



Optocheck

Automated Optical Inspection of Laser Components

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PROJECT MOTIVATION

In a laser, mirrors are positioned on opposite ends of an energized medium in order to form a laser resonator that is capable of producing a beam of light. The mirrors are vital to the function of the laser, and both must be within specified design dimensions to achieve optimal laser light performance. If the mirror dimensions are not correct, then the performance of the laser as a whole will suffer. Additionally, the mirror surfaces cannot be touched in any way or they could be damaged, since imperfections in the mirror surfaces could gravely impact the performance of the laser, which would lead to a financial loss for Iradion. In order to make sure the cost of laser production is kept at a minimum for Iradion, they need a way to quickly and accurately check the dimensions of each mirror assembly, which can be done with an in-process inspection station that can evaluate the mirror assemblies both quickly and with no contact.

ANTICIPATED BEST OUTCOME

The Anticipated Best Outcome of this project was to use a camera system and a linear stage to create a table top optical inspection station that can provide Iradion employees with a way to check if their mirror assemblies meet mechanical design criteria. The system would compare the scanned data to the mechanical model of the mirror assembly, and provide a pass or fail indicator to show if the mirror assembly meets the desired criteria. An error report would be generated if the part fails, in order to provide the user with information on the dimensions and measurements that fall outside of the thresholds.

KEY ACCOMPLISHMENTS

- 3D Scanner:** No amount of research could identify which 3D scanner would be the best within our budget. The message from the companies we have contacted has been clear: it is not easy or even possible to scan a reflective surface without using a spray or powder. For our project, we cannot make any contact with the mirror assembly, shown in Fig. 1, let alone cover it with a spray or powder. The scanners that could work without a spray or powder were far outside our budget.
- Software and GUI:** After speaking with Phil Chin, he persuaded us to use C# in our programming, as that is what is used in Iradion's software. A Graphical User Interface, or GUI, shown in Fig. 2, was created for this project. It can take data from a scan, compare them with the expected values, and display a pass or fail indicator. Additional tabs were added to show more information about the scan. The software has been adapted to automatically move the camera with the stepper motors, and trigger the camera.
- Camera System:** Our Camera System consists of the ThorLabs CS505MU camera, along with the ThorLabs MVL50TM23 lens, as shown in Fig. 4. This is then connected via Micro USB B to USB 3.0 A cable to the PC. This camera system is controlled entirely via our custom software. Used the spec sheet for the camera to determine requirements for a PC.
- CNC Router:** Since the camera system we chose has a field of view smaller than the top surface area of the mirror-sub assembly, we need a moving stage for the camera system to move on to capture the entire top-view of the mirror-sub assembly. We selected BobsCNC E3 CNC Router Kit, shown in Fig. 3, due to its compatibility with Arduino and its relatively small size, which is perfect for a table-top inspection station.
- GRBL, Arduino, and G Code:** Grbl is a highly-functional, open-source software for controlling machine motion. Fortunately, it can be flashed onto an Arduino Uno easily with the CNC Arduino shield that came with the CNC router kit. This shield also has drivers for the stepper motors that came with the kit, so they were meant to work together. Geographic Code, or G Code, is a programming language for motion. It can encompass all three axis, and is simple enough to learn. The Universal G Code Sender is software that can visualize and send G Code to the Grbl-flashed Arduino and control the motors accordingly. It has been proven that through the Universal G Code Sender, or UGS, commands can be given to control the motors. However, it is not needed for this project, as lines of G Code sent through the Arduino Serial Monitor are enough to control the stepper motors. Fortunately, there is a way to communicate with the Arduino Serial Monitor via C#. Additionally, there is also a way to take a text file containing G Code and turn it into an array of strings. With these ideas combined, it was possible to automate the stepper motor control process.
- Image Processing:** Matlab will be used for the image processing side of the project. Matlab has all of the toolboxes necessary to get the measurements we need, and can be easily implemented into our C# code. The image processing and computer vision tool boxes will be used in our application, in order to access certain Matlab functions that will allow us to make measurements, adjust contrast, detect pixels, and much more. Additionally, the camera should be able to export pictures directly into Matlab for processing, which will make the whole process go smoother.

IRADION
Ceramic Core CO₂ Lasers

PROJECT OUTCOME

The Anticipated Best Outcome was not achieved. While falling short on image processing, software that is capable of triggering the camera and its movement on the CNC router was successfully designed.

FIGURES

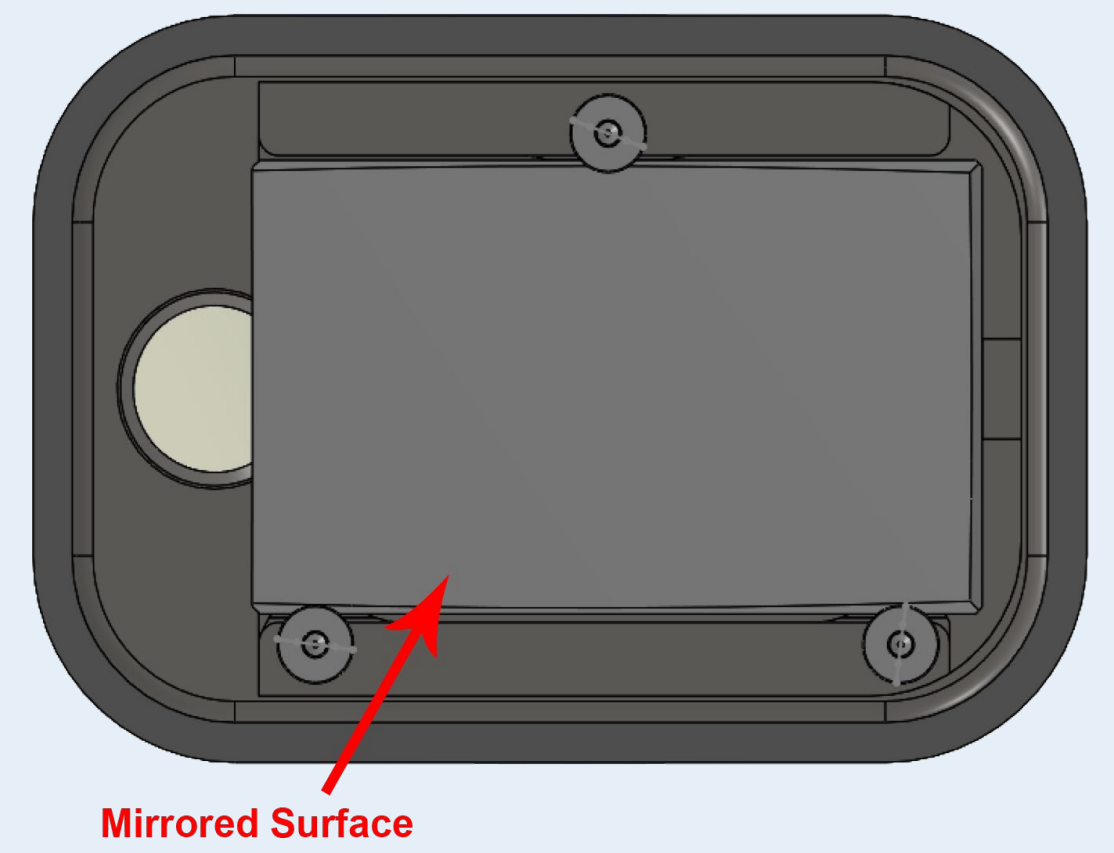


Fig.1: Laser Mirror Subassembly, the part we are trying to analyze

Name	Expected Value	Measured Value	Pass/Fail
Position	>8.83 mm and <8.93 mm	8.86 mm	Pass
Roll	>-1° and <1°	0.45°	Pass
Pitch	>-0.06° and <0.06°	0.07°	Fail
Yaw	>-0.06° and <0.06°	-0.03°	Pass

Fig.2: Graphical User Interface After Scan Has Completed

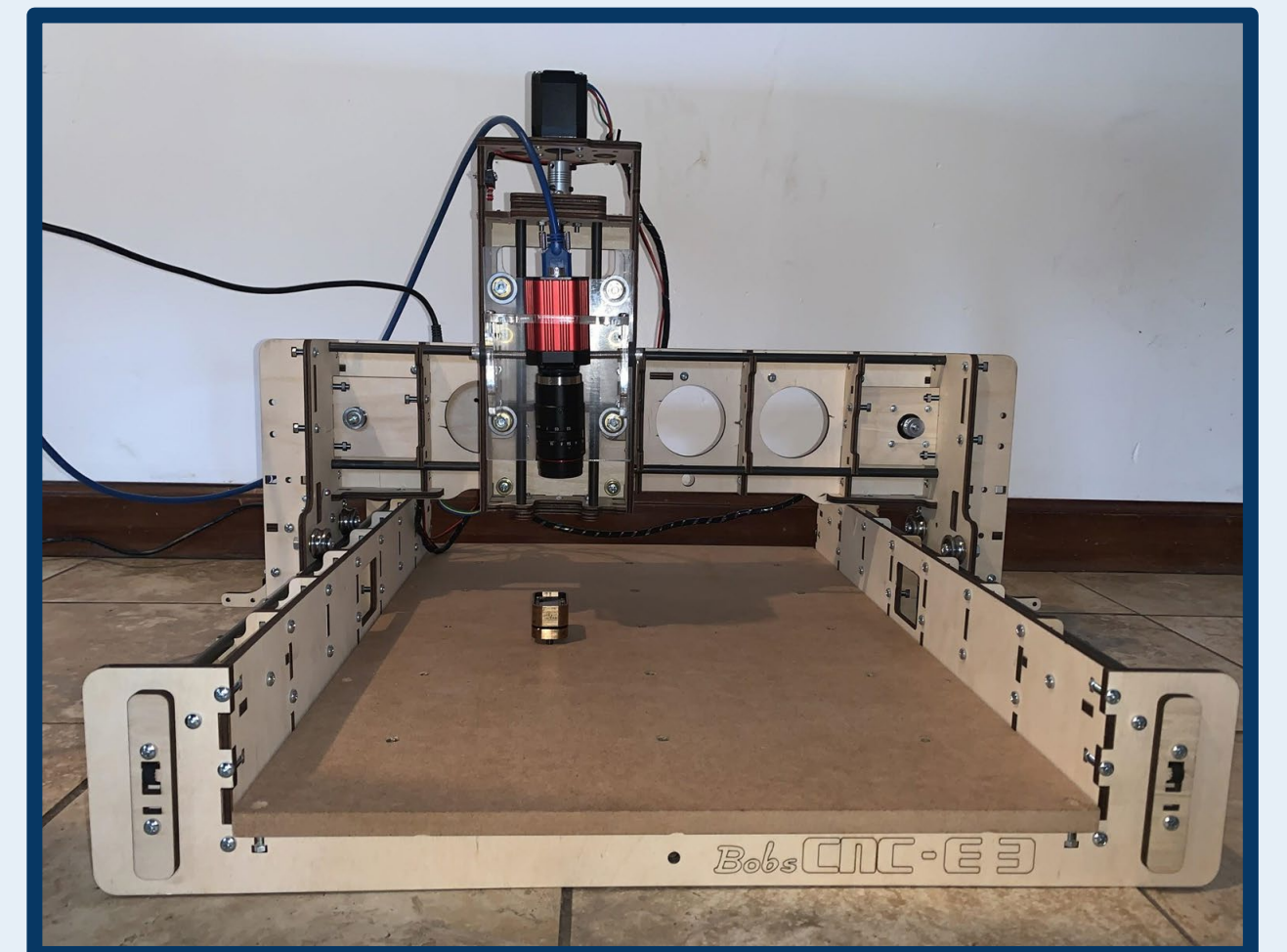


Fig.3: CNC Router Hardware



Fig.4: CS505MU Camera with MVL50TM23 Lens