Project Title

Design Document

Team sdmay20-30

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Executive Summary

Development Standards & Practices Used

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

Summary of Requirements

1. Setting up a simple 3D printing platform, light source, etc.
2. Establishing DMD Array to reflect UV light as a patterned light source.
3. Building an X-Y-Z Motorized System to make sure the stage can move layer by layer.
4. Designing the Graphical User Interface to upload the file which users want to print by our 3D printer.
5. Focusing on how to design a driver that could transfer the pattern from the GUI to DMD.
6. Testing our product and making continuous improvement.

Applicable Courses from Iowa State University Curriculum

EE 201. EE 230. EE 311,EE 332, EE 432, EE 531, Cpre 281. Cpre 288, Coms 228, Phys 221, Phys 222, Coms 227, Chem 167

New Skills/Knowledge acquired that was not taught in courses

1. SolidWorks
2. Stereolithography
3. Budget management

Table of Contents

List of figures/tables/symbols/definitions

Figure 1. Project plan

Time	Tasks
Oct. 2019	Setting up simple 3D printing platform, light source, etc.
Nov. 2019	Establishing DMD Array to reflect UV light as patterned light source.
Dec. 2019	Building a X-Y-Z Motorized System to make sure the stage can move layer by layer.
Jan. 2020	Still working on 3D Motorized Stage. Calculate cure speed and and Building head position.
Feb. 2020	Designing the Graphical User Interface to upload the file which users want to print by our 3D printer.
Mar. 2020	Focusing on how to design a driver which could transfer pattern from the GUI to DMD.
Apr. 2020	Testing our product and making continuous improvement.
May. 2020	Final presentation and document about our product.

1 Introduction

1.1 Acknowledgment

We would like to thank our advisors Meng Lu and Liang Dong for technical assistance and support. We would also like to thank our student advisor Le Wei in advance for helping to guide our team.

1.2 Problem and Project Statement

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

The project consists of three major tasks for us:

1. building an X-Y-Z Motorized System.
2. developing the GUI for users to generate patterns and integrate the system.
3. Testing and exam our products, then make continuous improvement.

The output of our design:

1. Well - worked 3D lithography printer.
2. Functional 3D lithography system.

1.3 Operational Environment

The 3D printer must be placed and operated in an environment at room temperature without strong light since different lights will affect the intensity and focus of the UV source to interfere with printing accuracy. Avoid direct contact between the skin with the liquid in the print container.

1.4 Requirements

1. Setting up a simple 3D printing platform, light source, etc.
2. Establishing DMD Array to reflect UV light as a patterned light source.
3. Building an X-Y-Z Motorized System to make sure the stage can move layer by layer.
4. Designing the Graphical User Interface to upload the file which users want to print by our 3D printer.
5. Focusing on how to design a driver that could transfer the pattern from the GUI to DMD.
6. Testing our product and making continuous improvement.

1.5 Intended Users and Uses

Our design is intended for various users:

1. Manufacturing applications:

   Mass customization, Rapid prototyping…
2. Medical applications:

   Bio - printing, Medical devices…
3. Industrial applications:

   Soft sensors and actuators…
4. Sociocultural applications:

   3D selfies, Art, Education…

1.6 Assumptions and Limitations

Assumptions:

1. Up to 95%, accurate microstructures can be performed.
2. Easy to perform for users.
3. High-intensity UV light source may increase the efficiency of the printer.

Limitations:

1. The surface texture is generally too rough.
2. It is difficult to 3D model.
3. Machines are generally too slow.
4. Generally a few colors.
5. The size of the printed object must be smaller than the size of the platform.

1.7 Expected End Product and Deliverables

Expected End Product:

1. Optical imaging system.
2. GUI.
3. X-Y-Z Motorized System.

Expected End Deliverables:

1. A functional 3D lithography system

2. An established standard operation procedure to print 3D microstructures using UV sensitive polymers

3. 3D microstructures printed using the developed system

2. Specifications and Analysis

2.1 Proposed Design

We are currently working on the light source, DMD array and find suitable resin. We have set up a sample GUI and chosen a suitable platform.

2.2 Design Analysis

We created a sample GUI and it worked. Because we want our users to upload a file from the interface and we can make that happen. We want to find a suitable DMD array to be continued because DMD array is the key element to generate a suitable pattern for lithography. A suitable DMD array can be **identified by computer easily**, but we get the DMD array from the projector, it's a **little bit expensive**.

2.3 Development Process

Basically, we followed the Water Model. In our project, it can be divided into several phases. We must make sure each phase must be completed before the next phase can be began. For example, only we solved the DMD array issue, we can develop a GUI to drive the DMD array.

2.4 Design Plan

Our current plan is to find a suitable DMD array which can be used in our project because the DMD array is the key element to solve the project. And then we can have a plan for the next step.

3. Statement of Work

3.1 Previous Work And Literature

Include relevant background/literature review for the project

– If similar products exist in the market, describe what has already been done

– If you are following previous work, cite that and discuss the **advantages/shortcomings**

– Note that while you are not expected to "compete" with other existing products/research groups, you should be able to differentiate your project from what is available

Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

3.2 Technology Considerations

Highlight the strengths, weaknesses, and trade-offs made in technology available.

Discuss possible solutions and design alternatives

3.3 Task Decomposition

In order to solve the problem at hand, it helps to decompose it into multiple tasks and to understand interdependence among tasks.

3.4 Possible Risks And Risk Management

Include any concerns or details that may slow or hinder your plan as it is now. These may include anything to do with costs, materials, equipment, knowledge of the area, accuracy issues, etc.

3.5 Project Proposed Milestones and Evaluation Criteria

What are some key milestones in your proposed project? Consider developing task-wise milestones. What tests will your group perform to confirm it works?

3.6 Project Tracking Procedures

What will your group use to track progress throughout the course of this and next semester?

3.7 Expected Results and Validation

What is the desired outcome?

How will you confirm that your solutions work at a **High level**?

4. Project Timeline, Estimated Resources, and Challenges

4.1 Project Timeline

• A realistic, well-planned schedule is an essential component of every well-planned project

• Most scheduling errors occur as the result of either not properly identifying all of the necessary activities (tasks and/or subtasks) or not properly estimating the amount of effort required to correctly complete the activity

• A detailed schedule is needed as a part of the plan:

– Start with a Gantt chart showing the tasks (that you developed in 3.3) and associated subtasks versus the proposed project calendar. The Gantt chart shall be referenced and summarized in the text.

– Annotate the Gantt chart with when each project deliverable will be delivered

• Completely compatible with an Agile development cycle if that's your thing

How would you plan for the project to be completed in two semesters? Represent with appropriate charts and tables or other means.

Make sure to include at least a couple of paragraphs discussing the timeline and why it is being proposed. Include details that distinguish between design details for the present project version and later stages of the project.

4.2 Feasibility Assessment

A realistic projection of what the project will be. State foreseen challenges of the project.

4.3 Personnel Effort Requirements

Include a detailed estimate in the form of a table accompanied by a textual reference and explanation. This estimate shall be done on a task-by-task basis and should be based on the projected effort required to perform the task correctly and not just "X" hours per week for the number of weeks that the task is active

4.4 Other Resource Requirements

Identify the other resources aside from financial, such as parts and materials that are required to conduct the project.

4.5 Financial Requirements

If relevant, include the total financial resources required to conduct the project.

5. Testing and Implementation

Testing is an **extremely** important component of most projects, whether it involves a circuit, a process, or a software library

Although the tooling is usually significantly different, the testing process is typically quite similar regardless of CprE, EE, or SE themed project:

1. Define the needed types of tests (unit testing for modules, integrity testing for interfaces, user-study for functional and non-functional requirements)
2. Define the individual items to be tested
3. Define, design, and develop the actual test cases
4. Determine the anticipated test results for each test case 5. Perform the actual tests
6. Evaluate the actual test results
7. Make the necessary changes to the product being tested 8. Perform any necessary retesting
9. Document the entire testing process and its results

Include Functional and Non-Functional Testing, Modeling and Simulations, challenges you've determined.

5.1 Interface Specifications

– Discuss any hardware/software interfacing that you are working on for testing your project

5.2 Hardware and software

- Indicate any hardware and/or software used in the testing phase
- Provide brief, simple introductions for each to explain the usefulness of each

5.3 Functional Testing

Examples include unit, integration, system, acceptance testing

5.4 Non-Functional Testing

Testing for performance, security, usability, compatibility

5.5 Process

– Explain how each method indicated in Section 2 was tested

– Flow diagram of the process if applicable (should be for most projects)

5.6 Results

– List and explain any and all results obtained so far during the testing phase

- – Include failures and successes
- – Explain what you learned and how you are planning to change it as you progress with your project
- – If you are including figures, please include captions and cite it in the text

• This part will likely need to be refined in your 492 semesters where the majority of the implementation and testing work will take place

-**Modeling and Simulation**: This could be logic analyzation, waveform outputs, block testing. The 3D model renders modeling graphs.

-List the **implementation of Issues and Challenges**.

6. Closing Material

6.1 Conclusion

Summarize the work you have done so far. Briefly, re-iterate your goals. Then, re-iterate the best plan of action (or solution) to achieving your goals and indicate why this surpasses all other possible solutions tested.

6.2 References

This will likely be different than in the project plan since these will be technical references versus related work/market survey references. Do professional citation style(ex. IEEE).

6.3 Appendices

Any additional information that would be helpful to the evaluation of your design document.

If you have any large graphs, tables, or similar that does not directly pertain to the problem but helps support it, include that here. This would also be a good area to include hardware/software manuals used. May include CAD files, circuit schematics, layout, etc. PCB testing issues etc. Software bugs etc.