Comparative study of Motion Reference Units

For motion compensation applications

Jan-Lucas Boxan. Maarten Vaandrager.

University of Applied Sciences, Konstanz, Germany. jaboxan@htwg-konstanz.de
JB Systems Industrial Automation, Vlaardingen, Netherlands. mva@jbsystems.nl

Abstract— The offshore industry is continuously improving safety and profitability by increasing operational limits. The use of motion compensated equipment plays an important role in this process. Accurate and real-time estimation of the vessel motions forms the basis for good motion compensation and are typically measured using a Motion Reference Unit (MRU). Predicting the MRU's performance in a real world use-case based solely on its spec sheet is close to impossible and tests on a vessel do not give exact insight since there is no absolute world reference on the vessel. To get insight into the accuracy of the most common MRU brands, types and price levels we have performed a comparative study. We tested the sensors on a motion platform and compared their motion estimates to the exact motion in the world reference frame. In addition we have looked at how good these motion estimates are when applied to compensation at the tip of an offshore crane. This whitepaper describes the tests and results.

I. INTRODUCTION

All sensors exhibit errors such as noise, bias, scale factor, nonlinearity and temperature effects. MRU's are no exception. The crucial part of the MRU's state estimation is correctly estimating the gravity vector. This is problematic due to the sensor's Bias instability and cross coupling.

Bias instability is an error contribution that is frequency dependent and it is almost impossible to translate the specification sheet to achievable accuracy for a specific use case. This is the first reason to do a comparative study with in a real use case.

Cross coupling refers to the phenomenon of acceleration in one axis having an effect on the measured acceleration or rotation on orthogonal axes. The specification sheets do not give insight into this error contribution and the reason to compare sensors in a test with on 6 axes simultaneously.

In addition, MEMS technologies have greatly improved performance and competitiveness in relation to the more expensive FOG and RLG technologies making it an interesting time to compare the current state of these different technologies.

II. TEST CASE

JB Systems has a number of accurate simulations that are typically used for testing software and training personnel. One of these simulations is based on the Siem Marlin (Figure 1). This is a Multi-Purpose Support Vessel (MPSV) with a length of 93.6m and a dead weight of 4213 ton. The waves and vessel motions were calculated in Simulink based on a realistic wave spectrum and the motion RAO's of the vessel.

- Vessel: MPSV Siem Marlin
- Significant wave height: H_s = 1.6 meter
- Peak period: T_s = 6.7 seconds
- Incoming wave direction: 50 degrees PS bow
- Crane tip location wrt COG = [-1.32 -18.18 -12.93]

Figure 1: Simulation of the Siem Marlin MPSV.

The tests were performed on the research simulator SIMONA at the Faculty Aerospace Engineering of the University of Technology in Delft.

Figure 2: Simona Research Simulator.

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