Roots Type Blower

Compressor with cycloidal gearing

Instructional tutorial for the Lua script for IceSl

Research Advisor:
Prof. Dr.-Ing. Stefan Scherbarth

Submitted by:11 Dynamic_Gear
Amey Birje (22102835)
Rohan Nawale (22106047)

Mechatronics and Cyber Physical Systems
Summer Semester 2022
Date 12.06.2022

Additive manufacturing, a technology of creating of a three-dimensional object form CAD model or digital image. It has shortened the cost and time which it takes to make a new product from the initial design to manufacturing. The prototypes made with AM can be used to examine the accuracy of the product to the given standards. It is also easy to perceive a physical model than the computer-generated model 2D model. The prototypes help in early detection of the errors if any. Also, in the field of education the prototype can be used to illustrate many engineering concepts as it enhances the learning. The more information about the Am can be found on Deliverable D3.9 (altairuniversity.com).

This tutorial is for the development and printing of main components of roots type blower for demonstration or prototyping purpose. The geometrical base for the respective component is provided in the Report (https://www.dropbox.com/s/6qtgttb3ph2j990/11_Dynamic_Gear_Technical_Report.pdf?dl=0). Based on the report a working fully parametrized code is generated in LUA script. The more information about LUA can be found here (https://www.tutorialspoint.com/lua/index.htm)The Lua script is then used in ISCL a advance modelling and slicing software for 3D Printing for printing the physical model.

Hardware Recommendations:

IceSL is available for Windows and Linux Systems (Both 64 and 32 Bits) only. However Following configurations are recommended

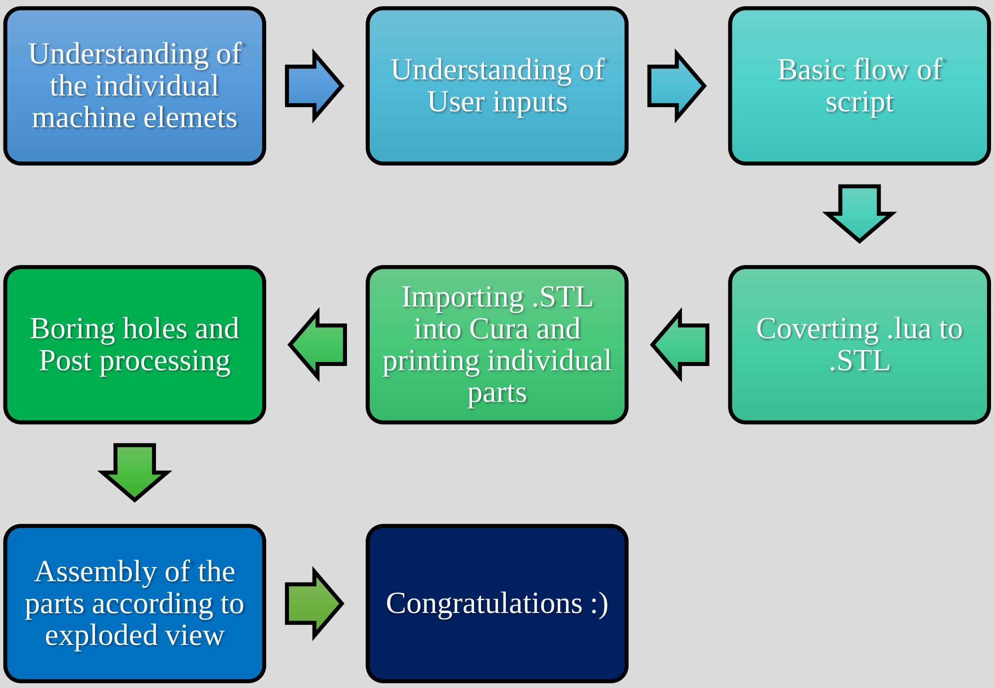
- GeForce GTX 480 / 580 / 680 / 970 / Titan / 1080
- GeForce GT 555M / 610M (nouveau driver) / GTX 1660 Ti Mobile
- Intel HD Graphics 630, 4600, 4400, 4000*
- AMD Radeon 290X

And in the following OS's:

- Windows 7/10 64 bits
- Debian stable/testing 64 bits
- Ubuntu LTS 64 bits

For more information, documentation and cheat sheet please visit (https://icesl.loria.fr/#header)

Tutorial Flow



Roots Type Blower:

Roots type blower are one of the positive displacement types with good clean in place properties. These blowers are widely used across various fields of application. The basic structure of Roots blower has two rotating lobes, a casing and back driving mechanisms.

1. **Input Parameters**: The module is created based on the geometrical profiles and the respective equations as mentioned in Report. As mentioned, the user need only following parameters to get the perfect profile. Also, the GUI will guide the user to set the required parameters.

r	Rolling Circle radius
z	Number of lobes
t	Impeller Thickness
n	Number of points
t_gear	Gear Thickness
z_gear	No. of gear teeth
len_shaft	Length of shaft

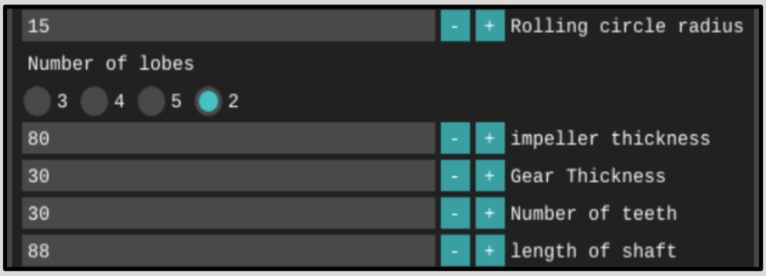
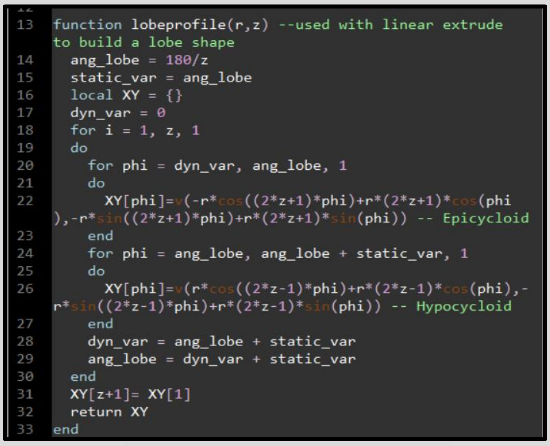


Figure 1Graphical user interface

2. **Lobes** :

The profile of the lobe consists of epicycloid addendum and hypocycloid dedendum. Based on the r and z the modules calculate the base circle radius ‘R’. In this module the function ***lobeprofile*** take the input r and z, then calculates the angle between the lobes. Further the nested loops having the geometrical equations for epicyloida and hypocyloid provides with complete lobe profile.



```
function lobeprofile(r,z) --used with linear extrude
to build a lobe shape
  ang_lobe = 180/z
  static_var = ang_lobe
  local XY = {}
  dyn_var = 0
  for i = 1, z, 1
  do
    for phi = dyn_var, ang_lobe, 1
    do
      XY[phi]=v(-r*cos((2*z+1)*phi)+r*(2*z+1)*cos(phi
),-r*sin((2*z+1)*phi)+r*(2*z+1)*sin(phi)) -- Epicycloid
    end
    for phi = ang_lobe, ang_lobe + static_var, 1
    do
      XY[phi]=v(r*cos((2*z-1)*phi)+r*(2*z-1)*cos(phi),-
r*sin((2*z-1)*phi)+r*(2*z-1)*sin(phi)) -- Hypocycloid
    end
    dyn_var = ang_lobe + static_var
    ang_lobe = dyn_var + static_var
  end
  XY[z+1]= XY[1]
  return XY
end
```

Figure 2 LUA script for Lobe

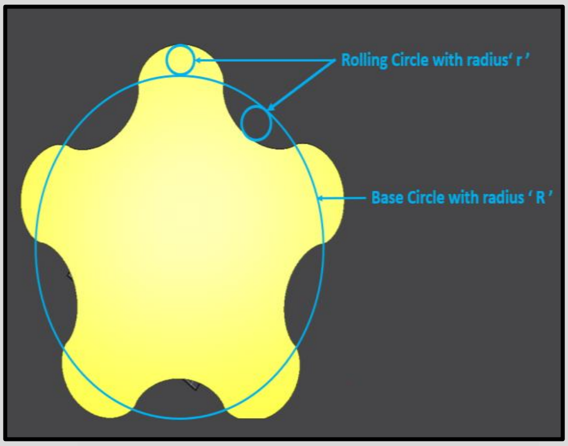


Figure 3 Reference Image for Lobe geometry

Following results can be obtained depending upon the user input given in tweeks.

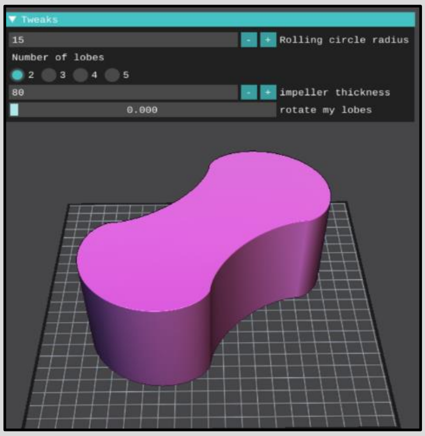


Figure 4 Two Lobe Profile

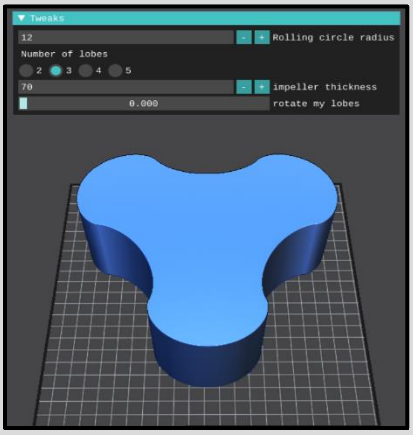


Figure 5 Three Lobe Profile

3. Casing:

The module here has a function ***casing*** having input parameters ‘r’ and ‘n’ that develops a casing. In first part of the code basic values for variables are assigned. The loop then traces the equation of straight lines and circles, giving the casing profile based on the same parameters used for generating the lobe profiles. The calculations are precise leaving no more gap than required for the functioning of the lobes.

! The same parameters used for lobe profiles should be maintained here as well.

```
function casing(r,n)
  m1=tan(0)
  R=2*z*r
  Rv = R+(2*r)
  x2=-R
  x=R
  theta=90
  theta_2=270;
  local XY = {}
  for i=1,n, 1
  do
    XY[i]=v(x,m1*x+Rv)
    XY[i]=v(x2,m1*x2-Rv)
    XY[i]=v(-R+(Rv)*cos(theta),(Rv)*sin(theta))
    XY[i+n]=v(R+(Rv)*cos(theta_2),(Rv)*sin(theta_2))
    x=x-n
    x2=x2+n
    theta=theta+180/n
    theta_2=theta_2+180/n
  end
  return XY
end
```

Figure 6 LUA Script for Casing

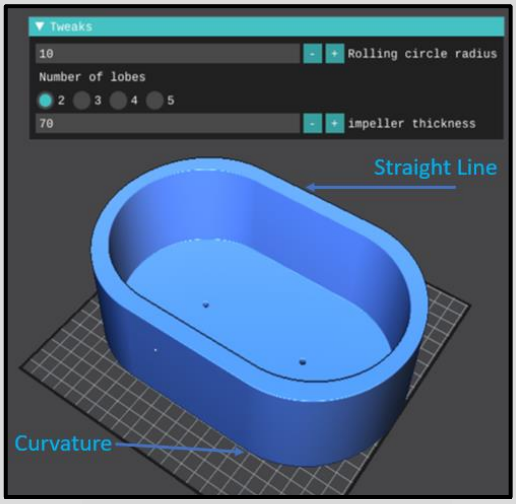


Figure 7 Casing reference profile

! The inlet and outlet ports and the back holes for the shafts are not shown as the printing accuracy varies from printer to printer, so will be the distances between the holes. It is advisable to make the required ports and holes in the post processing

4. Gears:

The lobes rotate with ratio of 1:1, a back driving mechanism is required to get this motion. A simple spur gear pair is used for the demonstration. Depending upon the smoothness, the number of teeth and type of gear can be selected from the library. The input parameters for the gears are rolling circle radius of lobes, number of lobes and gear thickness.

```
dofile(Path .. './gear.lua')
cpitch = (180*2*R)/(z_gear)

numt1 = z_gear
numt2 = z_gear

gear1 = gear{
        number_of_teeth=numt1,
        circular_pitch=cpitch,
        gear_thickness=t_gear,
        rim_thickness=t_gear,
        circles=0}
gear2 = gear{
        number_of_teeth=numt1,
        circular_pitch=cpitch,
        gear_thickness=t_gear,
        rim_thickness=t_gear,
        circles=0}
gear0 = translate(0,0,0)*gear1
emit(translate(0,0,-t*1.5)*rotate(0,0,show3)*(
gear0),1)
```

Figure 8 LUA Script for Gear

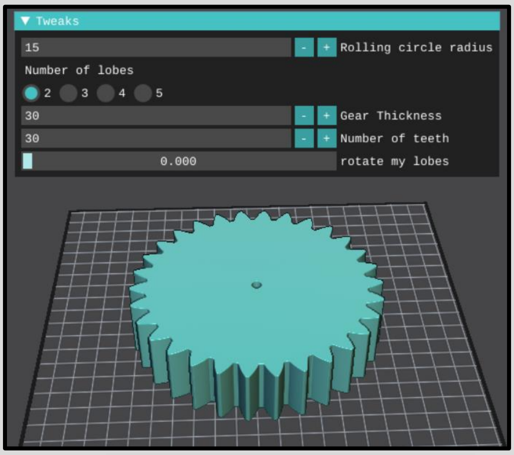


Figure 9 Gear reference profile

Different type of gear libraries can be found here by this path. The user can select the required gear.

Figure 10 Flow for the gear Library

5. **Shafts**: Depending on the user input radius (r_shaft) and length (len_shaft) the shaft can be generated. It is advisable to check with the standard drill tool radius first and then apply the parameters.

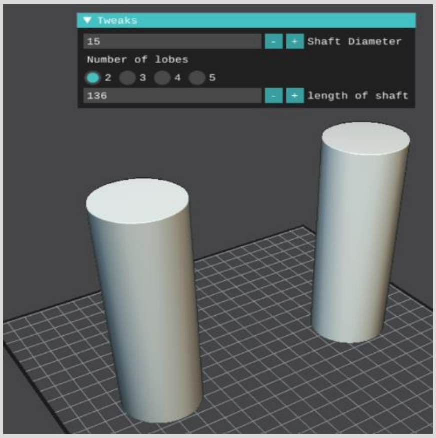
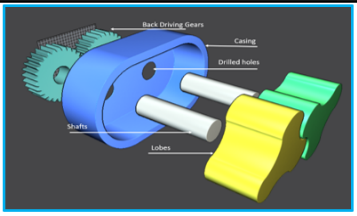


Figure 11 Shaft profile

6. **Part List**

[11_Dynamic_Gear]

© 2022-23 Dynamic Gear
Assembly Name: Roots type blower
Part Count: 13



Part #	Part Name	Description	Qty
1	Vanes	Can have 2 to 5 lobes	2
2	Casing	Covering the vanes and forming an enclosed space	1
3	shafts	Going through the vanes upto the backgears	2
4	Backgears	Driving mechanism	2
5	Wooden board	To mount the casing	1
6	Acrylic sheet	Education purpose. To cover and see the front view	1
7	Nuts, bolts/Screws	Clamping purpose	2-3 sets
8	Lever	To rotate one of the backgear	1
9	Bearings	Shaft & Casing	2
	Total		13

7. **Assembly**

Generating .STL file from Lua

A) Right panel: Expand the right panel to open the services.
B) Service: Select service as “Export to mesh” from the drop-down menu.
C) Meshing method: Select meshing as “Dual contouring” from the drop-down list.
D) Click to run: It will generate .STL file and ask you to save it on your device

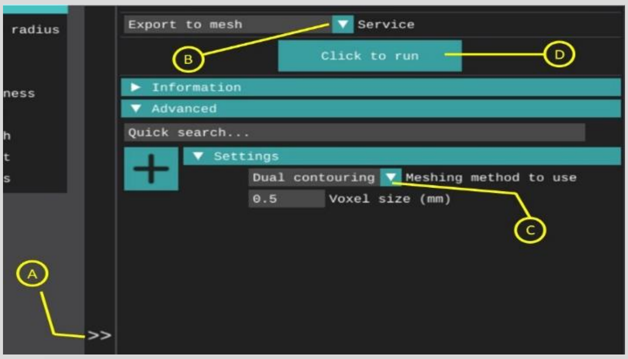


Figure 12 Isecl interface for conversion for LUA to STL file

Printer Software Guide: The Cura software is taken for guidance. It is not mandatory but recommended software for slicing. For installation of Cura please visit: https://ultimaker.com/software/ultimaker-cura

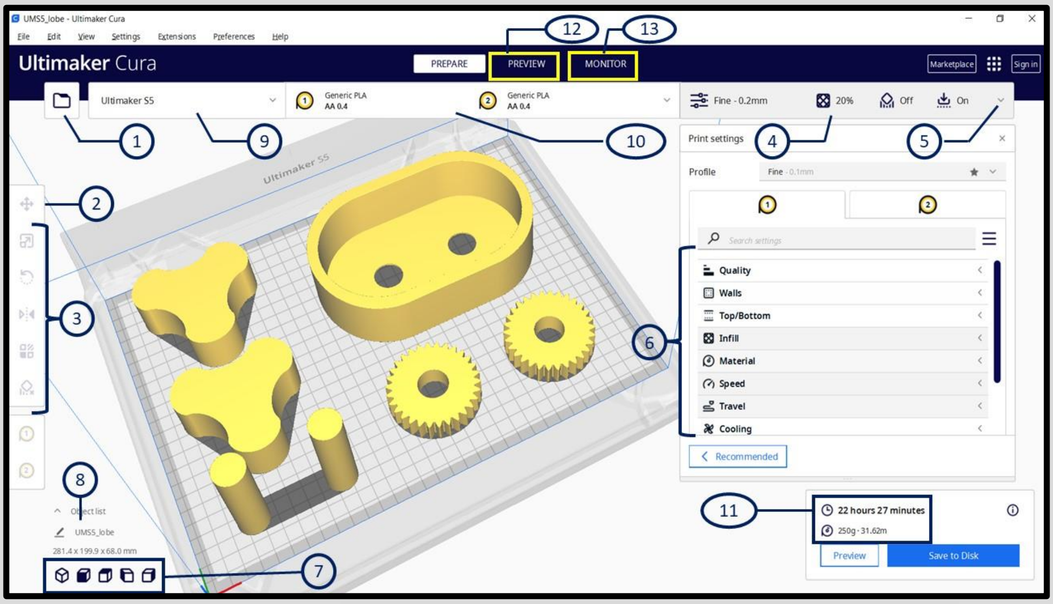


Figure 13 Cura Software Interface

1. Open File: You can open existing .STL files to the printing software.
2. Move: Once you load the element, you can move it in x, y and z direction.
3. Scale, Rotate, Mirror, Mesh etc.
4. Infill Details: You can select required infill % and other details.
5. Settings: Other related settings are provided for required use cases.
6. Some of the major settings are shown here.
7. Different viewing angles of the print bed for better visualization.
8. File tree: Shows all the loaded files.
9. Select and manage printers.
10. Select extruder material.
11. Slice: Calculates the required amount of time and material according to prior settings.
12. Preview: Layer view and extruder movement can be seen here.
13. Connect printer and monitor.

Post Processing: Boring holes

1. Vanes: The reference hole is provided for you convenience. Bore hole at the centre of both vanes with Diameter (D is same as shaft diameter selected above).
2. Casing: Two holes according to the bearing/ shaft size with centre distance as 2*R are to be drilled in the casing back plate. Again, the reference hole is provided to drill the holes.
3. Mounting board: Similarly, drill two holes in the mounting board.
4. Back Gears: Bore holes at the centre of both Back Gears with Diameter (D).

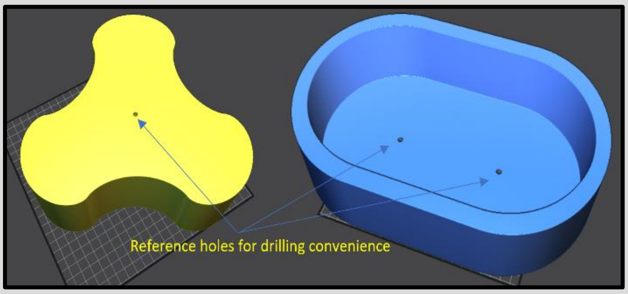


Figure 14 Reference Holes for post processing

Assembly Instructions:

1. Mount bearings on both shafts with Interference fit.
2. Connect bearings on the shafts to casing holes with Snug fit.
3. Mount vanes on the shafts inside the casing with interference fit.
4. Mount gears on the backside of the extending shafts with interference fit.
5. Attach the mounting/support board to the casing with screws.

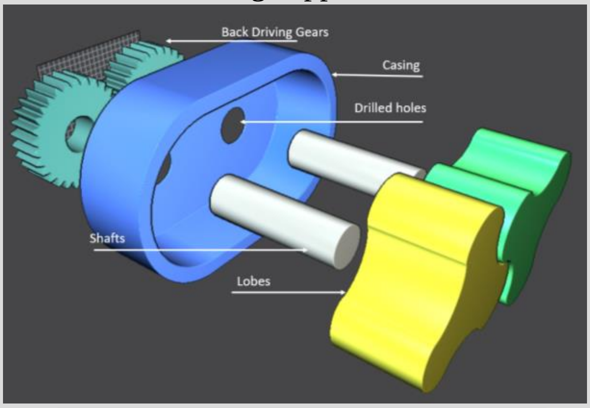


Figure 15 Assembly Exploded View

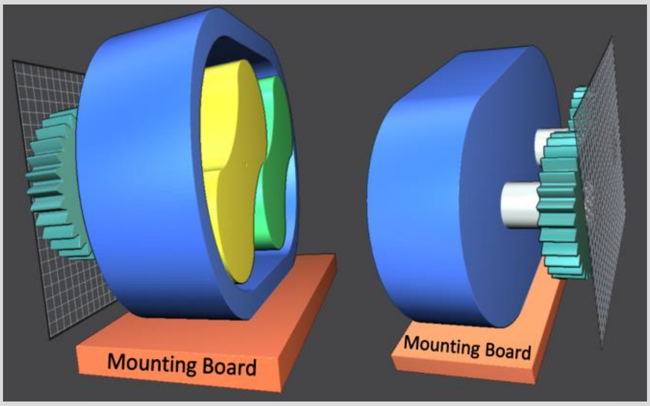


Figure 16 Mounting Suggestion (For Reference only)

Name : Contact details :

For More Information and details about the model tutorial, contact below.

Mr Amey Birje
Email: - ameybirje806@gmail.com

Mr Rohan Nawale
Email: - nrohan0@gmail.com

***