Lab #1: Introduction to 3D Printing and Remote Control

Objective:

- Study the components of the 3D printer.
- Understand the process of building and slicing the 3D model.
- Study the remote-control client of the 3D printer.

Equipment:

- Computer: a generic computer
- 3D printer: Ultimaker 3 Extended

Safety Rules:

1. Turn off power supply BEFORE disconnecting the power line.
2. Don't touch any power source when your hands are wet.

Task 1: Understand the components of the 3D printer

Figure 1: Ultimaker 3 Extended

1. Axes
   Fixed Rods The three axes that the 3D printer utilizes are on the Cartesian coordinate system. The linear fixed rods are maintained at right angles to each other and each represents a coordinate axis.
   Movement The timing belts and pulleys allow the movement of the hot end (or the print bed, depending on the type of 3D printer) along each axes according to the G-Code (generated by slicing software). The stepper motors power this movement.

2. Extruder
   Extrusion is the feeding of filament into the hot end of the 3D printer. This movement is also powered by a stepper motor.
   Retraction This mechanism is the pulling of the melted filament from the hot end. This movement is primarily programmed through the g-code to prevent the formation of unwanted filament creating a bridge between the two areas. The bridging of unwanted filament is referred to as stringing or the formation of cobwebs. Dual Extrusion Some models of 3D printers are equipped with dual extrusion capabilities. This allows for mixed material objects to be printed. Dual extrusion can be used to print out complex objects with a different color material as the support, making it easy to differentiate between the object and the support.

3. Hot End
   The hot end is heated to temperatures ranging from 160 C to 250 C, depending on the type of filament to be used. The hot end melts the filament and pushes the melted filament through the nozzle. The hot end needs to be thermally insulated from the other components of the 3D printer to prevent any damage.

4. Print Bed
   Heated Print beds that are heated improve the print quality of 3D printed objects. The heated bed is heated to the glass transition temperature of the filament being used. This allows the model layers to slightly melt and stick to the heated bed. Non-Heated Print beds that are not heated require adhesion in the form of glue, tape, hairspray, etc. In the innovation lab, painters tape is frequently used for adhesion.

5. Filament
   The filament is a consumable used by the 3D printer to print layers. Filament comes in a variety of materials and colors. The filament can be composed of metal, wood, clay, biomaterials, carbon fiber, etc.

   1) PLA is a thermoplastic that needs to be heated to temperatures from 160C to 220C. PLA is also biodegradable and emits slight odors. PLA is most frequently used in the Innovation Lab on all 3D printers.
   2) PVA is a water-soluble plastic that is frequently used for support in dual extrusion 3D printers. The printed object is left in the water where the PVA support is dissolved and the finished object printed in the other filament remains.

Task 2: The process of preparing the 3D model for 3D printer

1. Preparing 3D model in CAD (Computer-Aided Design) software
   The CAD software is used to create 3D models and designs. SOLIDWORKS main idea is used to create drawings directly in 3D or solid form. From this solid user can assemble it directly on their workstation checking clashes and functionality of it. Creating drawing is pretty easy just drag and drop the solid to drawing block.
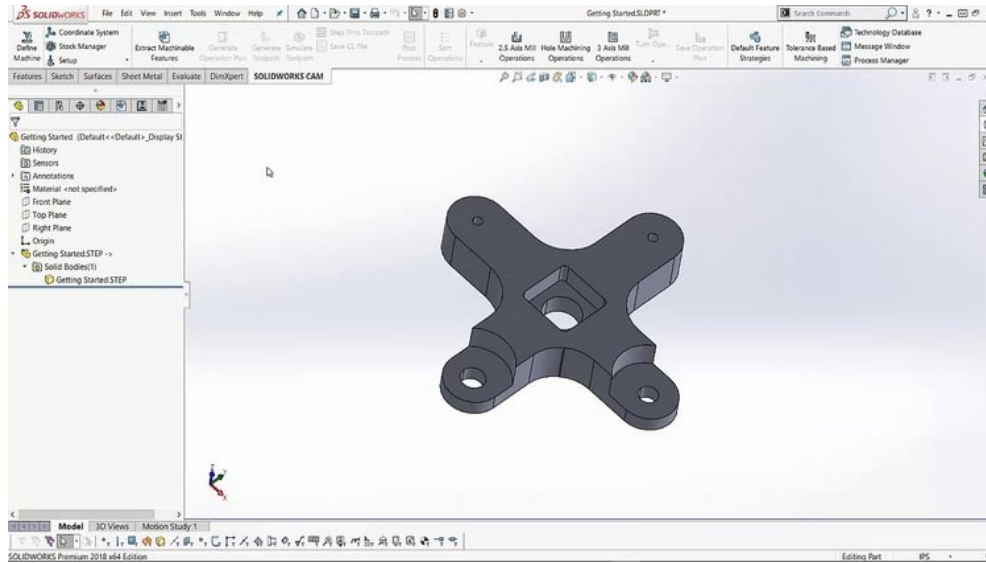
Figure 2 SOLIDWORKS

2. Slicing 3D model in Ultimaker Cura
   Ultimaker Cura's new user interface accommodates a range of skill levels and workflows.
   Three stages in the header clearly guide the process: prepare models in the prepare stage,
   simulate the 3D printing process in the preview stage, and monitor print progress for
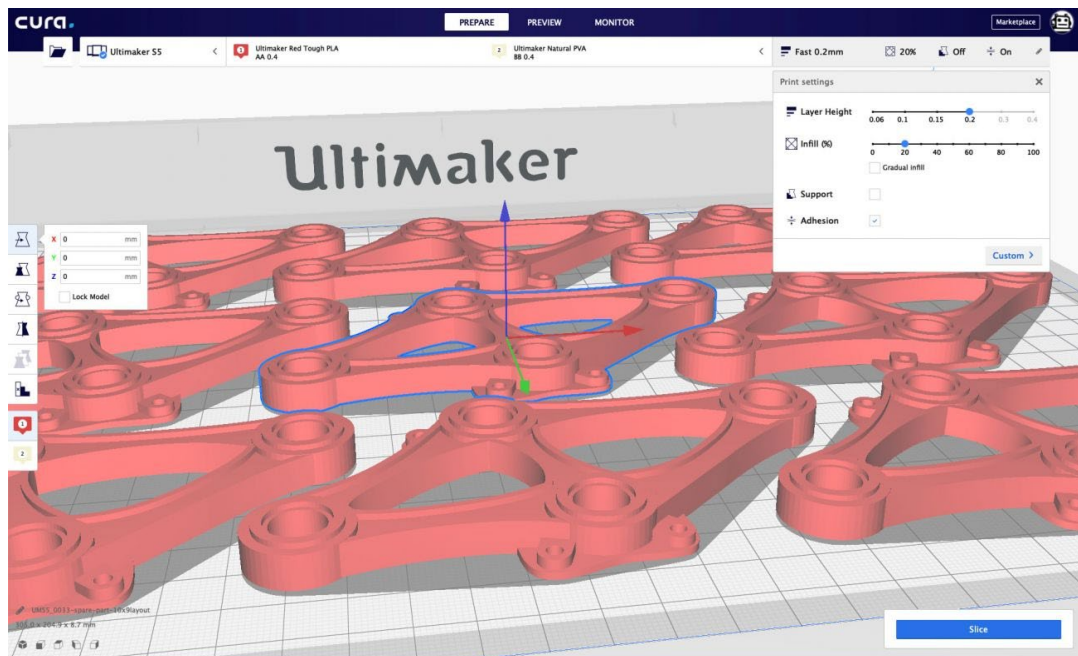   Ultimaker printers in the monitor stage.

Figure 3 Ultimaker Cura

3. Process of preparation for a print job
   Step:-1 Prepare the design Model using SOLIDWORKS.
   Step:-2 Convert the designed Model file in .STL format.
   Step:-3 Prepare the design model for printing Using Software Ultimaker Cura. Then

set all parameters (nozzle temp., build plate temp and support) and also repair your design using
software option. Then generate the file in .gcode format
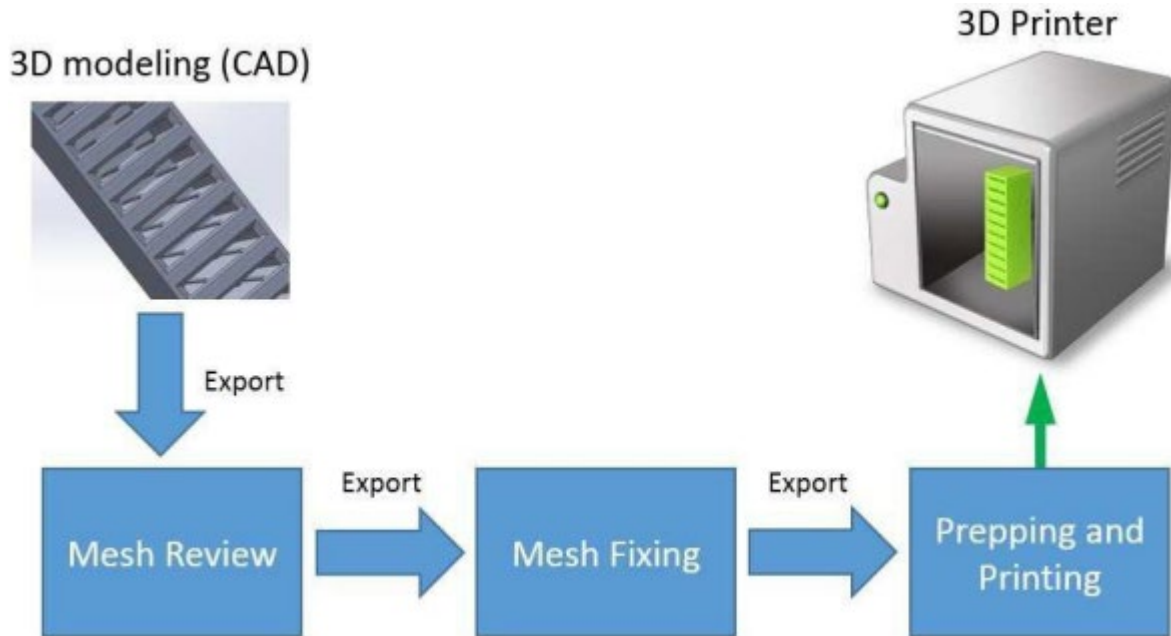Step:-4 Start print job on the remote control client by using Ultimaker 3 Extended.

Figure 4 Flow chart of 3D printing

Task 3: The remote control client of 3D printer

1. Turn on the power of the Unimate 3D printer, make sure it connects to Ethernet. Through SYSTEM> NETWORK> CONNECTION STATUS to check it and find out the IP address of the Unimate 3D printer. If not, then check it in SYSTEM> NETWORK> ETHERNET.
2. The remote control client is developed by the API documentation of the Ultimaker 3 Extended based on XAMPP. This API develops three main functions which are POST, GET and PUT. It provides seven functions which are Authentication, Materials, Printer, Network, PrintJob, System, and Camera.

3. Open a browser and enter 18.14.19.40/3dprinter/index.php. Create an account and then log in. The camera feed contains two parts, first is the built-in camera, second is a webcam. View the temperature of the bed, the temperature, and the name of extruders. Enter manual mode. Enter 50 in X. View the 3d printer movement from the camera. Next, enter 50 in Y. View the 3d printer movement from the camera. Then, enter 200 in Z. View the 3d printer movement from the camera. Finally, type "G28" in the textbox and then the 3D printer would perform "Home".