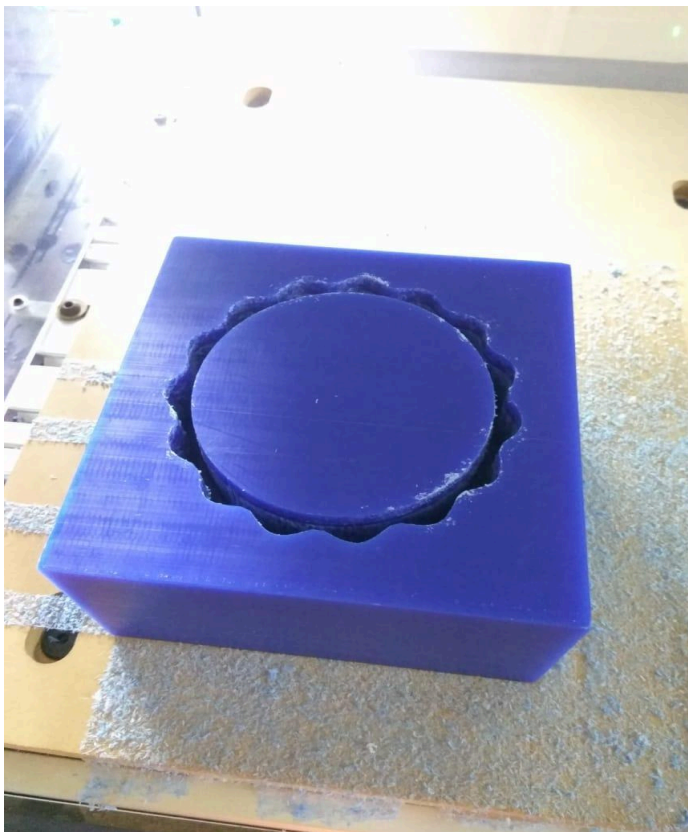
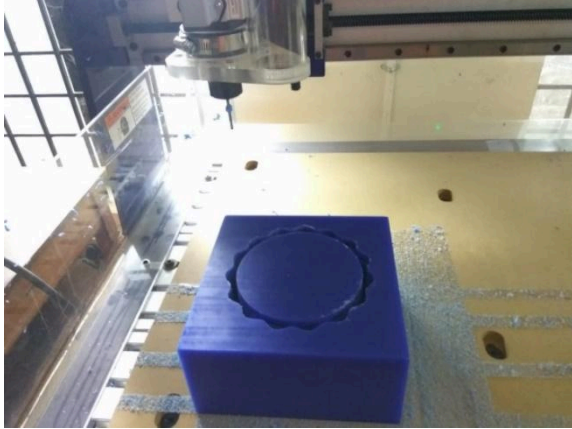
Change unit to mm. set Z automatically using alligator plate. After change unit to inch from mm.
input gcode file to cut.

RESULT : successfully completed operation.

VIDEO URL

1. https://drive.google.com/file/d/1ADHs0n-CmKWZPa4J7em0FkRNR_W4zCYo/view?usp=sharing

2. https://drive.google.com/file/d/1IWqP_wfBwAvXI3G06by5bXSxGHkXoRpL/view?usp=sharing



DAY 18

Now since we milled the desired shape of tyre grip in wax, the next step was to add liquid rubber inside it so that it casts the desired shape. This rubber would be flexible and strong enough to be used as a wheel grip.

In order to do this we prepared the liquid rubber mix by carefully mixing 1:1 ratio of both A and B in a small plastic glass followed by their mixing and continued stirring. We added the same into the tyre grip negative that was created in the wax.

We used a blower to blow over it so as to remove any trapped air present inside. The mixture was allowed to solidify overnight.



Video Link :

https://drive.google.com/file/d/1aRmJZw3AVvbKSRMpfhmA4Ba9Kljr5_hC/view?usp=sharing

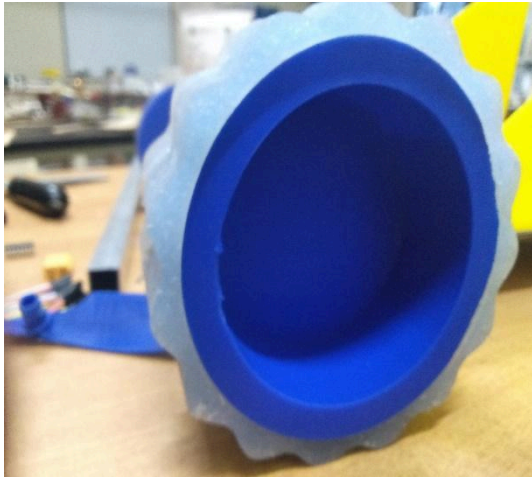
DAY 19

it was well solidified and we used a plucker to pull the rubber grip out from the mould.

We decided to make more grips for the remaining tyres but unfortunately our material ran out and there were no longer any liquid rubber (for mold) left with us.

So we decided to try it with Mold Max silicone rubber.

But the output of this was too brittle to be used for tyre grip. It was breaking and coming out very easily



USING MOLD MAX SILICONE RUBBER – FLEXIBLE, BRITTLE

INFERENCE : Brittleness may be due to improper composition or maybe nature like that.

DAY 20

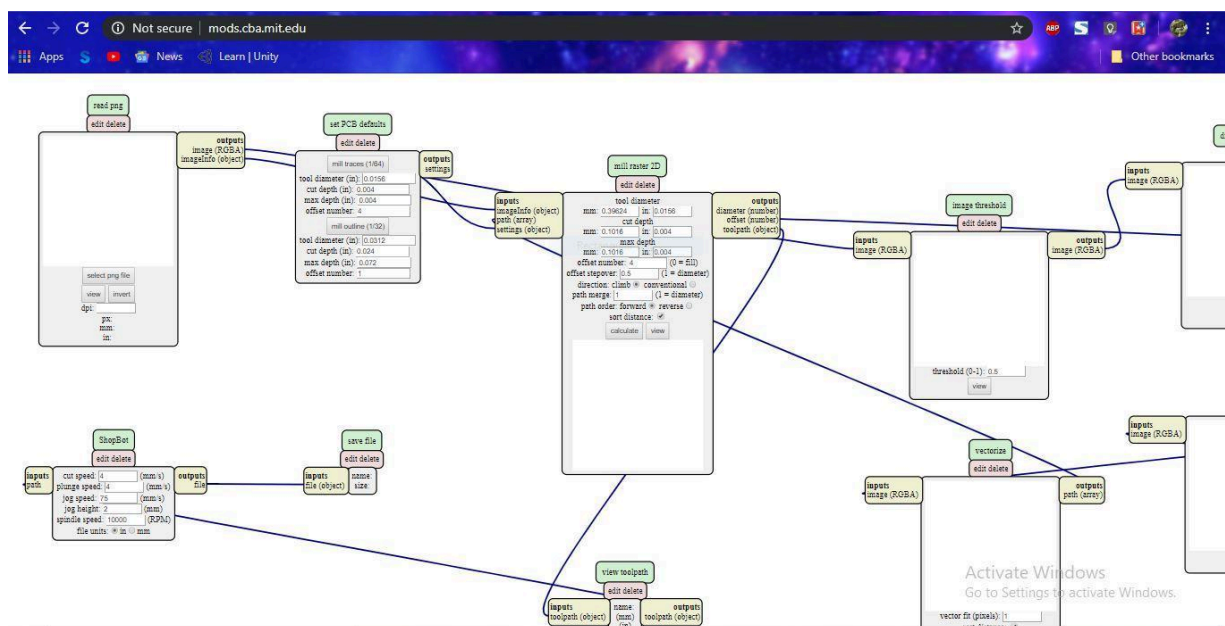
Now we had to focus our attention back to drone.

As we have already purchased and tested the electronic components and modules, next thing left to do was assembling them to a single unit so that it becomes functional.

We decided to make a power distribution system for the drone. The power distribution system was to be printed in a PCB (Printed Circuit Board).

The PCB Design was carried out in an open source online PCB Designing software called easyeda.

1. The PCB design was saved as a PNG file . The total design was saved as two files, one for the milling (using 1/64 bit) and the other for cutting (using 1/32 bit).The files were saved as black on white where black denotes cutting.
2. The png is opened in fab mods website.
3. Fab mods website (<http://mods.cba.mit.edu/>)>> SHOPBOT>> mill 2d PNG



4. First mill pcb using 1/64 inch bit - just select mill traces – no need to change the default values
5. Offset number have to be decided – how much width to be removed from copper track.
6. Stepmover we give 0.9 to speed up the task
7. Click calculate – file will be saved
8. Next the cut file is inserted
9. Select mill outline using 1/32 inch bit
10. Default values are used
11. Click calculate – gcode file for cutting will be saved

DAY 21

PCB MILLING:

ATTEMPT 1:

Problem :

We set Z axis zero as in previous milling in wax. But unfortunately the z didn't set correctly. The bit hit the plate like Z was under the plate. The 1/64 inch bit broken

Inference : reason not found. Again set z, to check slowly bit is moved down – just near the plate the z value is not near zero indicates the z is not correct.

ATTEMPT 2:

We tried to set z manually by moving down ram slowly. But unfortunately bit hit the surface of plate causing bit breakage.

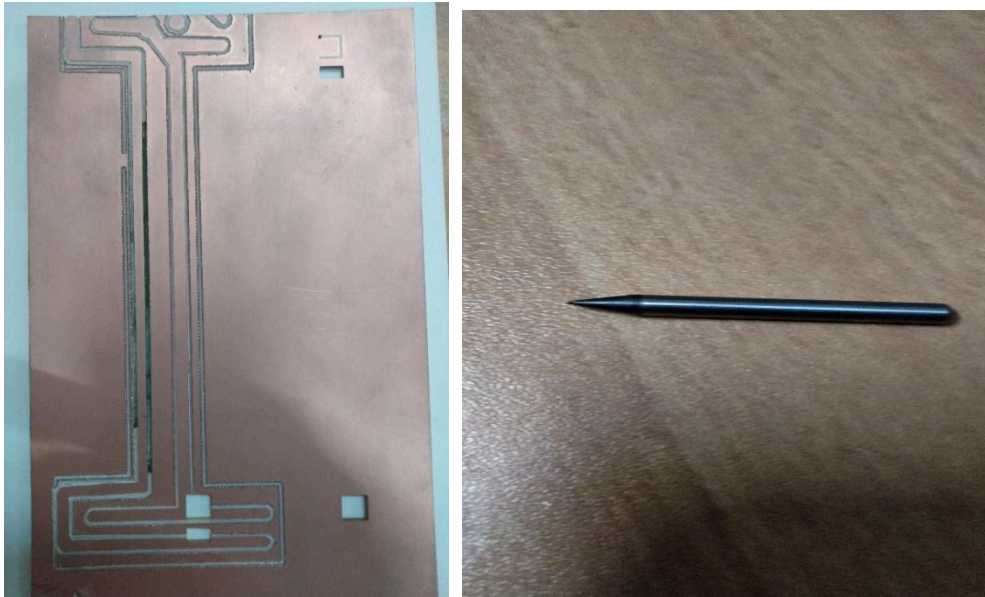
Inference : since shopbot is designed to do rough , hard work, it is not recommended to use pcb milling like soft work with this king of tiny costly 1/64 inch bit

ATTEMPT 3:

Took new bit and carefully, very slowly set z axis successfully.

Problem: the process was very good at the beginning but at around 67% the double sided tape ripped off from shopbot surface causing PCB plate keep moving with bit. Again bit broken

Inference : double sided tape must be stucked horizontal and vertical.



ATTEMPT 4 :

Since the bit is very costly. We tried to mill using the broken bit by modifying the already created circuit design by increasing the space between the tracks and some other modifications

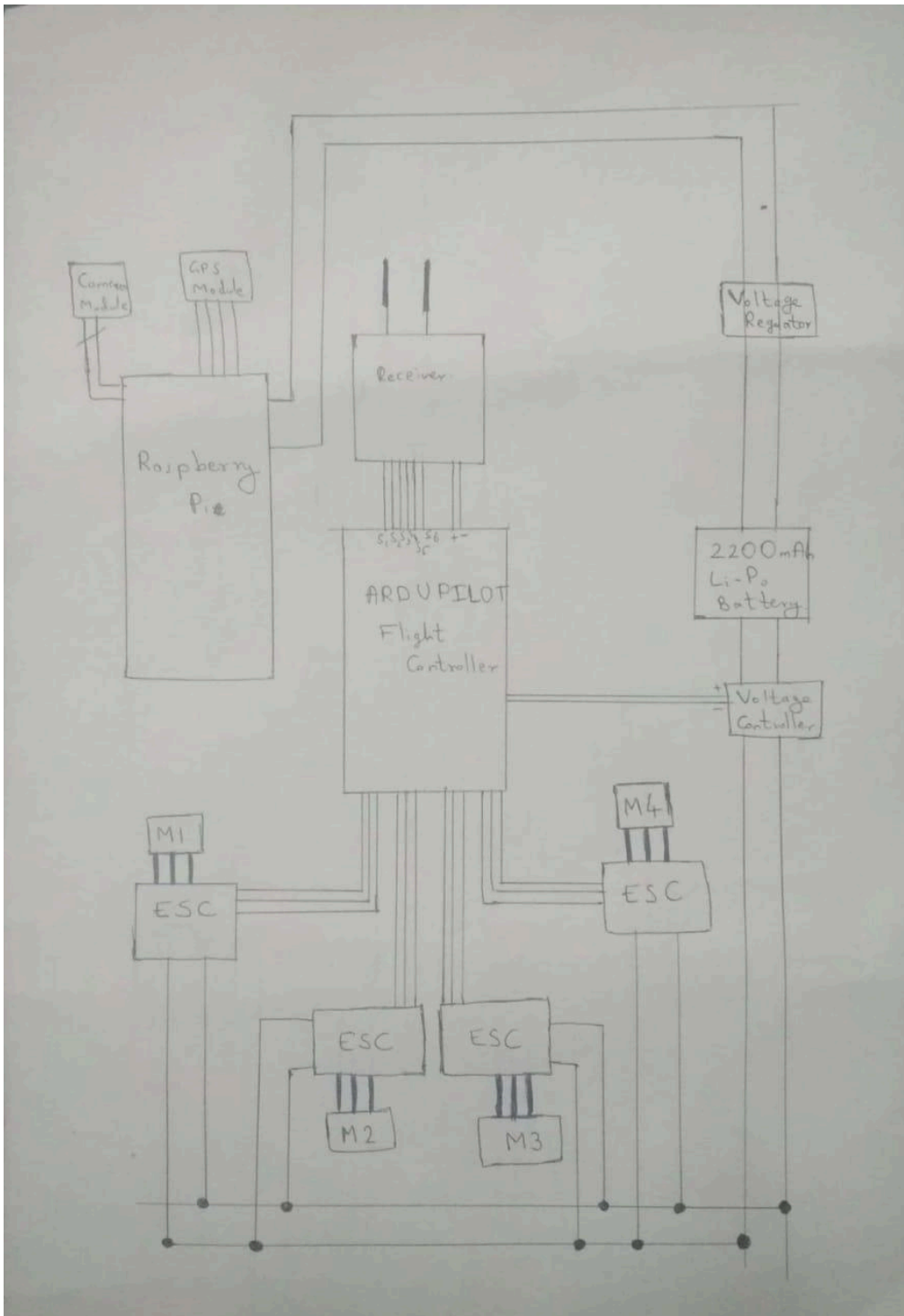
Result: successfully milled the PCB with broken bit.

Since track will be on high amp current, we created a molten solder path above the copper track.

DAY 22

After making the grip, we decided to focus our attention back to the drone.

We assembled all the electronic components in the drone as per the circuit given below.



We used striptags to tighten the components to the drone frame.

Now that the entire assembly of the drone is complete, the next step is to design the propellers of the drone.

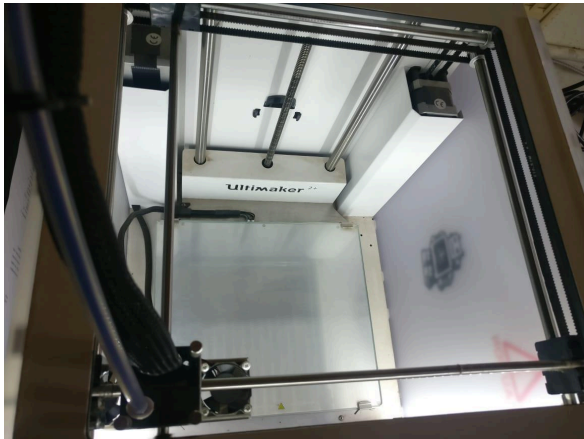
We decided to use Autodesk fusion360 to design the propeller and then to use 3D Printer to print it. First a weight analysis had to be carried out in order to analyse the required length of the wings.

We decided to use a **5 cm** wings as shown below.

The design was done in Autodesk fusion360 and the file is attached below

We used CURA again to convert the stl file of propeller into gcode.

We decided to align them parallel to the bottom surface of the 3D printer



We gave the propeller to print overnight.

We decided to give two propellers at a time.

DAY 23

The next day our print was complete. But due to support, it was very difficult to remove the unnecessary additions from the product.

Video link

https://drive.google.com/file/d/1B6t4L2ObWwWR34CSGWxAO_FYqXBi9vLU/view?usp=sharing

We used round files and triangular files present in FABLab to smoothen the wings and widen the holes.

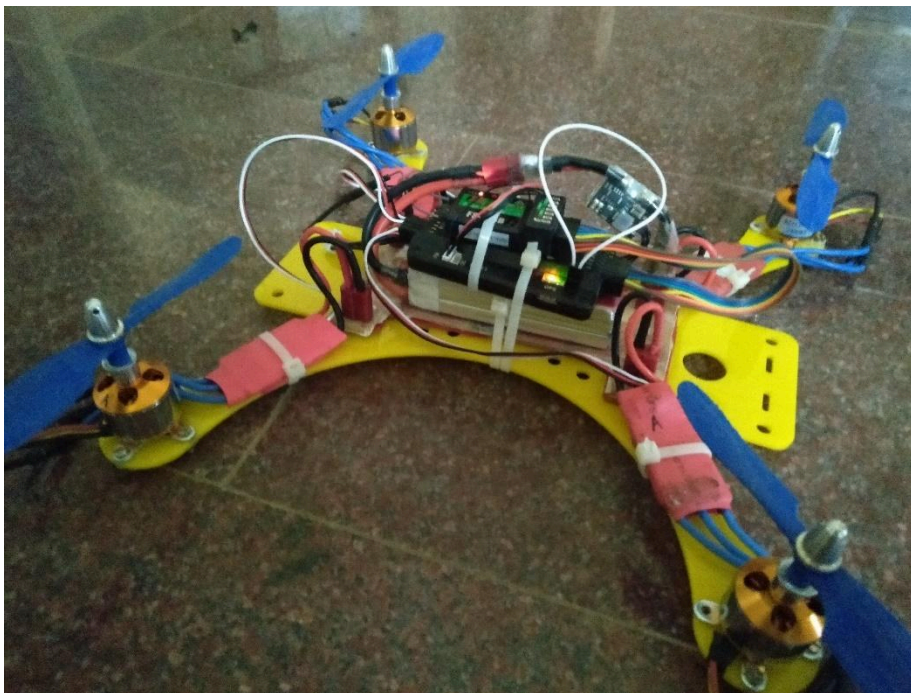


As the material used was old PLA (Poly Lactic Acid), it was a weak propeller.

We decided to give a test run to the BLDC motor using the propeller we just made. We had an extra BLDC motor and ESC. So we connected the BLDC and ESC with the power and Flight Controller and we attached the propellers to the motor.

Video link : <https://drive.google.com/file/d/15cCjEyPglYFcNkij95zGO7FgGE1XryZV/view?usp=sharing>

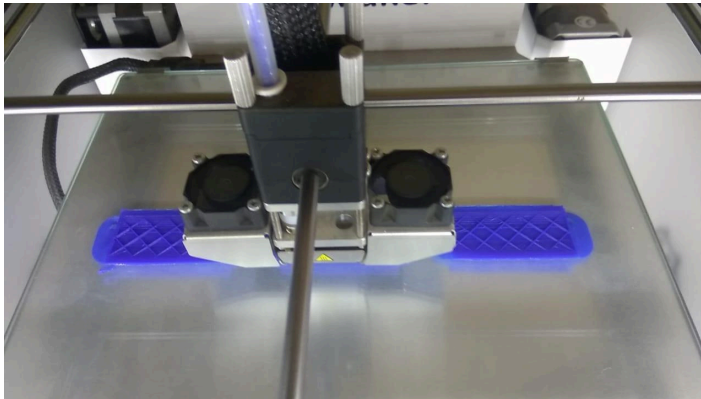
The propeller rotated at a very high rpm and due to the absence of any tighters the propeller instantly came out of the motor shaft due to the increasing centripetal force. It broke into pieces.



DAY 24

We redesigned the propeller by modifying it so that we could use tightening screws to the propeller so that it will remain intact with the motor.

The redesigned propeller (stl file and gcode) is given below.



(modified propeller with increased length and fine mode with minimum layer length)

We gave the new propeller design for 3D printing.

In order for testing of drone flight, we purchased some new propellers from the market.

DAY 25

Today we got our new propellers 3D printed.

We decided to test run the drone using the purchased propellers first. We were not at all succeeding in flying the drone and we had numerous failed attempts.

The PLA used is blue in colour

As far as our experience and observation in printing the material is very poor in quality, printing and strength.

VIDEO URL

https://drive.google.com/file/d/1qISOhaj2IxUdKQILaCDB_I3-TKjrz_j7/view?usp=sharing

FAILED ATTEMPT 1

We made proper connections, powered the drone and tried to turn ON the motors with the control.

But the drone didn't give any response. (Red color not locking problem)

There is a red color which must stop blinking before the drone can fly

The calibration of gyrometer , accelerometer must be proper. Otherwise it won't give a sustained flight

DAY 26

FAILED ATTEMPT 2

Now that the drone started responding to signals sent from the remote, we decided to test run the drone for the first time.

As we started the drone and increased the throttle, the motors began to rotate but the drone turned upside down and didn't take off.

We noticed that two of the propellers were rotating in the wrong direction because of which the propeller wasn't getting the lift.

So we decided to change the connecting wires from ESC to the Motor and trying again.

FAILED ATTEMPT 2

After trying by changing the connections, the drone again flipped upside down and slammed sideways.

We thought there was some error during arming of the drone so we decided to reset the entire settings and arm again by properly calibrating it

Successful ATTEMPT 1

Now, after calibrating and arming the drone properly, we decided to test the drone once again. The drone was taken outside and we started it.

We gave the throttle and drone slowly gathered the lift and flew to a small height.

https://drive.google.com/file/d/1gTdgva0a-TvIOOwLOPeiDCbpwSHf_0x5/view?usp=sharing

We tried again and the drone lifted to a great height.

We checked landing settings

We checked the maximum range of the drone too.

Maximum range checking 1:

<https://drive.google.com/file/d/1sc7hHI-QwWX9xqiCnLWk8WBbQQc3gJaO/view?usp=sharing>

DAY 27

After the successful making of drone, robot was the next one left.

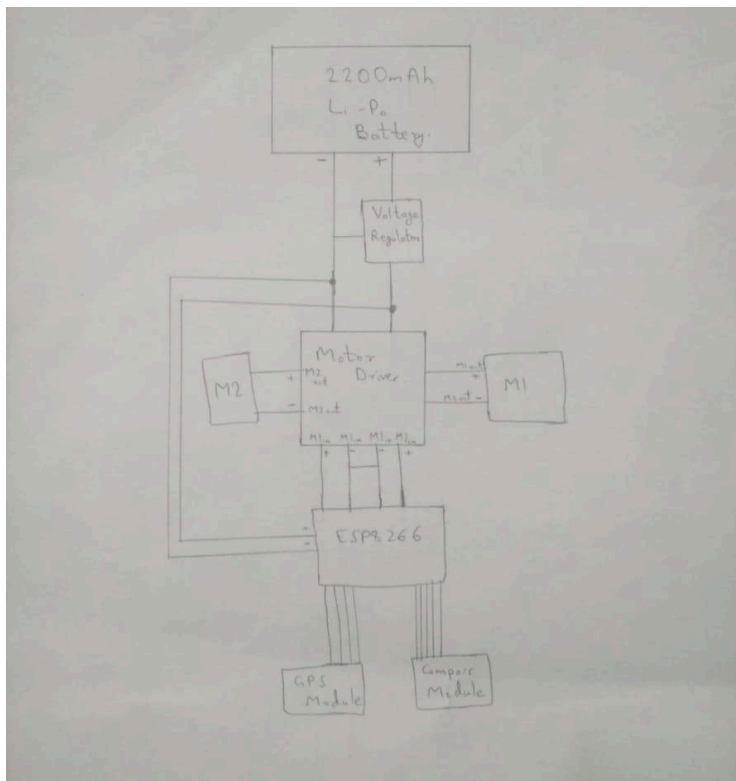
Design was already made and it was cut out using a laser cutter as mentioned.

We used acrylic as the body material.

Now we had to connect the 4 wheels already made and we had to drive it using a gear motor.

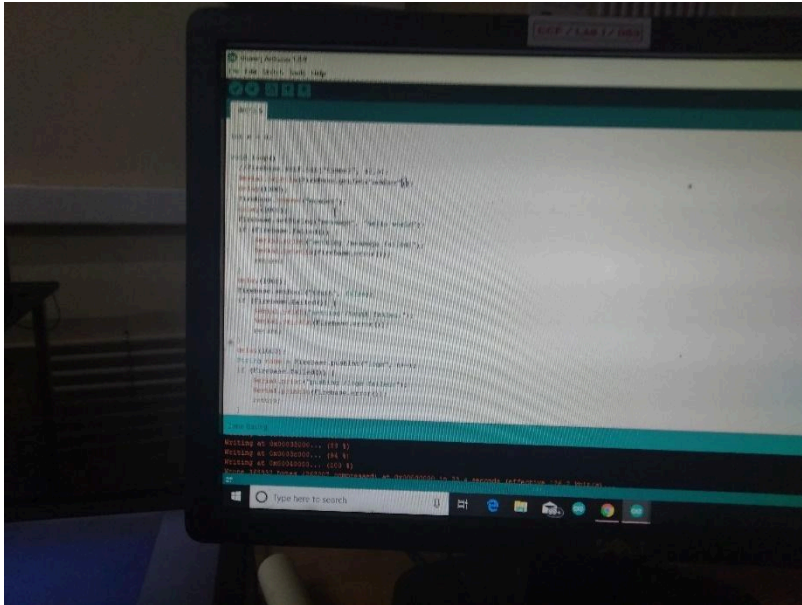
The three frames (left side, right side and base) were cut out and were attached to one another using flex quick.

The connections for the bot were made as given in the circuit below.



DAY 28

- 1.App is developed using MIT app inventor linked to firebase server. The app has the option for forward , backward and steering controls and stop.
2. gear motors are attached to the rear wheels which is connected to an Arduino board and NODE MCU (ESP module) which have an inbuilt wifi
3. the program linking board to controller via wifi is completed



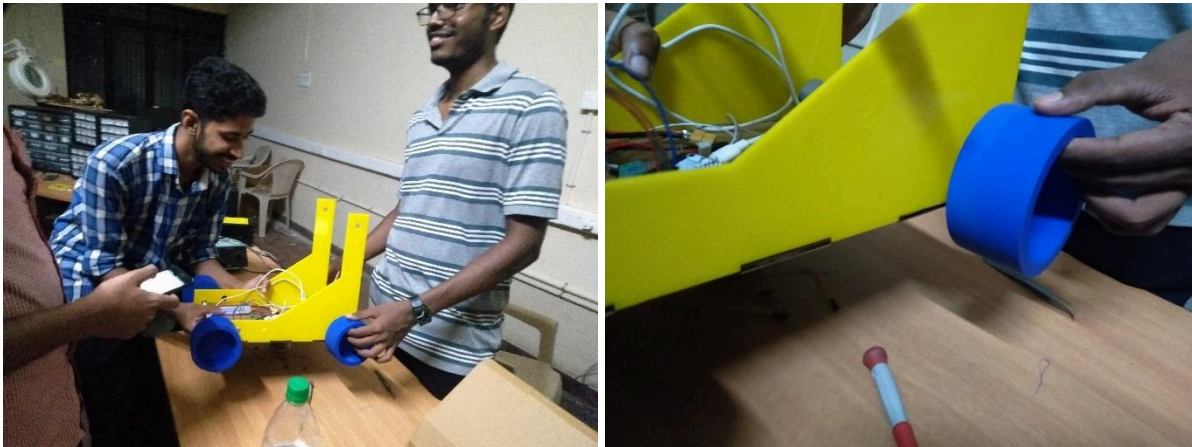
Attempt 1:

The program is written but it is not uploading to ESP.

Inference : the led light is not blinking which indicates the module is damaged

ATTEMPT 2 :

New esp is used program uploaded successfully



VIDEO URL :

<https://drive.google.com/file/d/1tT7qgAjYXenRYHsd04kM5UhPwwmpgZb/view?usp=sharing>

further modification on conveyor belt and waste basket and directing rotor to be added

Day 29

We need to identify wastes from beach or background

We have to implement machine learning and computer programming

Training is bit difficult and longer it takes.

So already available data sets is to be used and program a recursive learning through the data sets and data points available through implementation. So accuracy of detection can be increased further

(several classifier data sets are available from github which are free and proprietary)

We obtained one free classifier from github . now we are testing and doing a supervised learning on that set.

As far accuracy obtained is about 45- 55 % (tested by us)

Following object detection codes are studied

1. https://github.com/tensorflow/models/tree/master/research/object_detection
2. <https://github.com/EdjeElectronics/TensorFlow-Object-Detection-API-Tutorial-Train-Multiple-Objects-Windows-10>

(object detection classifier - training using tensor flow)

Day 30

Rollers are laser cut (square rollers)

Conveyer belt is made of tyre tubes

Using box design , applying kerf waste collection basket behind robot assigned and cut

Current status

1. DRONE for mapping is made
2. Camera module with RASPBERRY PI is made
3. Camera module to be connected to drone
4. Ground cleaning robot is made
5. The conveyer belt and waste collection box have to be attached to bot
6. Machine learning , classifier data set have to be connected to pi cam module
7. A gps module has to be connected which has to be linked to bot control

Day 31

A meeting of team members have been called. the following were the key points of discussion.

1. discussion on alternate solution for waste collection instead of conveyer belt(conveyer belt fabrication found difficult)
2. mathematical calculation on camera- area of vision and selection of region of interest(ROI)
3. training of data sets for waste recognition have been assigned to a team member who is an expert in machine learning
4. designing aspects and further analysis on cleaning robot is conducted

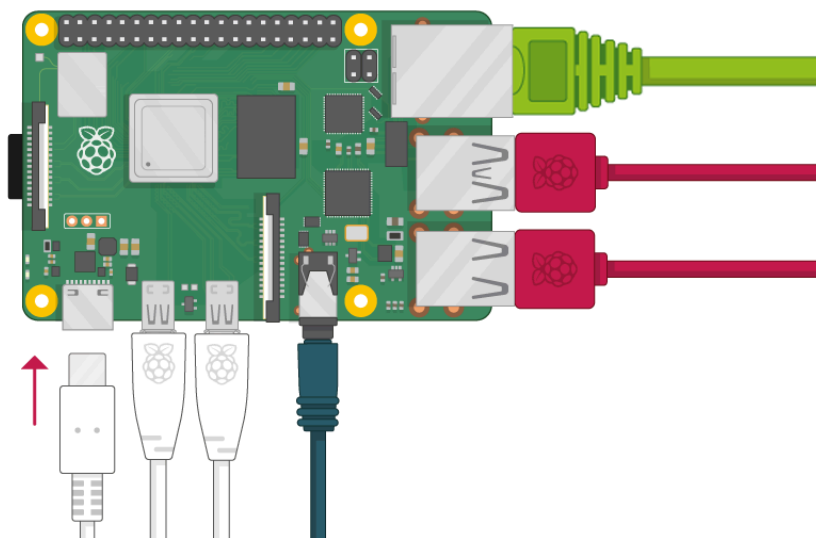
initial setup of Raspberry pi is conducted :

1. INSTALLING RASBIAN ON SD CARD (via noobs)

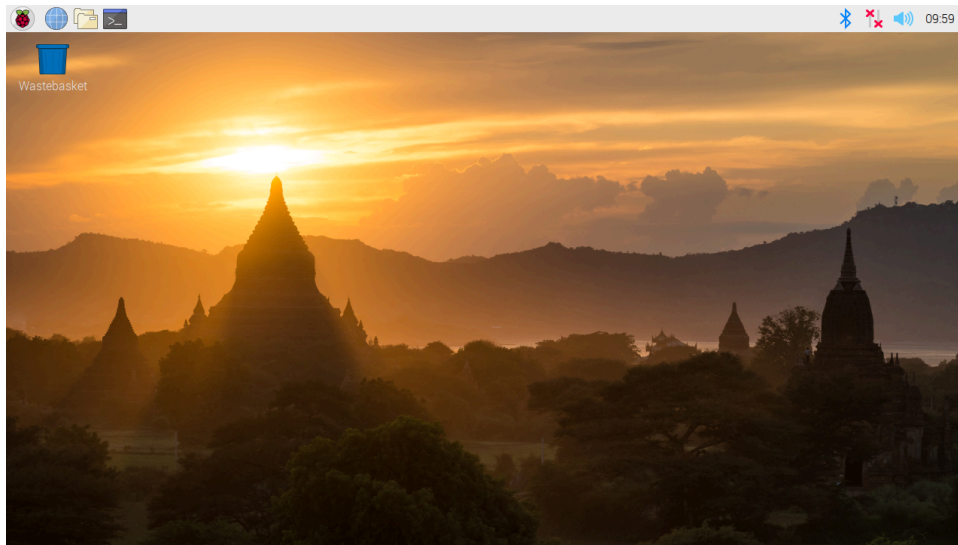
- a. Visit the **Raspberry Pi downloads page**
(<https://www.raspberrypi.org/downloads/>)
- b. click box linking to the NOOBS files
- c. download the zip archive of the files and extract the files.
- d. Select all the files in the NOOBS folder and copy to SD card. (format sd card before copying)

2. CONNECTION

- a. insert an SD card with Raspbian installed (via NOOBS)
- b. connect usb mouse, keyboards to usb ports in raspberry pi
- c. connect a display with hdmi pin to hdmi port of raspberry pi
- d. connect audio cables, lan cables to respective ports
- e. power board via micro-usb cable



f. after setup. display output

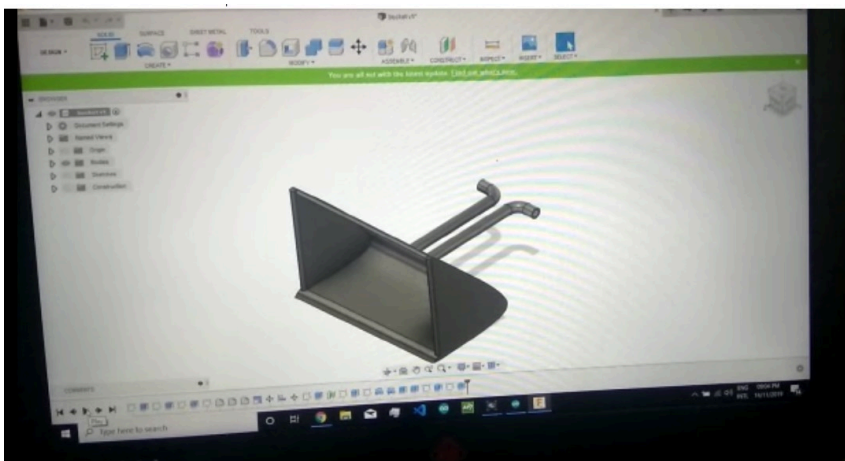


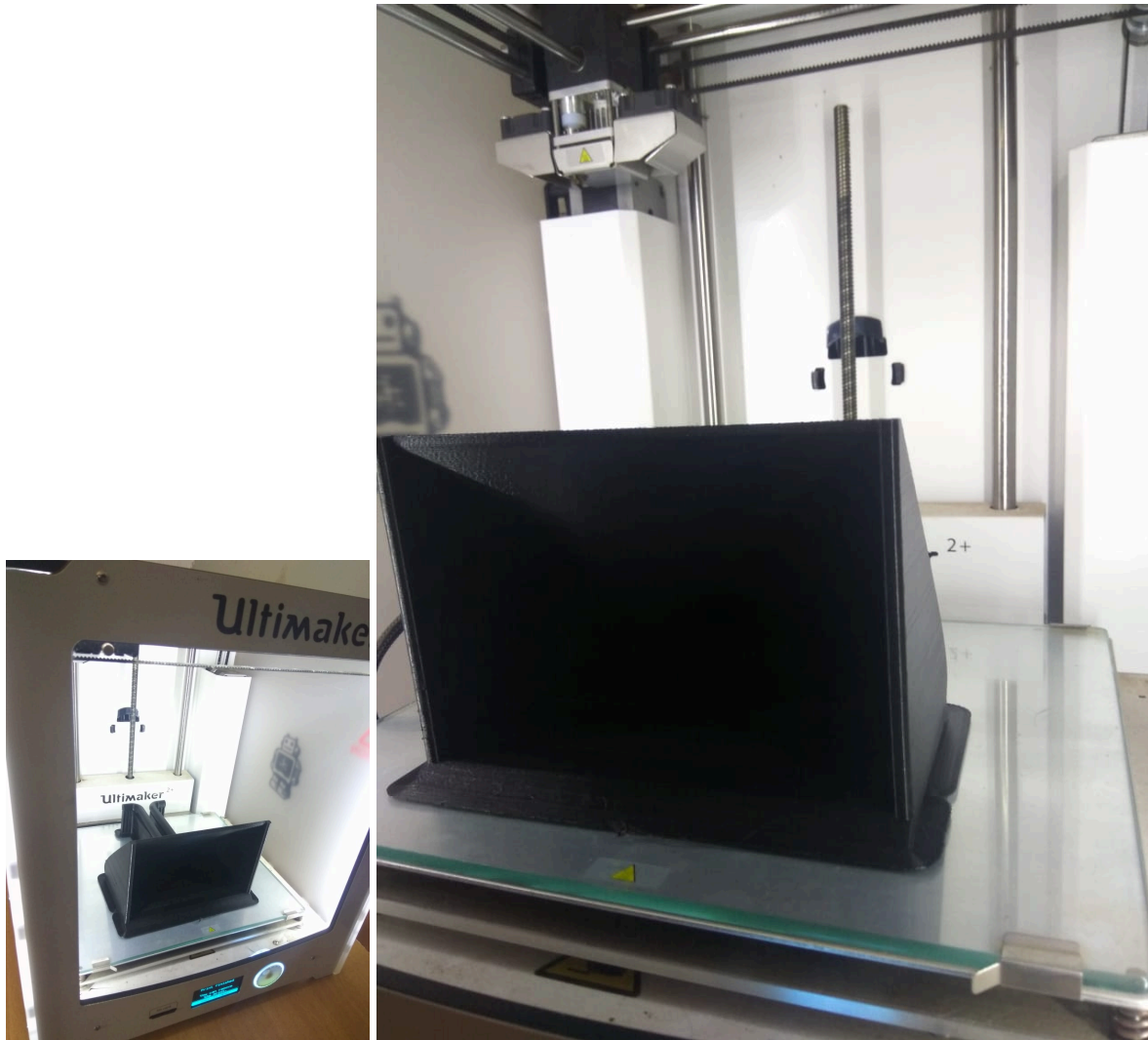
Day 33

decided to use a collect and drop mechanism powered by servo motors. The servo motors will rotate which facilitates the drop of wastes to waste bin located at back.

the collection mechanism is designed similar to the JCB. the model is loaded in cura and converted to gcode for 3d printing

- there is an extension provided to connect the collection system to servo motors
- the servo motor facilitates the rotation





Day 34

The next work was to roughen the tyres which are 3D printed. there are 4 tyres total.

need of roughing of tyres :

The tyre will be in contact with fine sand particles in beach. The coefficient of friction must be an optimal value since the decrease in value causes slip. Hence, forward motion and controlling will be difficult. unwanted energy loss will have an adverse effect on working time of robot.

Machine used : sand blaster

purpose : to remove the glassy like smooth surface by blasting sand with the help of high pressure to the surface

step:

1. switch on transformer, thus enabling power input to compressor and sand blasting machine
2. connect vacuum cleaner to the port
3. pull the pressure build lever in compressor to start compression of air in compressor
4. ensure zero output at delivery valve of compressor
5. put the wheels to sand blasting machine chamber. lock the chamber
6. open delivery valve after reaching air compressor pressure about 100 psi. delivery can be provided upto a maximum of 80 psi. recommended value is 50.(values may change with material)
7. press the pump value using leg to blast the surface
8. on finish blasting works, first off the compressor and release the air pressure using pump value or using safety valve

note : (safety valve if pressure is above 80 psi. careful with safety valve, high pressure can cause eye or ear damage)



video of working :

Day 35

PROGRAMMING END

for the working of robot fusion of hardwares to softwares is necessary.

The following softwares and codes are developed.

1. python coding to be implemented in Raspberry pi

- a. code for motor control
- b. code for waste detection

2. Embedded Java language and app interface for manual control

(later to be uploaded to cloud for automatic control by creating a channel to app thus the controlling will be autonomous)

1.a Python code for motor control

A python code has been developed by coding expert in our group. The basic idea of steering ground robot is by controlling the speed of tyres or motors in respective sides.

case1 : Turn left

- Tyres at left side - rotate in reverse direction or decelerate comparing to motors in right side.
- Tyres at right side : rotate forward with more speed

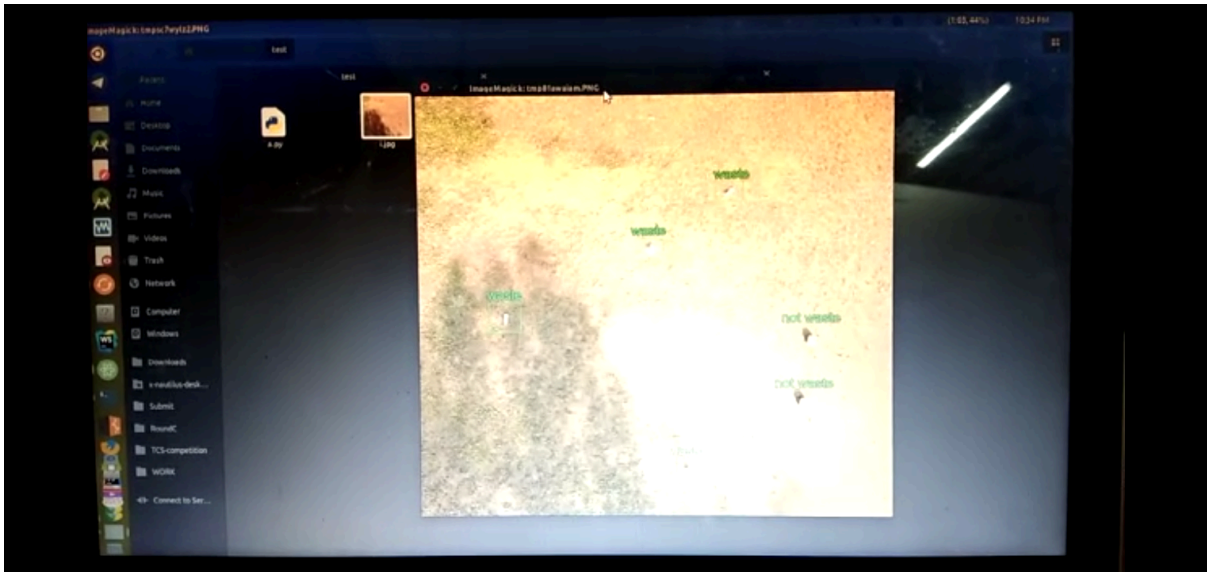
case2 : Turn right

- Tyres at right side in reverse direction or decelerate comparing to motors in left side

```
1 from socket import *
2
3
4 HOST = "ip-address"
5 PORT = 9005
6
7 s = socket(AF_INET, SOCK_STREAM)
8 print("1")
9 s.bind((HOST, PORT))
10 print("2")
11 s.listen(1)
12 conn, addr = s.accept()
13 print(addr)
14 print "Connected by: ", addr
15 while True:
16     data = conn.recv(1024)
17
18     data.rstrip()
19
20     if data == "u":
21         GPIO.output(5, True)
22         GPIO.output(6, False)
23         GPIO.output(13, True)
24         GPIO.output(19, False)
25     elif data == 'l':
26         GPIO.output(5, True)
27         GPIO.output(6, False)
28         GPIO.output(13, False)
29         GPIO.output(19, True)
30     elif data == 'r':
31         GPIO.output(5, False)
32         GPIO.output(6, True)
33         GPIO.output(13, False)
34         GPIO.output(19, True)
35     elif data == 'd':
36         GPIO.output(5, False)
37         GPIO.output(6, True)
38         GPIO.output(13, False)
39         GPIO.output(19, True)
40     else :
41         GPIO.output(5, False)
42         GPIO.output(6, False)
43         GPIO.output(13, False)
44         GPIO.output(19, False)
45
46     print "Received: ", repr(data)
```

1.b Python code for waste detection

- using machine Learning (ML) a set of datasets on beach and wastes has been trained on an existing object detection classifier.
- The retrained classifier have more accuracy in detecting wastes in beach.
- An algorithm is implemented on classifier which is uploaded to raspberry Pi which which retrieves the camera feed .
- the algorithm is applied on camera feed and wastes are detected

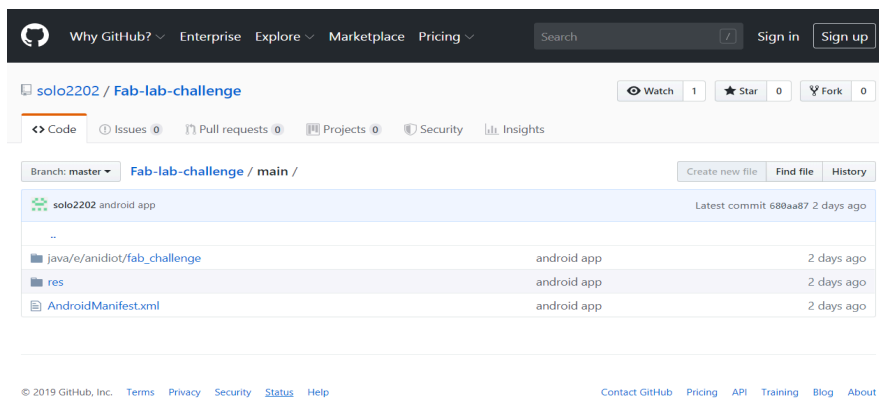


VIDEO URL :

<https://drive.google.com/file/d/1MwwJbFJoIrMYvfPYy8GOWUmFmECJmJqv/view?usp=sharing>

2. Embedded app for control of ground robot

An app is built in ANDROID STUDIO for control interface. App is coded to connect the Ground robot via a specified channel.



Github repository has been formed

1. Python code Github :
<https://github.com/solo2202/Fab-lab-challenge/tree/master/python-code>
2. App Code Github
[:https://github.com/solo2202/Fab-lab-challenge/tree/master/main](https://github.com/solo2202/Fab-lab-challenge/tree/master/main)

Day 36

Assembly of cleaning Robot is carried out

1. The outer body is rigidly connected
2. four motors has been fixed to body in respective position of wheels
3. the tyres has been connected to motors

electronics components connection of robot carried out :

1. four motors are connected to two motor driver boards. one motor driver for two motors
2. arduino mega connected to esp8266 is used to control motors
3. two motors connected to collector at front. they oscillate between two fixed points which is predefined in terms of time .
4. the code is written so the collector motors oscillate in a loop manner
5. The loop can be controlled.

problem : the raspberry pi model 3 shows an error in output after a successful trial attempt. The error couldn't be solved. the problem lies with the board.

solution : the raspberry has been replaced by arduino mega paired with a ESP8266



beautification works :

aesthetics are important to an extent. decided to label robot. the name suggested is fab rob. sticker is designed to imprint on robot

machine used : vinyl cutter

(roland GScam20 vinyl cutter)

steps followed:

(machine setup) + (software)

1. power on vinyl cutter
2. place sheet edges under the movable wheels.
3. the wheels must be moved to the middle of white marking
4. on machine display select type of paper(“roll,”edge”, “piece”)
5. open roland cut studio
6. select “cutting preview”>>select “machine settings”>> size - “get from machine”
7. draw design
8. select “cutting” option at the top

(sticking method)

1. using the white roll tape, stick on the vinyl sticker surface

2. press a force uniformly all over
3. remove the tape by pulling
4. the letters or design we need will be on white tape
5. stick tape on the location we need to place the sticker
6. slowly remove white tape
7. the sticker will be on the bot surface



video url :

<https://drive.google.com/file/d/11X3RW39YaUtuAsxaEU4MYGvq8My3GpLj/view?usp=sharing>

foldable circuit using vinyl cutter - (copper sheet roll)

replace paper roll using copper sheet roll

- The drone must have an indication light on surface of body
- that must be void of wires to ensure the safety of working of rotors

that is facilitated by using foldable circuit using copper sheet and surface mount leds which is light weight, small and works on low voltage and current

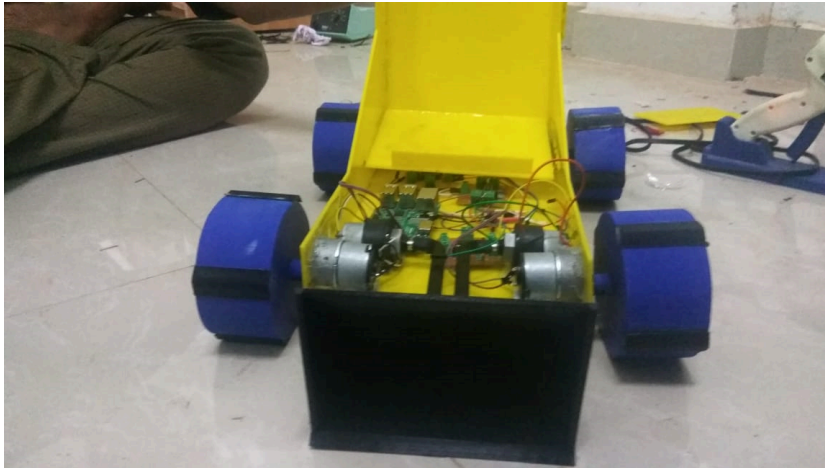


video url :

<https://drive.google.com/file/d/1YReWWvHCtZMFphx1VLVxoA71C11iPbxm/view?usp=sharing>

CONCLUSION

STATUS : robot is assembled and connected. working successfully



Issues still facing :

- communication problems:

communication between drone and robot faces issues.

two types of communication established and tested

- 1) Local Host network - (data transfer and communication via the same channel connected to the same network locally hosted server or sub-system)
- 2) cloud based - (communication via a cloud or distant server connected indirectly via a network protocol basically internet)

cloud based communication lags by a 2-3 seconds which cannot be tolerated.

raspberry pi have to be reconsidered for faster cloud communication

locally hosted channel communication is not practical

STATUS : Drone - assembled and working not as expected



ISSUES STILL FACING

1. material aspect : initial thrust for drone is important, for that it draws more current. if the payload is high and capacity limit crosses for electronics components chance of burning out is high.

- a. wood - light but not fit for durable drone body

vibration creates damping and breaking of arms observed (after 4 to 5 times of flying)

- b. acrylic - brittle, but have good strength.

the weight is more compared to wood.(main issue faced when we shifted the material to acrylic from wood)

solution (assumption) :

- either locating light weight material, non damping and can be cut using laser
- 3D printing can solve issue but not with PLA material, PLA is
 - moisture absorbing
 - brittle
 - not vibration resistant
- PVC or ABS material coils needed for 3D printing

2. battery issue :

available battery (need constant voltage output) is LIPO (3 cell 2000 rupees). but lipo weight is above tolerance component load value. need to find light weight high capacity drone battery.