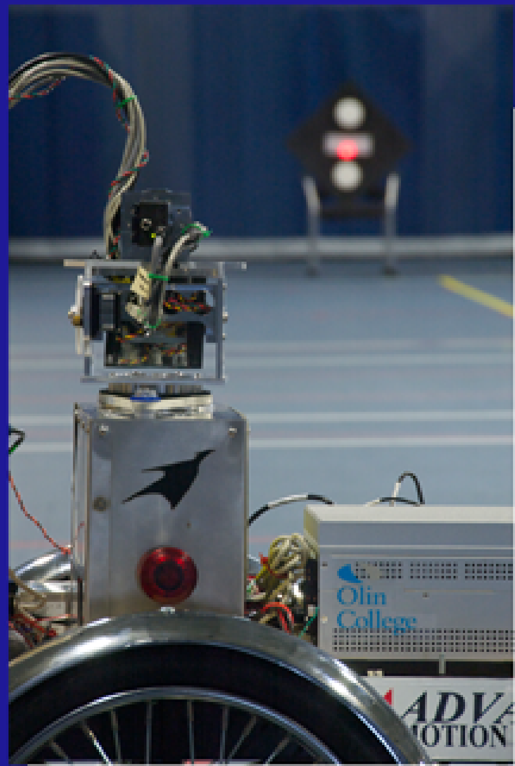
Affordable Relative Positioning Sensor



Project Background

The purpose of the MIT Lincoln Laboratory 2010-2011 SCOPE project is to build upon last year's development of an affordable, high accuracy relative position sensor. In certain situations, it is desirable to have a potentially expendable unmanned system that will serve to prevent damage to a more valuable, manned system. Expendability necessitates low-cost, therefore it is important that our unmanned lead vehicle not contain expensive technology.

MIT Lincoln Laboratory

SCOPE
Senior Capstone Program in Engineering

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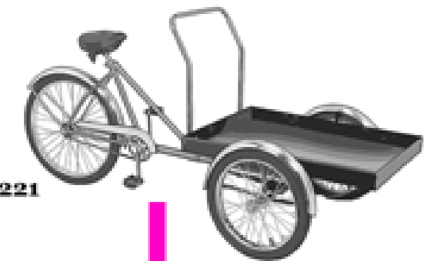
System Overview

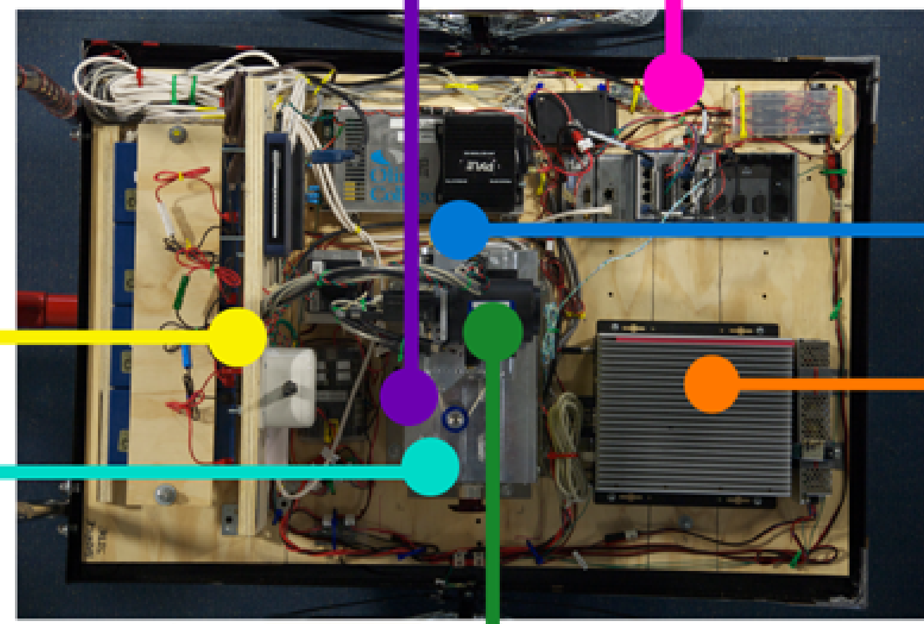
This year, the team expanded on the 2009-2010 SCOPE Team's optical turret system. A tracking turret, mounted on the follow vehicle, uses a set of cameras to track the target visually. A laser rangefinder is aimed at the lead target, returning a heading and a distance.

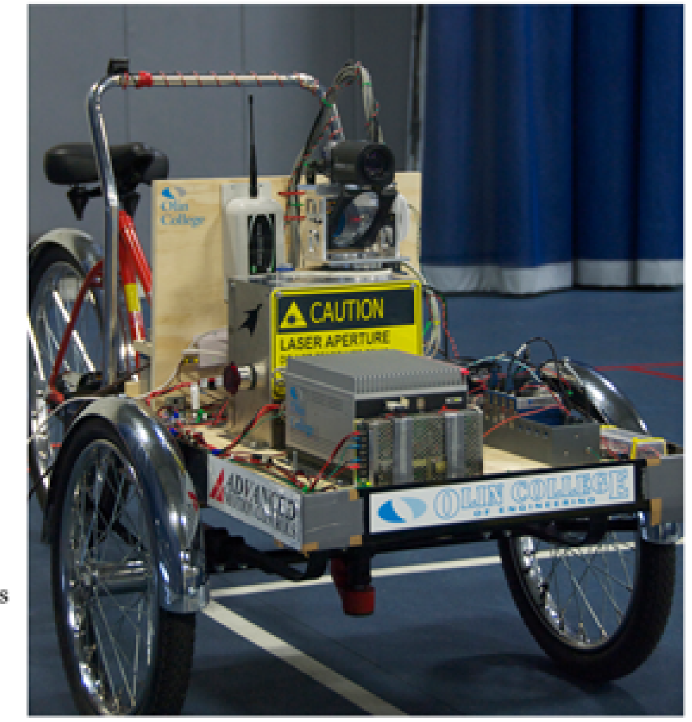
Hudson Brushless DC Motor - M3221
* High torque-to-inertia ratio
* High power



Test Platform
* Capable of speeds up to 5-10 mph
* Easy-to-access, "road-kill" style layout
* All components securely mounted
* Powered by on-board batteries or wall outlet

Ethernet Bridge
Allows communication between follow system, lead system, and remote user





SICK DME4000-313
Upgraded LIDAR from last year's
* Range: 200 meters
* Accuracy: +/- 6 millimeters
* Update Rate: 500 hertz

High Performance Pan-Tilt
* Open core pan mechanism
* Mirror tilt mechanism
* Mounting platform for foveated camera array
* Custom design

Point Gray Grasshopper and Tamron 8-80mm Zoom Lens

Same as last year, but can be upgraded to a three camera system with Point Gray Fireflies and VL550AI Lenses
* Accuracy: the vision tracking system has less than 10cm error at 45 meters.
* Range: up to 100 meters with 80mm zoom setting
* Update rate: 7 Hz

Operator Interface
* Intuitive, manual and automatic controls
* Active indicators provide clear, real-time feedback
* Robust against operator error

Software

The system has three computational devices: an FPGA, a PowerPC and a Sealevel PC. The diagram below displays which tasks run on each piece of hardware.

Sealevel PC	Image Processing	Motor Control	
PowerPC	LIDAR Parsing		
FPGA	Motor Encoder	Tilt Servo Control	LIDAR Reading

Testing Results

Overall, our tests indicate that when moving, we seem to have about 10cm of deviation. However, it is likely that much of this displacement is caused by the difficulty of steering the bike and holding the target steady because we can obtain much higher accuracy when we are static.

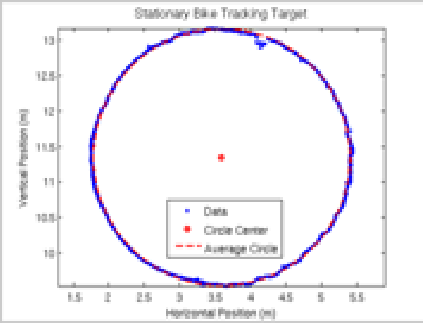


Figure 1: This image shows a circle we traced out with the target while keeping the bike stationary. Overall, it is very circular (especially compared to the red outline) with small deviations that are mainly caused by the difficulty in keeping the target perfectly aligned while walking about the circle. This test indicates that we can achieve good precision with our system.

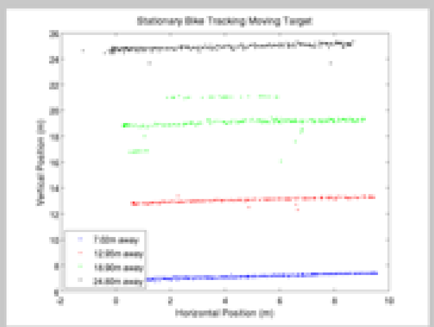


Figure 2: In this test, we tracked a target moving perpendicular to the stationary bike's line of sight. The colored lines represent tracking the target at different distances from the bike. Generally, deviations from the line along which the target was moving were small and on the order of 10cm. The larger errors were likely caused by the errors in the LIDAR, which has a tendency to produce erroneous results.