Senior Design
ENG EC 464

Memo

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Date: 2/13/18

Subject: Secondary Testing

1.0 Tracking Method 1: Tracking with one photodiode

1.1 Description of Test

In this test we will test tracking using one photodiode. The laser will make a circle to catch the photodiode when the signal is lost. When a point of the circle crosses the photodiode, we will try to center the laser onto the photodiode. As the photodiode moves around, there will be a circle encasing the photodiode.

1.2 Significance of Test

Tracking is the main problem in this project, and also the most difficult part. This tracking algorithm requires us to accurately predict when and where along the circle the laser has hit the photodiode so we can center the laser on the target. In order to do so, we would have to know the delay in our communication. We wanted to experiment with various tracking algorithms and see which one would suit our project the best.

1.3 Equipment and Setup

Single photodiode connected to an Arduino Leonardo via Analog Pin. Pair of NRF24L01 2.4GHz transreceivers each connected to a Arduino Leonardo, one with the photodiode array, the other with the base station. Arduino on the base station connected to a Particle Photon that is responsible for controlling the MEMS Mirror that is reflecting the laser.

1.4 Data Collection

The data will be serial prints from our microcontrollers.

1.5 Measurable Criteria

The metric for measuring success of our test would be if the circle can accurately follow the photodiode in every direction. In addition we will be measuring how far away and at approximately what speed the algorithm works.

2.0 Tracking Method 2: Tracking with five photodiodes

2.1 Description of Test

In this test we will demonstrate a rudimentary laser tracking mechanism. This test will use a laser (always on) being pointed with a MEMS mirror and a cluster of 5 photodiodes as the receiver. The photodiodes are arranged in a cross configuration. As the receptor moves left and right or up and down, the laser should be able to follow it.

The MEMS is programmed to move at a constant speed when it is not pointing at the target. When the laser hits the left photodiode, an interrupt is triggered and the MEMS changes its direction to move right. When the laser hits the right photodiode, an interrupt is triggered and the MEMS turns left. Similar interrupts are programmed for the up and down photodiodes. This test is an improvement upon the testing done last semester, since the laser will not move when it is directly hitting the target, so the tracking algorithm is slightly more stable. There are three main disadvantages of this tracking algorithm:

- We do not change the speed at which the laser moves when the target is lost, so the tracking will fail when the target is moving faster than the hard-coded speed of the laser.
- This algorithm could be improved if we program it to follow the target based on its past behavior (using a Kalman Filter for instance).
- There is no way to recover when we lose track of the target.

2.2 Significance of Test

As mentioned before, tracking is the main problem in this project. While the tracking setup demonstrated during this test is primitive, it is a good base to build more sophisticated tracking mechanisms upon. This test demonstrates our ability to control the laser with the MEMS.

This simple tracking algorithm gives a useful baseline to build upon for more sophisticated tracking methods.

2.3 Equipment and Setup

5 photodiodes in a cross configuration connected to an Arduino Leonardo via Analog Pins. Pair of NRF24L01 2.4GHz transreceivers each connected to a Arduino Leonardo, one with the photodiode array, the other with the base station. Arduino connected to a Particle Photon that is responsible for controlling the MEMS Mirror.

2.4 Data Collection

The data will be serial prints from our microcontrollers.

2.5 Measurable Criteria

The metric for measuring success of our test would be to approximate the maximum speed at which the laser still reliably follow the photodiode array. In addition we will be testing how far away the tracking algorithm works.