## Model Name

Thrust Allocation

## Revision History

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

## Model Hierarchy

This block consist of a “From Thrusters” subsystem which includes the from blocks for communication from thruster. A “for each” block is used to restack this vector of thruster bus to parameter/variables vectors. At last an s-function block is used to communicate with the c++ coded Thrust Allocation.

## Description

This block implements a Thrust Allocation. Features:

* Rotation of thruster (fixed and azimuth thruster are allowed)
* Singularity avoidance (thrusters will not be configured such that a singularity occurs)
* Power constraints
  + Each bus should not use more power than given by power available
  + Each thruster should not use more power than given by fast load reduction
* Search for best direction (positive or negative) is implemented.
* Allocate power to thruster. The thrusters are given maximum power consumption since the thrusters may use more power to reach the desired thrust. This is a redistribution of the power available for DP.

The implementation is done in C++ with use of Acado library. This must be recompiled if the configuration of thruster changes (number and position of thrusters), since the calculation of singularity avoidance cost is dependent of the configuration.

### How to build

#### Prebuild

1. Make sure a compiler supported by MATLAB is installed.
2. Download ACADO
3. Make matlab interface (“cd %ACADO ROOT%/interfaces/matlab” “make”)

#### Compile

1. Make sure all initialization files are up to date
2. In matlab open directory %MarinePowerSimulatorROOT /ThrusterAllocation/src
3. Run command “SingularityAvoidance.make()” this will generate singularity avoidance cost functions.
4. In make.m update acado folder path to the correct path.
5. Run make.m

### Implementation details

The “ThrusterAllocation” C++ object does the thrust allocation. This is the steps

1. Scale all variables
2. Find the current direction of thruster (are the giving positive or negative thrust).
3. Calculate the optimal thrust given the current direction of the thrusters (thrusters are allowed to rotate but not reverse direction of thrust).
4. Find the optimal direction of thrusters, by reverting thrusters where desired thrust = 0. The direction configuration with the smallest cost is used.
5. Scale back solution to nominal scale.

The thrust is calculated to be see Fossen 2011. The power consumption of each thruster is estimated to . The singularity avoidance cost is set to , where is the singularity avoidance cost gain and is the singularity avoidance cost smoother.

The thrust coordinates are defined as:

../../../../../Downloads/TA%20coordinate%20definition.pdf

For more details see documentation in source code or generated source code documentation by doxygen.

## Parameters (include parameter identification)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Dimension | Unit | Description |
| TA\_sampling\_time | 1 | s | Sampling time of Thrust Allocation |
| nThrusters | 1 | - | Number of thrusters |
| nSwitchboard | 1 | - | Number of switchboards |
| singularityAvoidanceCostGain | 1 | - |  |
| singularityAvoidanceCostSmoother | 1 | - |  |

## Input

### Ports

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Name | Dimension | Unit | Description |
| 1 | tau\_d | 3x1 | [N N N,] | Desired thrust in BODY: surge, sway, yaw |

### From

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Dimension | Unit | Description | From |
| powerAvailableDP | nSwitchboards x 1 | W | Power available for DP. Each element represent the power available for each **bus**. The nSwitchboard-nBus last elements are not used and could be set to zero. | PMS |
| FastLoadReductionThruster | nThrusters x 1 | W | Maximum power used by each thruster given by the fast load reduction in power management system | PMS |
| Switchboard2bus | nSwitchboards x 1 | - | Conversion from Switchboard ID (one based) to Bus ID (one based). | Electric voltage calculation |
| nBus | 1 |  | Number of electrical bus. | Electric voltage calculation |

## Output

### Ports

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Name | Dimension | Unit | Description |
| 1 | alpha | nThrusters x 1 | [rad] | Desired thruster azimuth angle of thruster |
| 2 | u | nThrusters x 1 | [-1, 1] | Desired thrust of thruster |
| 3 | Power allocated | nThrusters x 1 | [W] | Maximum allowed power consumption by thruster |

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

This is implemented by a Nonlinear programing solver, there is always a possibility for the solution to not converge.

## Validation

N/A

## Comments

## Reference

Acado http://sourceforge.net/p/acado/wiki/Home/

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