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Thrusters

How to Utilize Thruster Current Measurements to Improve Safety and Optimize DP Control Systems

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Abstract

Use of thruster current measurements, is an obvious way to improve safety and optimize DP Control Systems, but is rarely used by the Industry today. The interface is simple, no expensive HW is required and the measurements are reliable.

By introducing current measurements (or other load signals), DP Control Systems will be able to discriminate between set-point and feedback failure and can provide better decision support to the Operator.
Traditionally, the DP system has a RPM/Pitch set-point signal and a RPM/Pitch feedback signal. If we have a failure in one of these signals, the DP-system can not decide if it is the set- point or the feedback that's wrong. With a current measurement from the thruster motor, it can. The system can than give a clear message to the Operator; "Feedback failure" or "Set-point failure" on Thruster *X*.
Without a current measurement, the system can only give a "Set-point/Feedback difference" alarm, and leave it up to the Operator to find out if it is one or the other. Alarms related to set-point or feedback of a thruster can lead to dangerous situations in short time, and we need to provide the Operator with clear and precise information.
The system could switch to estimated feedback by itself, if the feedback signal was faulty or even automatically disable the thruster if the set-point loop was faulty.

By better calculations of torque and power, the control system will be able to handle thruster ventilation, reduce fluctuation in thrust and power production and provide a better thruster model. This will lead to less wear and tear and less fuel consumption.

Especially bow thrusters are exposed to thruster ventilations in rough sea. With the traditionally instrumentation today (RPM/Pitch set-point and feedback), the DP-system "does not realize" that the thruster is partly working in air instead of water. When the thruster is ventilating, the RPM may increase, but the thruster current decrease. Since the thruster current will decrease, the thruster model in the DP-system will calculate the force from the thruster to be higher than it actually is. What the DP system could do, if it new that one thruster is ventilating (by reading thruster current), it could for example reallocate thrust from the one that is ventilating to one that is not exposed to ventilation.

Why current measurement from each thruster?

Safety 

Performance 

Economy 

Each and one of these three elements, are, on it’s own a good reason to implement thruster current measurements or other thruster load signals.

"Setpoint alarm" or "Feedback alarm" versus Setpoint/Feedback difference alarm

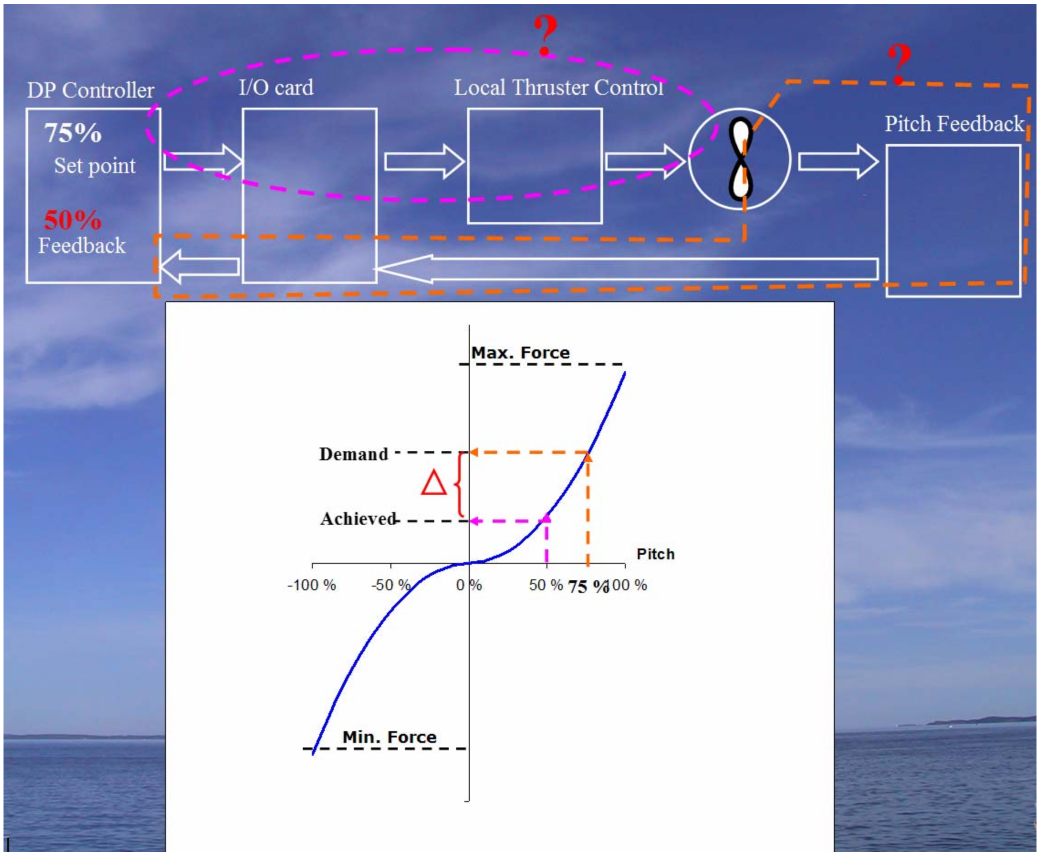

figure 1

If we have significant difference between setpoint and feedback on a thruster, and the only feedback available is pitch/RPM feedback, the DP Control System (DPSC) will not be able to determine if we have a setpoint failure and a feedback failure, see ***figure 1***.
DPSC can only report a setpoint-feedback difference alarm. Depending on type of failure, the action taken by the DPSC or Operator is different. To determine if we are dealing with a setpoint or feedback failure is of that reason of great importance.

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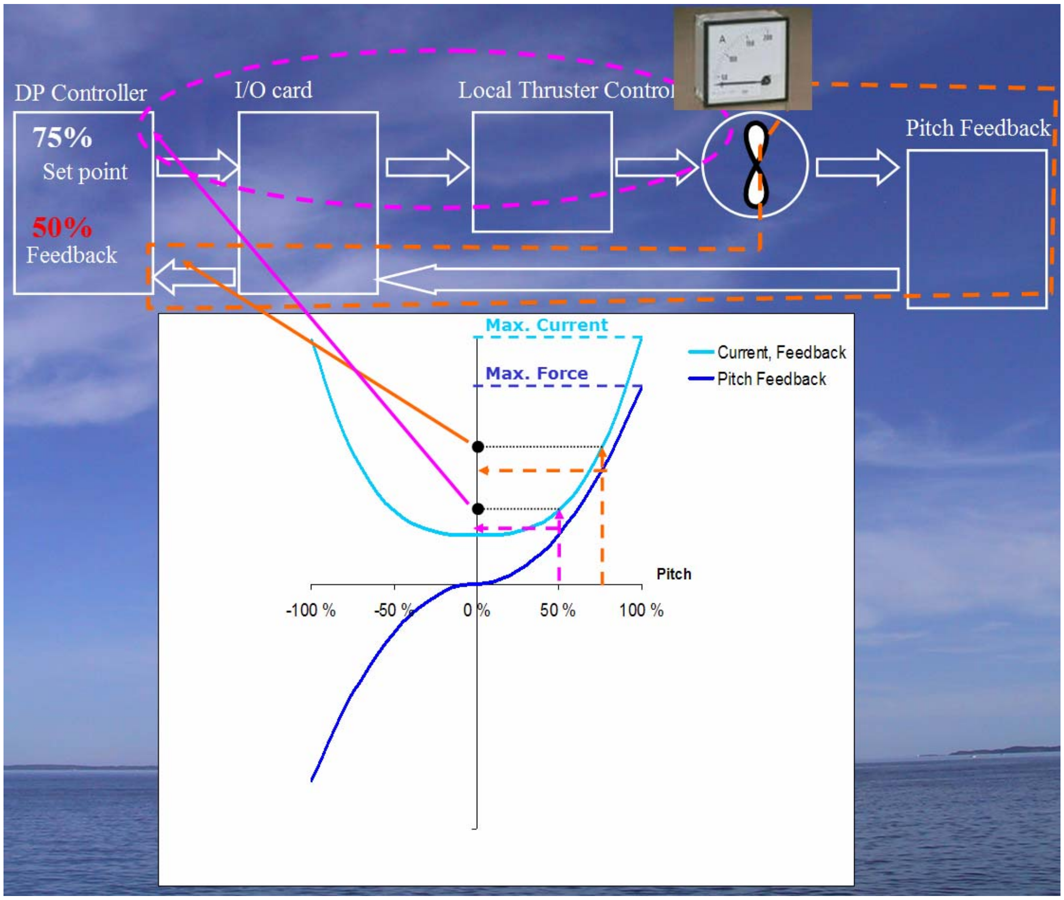

figure 2

By introducing a current reading from the thruster motor, the DPCS will be able to discriminate between a failure in the setpoint part of the control loop and a failure in the feedback part of the control loop, see ***figure 2***.
The Operator will get a more accurate alarm to support his decision to continue using the thruster or to stop it.
The DPCS system can for example switch to estimated feedback if it’s detected a feedback failure. The thruster can than still be used without significant performance impact.

"Thruster out of zero" detection

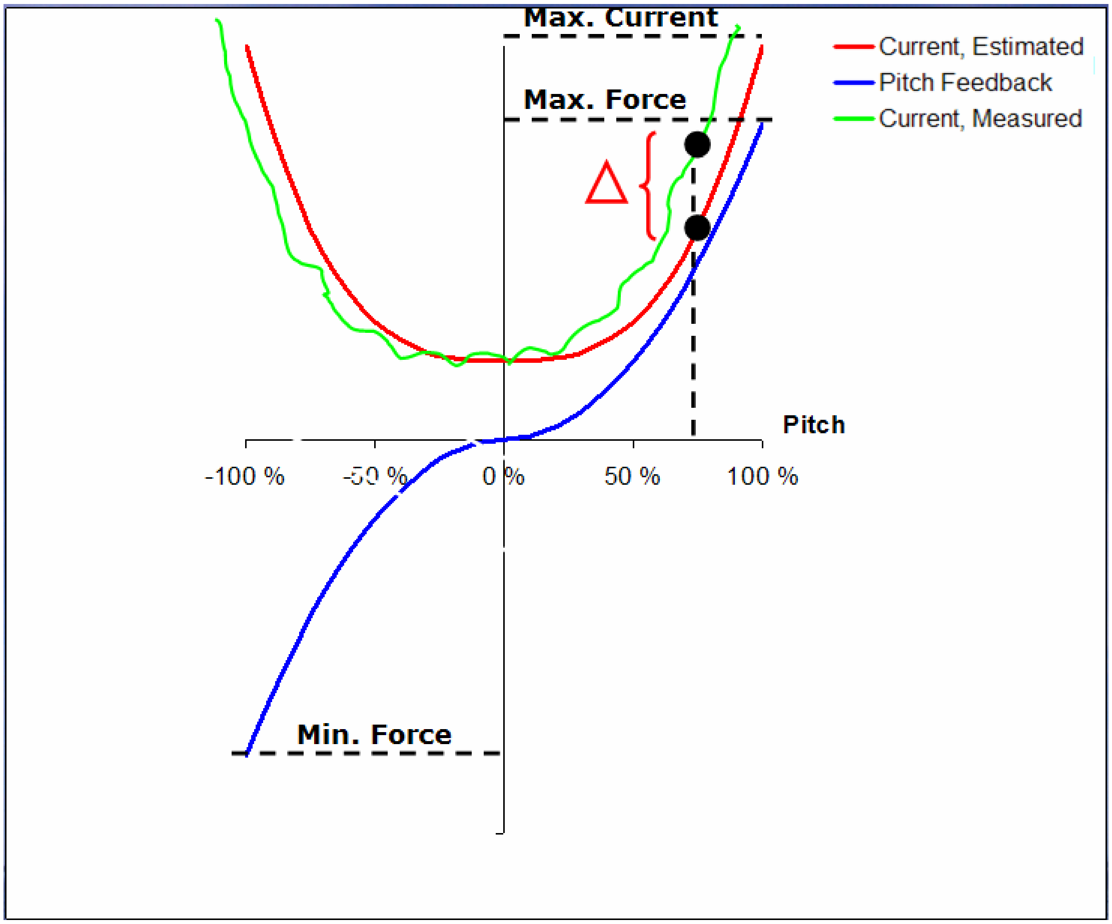

figure 3

By experience, we know that the potentiometer used by the local pitch control loop, can slightly slip out of position.
When the potentiometer for the local pitch control and the potentiometer to the DPCS are identical but with different decks, the DPCS system will not be able to detect if the thruster is out of "zero force" alignment.
The DPCS can, based on the pitch feedback, estimate the current/load feedback on the thruster. By introducing thruster current feedback, DPCS could compare estimated current up against measured current, and by using data from the initial sea-trial, the DPCS could warn the Operator on an early stage about the misalignment, see ***figure 3***. It is of great importance to detect problems like this, before it starts to develop and give a significant impact on performance, safety and economy.
If we have different potentiometers for the local control and the DPCS feedback, the problem can be detected by comparing pitch and feedback difference.

Thruster performance check

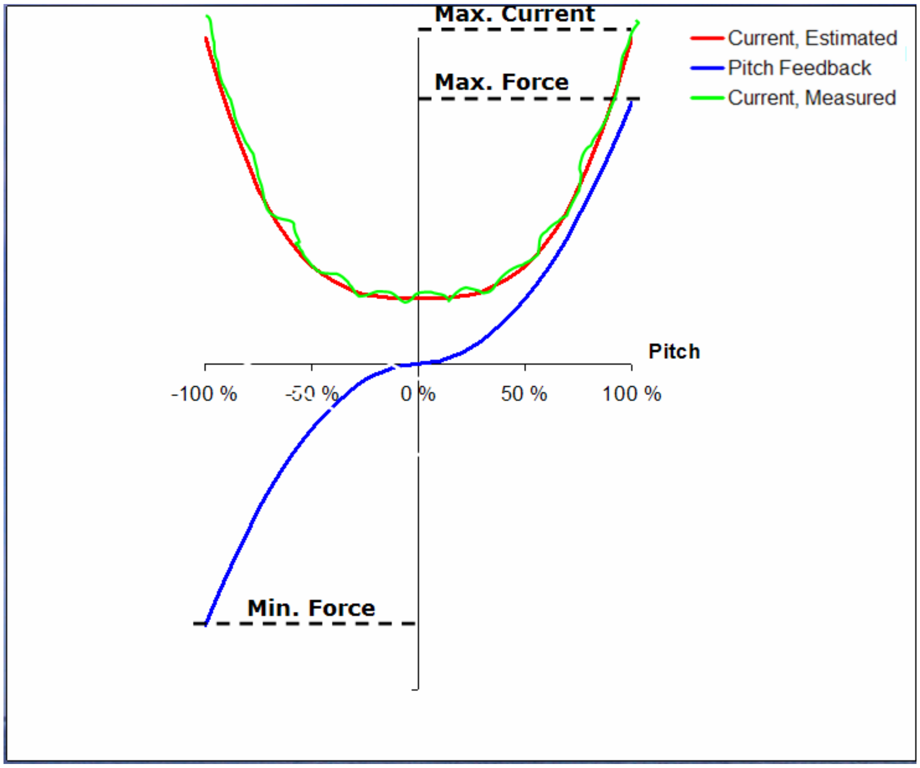

figure 4

During a DP-trial a lot of effort is spent by thruster and DP manufacturer to setup the thrusters and DP system correctly. To keep track on how the system behaved the day it was all lined up, would be valuable. By logging and storing the characteristics between RPM/Pitch setpoint, feedback and load feedback on the DPCS, we would have a "footprint" of characteristics on each thruster, see ***figure 4***. On a regular basis or before critical DP jobs, DPCS could compare the initial footprint up against the "actual", to ensure optimal performance.

Thruster ventilation

Air suction and "in and out of water effect", is what we call Thruster Ventilation.
For a DPCS system, it would be a great benefit to know that a thruster actually is in this condition.
By using thruster current feedback, the system could easily detect ventilation.
The DP should than act accordingly. Either by reallocate demand to other actuators, by reducing the demand on the actual thruster, change heading etc.