AutoLase

Automatic Laser Optimization

ELECOMP Capstone Design Project 2017-2018

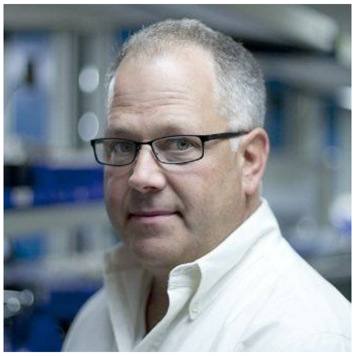
Sponsoring Company:

Iradion Laser, Inc.
51 Industrial Drive, North Smithfield, RI, 02896
Phone: (401) 762-5100
www.iradionlaser.com

Company Overview:

Since 2007, Iradion Laser, Inc., has been dedicated to design, development, and manufacture of various CO_2 lasers for a wide range of applications in industrial, medicine, science, and military. Iradion's custom, RF excited, ceramic core CO_2 technology provides a significant edge over competitors by placing all reactive components outside of the laser vacuum. This makes Iradion's lasers far more reliable over time, last longer, as well as easier to build. Iradion Laser, Inc. distributes their products worldwide with distributors in Germany, India, Korea, Japan, and more. Applications include laser cutting, laser welding, marking, laser coding, laser drilling, medical, and semiconductor. Iradion's headquarters and manufacturing facility is located in North Smithfield, RI.

Technical Director:



Robert Milkowski
Engineering Manager
Email: rmilkowski@iradion.com
LinkedIn: https://www.linkedin.com/in/robert-milkowski-5b4b551b/

Project Motivation:

At its most basic, laser light is produced through stimulated emission within a lasing medium. Mirrors at both ends of the laser cavity are used to provide feedback. Thus, a laser resonator is formed. This means that the alignment of the mirrors with respect to the medium and other mirrors heavily impacts many attributes of the laser beam. Two attributes in particular this project will focus on is the power output of the laser and its spatial beam quality.

Currently, the mirrors are adjusted for optimal power output and spatial beam quality by using long screwdrivers to turn a series of screws on the back of the mirror. Even for simple mirror systems, this task has proven to be tedious, inaccurate, and takes many hours from the production team's valuable time. For more complex mirror systems, it can take a full day or even multiple days to optimize the power output and spatial beam quality of the laser. This is simply too much time.

The aim of this project is to design and implement the necessary hardware and software to automate the process of adjusting mirrors for optimal laser attributes.

Anticipated Best Outcome:

The best outcome would be to create software and hardware to automate the alignment of mirrors such that power output and spatial beam quality of the laser beam are optimized.

Project Details:

Mathematical tasks include:

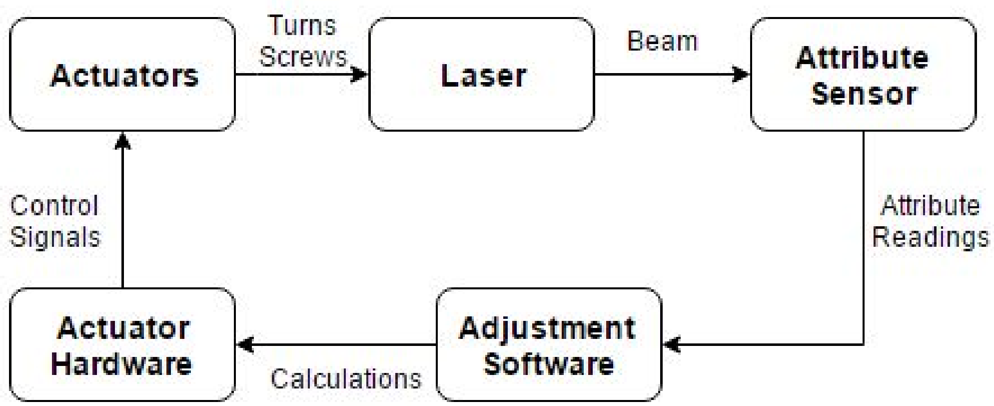
- Mathematically model the laser beam and laser attributes.
- Understand how each laser attribute is related to each other.
- Mathematically model how each laser attribute is related to mirror adjustments.

Software tasks include:

- Using the mathematical models, implement software that will calculate the amount each screw must be adjusted to achieve optimal spatial beam quality and power output.
- Software for linking the laser software to the hardware.
- Optimize software for speed.

Hardware tasks include:

- Research applicable actuators for rotary movement of screws. Actuators must be precise enough for compatibility with specific screw threading.
- Build hardware interface to link the software and the actuators.
- Build hardware to link the attribute sensor system and software.



Block diagram of the automatic laser adjustment procedure.

The first major task is to work with a helium neon (He-Ne) laser beam in a simple mirror reflection configuration to automate the adjustments of the three mirror tilt adjustment screws for a single mirror mount, simultaneously to compensate for their cross-coupling through the mirror mount flexure membrane such that the spatial position of the reflection can be controlled and adjusted to deflect the beam along truly orthogonal directions.

From here, the team can begin to implement calculations for spatial beam quality and power output by mathematically modeling and implementing them into software.

The power is measured with an external power meter and the mode beam quality (BQ) is measured with burn cards in production now. We can measure beam quality using the Spiricon Beam Profiler by passing the beam though a lens and measuring the beam sizes in X and Y vs distance before/after the lens. A simple curve fit and calculation yields the M-squared values in these orthogonal directions.

The programming language used for calculation implementation is still up for discussion. (Mathematical, LabVIEW, etc.)

The actuator hardware must be designed so that removing it will not misalign the mirror positions. It must also be physically portable.

If time permits, the team can then apply the above to more complex mirror systems, such as the Z-folded configuration, and to lasers of higher power levels.

Composition of Team:

Two computer engineers who will split:

- Learning laser physics and laser beam attributes.
- Creation of a mathematical model of how attributes relate to screw adjustment.
- Programming the alignment algorithms
- Actuator hardware
- Hardware required to link software and actuator hardware, and sensing hardware.

Skills Required:

- Strong Mathematical Background
  - Multivariable Calculus
  - Differential Equations
  - Mathematica (preferred)
- Programming Experience
  - Object Oriented Programming
  - Low-level Programming
- Knowledge in Digital and Analog Circuits

Anticipated Best Outcome's Impact on Company's Business:

The impact that the best outcome will have on Iradion Laser Inc. is massive. The current process of mirror alignment is extremely tedious and time consuming and therefore automation of this process will significantly speed up production.

The system can be applied to build a variety of laser products with greater consistency and better performance.

With the rapid optimization of desired laser attributes, Iradion can significantly increase the throughput of lasers sold every month thus increasing profitability of the company.

Broader Implications of the Best Outcome on the Company's Industry:

The introduction of automation in the laser adjustment procedure will create an opening for increased specialization of workers within the industry. Such specialization will drive innovation and produce higher quality products at a significantly lower cost.