Selective Laser Sintering (SLS) 3D Printer

Group 12

Luis Carrillo	Electrical Engineer
Michael McMahon	Photonic Engineer
Michael Rogatinsky	Computer Engineer
Daniel Valledor	Electrical Engineer

2. Project Description

2.1 Motivations

Transforming data from one medium to another has been a process known to humans for thousands of years. Printing in the form of woodblock on textiles or paper was known and widely used throughout East Asia since 220 AD. The printing press, a revolutionary device which could print thousands of pages per day, was created in 1440. The art of lithography, which is pattern transfer and replication from one material medium to another, has been around since 1796. Of course, digital printing, where computer data is converted to paper, has manifested as laser printing, inkjet printing, and other types, since the early 1900s.

The nearly 2000 year history of printing has one common theme: all printing materials were two dimensional in nature. With the advent of computers, and thus computer aided design, there was a need to develop printing methods based in three dimensions that didn't involve extensive manufacturing, such as metal machining or forging. First discussed in the 1940s and 1950s, 3D printing came to fruition as additive manufacturing in the 1980s.

As is expected with any new technology, the 3D printers in the mid 1980s cost hundreds of thousands of dollars. Nearly 40 years later, 3D printing is an affordable table-top hobby enjoyed by millions of people worldwide.

Today, 3D printing takes on many forms. Enthusiasts can purchase printers which extrude heated thermoplastic into arbitrary shapes for less than $1000. These are the prototypical 3D printers, but they have limitations. Some of these limitations include necessitating support structures for the builds, as well as constraining users to only printing models with thermoplastic materials, such as acrylonitrile butadiene styrene (ABS) or polylactic acid (PLA).

3D printing with different materials can be done with other types of printers. A subset of laser additive manufacturing, selective laser sintering (SLS) is a 3D printing method which uses a laser to selectively fuse together, or sinter, a powder into arbitrary shapes. One of the biggest advantages of this method is its ability to sinter any powdered material; the limitations arise only from thermal properties of the powder itself. Unfortunately, the cheapest SLS printers can cost upwards of over $18,000, still significantly out of the common enthusiast's price range. Further, these systems are usually only intended for single-material type use. Multi-material SLS printers can exceed $100,000.

2.2 Goal and Objectives

Our goal is to design and build a SLS 3D printer at a price level that would make it accessible to the regular consumer as well as competitive with traditional 3D printers in the market. The vast reduction in price would come from designing our own modules and part selection. We will prototype and extensively test each module to ensure reliability and repeatability. Once the subsystem prototyping is complete, we shall build the complete system prototype and continue testing. The final prototype will be completed during Senior Design II. The product will be capable of printing basic 3D shapes according to the specifications later defined in this document.

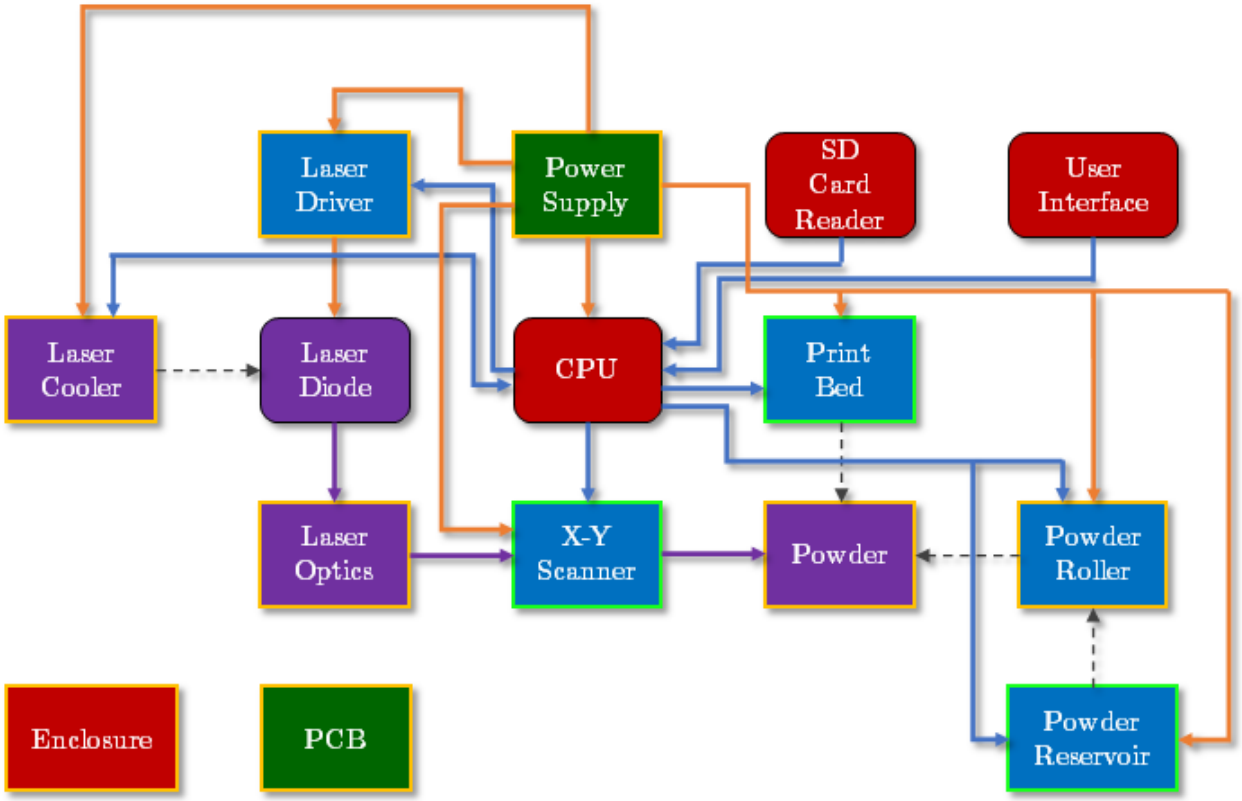
2.3 Functionality

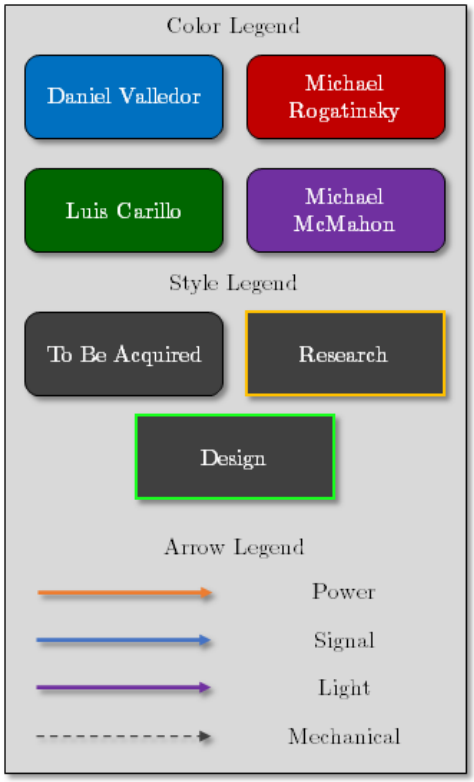
The SLS printer should include all basic functions of a standard 3d printer including, receiving g-code produced by a standard slicer program, parsing and interpreting the g-code as useful instructions, moving a printhead or printhead analog in accordance with the g-code instructions, fusing material in a layer to the objects previous layer or the build surface, and adding material to a new layer to be fused based on parameters defined in the g-code or a premade template for the material. In addition, our SLS system should further include a fixed position laser subsystem and the functionality to move the location of the laser's focus as a printhead analog, an LCD based graphical user interface, and appropriate sensors to monitor all systems requiring monitoring.

3. Requirements Specifications

Specifications	
Print Bed Area	10 cm x 10 cm
X-Y Build Area	9 cm x 9cm
Print Height	9 cm
Power Source	Wall Power
Display	LCD
G-code Storage Device	Micro SD
Laser Diode Output Power	2W - 5W
Laser Diode Wavelength	400 nm - 750 nm
Beam Focal Length	10 cm - 50 cm
X-Y Scanning Speed	TBD mm/s
Material Type	Sugar, Thermoplastics
Material Size	500 µm - 2000 µm

4. Block Diagram





5. Projected Budget and Financing

Subsystem	Estimated Cost
Laser Diode	$60
Laser Diode Collimating Lens	$15
Laser Driver	$20
Focusing/Scanning Lens	$30
Build Plate Assembly	$70
X-Y Scanner Assembly	$50
Enclosure	$50
User Interface	$20
Power Supply	$40
PCB	$30
Grand TOTAL	$385

The SLS 3D printer will be fully funded by the team. The team member who wishes to keep the project after completion will contribute the most. Our estimated budget for the SLS printer is around $385. After discussing as a team, we are all willing to contribute $500 to the project. This leaves us with $115 to use for miscellaneous costs, prototyping, and repurchasing parts in the event that a part breaks.

6. Project Milestones

Senior Design 1 Schedule

Milestone Description	Type	Start Date	Due Date
Project Idea	Action	8/27/2021	9/10/2021
Divide and Conquer Initial Documentation	Deliverable		9/17/2021
Research	Action	9/17/2021	10/1/2021
Divide and Conquer V2	Deliverable		10/1/2021
Design / Part Selection	Action	10/1/2021	11/5/2021
Senior Design I Documentation - 60 Page Draft	Deliverable		11/5/2021
Senior Design I Documentation - 100 Page Draft	Deliverable		11/19/2021
Design / Prototype	Action	11/19/2021	12/7/2021
Senior Design I Documentation - Final Documentation	Deliverable		12/7/2021

Senior Design 2 Schedule

Milestone Description	Type	Start Date	Due Date
Prototype	Action	TBD	TBD
Test and Redesign	Action	TBD	TBD
Final Prototype	Action	TBD	TBD
Peer Presentation	Deliverable		TBD
Final Report	Deliverable		TBD
Final Presentation	Deliverable		TBD