Health Monitoring of Propulsion and Steering Devices

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Abstract

Dynamic Positioning and Dynamic Mooring systems ("DPM systems") deal with a lot of uncertainty. This uncertainty is partly related to the position reference systems and partly related to the machinery side. DPM systems are applied for critical operations as offshore drilling, FPSOs, heavy lift operations etc.

To deal with the uncertainty the ship configuration is such that position reference sensor systems or propulsion and steering devices may fail without endangering the operation. Full duplex, or even triplex, redundant systems are applied. Present DPM solutions are aimed at the application of Extended Kalman Filtering, which is able to detect degraded positional reference sensors or non-responsive propulsion and steering devices. However, all these systems are mainly dealing with safety, which of course is to be of primary concern, but not at reducing operational down-time and extending the operational availability of a platform.

On a lower level, the propulsion units of a vessel are guarded via regular checks and with the aid of alarms. The regular checks may visualize a changing condition of the system, alarms only indicate when the condition has reached an unacceptable level, which may result in stopping the system and repairing it. Furthermore, inspection intervals for complete propulsion units are prescribed by class societies, varying from 2.5 years for intermittent surveys over 5 years for major inspections.

When operating far away, at the deep seas, docking facilities are rare. Modern thrusters systems are under water exchangeable, such that the vessel has not to leave the operational location in search for a dry-dock. But nevertheless also such a replacement interrupts the operation. Downtime will cost tremendous amount of money.

So besides the safety aspects of the DPM system it is worth to have also systems monitoring the health of the propulsion and steering devices, so that preventive actions can be taken in time. A device failure is mostly not catastrophic to such an extent that the device has to be isolated from the operation, i.e. stopped. Mostly the affected device can be loaded lower, whereas the healthiest device can be loaded higher. So a power distribution among the devices based on the measured health will give an extension of its use.

For propulsion and steering devices, actuated by hydraulic means, three aspects are of importance for health monitoring:

1. Lubrication oil state, such as water ingress, seizes and amount of metal particles and state of additives and viscosity needed for optimal lubrication.
2. State of roller bearings and gears, which can be assessed by high frequent acceleration measurements.
3. Device response characteristics, which are influenced by the state of valves, pumps, leakages.

The health monitoring system uses existing sensors of the device control system, but also some additional sensors are added, such as accelerometers and oil sampling sensors.

After signal analysis, the resulting characteristic data are fused to a general health number varying from 0.000 to 1.000 for respectively totally not fit for use to total fit for use.

The paper indicates, which device parameters are to be used for the health monitoring, how the health is determined and how the result is used to improve the operational availability of the vessel.

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