8th Wernher von Braun Memorial Symposium
October 27 – 29, 2015

# Dynamic Modeling & Attitude Control of a High Altitude Balloon Payload


**_Nathaniel A. Stepp_**

*Department of Mechanical & Aerospace Engineering*


## Mission & Motivation:

- Attitude stabilized and attitude controllable high-altitude/near space ballooning platform for UAH's Space Hardware Club
- Multiple applications for high altitude scientific experimentation & engineering applications
- *Central motivation:* Stabilized video of the 2017 Solar Eclipse from ~100,000 ft altitude
- Incremental development schedule
- First increment to achieve stabilization in yaw-axis (most unstable flight mode)

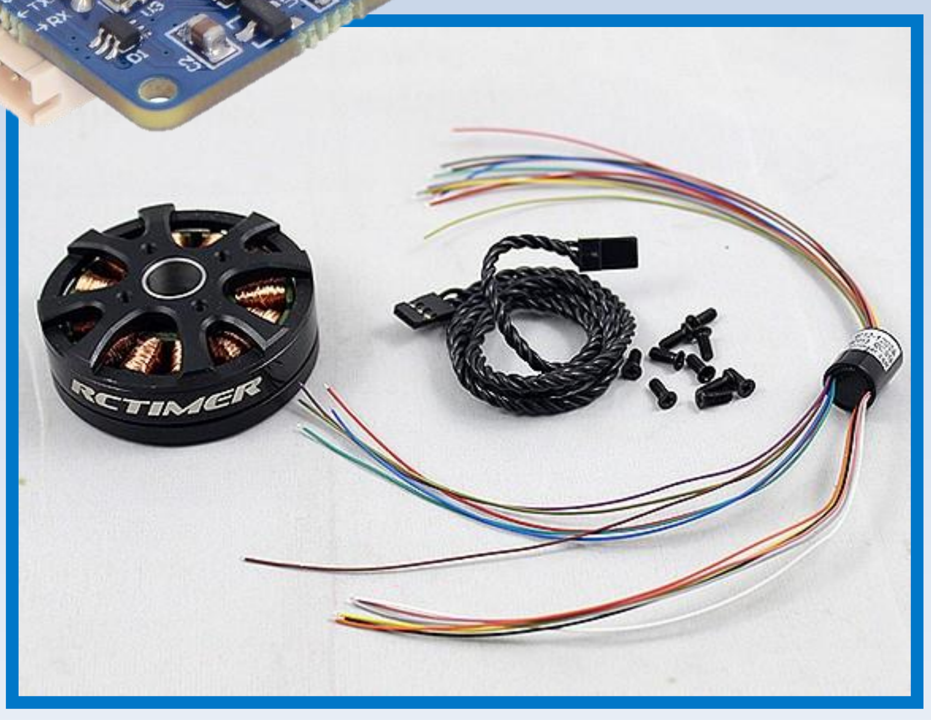
## Design Overview & Features:

- Attitude state estimation using 9-DOF IMU + GPS & Quaternion-Based Extended Kalman Filter Algorithm
- Continuous yaw stabilization and control achieved using single axis brushless gimbal setup within clear payload container
- Proposed PID control regime on yaw angle attitude feedback
- Model-based simulation and control law development in MATLAB/Simulink

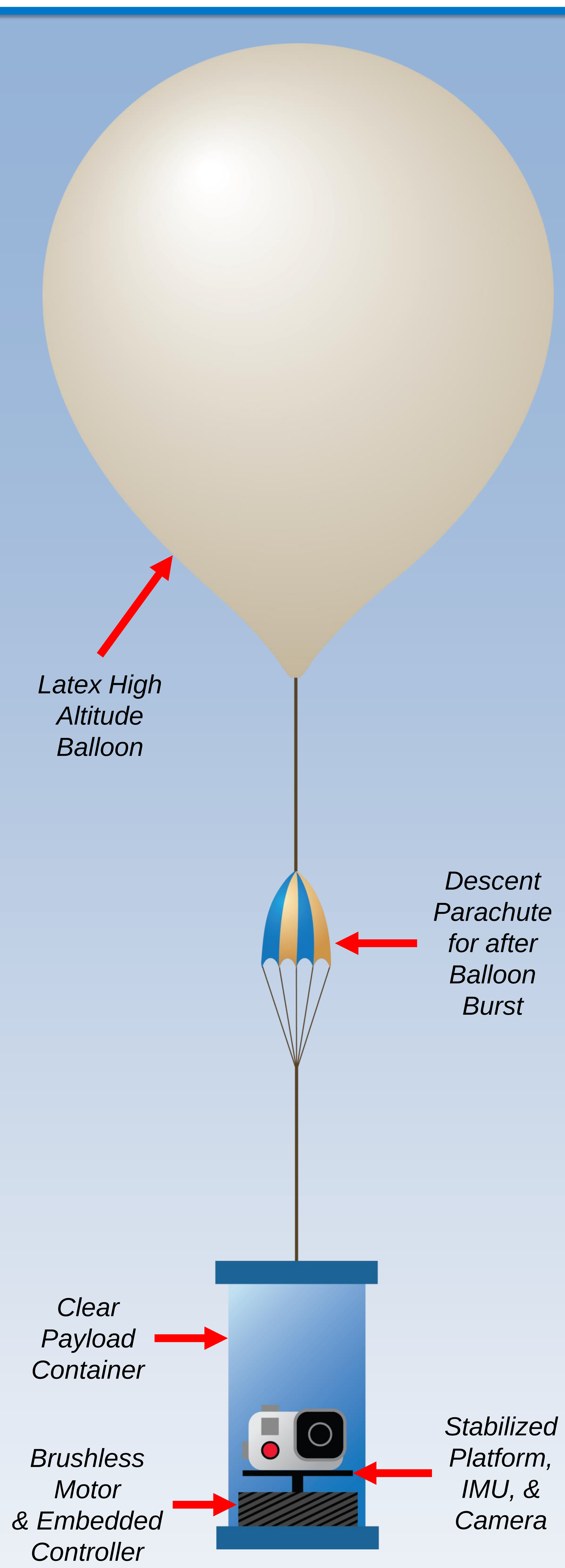
*Artist Depiction of Solar Eclipse Captured at High Altitude*

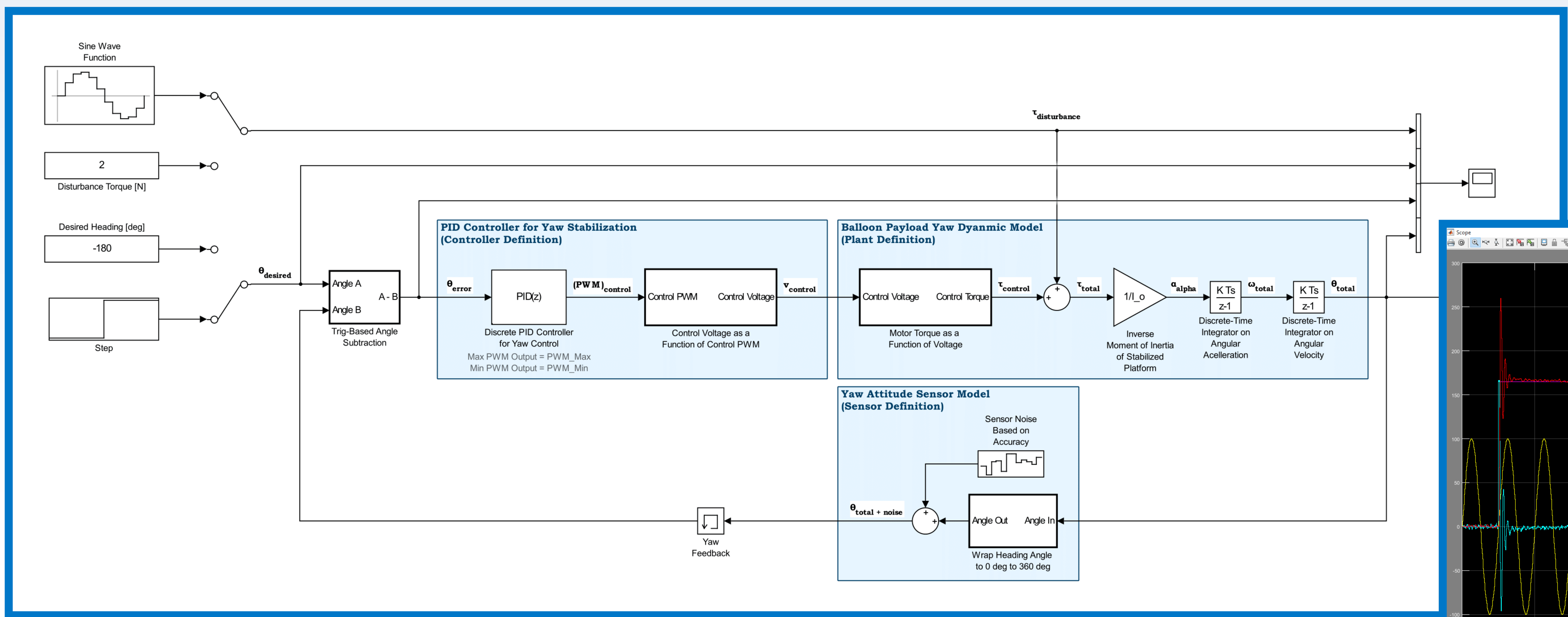
*UAHuntsville's Space Hardware Club BalloonSat Launch*

*CMRobotics' UM7-LT DMP IMU+GPS Unit*



*Brushless Gimbal Motor with Slip Ring for Continuous Yaw Rotation*

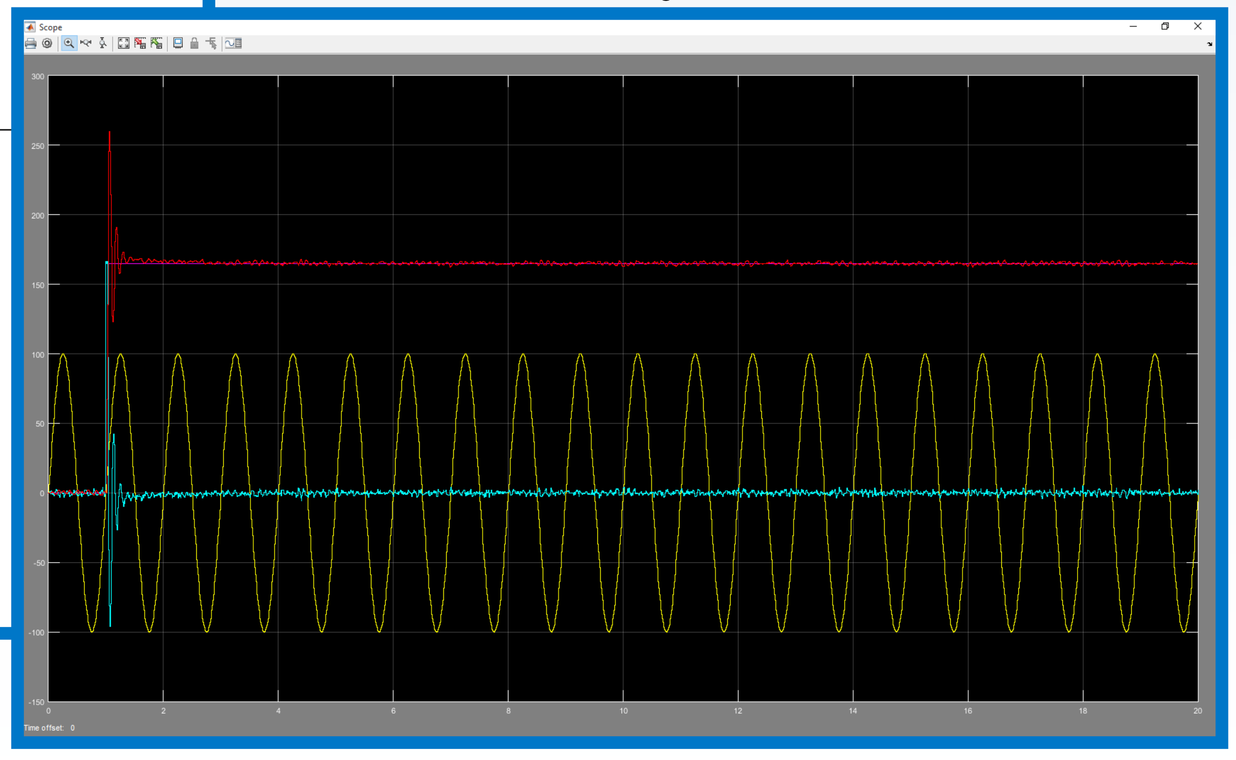



*Model-Based Simulation & Controller Design in MATLAB/Simulink*

*Control Law Formulation:*

$$\tau_C = K_P\theta_e + K_I\int_{t_0}^{t_f}\theta_e\,dt + K_D\dot{\theta}_e$$




## Acknowledgements:

*Project Advisor/Mentor:* Dr. Thomas Kelly
*Additional Consulted Professors:* Dr. James Richard Forbes (Univ. of Michigan), Dr. John Piccirillo
*Supporting Organizations:* Office of The Vice President for Research and Economic Development, Honors College, College of Engineering, The Space Hardware Club


Space Hardware Club
HONORS COLLEGE THE UNIVERSITY OF ALABAMA IN HUNTSVILLE
COLLEGE OF ENGINEERING THE UNIVERSITY OF ALABAMA IN HUNTSVILLE