## Model Name

DP controller

## Revision History (Date/Author/Changes made)

|  |  |  |  |
| --- | --- | --- | --- |
| Version | Date | Author | Changes Made |
| 1 | 2014/06/20 | Torstein Ingebrigtsen Bø | Initial |
|  |  |  |  |

## Model Hierarchy

## Description

DP controller is a block that calculates the desired thrust command based on the error in the position and velocity. This is implemented as a 3-DOF PID controller (surge, sway, and yaw). It is possible to run with either measured input or estimated inputs.

### Implementation details

The errors are calculated in NED, the error in yaw angle is mapped to the closest angle [-pi pi]. The error is the rotated to BODY and then multiplied by the gains. The rotation is done before the multiplication with the gain to utilize the point-asymmetry. Which means that the gain for surge and sway can be different. (Normally the rotation is done after the multiplication, but then the gains for north and east must be equal)

## Parameters (include parameter identification)

|  |  |
| --- | --- |
| Name | Description |
| DP.Kp | 3x3 matrix with proportional gains |
| DP.Ki | 3x3 matrix with integral gains |
| DP.Kd | 3x3 matrix with derivative gains |
| DP.tau0 | 3x1 vector with initial force in NED coordinates |
| UseObserver | Boolean. True if estimated values should be used. False if raw measurements should be used. |

DP gains must be found by proper tuning. An example can be:

%% Controller gains

w0Control = diag(1/30\*[1 1 1]); % Eigenfrequency of DP

XiControl = diag([1 1 1]); % Relativ damping of DP

dim = [1 2 6]; % Dimmensions of interest

DP.Kp = w0Control.^2\*M; % P-gain in DP

DP.Kd = (2\*XiControl\*w0Control\*M-D(dim,dim)); % D-gain in DP

DP.Ki = DP.Kp\*1/300; % I-gain in DP

Here the eigenfrequency of DP is set to 1/30, and the relative damping is set to 1. M is the total mass of the vessel (rigid body + added mass), D is the damping.

## Input

### Ports

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Name | Dimension | Unit | Description |
| 1 | nu | 3x1 | [m/s m/s rad/s] | Measured velocity in BODY: surge, sway, yaw |
| 2 | eta | 3x1 | [m m rad] | Measured position of vessel: north, east, heading |
| 3 | eta\_hat | 3x1 | [m m rad] | Estimated position of vessel: north, east, heading |
| 4 | eta\_dot\_hat | 3x1 | [m/s m/s rad/s] | Estimated velocity in NED: north\_dot, east\_dot, heading\_dot |
| 5 | eta\_d | 3x1 | [m m rad] | Desired position: north, east, heading |

### From

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Dimension | Unit | Description |
| y | 3x1 | [m m rad] | Measured position of vessel: north, east, heading |

## Output

### Ports

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ID | Name | Dimension | Unit | Description |  |
| 1 | tau | 3x1 | [N N Nm] | Desired thrust |  |

## Limitation (include some comments of possibility to increase/decrease fidelity)

More controllers can be added, for example MPC. Feed forward should be used if a time varying reference is used.

## Validation

N/A

## Comments

## Reference

Fossen, Thor I. 2011. *Handbook of Marine Craft Hydrodynamics and Motion Control*. *Handbook of Marine Craft Hydrodynamics and Motion Control*. John Wiley and Sons.