3D PROTOTYPING MACHINE

Bishoy Gamal Fayez

Ingrid Ahab Youssef

Micheal Ramez Wadee

Nadine Samy Zaki

Agenda

- Introduction
- Main Components
- Machine Design
- Software Development
- System Installation and outputs
- Conclusions and for better results
- Demo

Introduction

- Resin Based 3D Prototyping Machine

Motivation

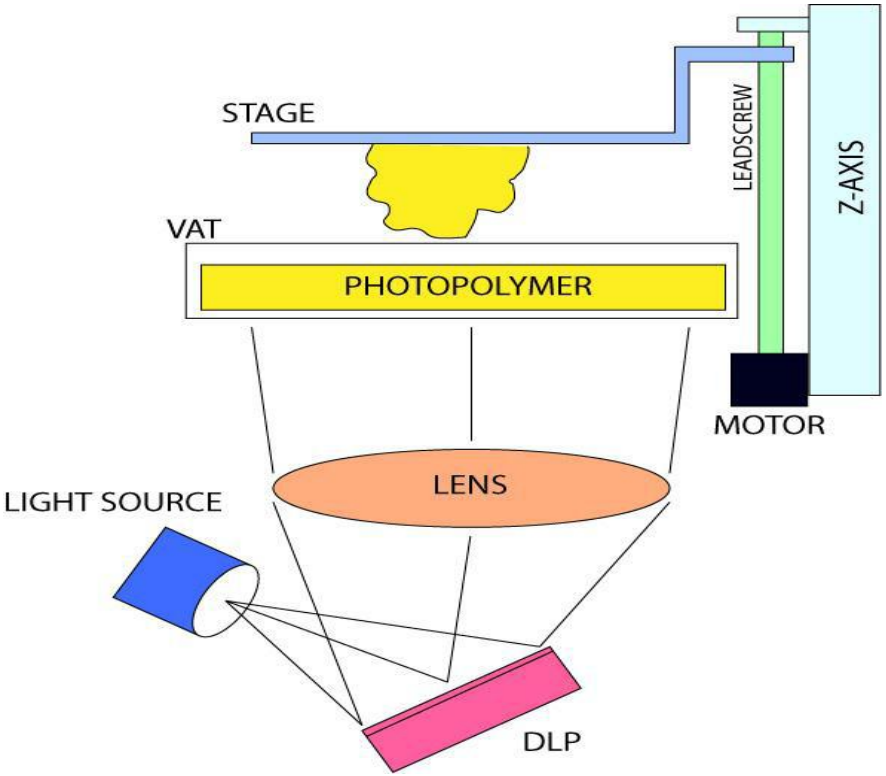
- Why did we choose this project?

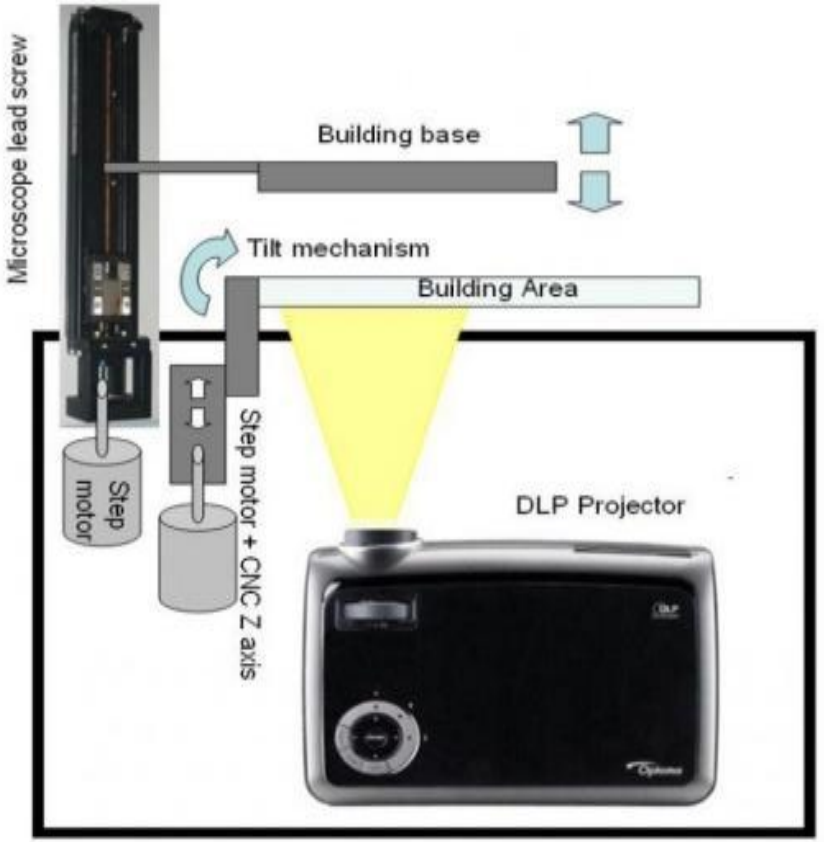
1. Helping a lot of people in their work such as (doctors, engineers, architectures).
2. 3D object makes a lot of work easy.

Objectives

There are a lot of techniques for prototyping machine.

- Our technique is DLP
- What is DLP?





Main Components

a. Photopolymer

b. DLP Projector

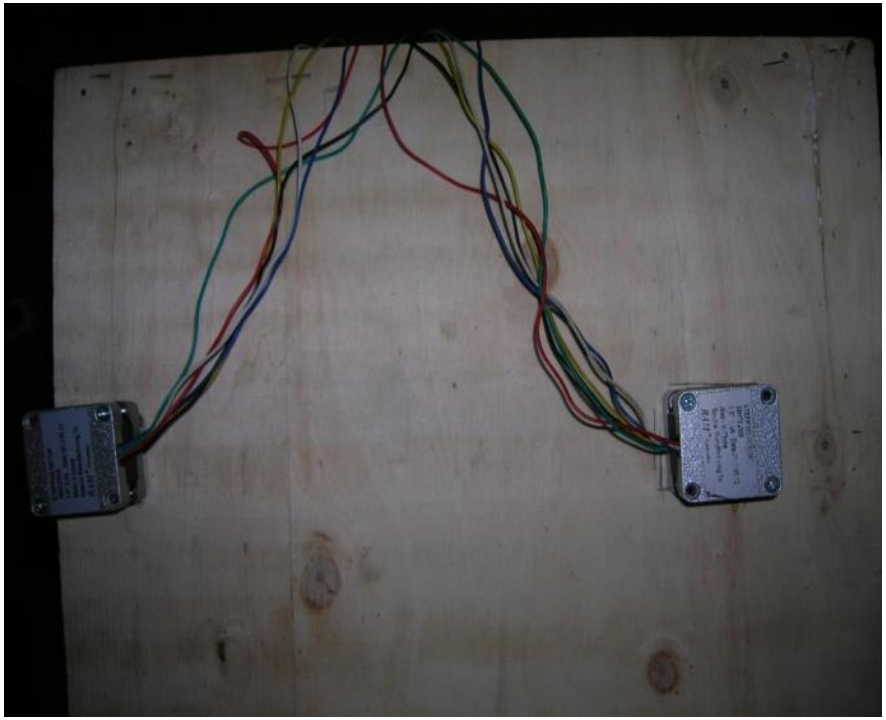
c. Stepper motors

Photopolymer (photoinitiator+ polyester)

DLP Projector

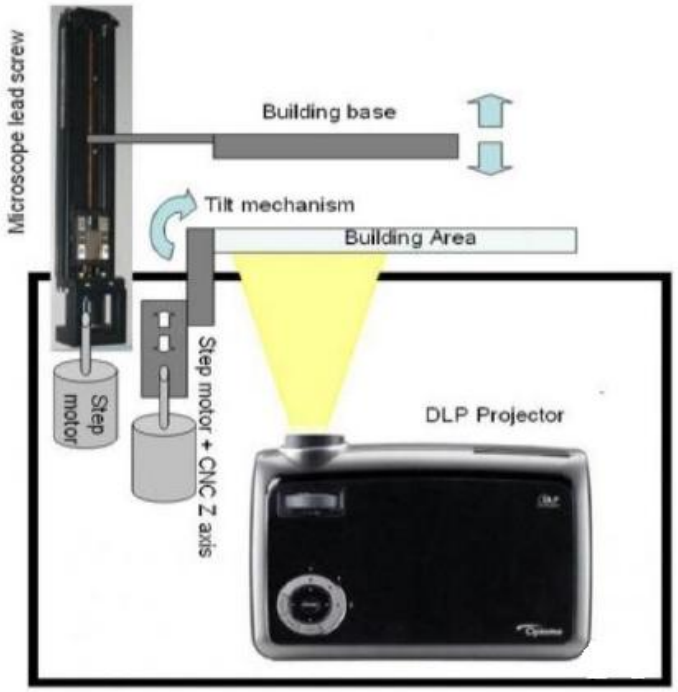
Stepper motors

- For moving in Z-axis (displaying successive cross-sections)

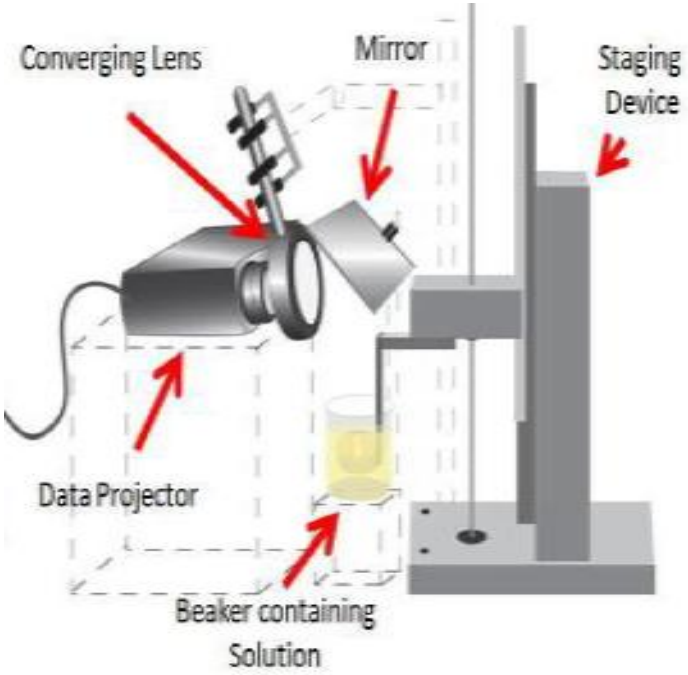


The Machine Design

- Choosing the concept for our design



Model 1



Model 2

Our Design

- We thought about making a design that can be used for the two Models.

- The main components of our design.
  - Printing Frame
  - Projector Handler

Printing Frame

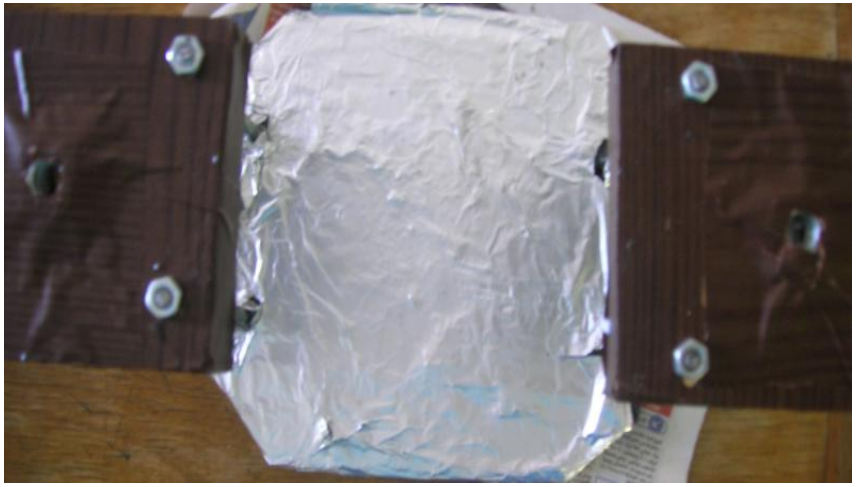
- Main Components
  - Stepper motors
  - Object sheet
  - Object sheet handler
  - Container

Printing frame model

Object sheet and it’s handler

- For Model 1

For Model 2



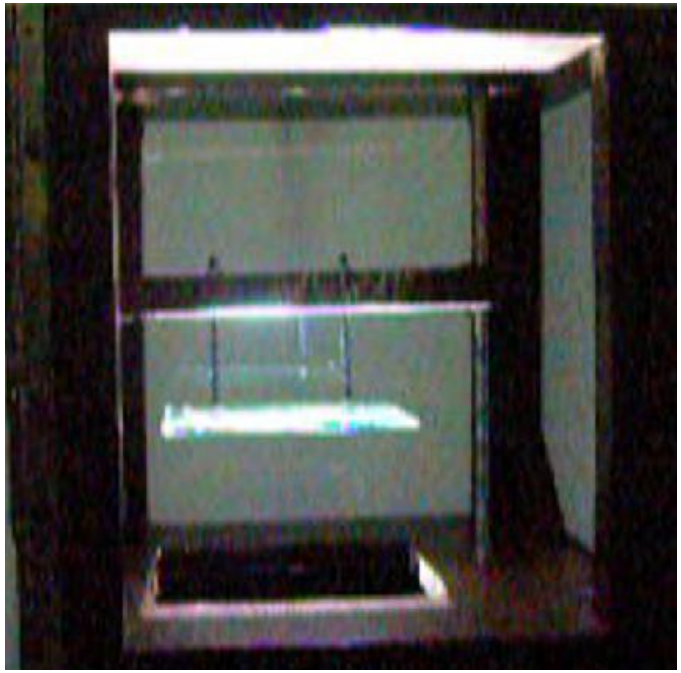
Container

- For the first model the resin container is made from glass and is covered by a screen protector.

- For the second design the container can be made of glass or plastic but it’s dimensions must be bigger than the object.

Printing frame installation

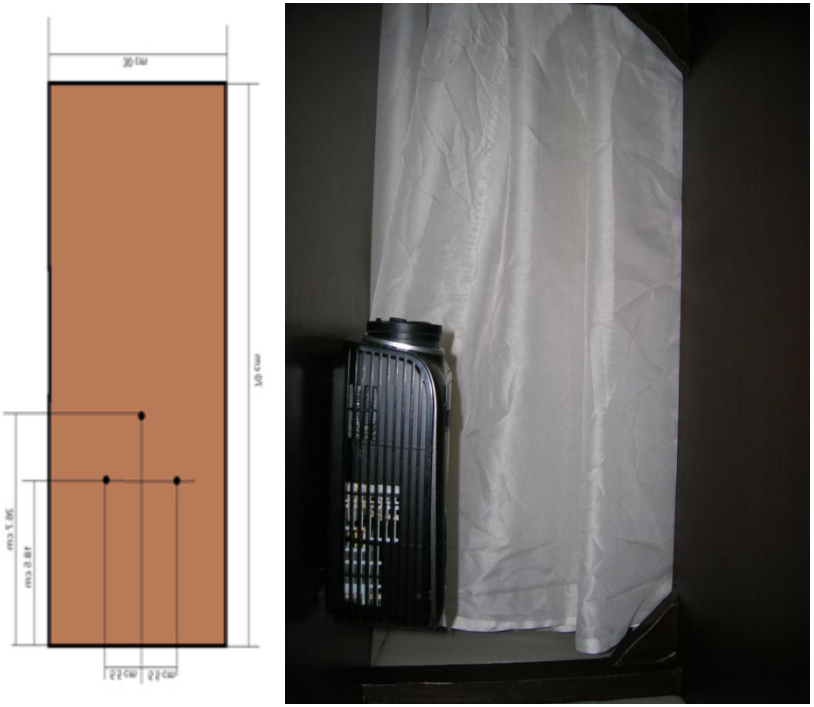
For model 1



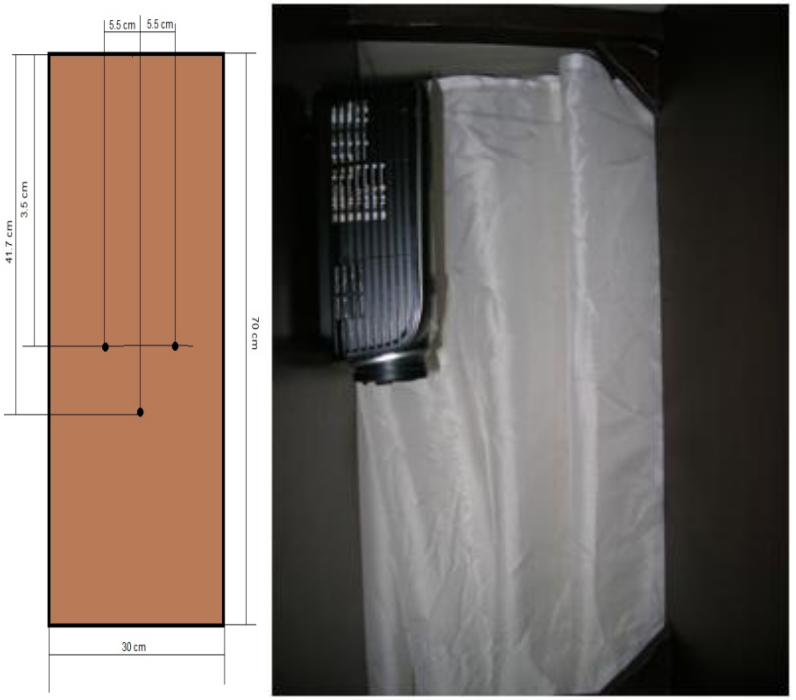
For model 2

Projector handler

Model 1



Model 2



Software Development

- Our project has 2 main components to be controlled all over the printing process:-

1. First the stepper motors to control the motion in the "Z-axis" (control the sheet where the object is built). These stepper motors are controlled with a stepper motor interface through a parallel port.
2. Second the projector that displays different cross sections. The projector is considered the main display of the computer. Besides that the software manages the whole process; it controls the timing, in addition to both the initial and the final position of the sheet.

Main variables that control the process

- Layer time:

  It is the time required for a layer to be cured (solidify). It depends on the illumination of the projector and the thickness of the layer. We calculated the time needed for 1mm to be cured, it was found to reach 600 sec.

- Layer step:

  In order to move one layer in "Z-axis" direction, we have to define the number of steps to be moved to accomplish the movement for one layer. We found that each step of the stepper motor achieves 0.03 mm. Therefore a layer of 1 mm has layer steps equal 34.

Main variables that control the process

- Color level:

The value of this variable shows only areas of interest by setting the color level of the vtk image viewer to a certain value. It differs depending on the area we are interested to print. If we need bone only we should choose the appropriate positive value that give a binary image (300 - 500).And if we need to print a solid object showing all the details we should choose the appropriate negative value that give a binary image (-300 - -500)

Low color level  High color level 

Main variables that control the process

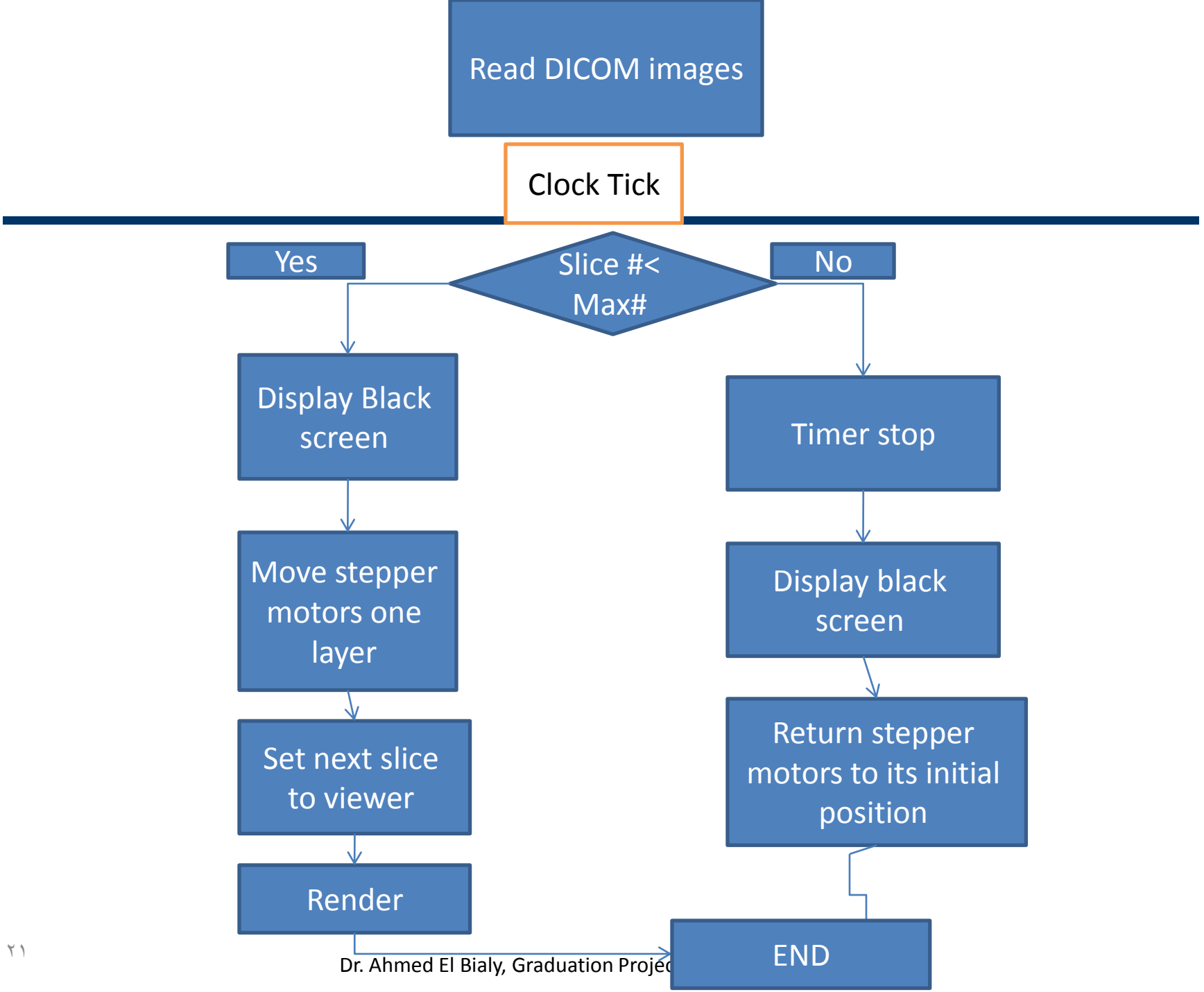
- Slice:

  It is the value of the current slice .Used to display the current slice after updating its value.

- Timer:

  It ticks every Layer Time (600 sec for a 1 mm layer). In every clock tick time “Timer1_Tick” it displays another slice.

- Run program:


Read DICOM images
Clock Tick
Slice #< Max#
Yes
No
Display Black screen
Move stepper motors one layer
Set next slice to viewer
Render
Timer stop
Display black screen
Return stepper motors to its initial position
END

System installation

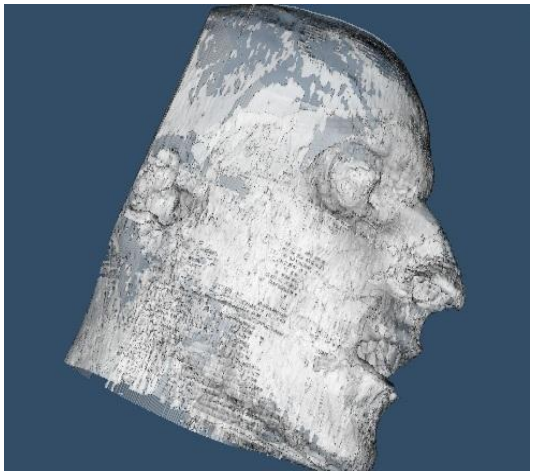
- Using Model 1 (projector below the container)

  - Problem: Chemical reaction takes place between the plastic and the Resin.
  - Solution: Non Sticky material.

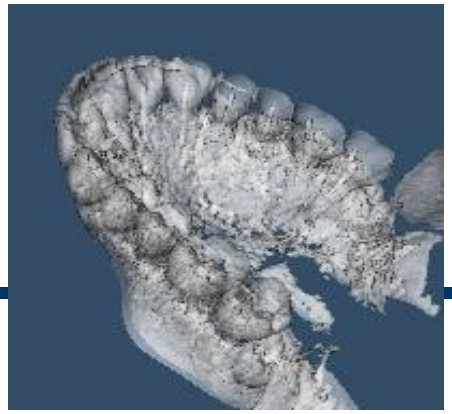
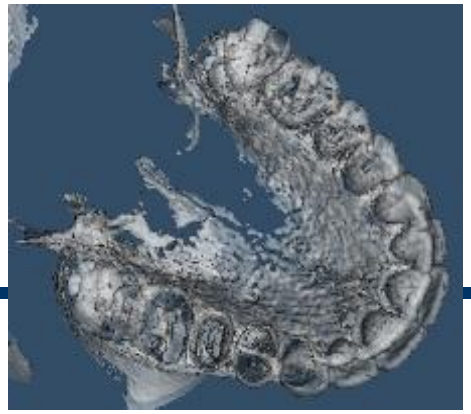
- Using Model 2(projector above the container)

Outputs:

The distance between each cross section and the following one is 2.5 mm. We printed a scaled head with dimensions quarter of the real dimensions for layer thickness to be 0.625mm. Since our maximum accuracy in the Z-direction is 1mm so we printed the odd slices only and made the layer step 1.25mm. But there was a problem that the projector made scaling in one planner axis, we didn't recognize it at the beginning and solved this problem in later prints.



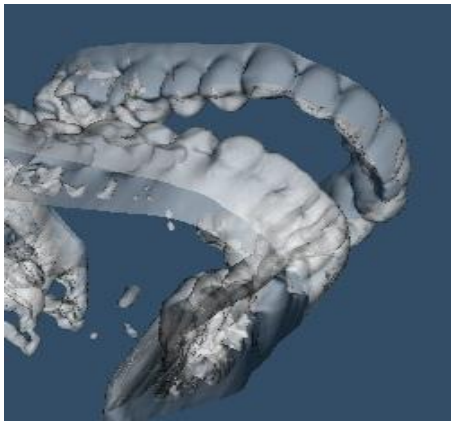
Outputs


- Another print was from a dental database we printed the lower jaw, we wanted to print it with its real size. The distance between each cross section and the following one was 0.5cm, but as the maximum accuracy of the system was 1 mm we also printed the odd slices only. The print took 3 hours number of layers were 17 layers, the height of the object was 1.7 cm. We used a high color level to show only the teeth and bones. To make the object in real size we needed to zoom in the images but a clipping occurred in the front teeth.

Outputs

3D Digital model of lower and upper jaw half its real size to avoid the clipping happened in the previous model.



Printed 3D jaw

Outputs

All printed objects

Conclusions

1. Resin
2. Projector
3. Whole design

Resin

- We should not change in the way of preparing the resin, as any change will affect the curing speed and the accuracy of the resin.

- The resin should not be stored for more than 4 days because its viscosity increases with the time and makes the resin not suitable for our application.

- It’s preferred to mix all the resin at one time to give the same thickness and the same curing time for the whole object.

Projector

- Some projectors are not designed to work in a vertical position and when used for a long time in this position, some black and white spots appear and that was the case we had.

Whole Design

- Model 1 was better because The accuracy in the Z-direction is independent on the viscosity where it depends only on the minimum step in the Z-axis of the stepper motor.

- But had the problem that the resin stuck to the glass container and the stepper motor could not remove it, and previously it reacted with the screen protector so we used model 2.

Whole Design

- Model 2 drawbacks :

  - The resin viscosity was a problem that made the minimum layer thickness 1 mm.

  - The object is immersed in the resin making it covered by a layer of the resin that is not easily removed.

  - As the object will immerse in the resin this requires a big container that should be all filled with resin (6L) and this is a big amount of resin.

For Better Results

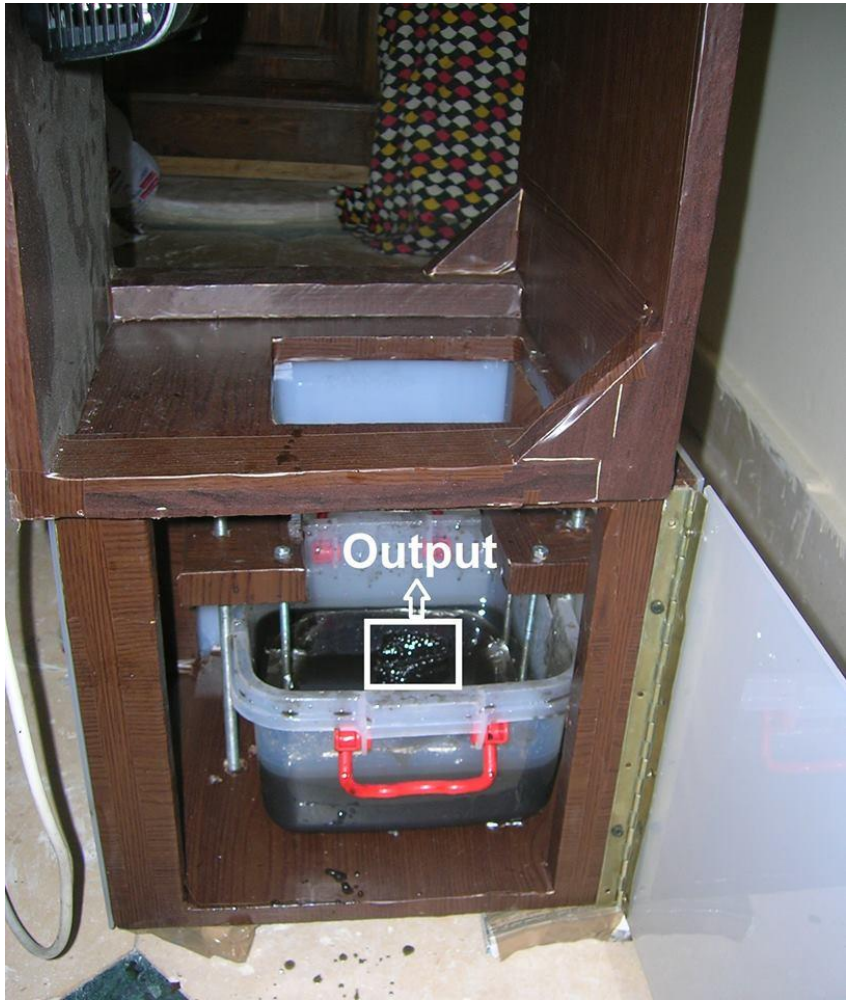
- Try Less viscous resin if you are using Model 2
- Search for non-stick material that don’t react with the resin to use Model 1.
- Replace projector lamp with UV lamp that has all its spectrum in the UV range to be stronger in curing the resin.
- Design the system by limiting the stray light coming from the projector as this helps the resin to be used for many prints with no problem.

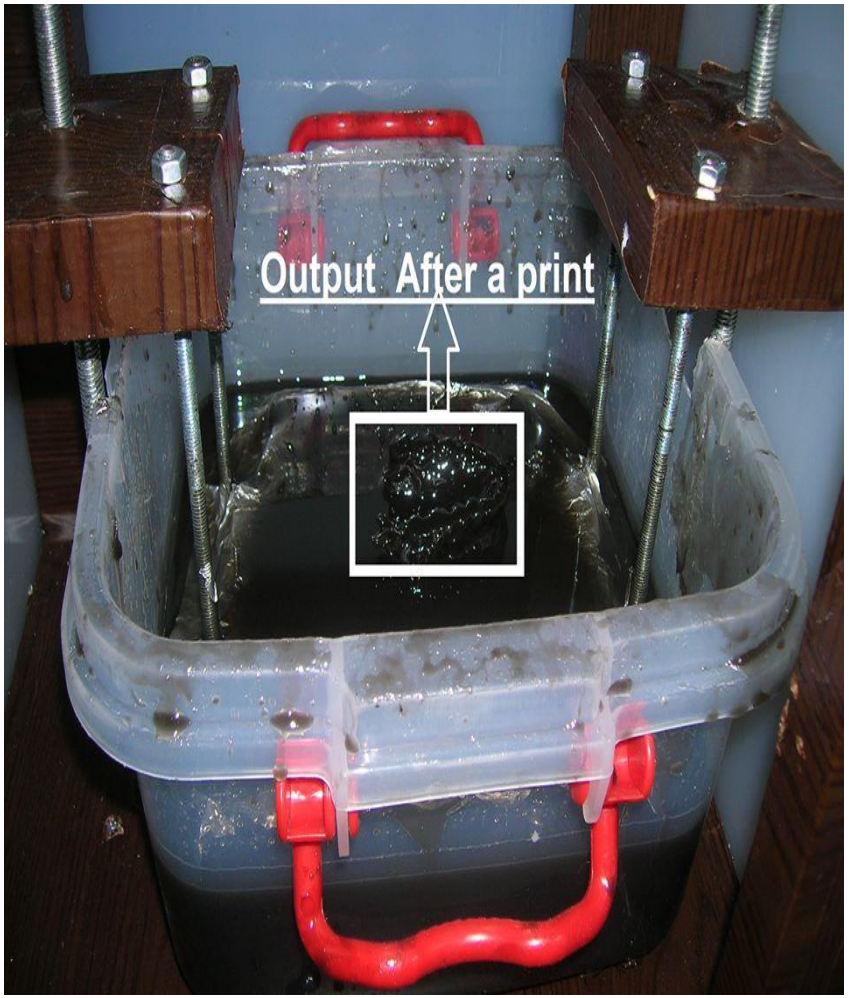
More Illustrations

- Before Printing

Printing

More Illustrations





More Illustrations

- Output

The Demo

We are going to play a small demo of our system :

- 4 layers
- Color level (-300)
- Layer time (assumed 5 sec)
- Layer step (according to accuracy we will assume 1 mm)

Any questions?

Thanks for listening,…