**Biographical Sketch**

Tse-Huai Wu is a Ph.D. student of Department of Mechanical & Aerospace Engineering. He received his B.S. degree from National Tsing Hua University, Taiwan, in 2008. He started his graduate study in GWU from 2011. His research interests include application of nonlinear control theory and control system design for autonomous vehicles.

**Education**

M.S. Mechanical & Aerospace Engineering, George Washington University, 2011-2013

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The Department of Mechanical and Aerospace Engineering

School of Engineering and Applied Science of

The George Washington University

Announces the Doctoral Dissertation Defense

Of

Tse-Huai Wu

In Partial Fulfillment of the Requirements for the Degree of

Doctoral of Philosophy in

Mechanical Engineering

Novermber 19th 2015, 1:00 pm

at

800 22nd Street NW

Science and Engineering Hall 2990

Washington DC 20052

**Dissertation:**

Geometric Attitude Controls And Estimations On The Special Orthogonal Group

**Field of Studies:**

Control System

**Admission to Doctor of Philosophy Program:** Spring, 2013

**Qualifying Examination Passed:**

Spring, 2014

**Dissertation Director:**

Taeyoung Lee, Associate Professor

**Dissertation Research Committee:**

Michael Keidar, Professor, GWU

James Lee, Professor, GWU

Taeyoung Lee, Associate Professor, GWU

Amit Sanyal, Associate Professor, SU

Adam Wickenheiser, Assistant Professor, GWU

**Abstract of Dissertation:**

This dissertation in concerned with spacecraft attitude control and estimation problems from the point of view of geometric mechanics. The controllers and observers are built on the special orthogonal group without any parameterizations, where the attitude dynamics is treated in a global and unique manner.

The dissertation is composed of three parts. A leader-follower attitude formation control scheme is reported such that the leader spacecraft control its absolute attitude with respect to the inertial reference frame and the follower spacecraft control relative attitude with respect to other spacecraft in the formation. The unique feature is that both the absolute attitude and the relative attitude control systems are developed directly in terms of the line-of-sight observations, where attitude determination and estimation processes are not required.

Second, an angular velocity observer is developed such that the estimated angular velocity is guaranteed to converge to the true angular velocity asymptotically from almost all initial estimates. Then, the presented observer is integrated with a proportional-derivative attitude tracking controller to show a separation type property for attitude tracking in the absence of angular velocity measurements.

A hybrid observer for the attitude dynamics of a rigid body is proposed to guarantee global asymptotic stability. By designing a set of attitude error functions, attitude estimates are expelled from undesired equilibria to achieve global asymptotic stability. To guarantee that the estimated attitudes evolve on the special orthogonal group, a numerical algorithm based on the Lie group method is presented.