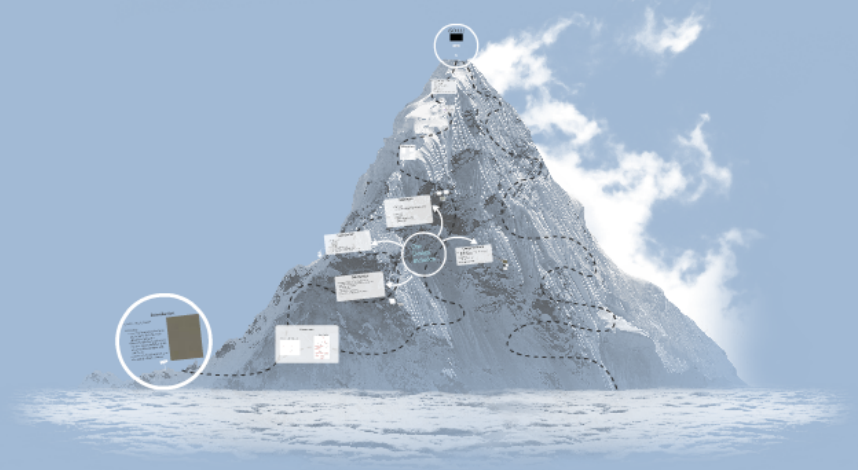
The Q-Laser

Team Member: Ammar Ahmed, Thomas Bock, Tan Hua, Michael Golez



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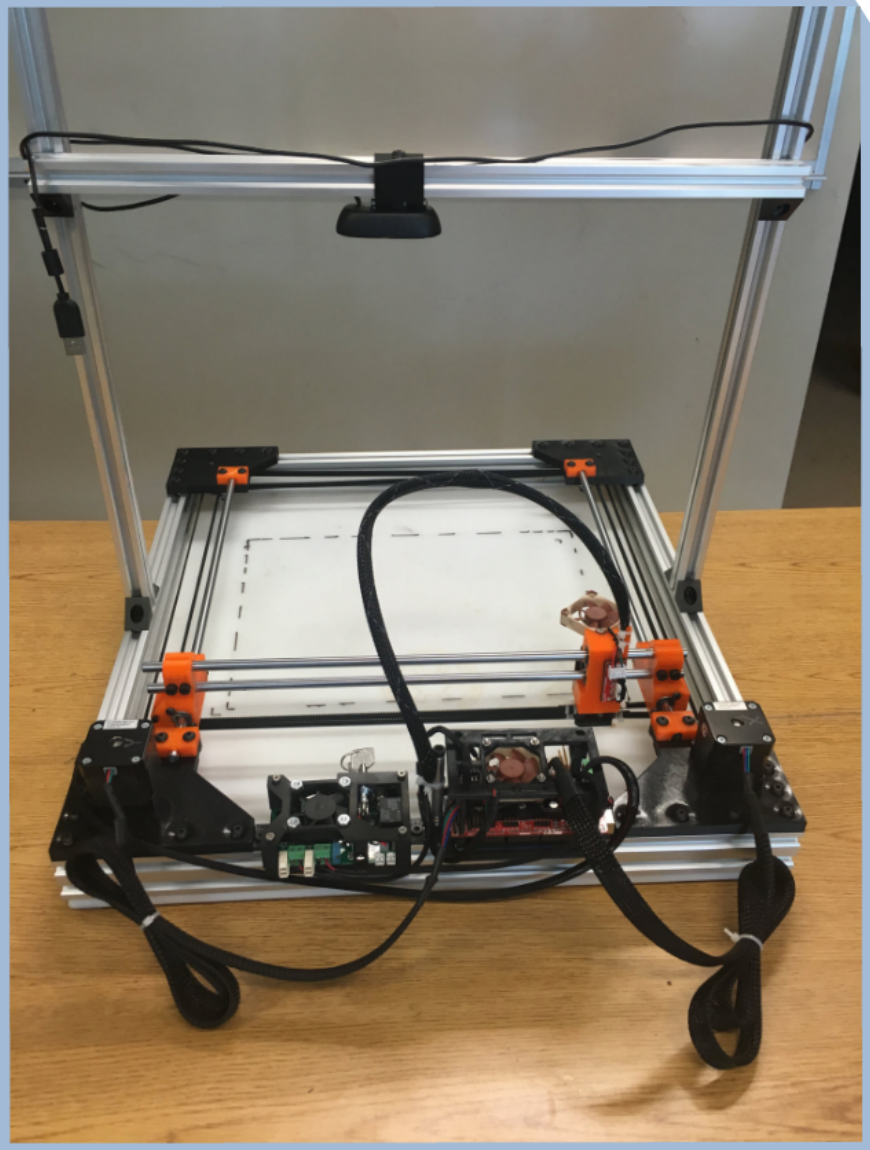
Introduction

I. What is the Q Laser?

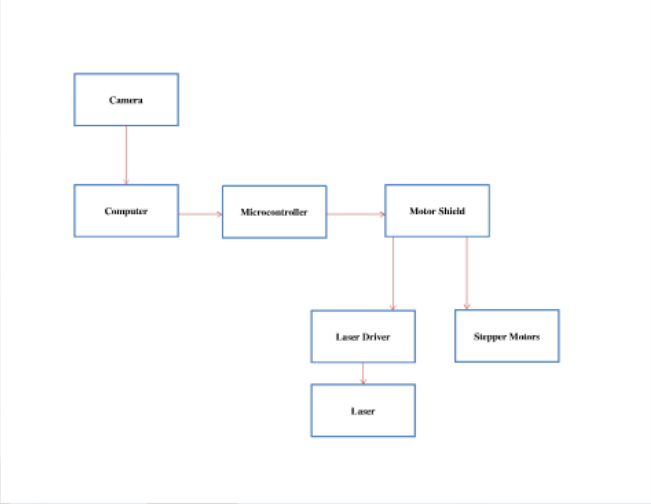
II. Purpose

- Low cost laser cutter/engraver that is meant for hobby and educational purposes.
- Materials that the machine can cut and engrave includes: balsa wood, cardboard, paper, and craft foam.
- Allows cutting of material up to the size of a sheet of paper

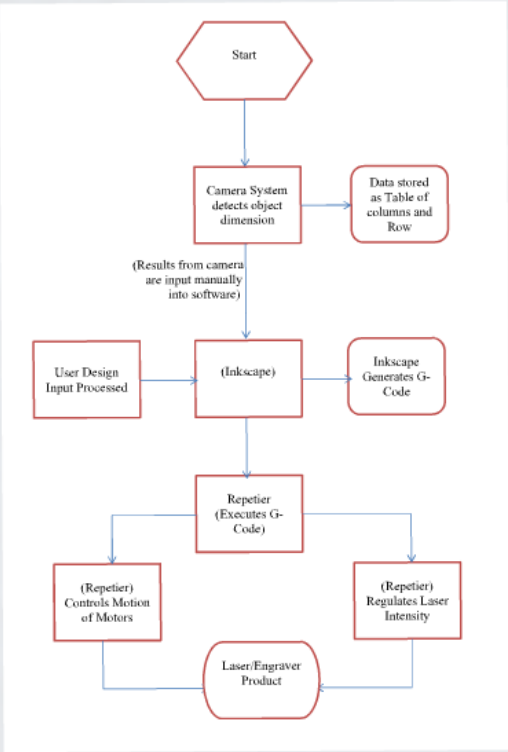


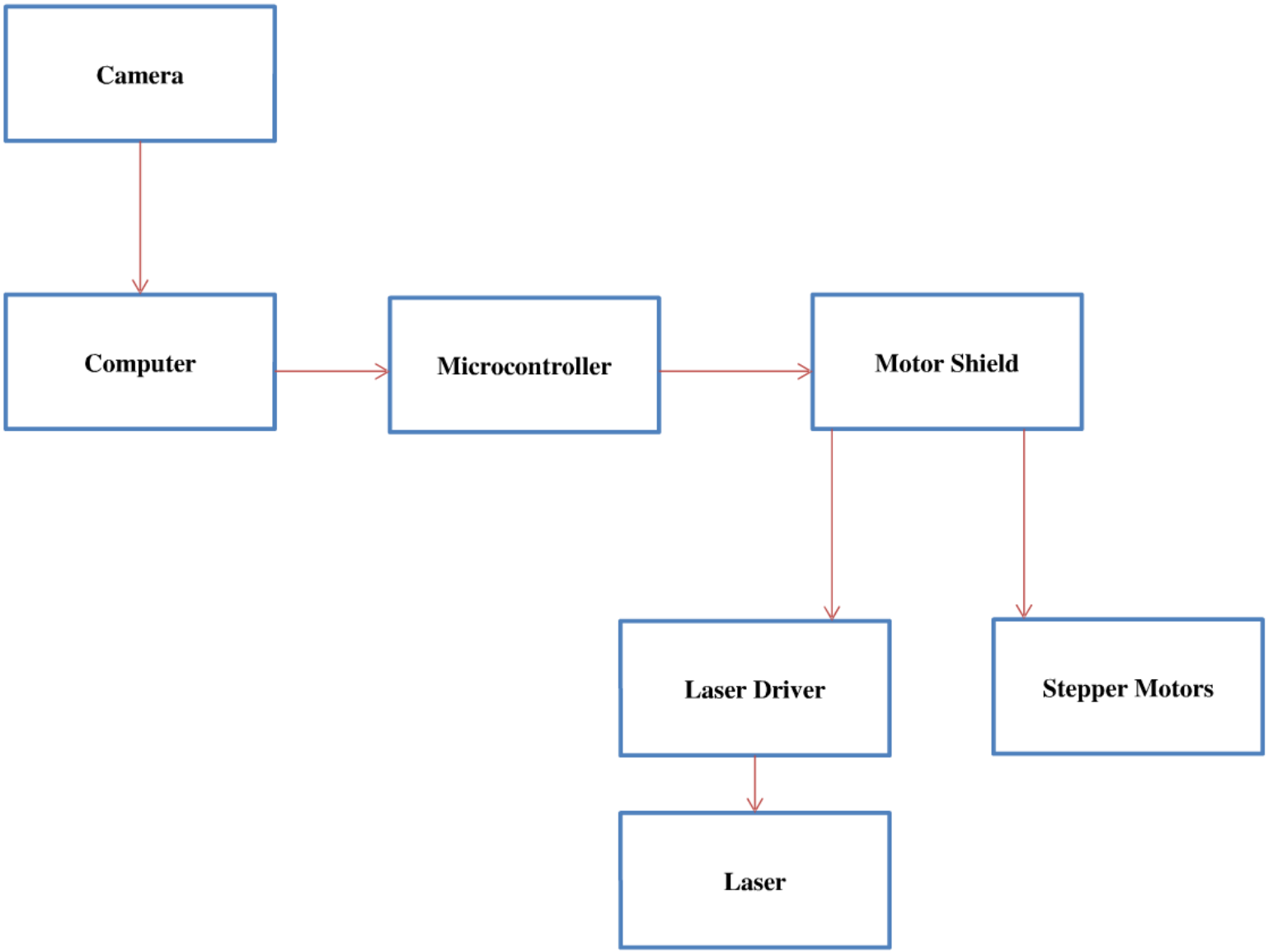
Overview:

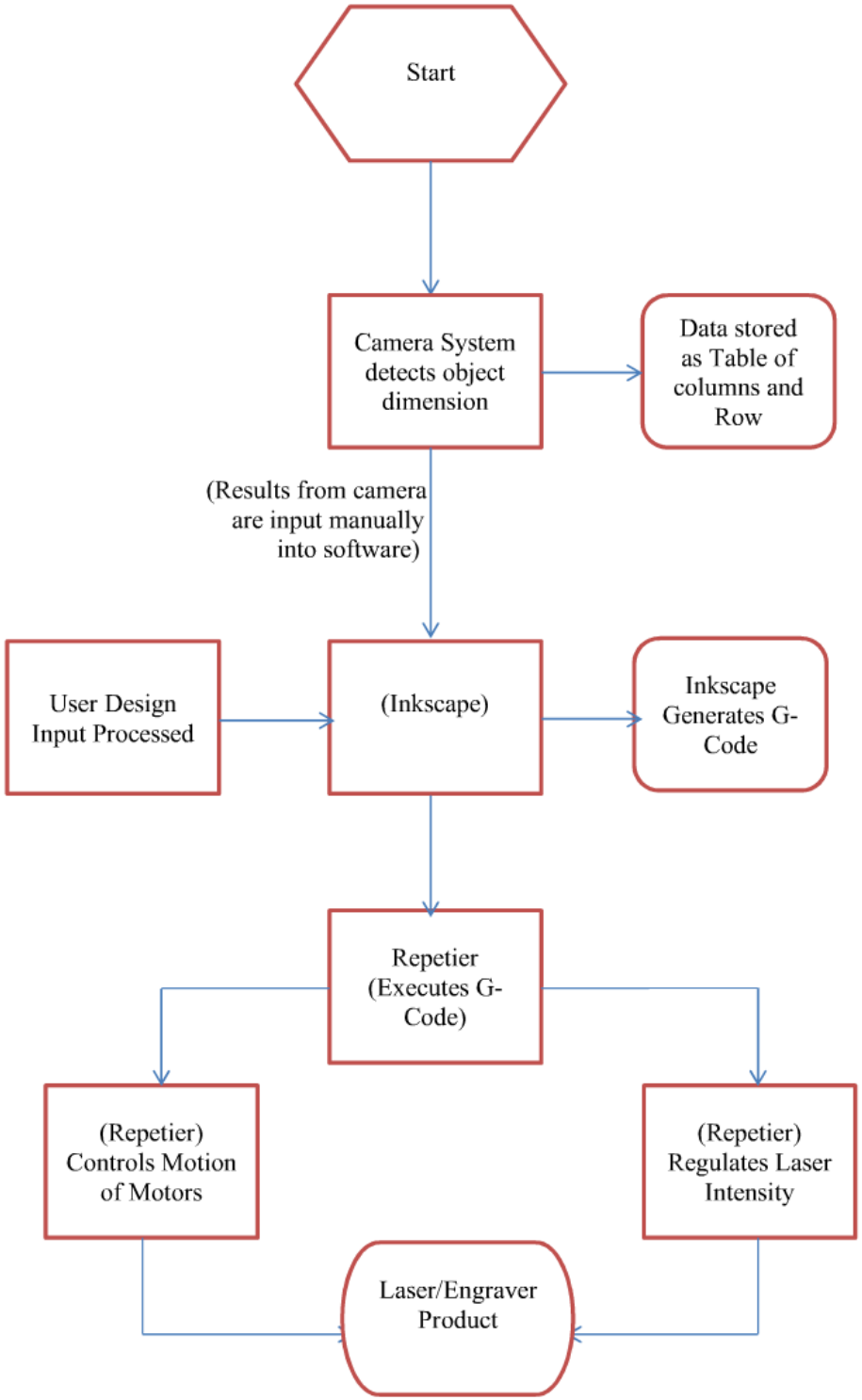
Hardware Block Diagram

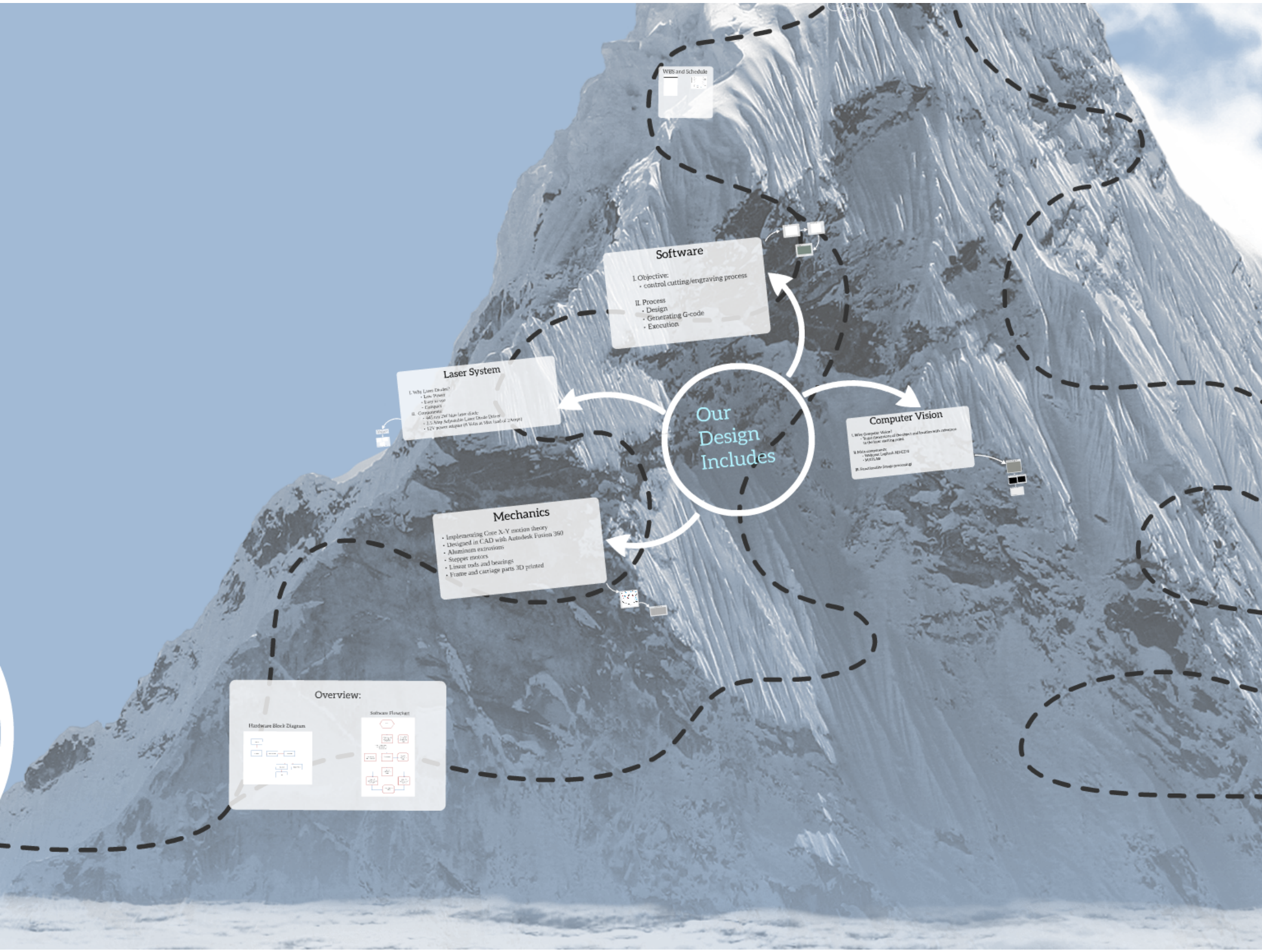


Software Flowchart




Camera
Computer
Microcontroller
Motor Shield
Laser Driver
Stepper Motors
Laser


Start
Camera System detects object dimension
Data stored as Table of columns and Row
(Results from camera are input manually into software)
User Design Input Processed
(Inkscape)
Inkscape Generates G-Code
Repetier (Executes G-Code)
(Repetier) Controls Motion of Motors
(Repetier) Regulates Laser Intensity
Laser/Engraver Product


WBS and Schedule
Software
I. Objective:
• control cutting/engraving process
II. Process
• Design
• Generating G-code
• Execution
Laser System
Our Design Includes
Computer Vision
Mechanics
• Implementing Core X-Y motion theory
• Designed in CAD with Autodesk Fusion 360
• Aluminum extrusions
• Stepper motors
• Linear rods and bearings
• Frame and carriage parts 3D printed
Overview:
Hardware Block Diagram
Software Flowchart

Our Design Includes

Software

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Laser System

I. Why Laser Diodes?
- Low Power
- Easy to use
- Compact

II. Components:
- 445 nm 2W blue laser diode
- 2.5 Amp Adjustable Laser Diode Driver
- 12V power adapter (8 Volts at Max load of 2Amps)

Computer Vision

I. Why Computer Vision?
- To get dimensions of the object and location with reference to the laser starting point.

II. Main components:
- Webcam: Logitech HD C270
- MATLAB

III. Functionality (image processing)

Mechanics

- Implementing Core X-Y motion theory
- Designed in CAD with Autodesk Fusion 360
- Aluminum extrusions
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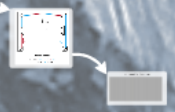

Mechanics

- Implementing Core X-Y motion theory
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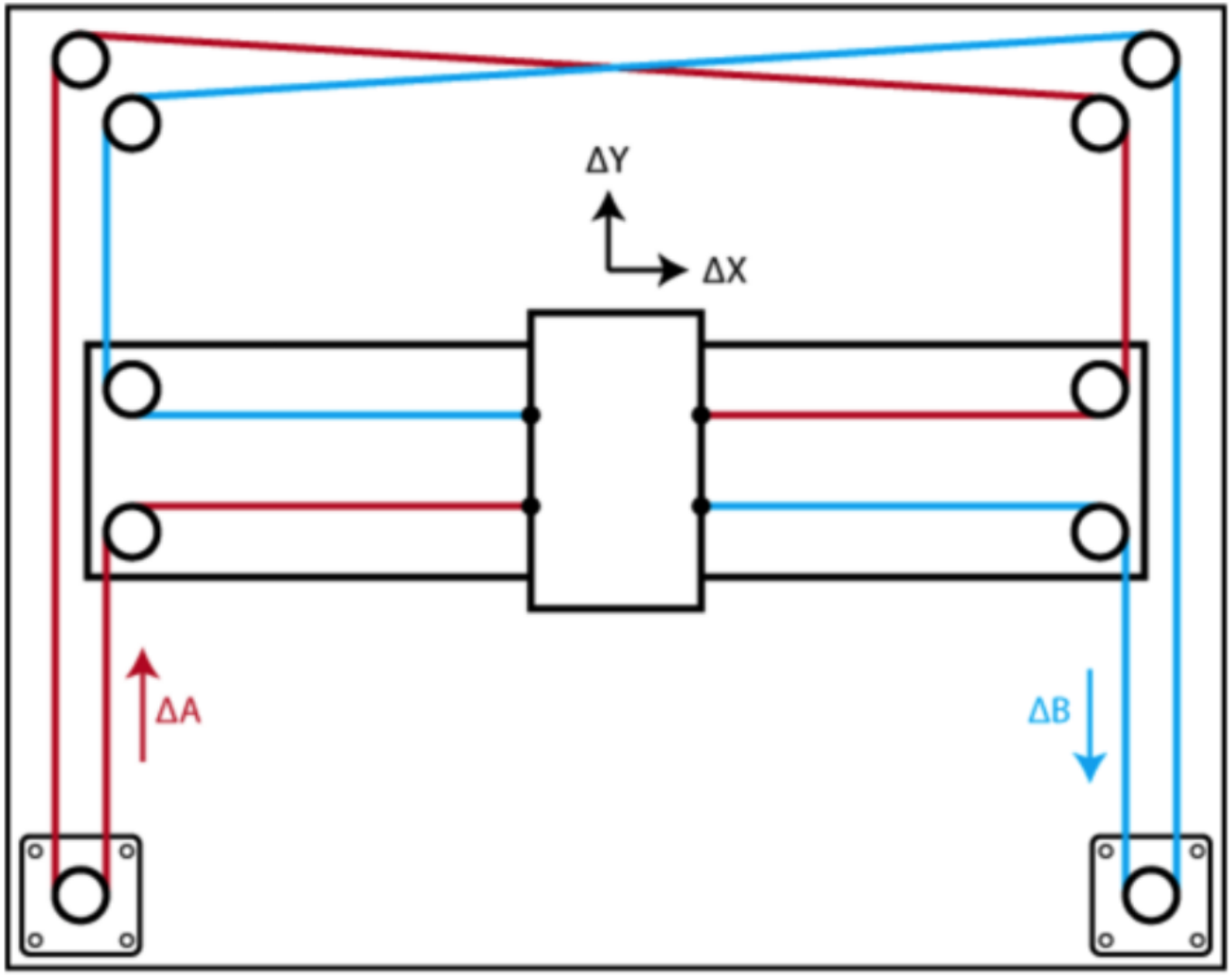
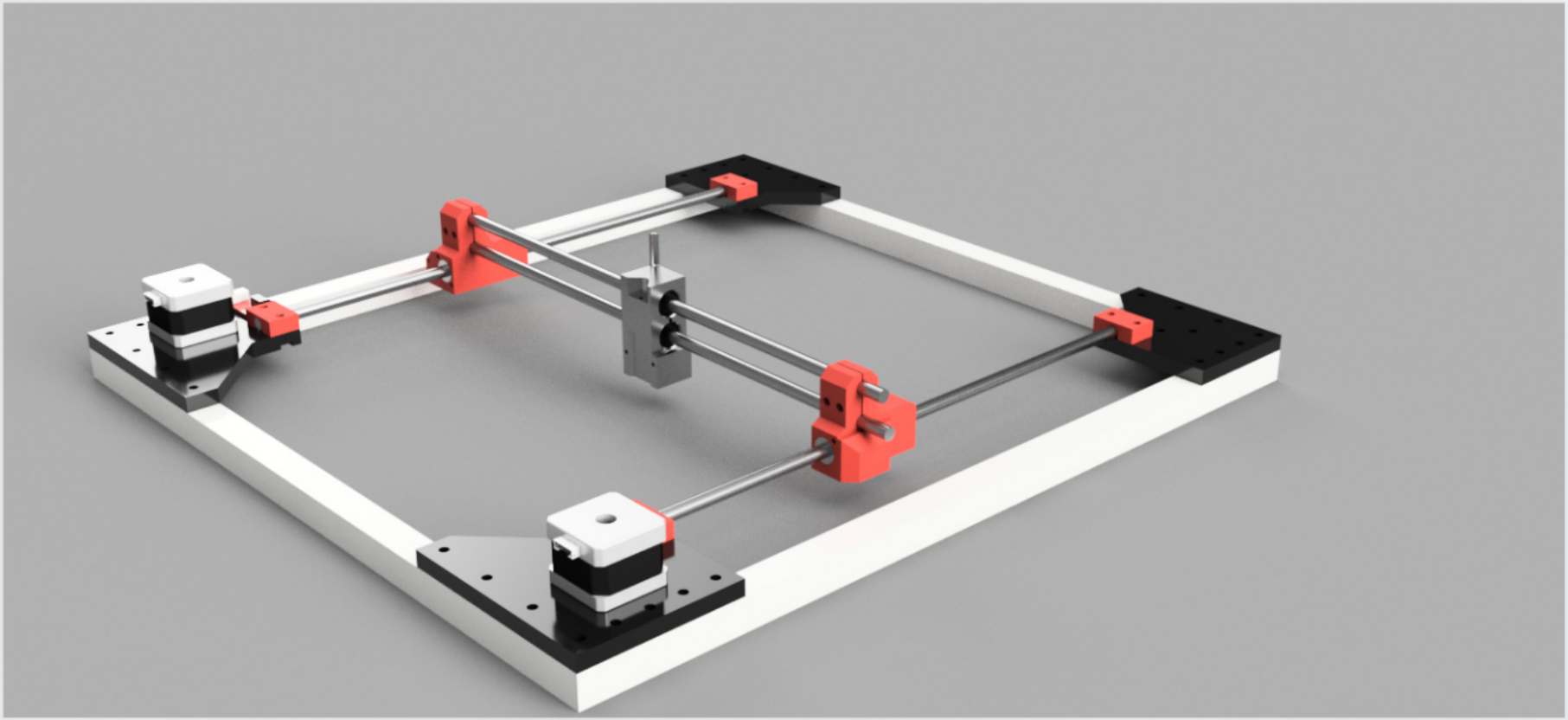


Equations of Motion:

$$\Delta X = {}^1/_2(\Delta A + \Delta B), \quad \Delta Y = {}^1/_2(\Delta A - \Delta B)$$

$$\Delta A = \Delta X + \Delta Y, \quad \Delta B = \Delta X - \Delta Y$$

CAD Model of laser cutter:



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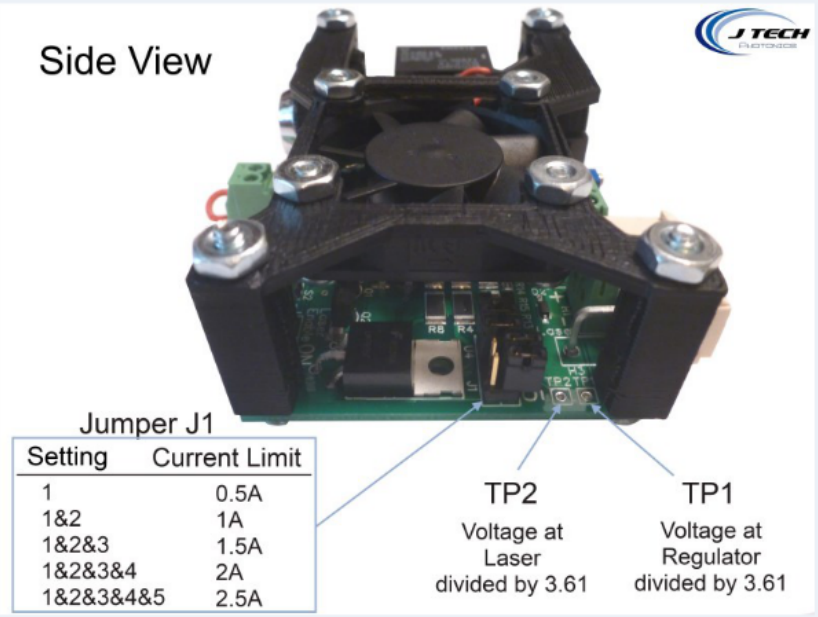
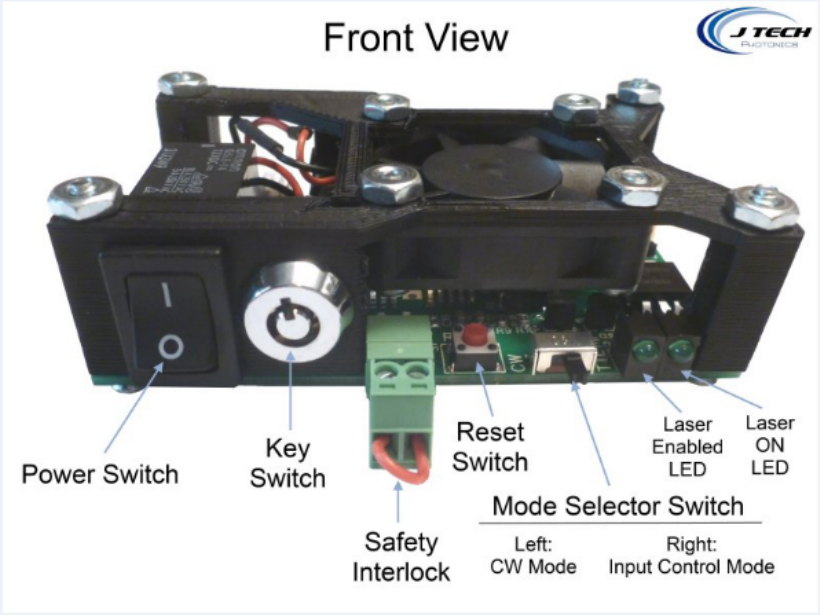
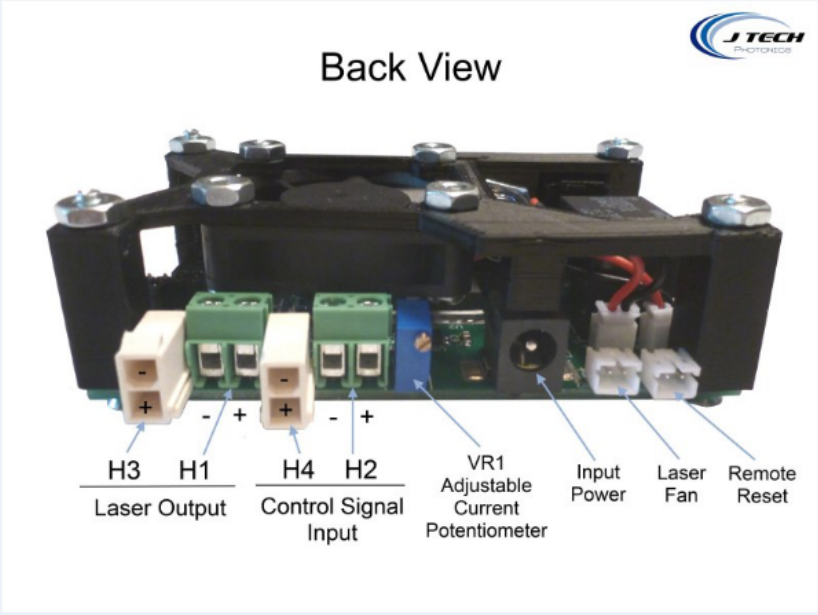
Powering of Laser Diode

- Laser Diode Driver, provides constant current source
- Laser diodes have threshold current for operation
- 2W 445nm Blue diode threshold limit 1.7A.
- Driver prevents Thermal Runway







https://jtechphotonics.com/?product=2-0-amp-adjustable-laser-diode-driver-kit-8v-compliance

Software

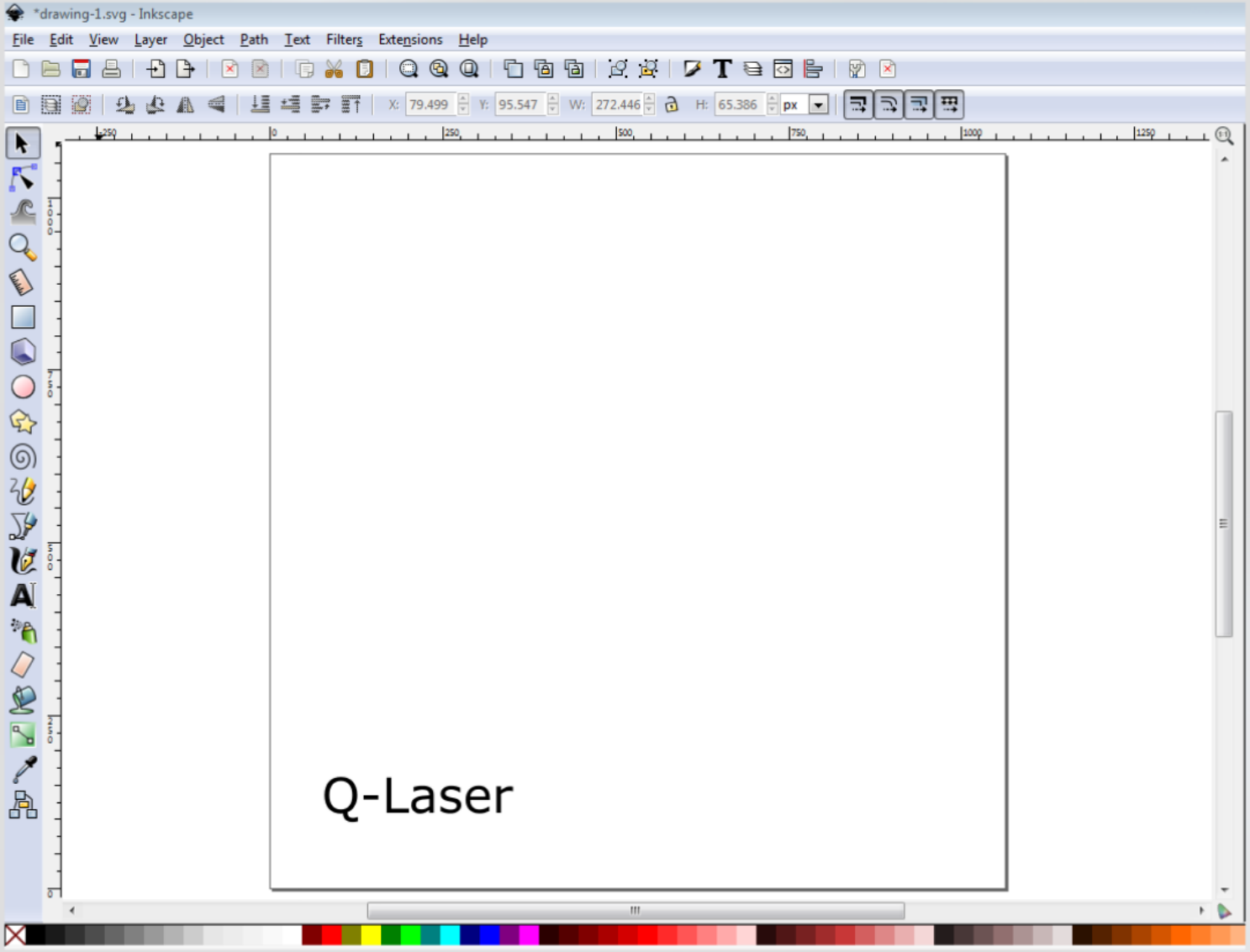
I. Objective:

- control cutting/engraving process

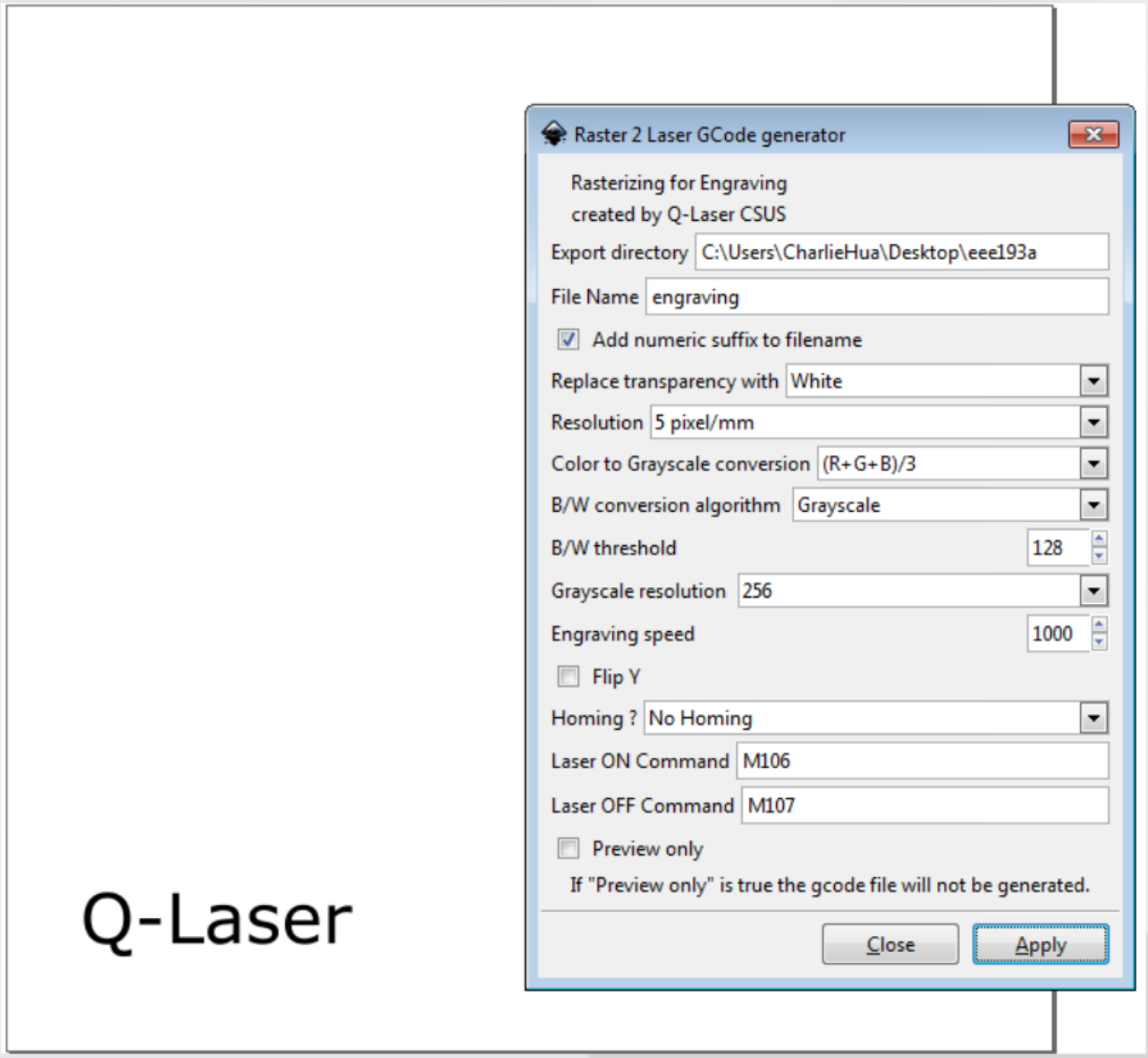
II. Process

- Design
- Generating G-code
- Execution

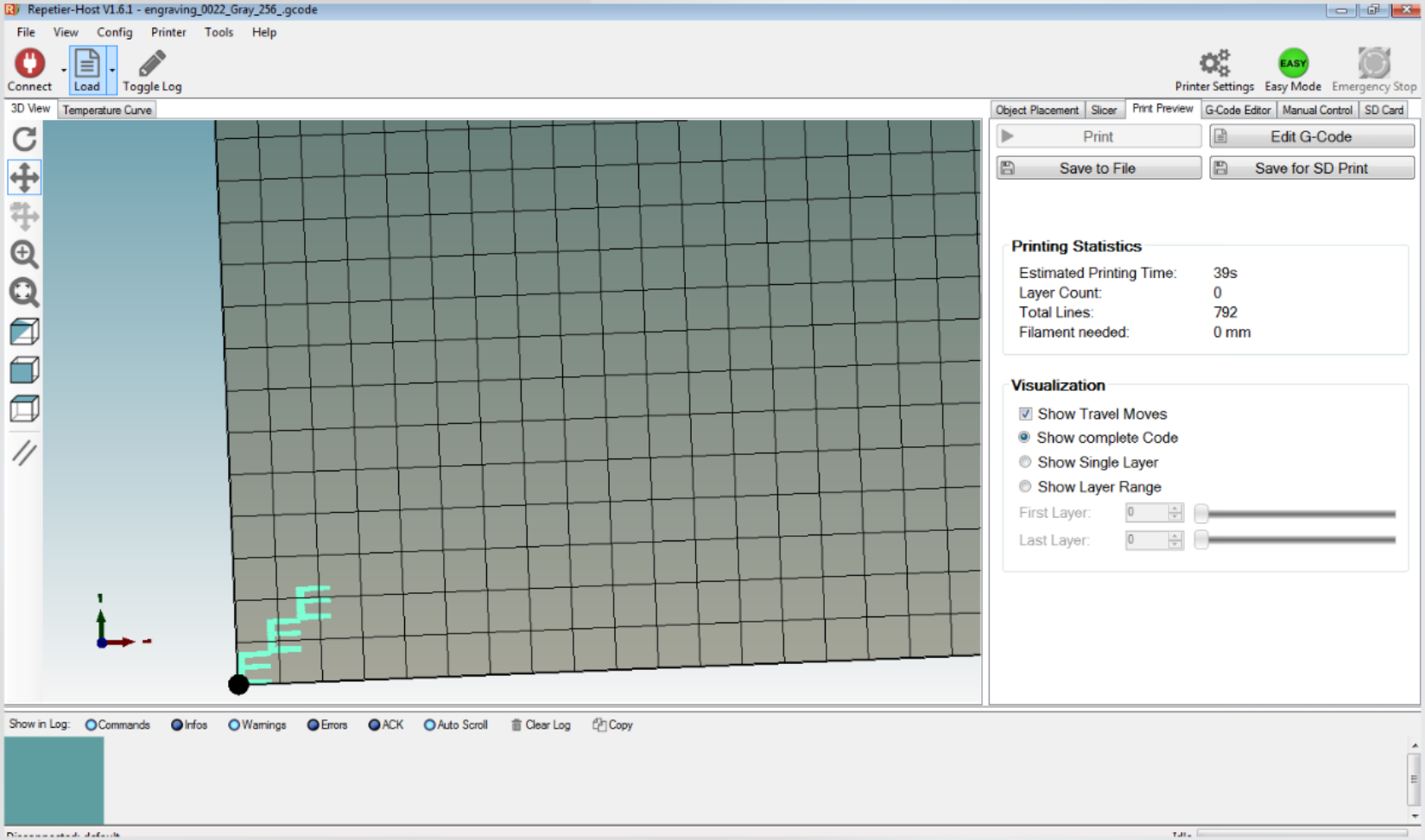
1) Design


*drawing-1.svg - Inkscape
File Edit View Layer Object Path Text Filters Extensions Help
Q-Laser

2) Generate G-code



3) Execution


Repetier-Host V1.6.1 - engraving_0022_Gray_256_.gcode
File View Config Printer Tools Help
Connect Load Toggle Log
Printer Settings Easy Mode Emergency Stop
3D View Temperature Curve
Object Placement Slicer Print Preview G-Code Editor Manual Control SD Card
Print Edit G-Code
Save to File Save for SD Print
Printing Statistics
Estimated Printing Time: 39s
Layer Count: 0
Total Lines: 792
Filament needed: 0 mm
Visualization
Show Travel Moves
Show complete Code
Show Single Layer
Show Layer Range
First Layer: 0
Last Layer: 0
Show in Log: Commands Infos Warnings Errors ACK Auto Scroll Clear Log Copy

Computer Vision

I. Why Computer Vision?

- To get dimensions of the object and location with reference to the laser starting point.

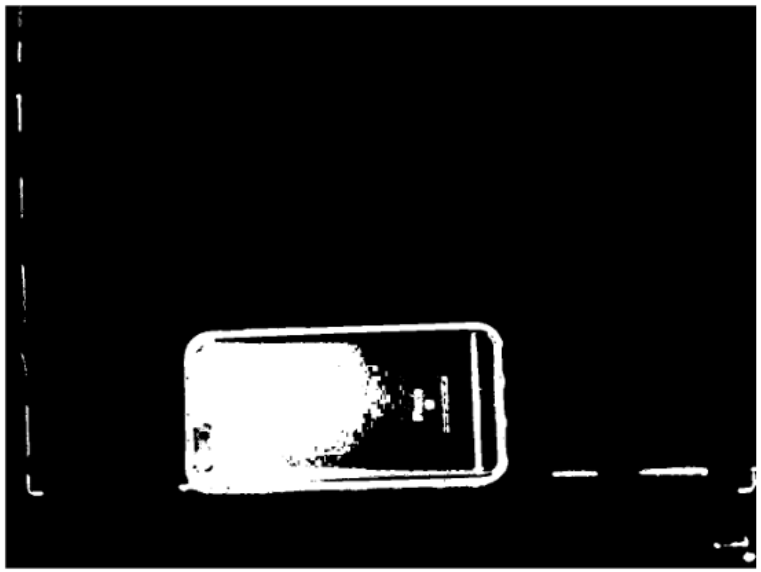
II. Main components:

- Webcam: Logitech HD C270
- MATLAB

III. Functionality (image processing)

1) Picture is captured using Image Processing and Computer Vision toolbox on MATLAB.

2) Image converted to binary image



3) Noise filtration and Morphological Transform (dilation)

4) Calibration factor to convert pixels to cm

/ ▸ Users ▸ ammarahmed ▸ Documents ▸ EEE 193A ▸

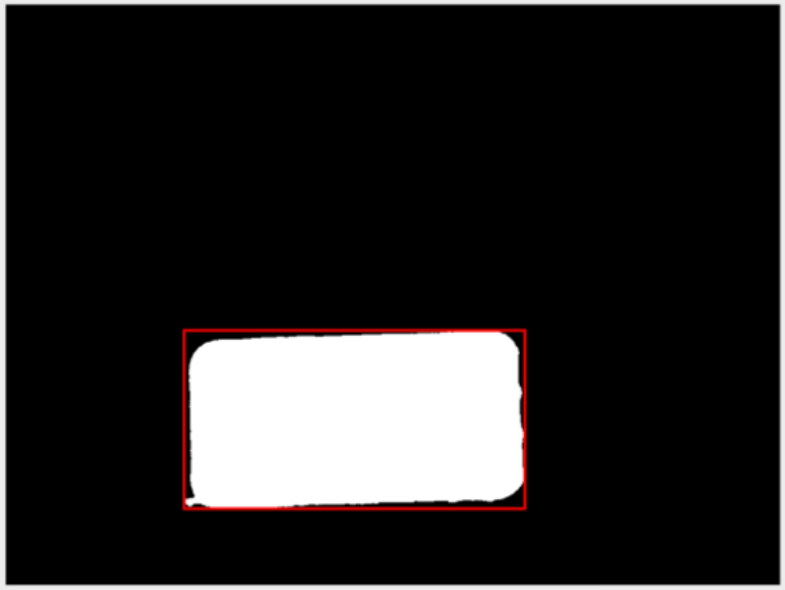
Editor - /Users/ammarahmed/Documents/EEE 193A/Drawing...

+1 | Test2.m | DrawingBox.m | Test3.m | Test5.m | +

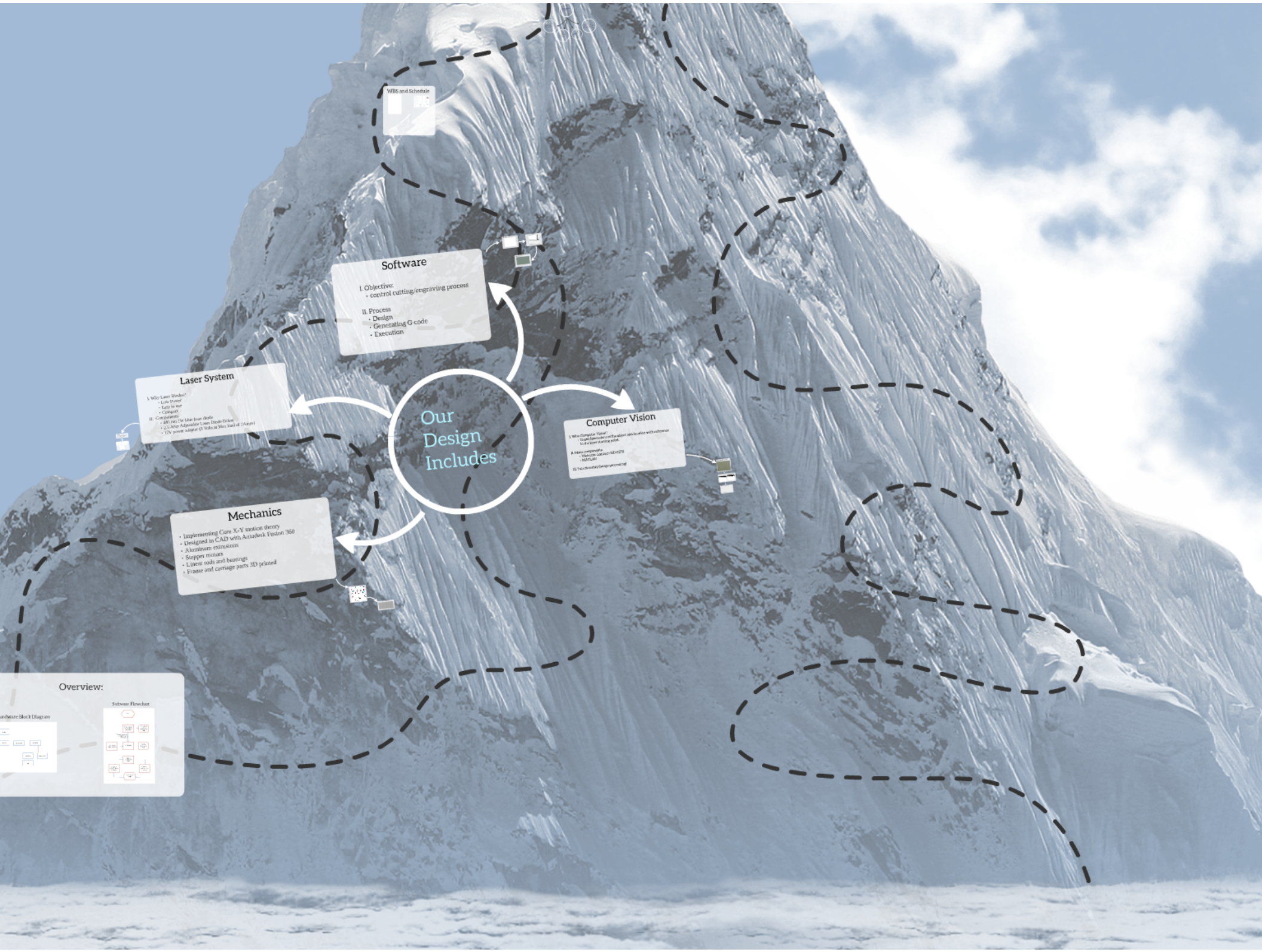
```
1 -  close all; clear all;  clc;
2
3 -  vid = videoinput('macvideo', 2, 'ARGB32_1280x960');
4 -  src = getselectedsource(vid);
5 -  vid.LoggingMode = 'disk&memory';
6
7 -  img = getsnapshot(vid);
8
9 -  SE1 = strel('disk',1);
10 - img = rgb2gray (img);
11   %imshow(img) %0.6
12 - img = im2bw (img, 0.4); %% 0.38 %0.59%0.51
13 - img = imcomplement(img);
14 - img = bwareaopen(img, 2000);
15
16 - C = imfill(img, 'holes');
17 - C = imdilate(C, SE1);
18 - figure(4)
19 - imshow(C);
20 - fname = ['Image'];
21 - imwrite(C,fname,'jpg')
22 - I = imread('Image');
23
```

Command Window

```
T =

    centerY    centerX    x1length    y1length
    _______    _______    ________    ________

    19.998     5.3385     14.075      7.2521

fx >>
```



5) Results transferred to Inkscape.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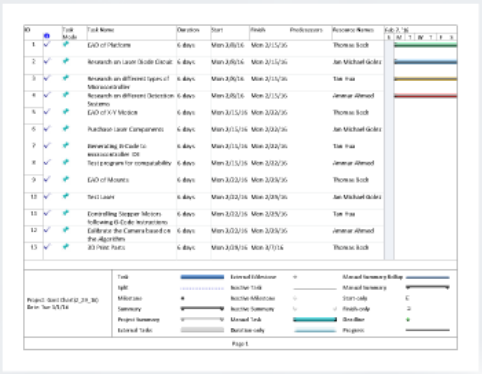
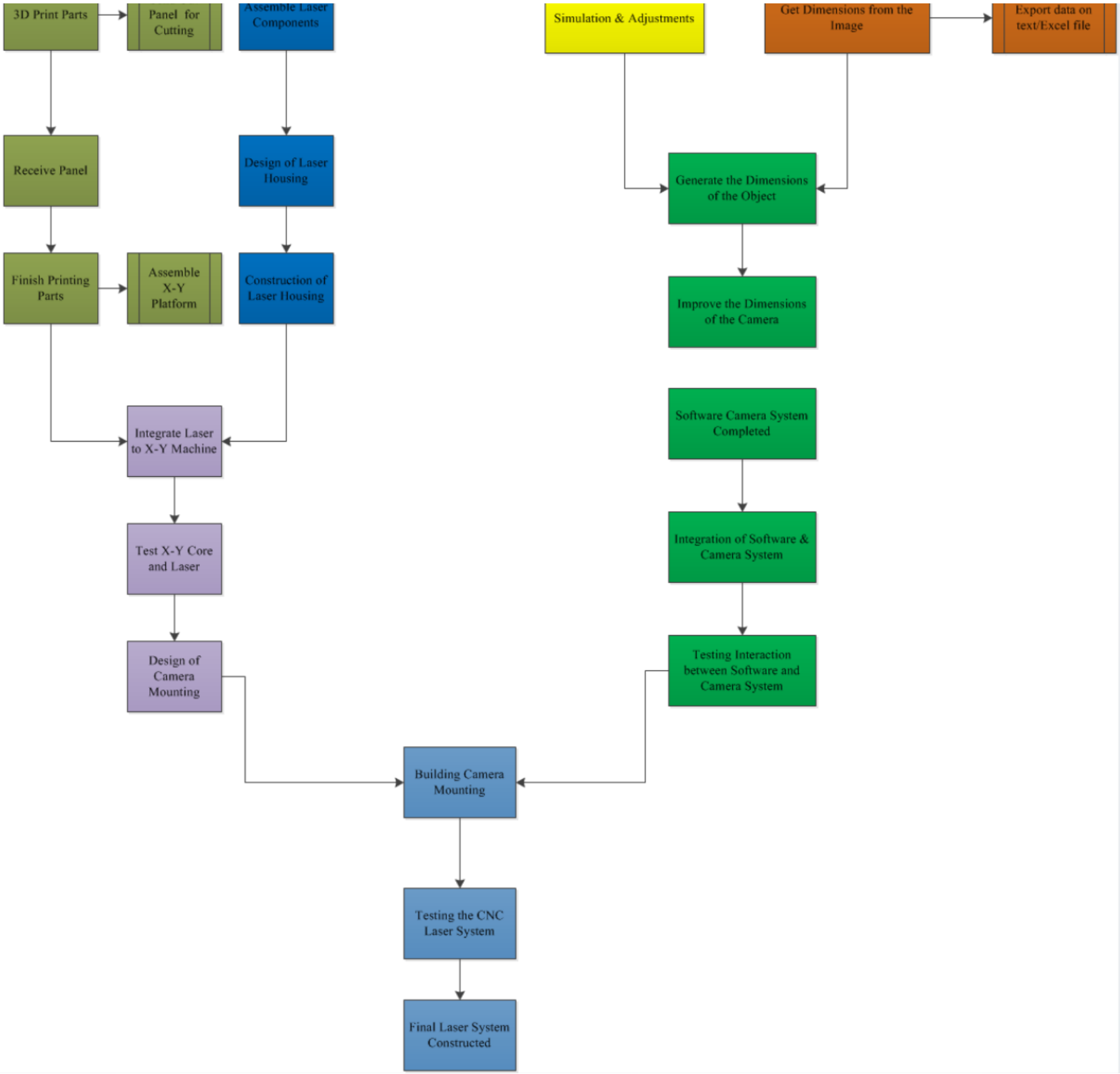
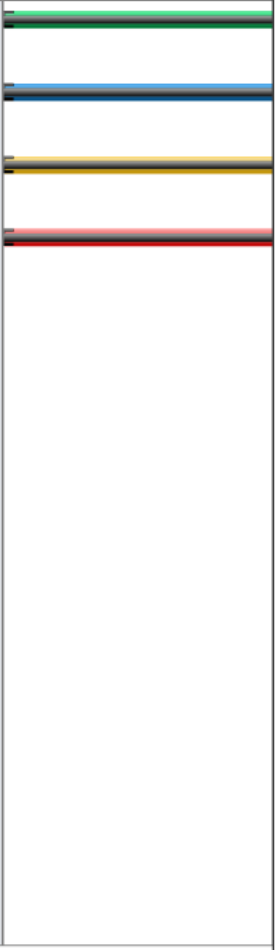



CNC Laser Cutter/ Engraver
Thomas Bock (Mechanics)
Michael Golez (Laser Diode)
Tan Hua (Software)
Ammar Ahmed (Computer Vision)
CAD of Platform
CAD of X-Y Motion
CAD of Mounts
Buy Needed Parts
3D Print Parts
Send Out Panel for Cutting
Research on Laser Diode Circuit
Purchase Laser Components
Laser Diode Laser Driver Power Supply
Test Laser
Intensity/ Wattage TTL Compatability
Assemble Laser Components
Research on different types of Microcontroller
Generating G-Code to Microcontroller IDE
Controlling Stepper Motors following G-Code Instructions
Simulation & Adjustments
Research on Different Detection Systems
Test Program for Compatibility
Work on Algorithm (Edge Detection)
Calibrate the Camera based on the Algorithm
Understand Watershed Algorithm
Get Dimensions from the Image
Export data on text/Excel file


3D Print Parts
Panel for Cutting
Assemble Laser Components
Simulation & Adjustments
Get Dimensions from the Image
Export data on text/Excel file
Receive Panel
Design of Laser Housing
Generate the Dimensions of the Object
Finish Printing Parts
Assemble X-Y Platform
Construction of Laser Housing
Improve the Dimensions of the Camera
Integrate Laser to X-Y Machine
Software Camera System Completed
Test X-Y Core and Laser
Integration of Software & Camera System
Design of Camera Mounting
Testing Interaction between Software and Camera System
Building Camera Mounting
Testing the CNC Laser System
Final Laser System Constructed

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		CAD of Platform	6 days	Mon 2/8/16	Mon 2/15/16		Thomas Bock
2		Research on Laser Diode Circuit	6 days	Mon 2/8/16	Mon 2/15/16		Jan Michael Golez
3		Research on different types of Microcontroller	6 days	Mon 2/8/16	Mon 2/15/16		Tan Hua
4		Research on different Detection Systems	6 days	Mon 2/8/16	Mon 2/15/16		Ammar Ahmed
5		CAD of X-Y Motion	6 days	Mon 2/15/16	Mon 2/22/16		Thomas Bock
6		Purchase Laser Components	6 days	Mon 2/15/16	Mon 2/22/16		Jan Michael Golez
7		Generating G-Code to microcontroller IDE	6 days	Mon 2/15/16	Mon 2/22/16		Tan Hua
8		Test program for compatability	6 days	Mon 2/15/16	Mon 2/22/16		Ammar Ahmed
9		CAD of Mounts	6 days	Mon 2/22/16	Mon 2/29/16		Thomas Bock
10		Test Laser	6 days	Mon 2/22/16	Mon 2/29/16		Jan Michael Golez
11		Controlling Stepper Motors following G-Code Instructions	6 days	Mon 2/22/16	Mon 2/29/16		Tan Hua
12		Calibrate the Camera based on the Algorithm	6 days	Mon 2/22/16	Mon 2/29/16		Ammar Ahmed
13		3D Print Parts	6 days	Mon 2/29/16	Mon 3/7/16		Thomas Bock



Project: Gant Chart(2_29_16)
Date: Tue 3/1/16

Task	External Milestone		Manual Summary Rollup
Split	Inactive Task		Manual Summary
Milestone	Inactive Milestone		Start-only
Summary	Inactive Summary		Finish-only
Project Summary	Manual Task		Deadline
External Tasks	Duration-only		Progress

Challenges and solution

Mechanics

- Initial hurdle of learning the CAD software
- Size constraints of the metal pieces
- Initial designs were too costly to produce
- 3D printed parts design
- Making sure the machine was rigid to minimize binding issues

Laser

- Pre-made Controlled Current Source, Low Current Output
  - solution: replace with X-Drive
- 1.8A X-Drive V6 Laser Driver no PWM compatibility
  - solution: replace driver with PWM
- 12V TTL 3W Laser Diode Driver current regulator busted.
  - solution: replaced current regulator
- Replacement of Laser Watt.
  - solution: Compliant Laser Best compability for Software and Hardware.

Software

- Microcontroller compatibility
  - *solution:* Arduino Mega and Ramps 1.4
- Engraving laser intensity
  - *solution:* Adjust the laser intensity to 10%

Computer Vision

- Shadows creates noise
  - solution: LED strips all to eliminate shadow
- Accuracy of measurements
  - solution: error will be there but within 3%
- Color detection issues
  - *solution:* use dark colored objects

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Safety

- Laser emission hazard
  - *solution:* safety goggles are used at all times and operated in a secure area.
- Smoke hazard
  - *solution:* external fan is used in a ventilated area
- Fire hazard
  - *solution:* temperature control built into laser driver and machine never left alone

Cost Analysis

- Group allocated budget: $1,000
  - Total cost: ~$800
- Prototype Cost: ~$500
- Comparable Machines:
  - Emblaser 2W laser cutter: ~$700
  - Glowforge 40W laser cutter: ~$2,500

Accomplishments & Design Improvement

A) Accomplishments:

- Machine is fully operational
- We came in under budget
- Minimum size requirements were meant

B) Design Improvement Ideas (for next semester):

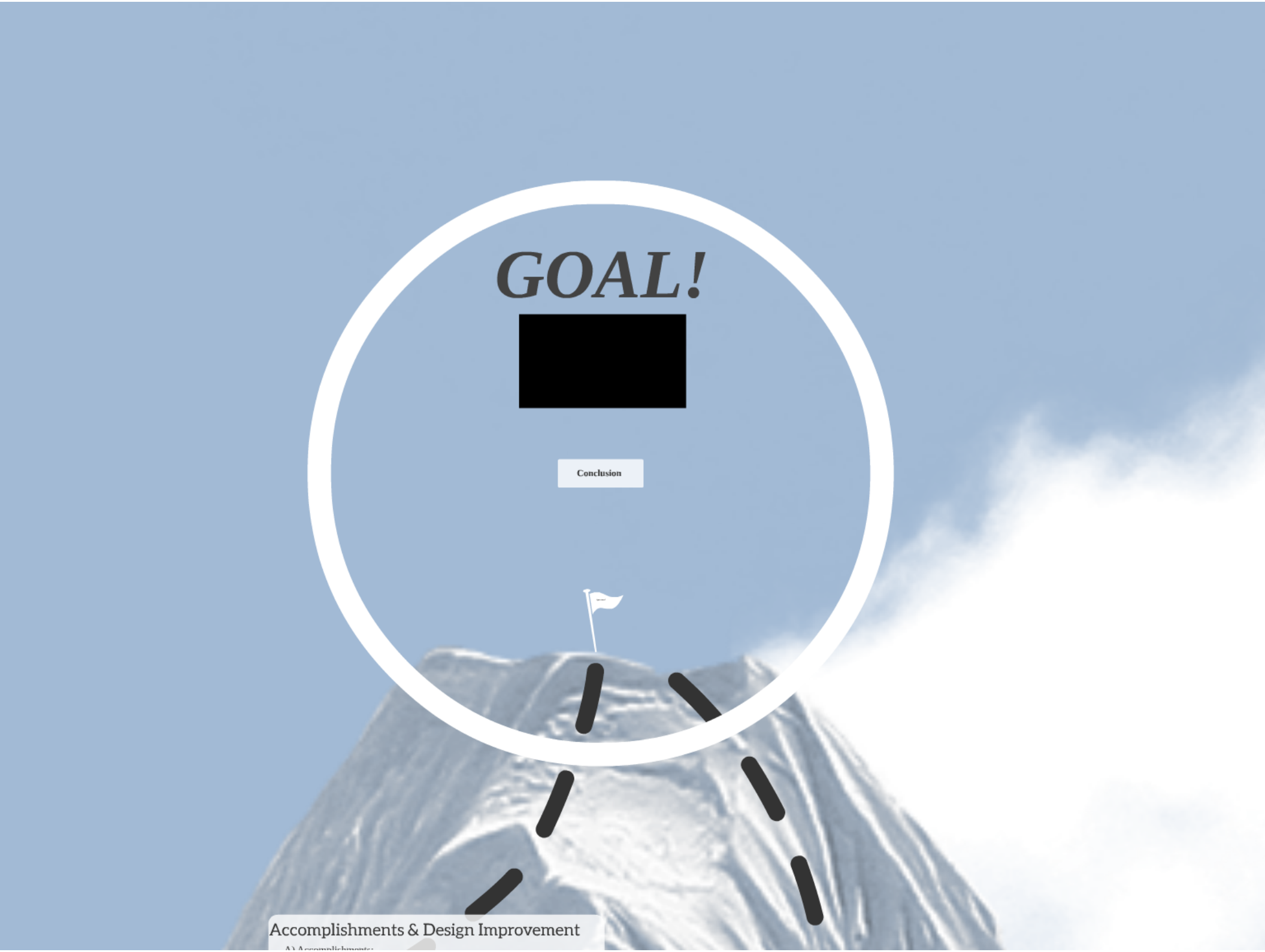
- Filtration System
- Machine enclosure
- Improve engraving algorithm
- Improve camera accuracy
- Built a connection between camera system and software to fully automate the machine

GOAL!

[redacted]

Conclusion

Conclusion


GOAL!
[redacted]
Conclusion
Accomplishments & Design Improvement

Questions?

The Q-Laser

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