Senior Design Presentation

Title: Building a 3D Micro-Manufacturing System using Digital Micromirror Device

Team: sdmay 20-30(Tong Di, Di Meng, Yu Cheng, Shengpu Zou, Haolun Ping)

Client: Meng Lu

Advisor: Meng Lu

Project Plan

- High level overview of the project
- Problem Statement
- Conceptual Sketch
- Functional Requirements
- Technical/Other Constraints/Considerations

High level overview of the project

This project aims to build and demonstrate a 3D lithography system by using the existing digital micro-mirror array and the inverted microscope in the lab. 3D lighgraphy system is important in many fields, for example, it could be used to develop microscale biorobots, microfluidic devices, and metamaterials.

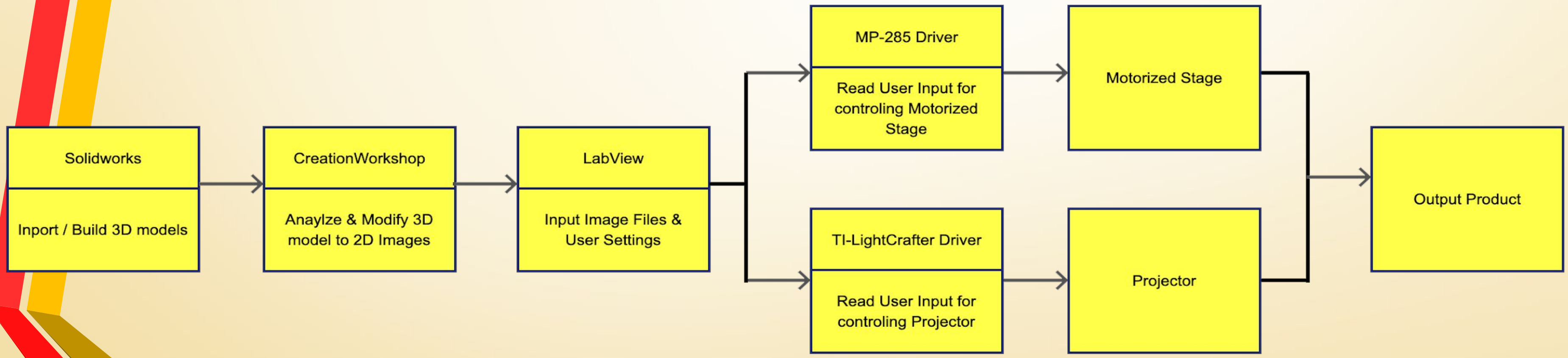
Engineering Standards and Design Practices

1. IEEE development standards
2. Digital design development standards
3. VLSI design development standards
4. Lab safety development standards

Problem Statement

- What is the project attempting to accomplish?
  Answer: 3D lithography printer prototype
- Who cars about 3D lithography?
  Answer: Micro fabrication researcher
- What knowledge will be used in the project?
  Answer: programming knowledge and knowledge on lithography
- Is the project a difficult job?
  Answer: Yes, it's a difficult job.

Conceptual Sketch



Functional Requirements

- UV light source
- Accurate 3D model to printed model scaling
- Satisfy microfabrication requirement
- Output 3D product accurately
- Maskless lithography

Technical/Other Constraints/Considerations

- How to construct the system
- How to increase the accuracy of printer
- How to improve the efficiency of the system

Potential Risks & Mitigation

Potential Risks	Mitigation
DLP4500 generates a lot of heat when working	Ensure that the equipment is monitored during work, and stop working when necessary
The light is harmful to eyes	Wear goggles
Resin will be influenced by light and temperature	Avoid direct sunlight and control the temperature

Resource and Cost Estimate

- The DLP LightCrafter 4500: A module which provides a flexible light steering solution with high brightness and resolution for industrial, medical, and scientific applications. Cost = $1299
- MP-285 Motorized Micromanipulator: MP-285 was designed to meet a wide variety of positioning needs for the scientific community, and is suitable for patch clamp experiments, extracellular recording, and precision robotic positioning applications. Cost = $0(Available in lab)
- Lens: Focus the light which comes from DLP4500. Cost = $0(Available in lab)
- Computer: Use software called "Labview" to control the devices. Cost = $0(Available in lab)
- Gloves and Masks: Protection. Cost = $0(Available in lab)
- Resin: The material which will be used in printing. Cost = $0(Available in lab)

The total cost = $1299

Project Milestones & Schedule

- January 2020: Team allied UV light source to the projector.
- February 2020: Team finished the test for DLP4500
- March 2020: Team finished the test for MP285 on Labview.
- Aprial 2020: Set up the whole system and started tests for 3D printing.

System Design

- Functional Decomposition
- HW/SW/Technology Platforms used
- Detailed Design
- Test Plan
- Prototype
- Implementations

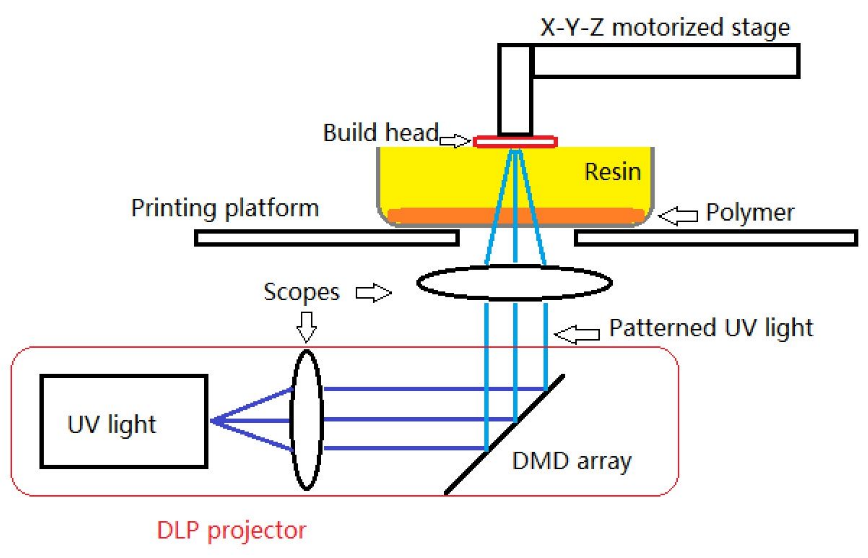
Functional Decomposition

- Projector: We have implemented a projector prototype using the Blue LED light source (cover 420nm). We have simulated the printing process using the projector. We can replace the light source to UV light (385nm) in the future to optimize the efficiency.
- Motorized stage: We have successfully connect the MP-285 Motorized Micromanipulator to the computer using the official driver and the LabView code. We are still implementing and testing the code to connect the motorized stage with the projector for the whole printing process.

Detailed Design

Patterned UV lightsource generated by DLP projector

Patten focus on the building head to cure resin



HW/SW/Technology Platform(s) used

- Hardware:
  - MP285 (motorized stage): MP-285 was designed to meet a wide variety of positioning needs for the scientific community, and is suitable for patch clamp experiments, extracellular recording, and precision robotic positioning applications.
  - DLP4500 (UV projector): A module which provides a flexible light steering solution with high brightness and resolution for industrial, medical, and scientific applications.

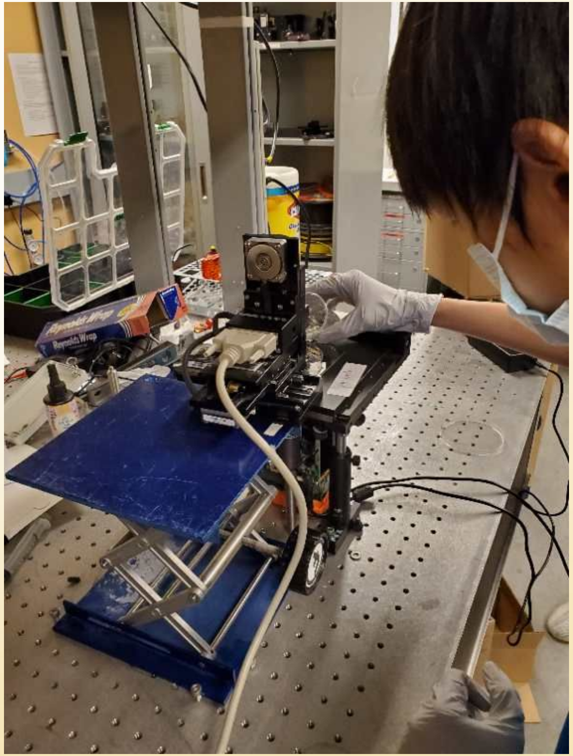
Software:

- Labview (main program) The MP285 and DLP4500 provide official drivers which supported by LabView. Technically, we are able to controlled the combined system with LabView program.
- SolidWorks (3D model design)
- CreationWorkshop (model analyzing)

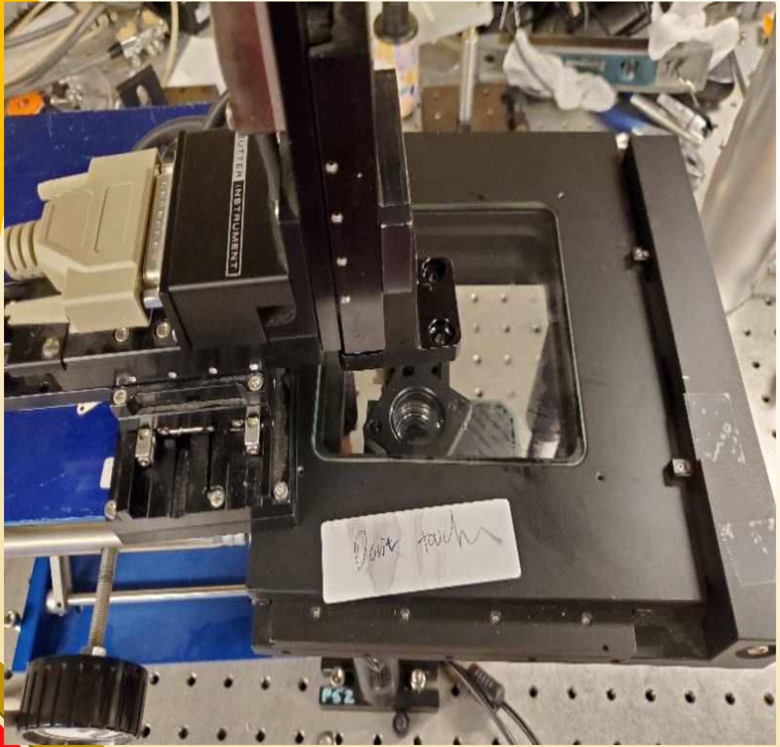

MP-285A
MP-285
Motorized Micromanipulator

Tests

- At this point, we did many tests.
- For the DMD-Array tests, we can print a signal layer which means the DMD-Array is work, and it can generate the pattern which we want to print.
- For the motorized stage tests, we use a driver to implement the motorized stage. It can move toward x-direction, y-direction, and z-direction with given speed and distance.
- We tested that our printer can perform 2D lighthograthy on Silicon wafer (Az5214). Also, we tested that our lightsource were able to cure the 420nm Cure resin.
- Howerever, we still can't finish the actual 3D printing. The choice of optical lens and the focal plane distance require a large number of tests. Due to COVID-19, we were not able to find out the appropriate setup.



Implementations



Conclusion

- Task responsibility
- The future prospect of the project

Task responsibility/contributions of each project member

- Haolun Ping, Tong Di: Working on the software part in the project, reprogramming the driver of MP285 and DLP4500 on the Labview, testing the movement of building head, and helping setup the equipments.
- Shengpu Zou : Working on hardware test and design. Build the optical platform and test the resin. Responsible the working distance of dlp4500.
- Di Meng, Yu Cheng: Working on the model design in the project, learning how to use Creation workshop and Solidworks to create 3D models and cut them into slices.

The future prospect of the project

3D printing is moving in several directions at this time and all indications are that it will continue to expend in many areas in the future. It can be used in medical, semiconductor, industry, etc. It will increase the efficiency and accuracy of the product and reduced the cost. It will benefit the daily life.

Thanks for watching