

Light Materials Testing Rig Drive Calibration Testing

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Abstract:

This report contains the test data from a load test device and its accuracy in its calibration of the movable member. On average the error in velocity is approximately 0.95% +/- 0.36% faster than the target velocity on average.

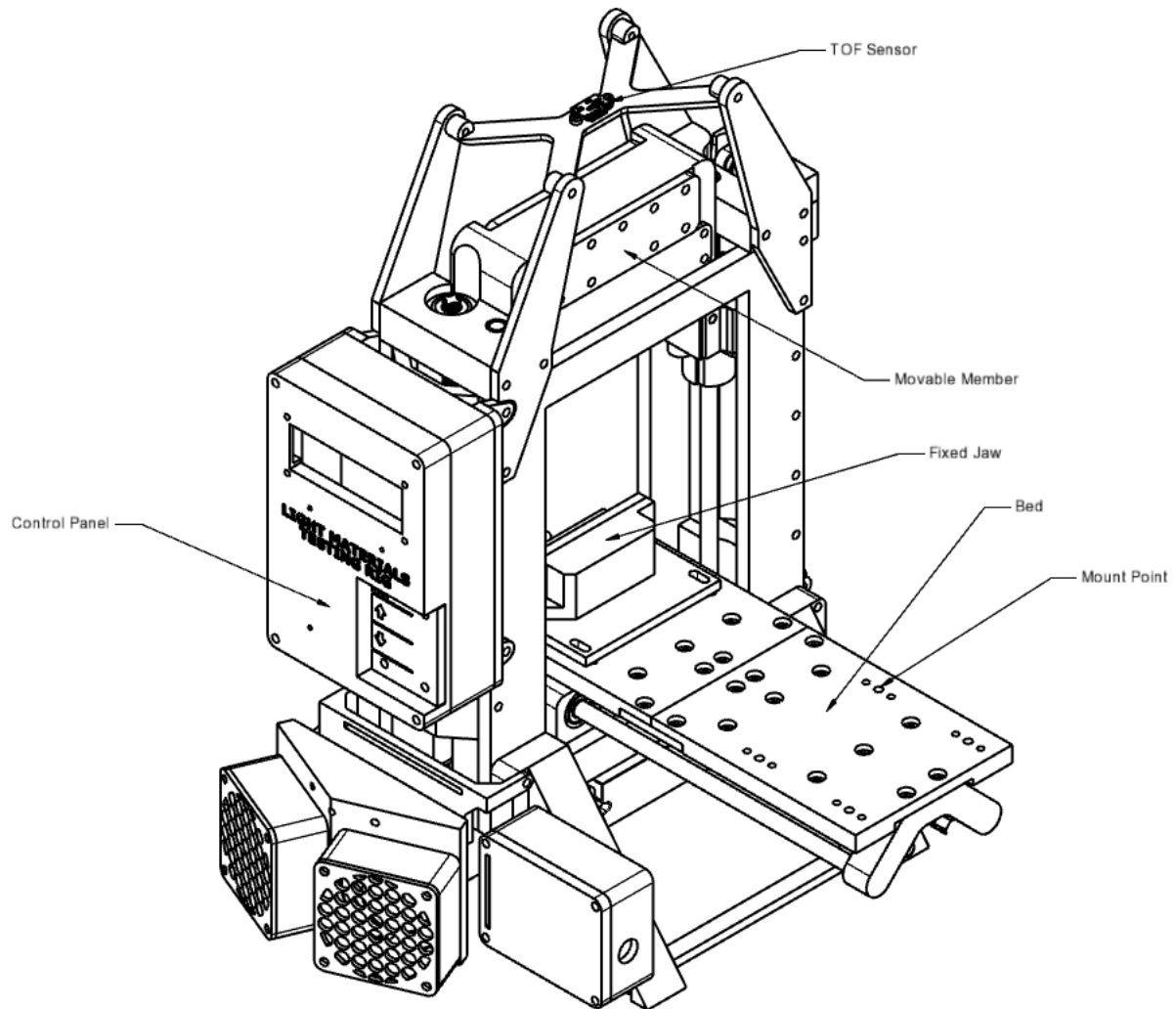
Introduction:

The objective of this experiment is to verify the calculations and methods used to set the velocity of the moving member in the load test rig.

Materials and Methods:

Materials:

- Stepper Motor
- VL53L0/1XV2 TOF Sensor
- Raspberry pi pico Microcontroller
- 8 mm pitch lead screw
- DM542T Stepper Driver

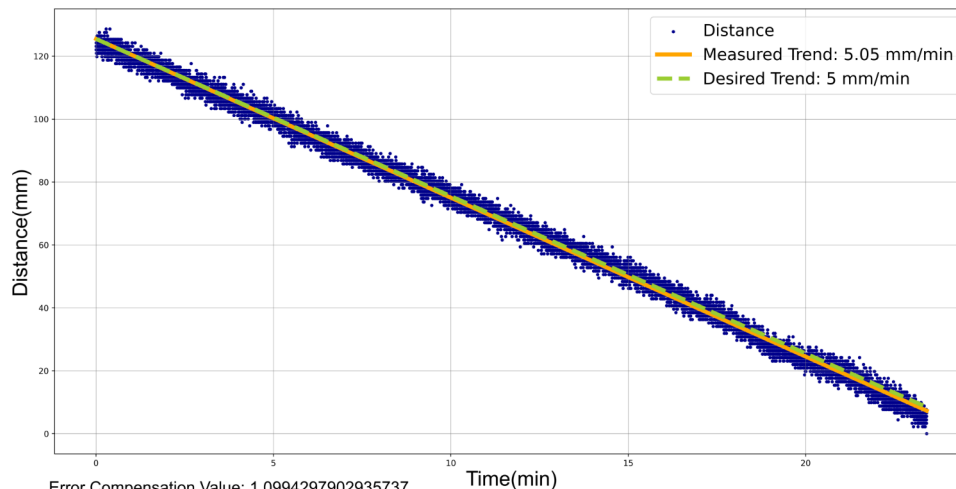


Methods:

- TOF Calibration:
 - To calibrate the TOF sensor two distances were measured (with the sensor and a digital vernier caliper) from the TOF sensor mount to the movable member. Due to the TOF sensors low accuracy from a single measurement approximately 5000 data points (outliers were removed) were gathered to achieve the most accurate value for both distances. The two measurements were subtracted (caliper measurements [84.95 mm +/- 0.01 mm and 63.75 mm +/- 0.01 mm] and TOF measurements [109.05 mm +/- 0.04 mm and 89.76 mm +/- 0.04 mm]). From the difference in the two distances an error compensation value was created: 1.099 mm/TOF measurement.
- Velocity control formula:
 - $$\frac{\text{Screw Pitch} * 60000 \text{ ms/min}}{2 * \text{Pulses Per Revolution} * \text{Target Velocity (mm/min)}}$$
 - The formula describes half the length of what the pulse should be (for the on and off period of the pulse, with an on and off or off and on being considered a complete pulse)
 - Pulses Per Revolution:
 - Amount of pulses per revolution can be modified through the dip switches on the DM542T Stepper Driver and was set to 400 pulses for this test
- Testing:
 - There were a series of 6 tests that were conducted ranging from 1 mm/min to 50 mm/min. To run each test a target velocity was inputted and the movable member was placed approximately 100-120 mm away from the TOF sensor. Over the course of 120-2.5 min the movable member traversed its way until the TOF sensor read a return of 0 mm or less.

Results:

Calibration Graph



Error Compensation Value: 1.0994297902935737
Slope: -5.049612486852339 mm/min
R Value: -0.9984040189849359
CI(95%): 0.004553926657563667 mm/min
Number of Samples: 15117

Interval
Positive: -5.045058560194775 mm/min
Negative: -5.054166413509902 mm/min

On average the testing rig movable member traversed on average 0.95% +/- 0.36% faster than the target velocity. The graph shows what an average error might look like when plotted.

Discussion:

It is currently unknown what is causing this overshoot in velocity, however, this could stem from the `time.sleep_ms()` function found in Micropython, since it requires an integer to function it may be that the delay input gets truncated shortening the delay just enough to induce this error in velocity.

Conclusion:

An unknown mechanism shortening the pulse length on the pico board causes a subtle increase in velocity in the range of 0.95% +/- 0.36% for most given velocity inputs.