**MEMORANDUM** 3 March 2011

From: 3/C McVay and 4/C Tomaszewski, section

To: Professor Piper

Subj: Project 2

**1. Objectives:**

1. To investigate SIMULINK's dynamic system simulation capabilities
2. To design controllers for coupled differential equations

**2. RESULTS**:

Propulsion Matlab code

function thrust = propulsion(xd,yd,x,y,speed)

Kd=8; % Damping Constant

Kthrust=5; %Thrust Constant

if((abs(xd-x)<.1)&&(abs(yd-y)<.1))

thrust=0; %If the ship is within the allowed

else %error, cut propulsion

thrust=Kthrust\*(sqrt((xd-x)^2+(yd-y)^2))-Kd\*speed;

end

Real Dynamics Matlab code

function [vx,vy] = real\_dynamics(speed,yaw)

vx=speed\*cos(yaw);

vy=speed\*sin(yaw);

Steering Matlab code

function rudder = steering(xd,yd,x,y,yaw)

Ksteer=100;

yawd=atan2((yd-y),(xd-x)); %desired yaw value

yaw\_err=yawd-yaw; %error in yaw

while(abs(yaw\_err)>pi) %while trying to go long way

yaw\_err=-sign(yaw\_err)\*2\*pi+yaw\_err; %add/subtract 2\*pi

end

rudder=Ksteer\*(yaw\_err); %base rudder angle shortest turn

|  |  |
| --- | --- |
| Constant | Final Value |
| Ksteer | 100 |
| Kthrust | 5 |
| Kd | 8 |

|  |  |
| --- | --- |
| Final Error with xd=0 | 0.0669 |
| Final Error with xd=150 | 0.0404 |

3. **CONCLUSIONS:**

Each individual constant affected the performance of the ship in a different way. The damping constant affected how much the ship would slow down as it approached the target, and it would also dampen the effects of increasing the thrust constant. Increasing the dampening constant would thus allow the ship to travel faster while still coming to a stop before over-shooting the target. Increasing the thrust constant would increase the speed of the ship, but this effect would be decreased by increasing the dampening constant. However, this cancellation effect did have it limits. Increasing both constants would eventually cause the ship’s operation to become unstable. The steering constant, on the other hand, had to be very high compared to the other constants in order for the ship to get on target. Because the ship was initially oriented away from the target, having anything less than a high steering constant would cause the ship to go by the target, increasing the error and causing the thrust to increase, which would then increase the turning radius of the ship, and the system would continue to spiral outward in this manner. With the proper tuning, however, we were able to have the ship perform extremely well, reaching the target in under 4 seconds in some cases.

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Simulink Function



Final Plots

