**MEMORANDUM** 11 Mar 2011

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To: Prof. G. E. Piper

Subj: Lab Report

Encl: (1) Matlab Graphs and SIMULINK models with MATLAB script

**1. OBJECTIVES:**

1. To explore advanced simulation with SIMULINK
2. To design controllers for coupled differential equations
3. To investigate the effect of proper modeling and control design

**2. NARRATIVE AND OBSERVATIONS/RESULTS**:

We investigated the paramecium model. Initially, we modified the thrust controller to calculate the error in the x-direction from the yaw error, taking into account that the paramecium might be facing the wrong direction. We then adjusted the steering controller so that the steering angle will reverse when the paramecium is moving backwards.

Due to the high K(steer) value, the paramecium still made an initial spin quickly to face the target before arriving there quickly. There was not much difference in performance with a high value of K(steer), being 100 from the previous model. After changing the initial starting angle to –pi/4, the performance remained the same. The paramecium spun quickly at the start of the simulation to face the proper direction before arriving quickly on target. Removing the “sign(speed)” term similarly had no effect, since the paramecium never moved backwards. It was not until we lowered the K(steer) value from 100 to about 20 that the paramecium began to move backward at the start of the simulation. The steering gain remained very high while in reverse, and this could be corrected by adjusting the calculation of yaw error to account for backwards motion.

After adjusting the yaw error accordingly, this reduced the vibration or “rapid wobble” when moving in reverse. We also noticed a gain in performance at this point if we lowered the K(steer) value to about 1.4, since the increased stability of the system in addition to the ability to move in reverse allowed it to handle a much lower steering gain and still move on target.

3. **CONCLUSIONS:** It appears that SIMULINK has almost boundless limits for model simulation. Although we can only assume that it uses Euler’s method of approximation for solving such complex differential equations, it seems to do so with extreme accuracy and computational power. We also realized that there are multiple consideration that must be accounted for when giving an object the ability to move in reverse, as the angles involved must be calculated properly for both the forward and reverse directions to accurately simulate multi-directional motion.

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Encl (1): MATLAB graphs and SIMULINK models with MATLAB scripts

1. Initial Simulation with initial angle –pi/2:



1. Initial condition changed to –pi/4:



Unfortunately, the data for the remaining plots, as well as the saved simulink models, were corrupted in copying to a Hard Disk Drive. As we did not discover this until it was too late to get the originals, reproduction of these models unfortunately proved outside of our capabilities.