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Performans İzlemedeki Bazı Gerçek Dışı Uygulamaların Tekrar Gözden Geçirilmesi

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ÖZET

Bu makale, performans izlemede ortaya çıkan bazı varsayımlara ve iddialara eleştirel bakmaktadır: her derde deva olan bir veri frekansı; tekne bozulmasını ve pervane bozulmasını ayırma yeteneği; 4 ve daha üstü deniz durumu için düzeltme kabiliyeti. Hata analizinin eksikliği,sorgulanan güven ve iddiaların temel nedeni olarak gösterilmektedir.

Anahtar kelimeler: Performans izleme, ISO 19030, ek direnç, rüzgâr direnci.

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Some Fairy Tales in Performance Monitoring Revisited

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ABSTRACT

This paper looks critically at some assumptions and allegations floating around in performance monitoring: data frequency as a cure-all; capability to separate hull degradation and propeller degradation; capability to correct for sea state 4 and above. Lack of error analyses is pointed out as a frequent root cause for questionable confidence and assertions.

Keywords: Performance monitoring, ISO 19030, added resistance, wind resistance.

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1. Introduction

The HullPIC conference has promoted our collective insight into hull and propeller performance monitoring. And, by and large, the performance monitoring solutions employed now are much better than what was on the market when the Working Group for ISO 19030 started its work.

We have moved from the dark middle ages to a period of (early) enlightenment. However, some old wives' tales and half-truths are hard to eradicate, especially if they make for convenient short-cuts in performance monitoring models. Most old wives' tales contain some truth or are sometimes true, and therefore sound so convincing. And covered in a cloak of a nice-sounding "law" or Big Data new-age mumbo-jumbo, the middle-age beliefs keep coming back. Maybe this paper can contribute to more transparency and enlightenment on some of the most popular half-truths (a.k.a. fairy tales, old wives' tales, urban myths, or marketing).

2. Urban Myths Concerning Data Quantity

2.1 More data sets = better results, always

"The higher the frequency in data logging, the better the results." There is a widespread belief that ever-higher sampling frequency will improve insight. ISO 19030 uses 0.07 Hz (1 data set every 15 s) as minimum requirement for the default method, but some in the industry boast sampling rates of 1 Hz and above. But how useful is higher data sampling frequency really?

We could copy and paste the same data set 1000000 times. Obviously, that would not give any more insight. More data sets are no good if they are exactly the same, and little good if they are almost the same. We need independent data sets with sufficient variation in (steady) variables to derive useful insight. If the sampling frequency is higher than the frequency of ship motions (encounter frequency), there will be spurious changes in key variables. While added resistance in waves is negligible for most ships up to sea state 3, the periodic surge motion in longitudinal direction induces non-negligible changes in speed, propeller rpm and torque. These make averaging a necessity. The recommendations of ISO 19030 make sense here. With 10-minutes averaging, the fluctuations due to ship motions will average out for most cases. Only in following seas, very low encounter frequencies may occur.

There is no harm (and little gain) in higher data sampling frequency. The average values over 10 minutes are probably quite constant if data frequency is increased. Perhaps someone with access to high-frequency data could verify this assumption. The advantage of high-frequency data is that both average value and standard deviation (or another measure of variation) can be derived. This can help in filtering data sets where above-average variation indicates atypical conditions during the sampling interval, e.g. maneuvering.

In any case, averaging intervals should be short enough to ensure that the statistical characteristics of the seaway (significant height and period, direction) and ship speed are constant. Again, the ISO 19030 default recommendations of 10 minutes fulfills this requirement.

2.2 Everything will average out for the best

"Everything will average out for the best." This is another hopeful adage in performance monitoring, particularly if correction methods are weak. But this assumes that there are no long-term operational changes (e.g. different routes due to different demand), no large-scale ambient changes such as fluctuations in the Gulf stream or sea state climates.

For ferries on a fixed route, with little variability in draft, trim, speed, etc., "everything will [indeed] work out for the best". For chartered multi-purpose vessel, most likely by the time averaging has taken care of your errors, any useful insight comes too late.

3. Hull and Propeller Lived Separately Ever After

"We can separate propeller and hull performance without thrust meter." And we can make it look scientific or we can make it simple and appealing to the common sense. We have three (virtually) independent variables: speed, propeller rpm and torque. If, compared to the clean reference condition at same propeller rpm, we have

a) Lower speed, then the resistance has increased and we blame hull fouling

b) Higher torque, then we blame propeller fouling/degradation

In reality, for same rpm, we will typically see both speed loss and torque increase. The hull fouling will change the inflow to the propeller and thus also propeller efficiency. But let's say these inter-action effects are small; then we could use as a rule of thumb the percentage loss in speed and the percentage torque increase and split the total degradation accordingly. But this is very coarse and the insight is mostly that you should clean both propeller and hull.

One can try to estimate the contributions from propeller and from hull by using more elaborate theories. Maybe I should be pleased that many such attempts give reference to my book, Bertram (2012). But should I be pleased when the formulas are used without the hydrodynamic understanding that I had hoped the book would bring? Maybe they don't see it, maybe they try to blind us with science. The formulas use assorted efficiencies η and/or wake fraction w and thrust deduction t. If you only look at the design condition (design draft, zero trim, design speed, no wind, no sea state), these variables are constants as the single symbol suggests. But for performance monitoring, they are functions of many parameters. For example, we should write w(V,T,θ,…) instead of w; and any approach should document how each function is modelled. For example: "w will change with draft, but we don't know how and therefore always take the value at design draft. w will change with trim, but we don't know how and therefore always take the value for zero trim. w will change with…" You get the idea.

The quantities depend also on scale, i.e. they differ between model tests and full-scale ship. This should be kept in mind, as many approaches take them from model basin reports where "experience-based" extrapolation leads to significant variations (10% have been reported in oral communication by Maersk) between different model basins. If such approximate full-scale extrapolation for a specific ship are not available from model-basin reports, some people use an approximation of the approxima-tion: design formulas (for design conditions and typically based on ships tested in the 1960s) as found in Bertram (2012).

"All models are wrong, but some are [still] useful," said George Box. More precisely, all models are approximations. Some may be very good approximations, some may just get the order of magnitude right. ISO 19030 quantified the uncertainty for the performance indicator for the default method described in Part II of the standard, using random variations within the range of uncertainties of the input variables to see how this would affect the final results. A corresponding approach would be needed in the assorted hydrodynamic models trying to separate propeller and hull performance. We need to estimate uncertainty (or accuracy) of variables and functions and see how the errors propagate to the end result. Maybe some very rough estimates are OK, maybe some simplifications lead to 50% variation in the final numbers. Assuming uncertainties and seeing how they propagate is a task any developer can do and we should ask for this at least in scientific publications.

Quantifying the effect of speed, draft, trim, possibly induced motions by ambient waves on e.g. the wake number at full scale would be a nice research project for the CFD (Computational Fluid Dynamics) community.

4. My Formula / Machine Learning Can Correct For Sea State 4 and Above

"We can correct for sea state 4 and above." This may come in disguise with filters set at higher sea states. We can apply formulas and software, but the errors will be high, easily 50%, possibly 100%. Among experts, we may argue whether correcting for sea state 4 is possible with acceptable errors. For sea states up to 3, you can use any correction or none at all (as in the default method of ISO 19030). If your wave heights are derived from sea state estimates from the crew, you may as well omit any correction. See Bertram (2016) for a detailed discussion.

If we have good measurements of the actual near-field of waves around the ship and good three-dimensional methods to compute the added power in oblique waves, we may correct for higher sea states. But probably the best approach would be to compute the speed loss or added power and filter based on percentage of the calm-water power for that case, as promoted in Schmode et al. (2018). Vendors of wave measurement equipment and services should publish comparisons with wave buoy measurements to get realistic estimates for errors in wave measurements. Then error propagation analyses should give insight into the effect on performance indicators.

Machine learning is just another (and more obscure) way of approximating a relation between waves and added power or speed loss. It does not change the fundamental dilemma.

5. Conclusion

Data frequency is not a cure-all. Averaging over sampling intervals is necessary to remove fluctua-tions from ship motions in waves. When averages and standard deviations no longer significantly change with higher frequency, further increase in frequency becomes pointless.

Nobody can correct reasonably for higher sea states, because the initial information on waves becomes too uncertain and the correction methods have large errors in real seaways. Filtering at sea state 3 is fine, filtering at sea state 4 often an uncomfortable necessity; beyond that, the data sets cause more harm than good.

We should collectively work more on error estimates, particularly on error propagation in the performance monitoring models.

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