L3 Photonics
Controlling an Optical Fiber Based Interferometer

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Abstract

Fiber optic interferometers are used in countless sensing, measurement, and communications applications. The all-optical method can be extremely sensitive to external thermal and mechanical variations.

For many of the applications of interest to L3 PHOTONICS, stringent stability is required. To compensate for these external influences a control system is needed that can appropriately adjust the phase, polarization and/or amplitude of the interferometer. For many of the intended applications, the phase is the most critical and fastest varying parameter but also the most linear/direct transfer function for the input to output response. This project is to determine the optimum phase control method using both traditional feedback systems as well as explore the application of machine learning methods in a control system.

Team

- **Mike Mencel:** Electrical Hardware Specialist
- **Taylor Wong:** Machine Learning/Software Specialist
- **Jackson Herget:** Machining Specialist
- **Brandon Hardy:** Electrical Hardware Specialist

Solution Requirements

- Achieving stability and robustness by adjusting 3 parameters: Phase, Amplitude, and Polarization
- Measure the stability of the open-loop system in a mechanically-controlled environment
- Compare our control system to an existing/active open loop control system
- Environmental factors: Temperature, Vibration, Pressure, Sound, and Humidity
- Total cost less than $1,000

System Design

- ✓ Microcontroller to implement PID control system
- ✓ Explore machine learning approaches to implementing a control system to increase stability
- ✓ Thermal and vibration isolation using a cooler and anti-vibration mounts

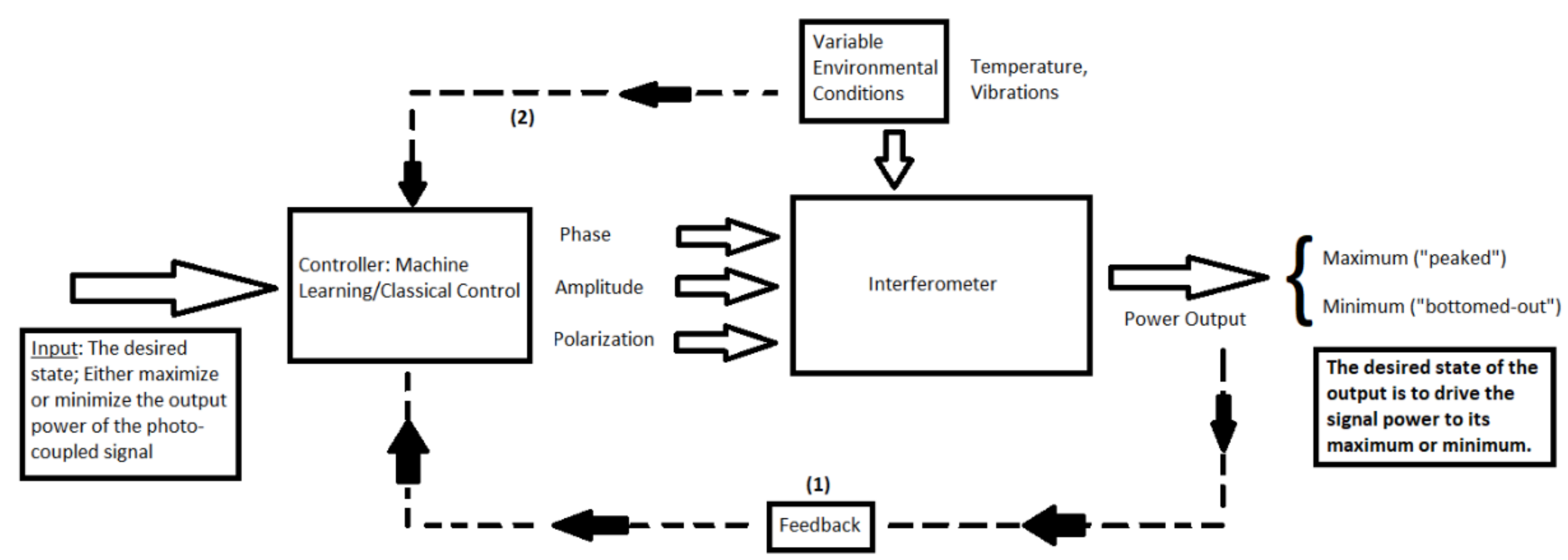


Figure 1. Customer Requirement Schematic for Interferometer Control System

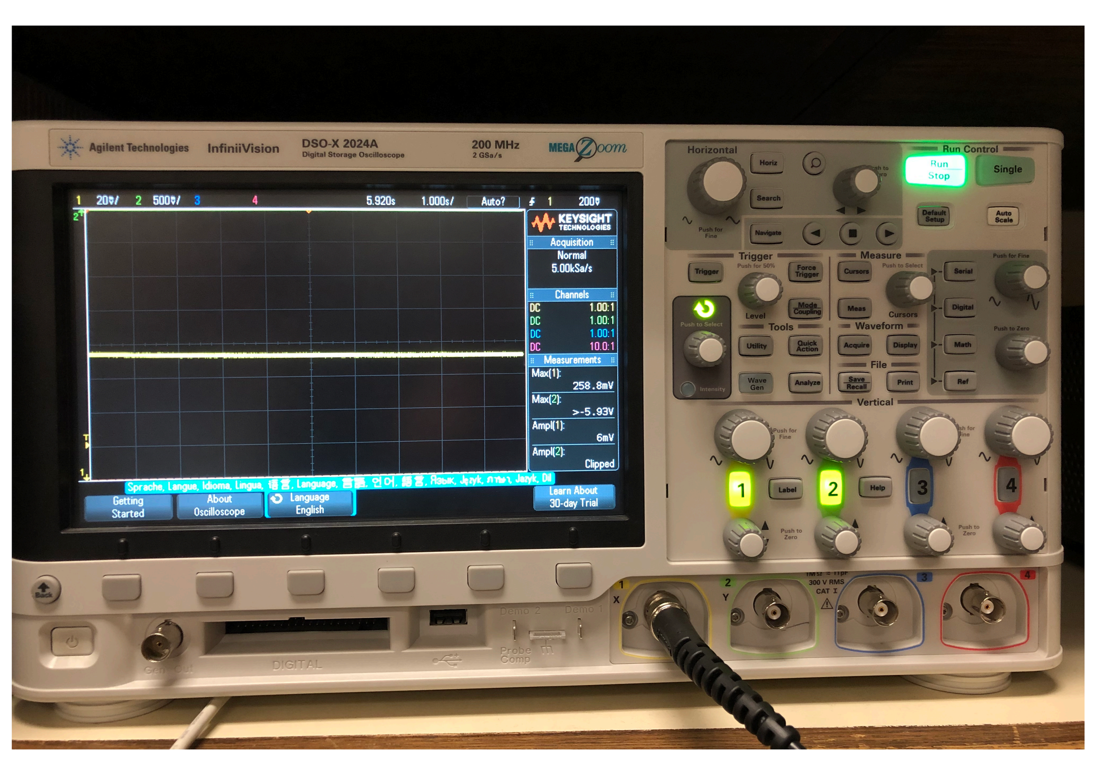


Figure 2. Interferometer Baseline

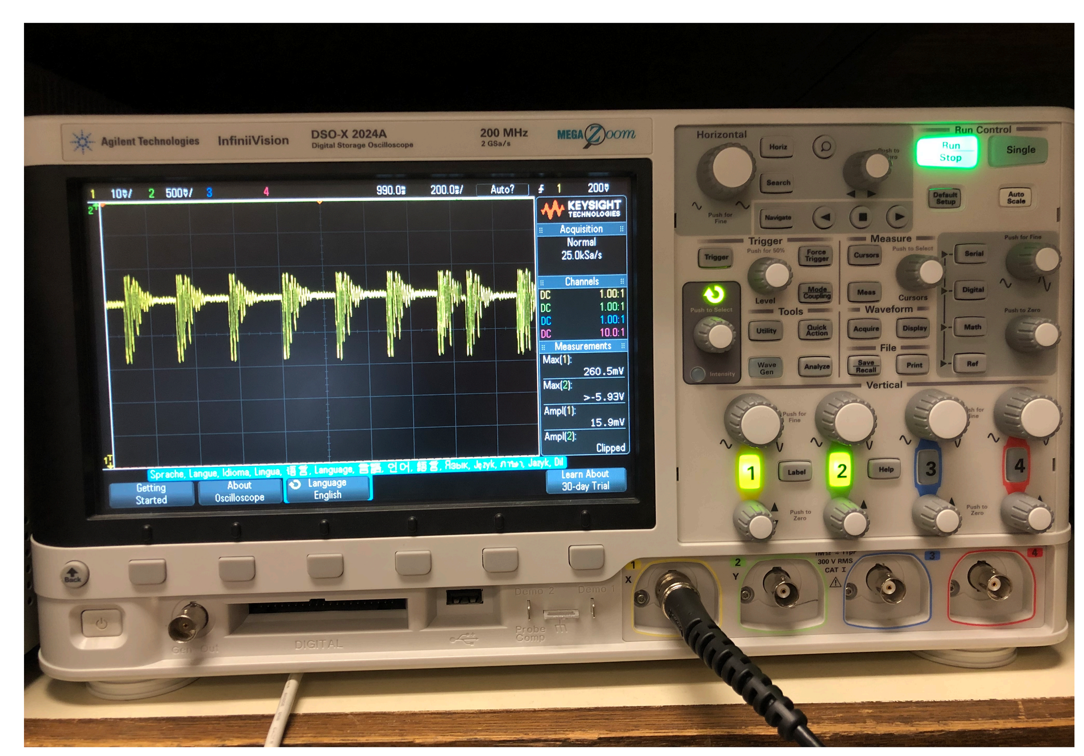
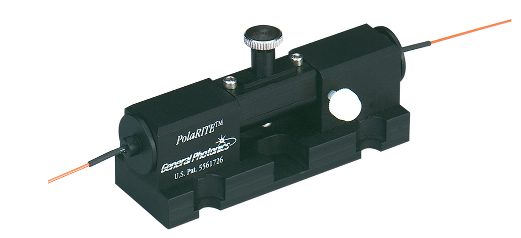


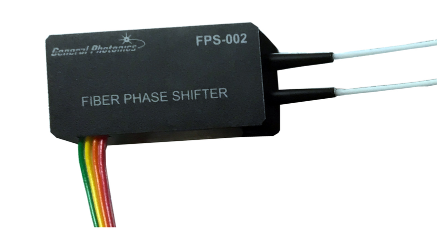
Figure 3. Interferometer With Disturbance

Major Subsystems

Microcontroller
PIC18F4321 used to control fiber phase shifter to achieve desired voltage output



Polarization Controller
Twist, squeeze, and rotate fiber to alter the polarization of one channel of light to match the other



Fiber Phase Shifter
Delays light phase by a variable amount proportional to the input volt

NoTail Coupler/WDM
Splits and recombines fiber optic signals

SFP Driver (CW Only)
10W laser driver outputting light to the input at a constant frequency

Universal Fiber Optical Detector
Converting a fiber optic signal to an electrical signal (voltage)

Project Plan

First Semester:

- Identified major components for final system
- Data collection on open loop uncontrolled system
- Mechanical and environmental isolation and design

Second Semester:

- Build and implement algorithm on PIC18F4321
- Compare results to data collected in first semester
- Machine Learning Application to Control System