5.9 TASK 9
Adaptive Sensing and Controls for Time Variant Systems
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Task 9 Technical Requirements

Overview:
Control methods are a required component of many dynamic systems because of safety concerns, inherent complexity, or optimized behavior. Control methods often make use of plant or system actions by sensor measurements that interpret motion physics. Optical sensors, both laser and fiber optic, have a history of being accurate and precise in taking those measurements. However, there are few theoretical or commercial representations that unite optical control methods with optical sensing in order to manipulate dynamical systems. The student proposes research that will provide a framework for taking optical measurements, processing its digital signals, feeding that information to controls or intelligent decision makers, and eventually affecting or changing the state and actions of time variant systems. Since the system is moving, the optical sensors will have to adjust to the altered conditions. As a result, the framework must not only control the system but the sensors as well. There are many applications for this type of research, from biomechanical prostheses, to structural health monitoring, robotics, and even improved human out of the loop experimentation.

Scholastics
Required classes in control systems, photonics, numerical methods, and signal processing were completed and are scheduled to be the core concepts in the Departmental Qualifying Examination (DQE) to be taken the summer of 2008. Tentative committee members include Profs. Thomas Bewley (MAE), Joseph Ford (ECE), William Hodgkiss (ECE), and an MAE department appointment. The senate exam will follow in early 2009.

Technology Development 08-09
The rudimentary design of a hybrid optical-visual range sensor has been completed. The foundation is an oscillating MEMS mirror that projects a laser line in 3-dimensions, a form of structured illumination. Also included is a monovision camera system that observes amplitude shifts and calculates distances from a source using triangulation of the laser projection. Consequently, two avenues of machine perception can be researched in the coming year. The first is the mapping of distances to images. Each image pixel would then be characterized by a vector with X, Y, and distance values. The next step is to take sequences of images, associating calculated vectors with known features so that the sequence can be "stitched", a seamless mapping of photographs on a 3-dimensional representation. This would be a key component in advancing state of the art in simultaneous localization and mapping with minimal system overhead.

The second research track is developing coordination between the vector information and machine learning algorithms for object identification and path planning. Modern identification methods such as Viola and Jones will be evaluated for use with range finding for the current mobile platforms being developed at the Coordinated Robotics Lab, UCSD.

Task 9 Deliverables

	Task 9 - Deliverables	Delivery (days after award)
8.1a	Provide report summarizing commercially viable structured illumination project 180 days after award.	180
8.1b	Submit report on coordinated ranging and object identification.	
8.2	Paper abstract submittal for Optics & Photonics 2009.	
8.3	Paper submittal and presentation for Optics & Photonics 2009 conference.	