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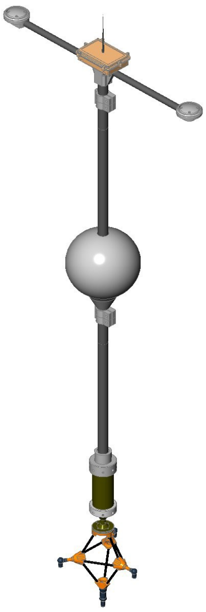
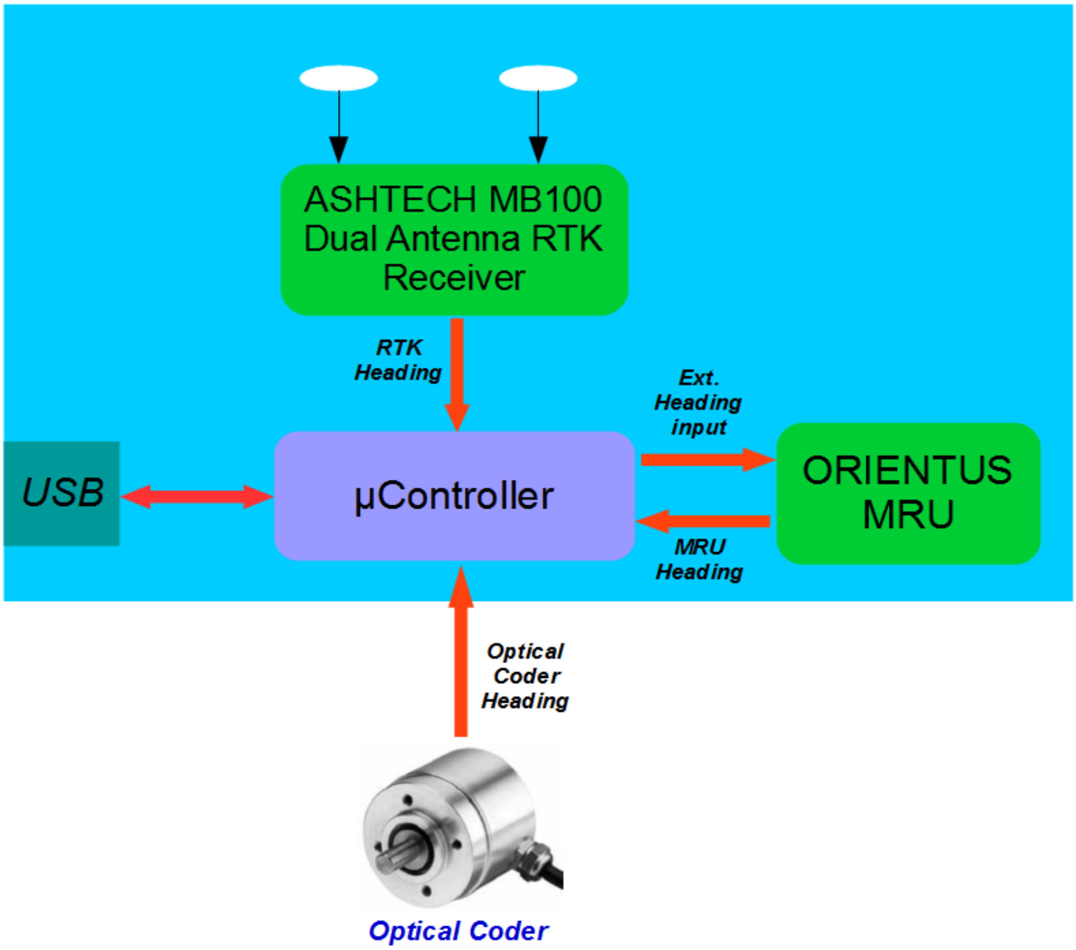
Object: Orientus MRU & Dual Antenna RTK heading fusion, typical tests results

This short paper presents typical results of the tests conducted mid-2014 to qualify the integration of the Orientus OEM MRU with a dual antenna GPS-RTK receiver in order to measure the true heading of an instrumented buoy, the RTKDuo USBL/RTK buoy dedicated to georeferenced underwater positioning. The goal of this sensor fusion is to get the best from each sensor: the true and bias free, but noisy heading from the RTK dual antenna receiver, and the low noise and accurate, but that drifts Yaw of the MRU which is moreover not affected by satellite reception interruption.



The RTKDuo USBL/RTK buoy used for a dam survey

The sensors configuration used for tests appears below:



Heading test tool configuration

A microcontroller manages the unit that includes:

- a dual antenna RTK receiver from ASHTECH (MB100 model) that measures the heading of the baseline along the two antennas baseline and reports it to the µController ($ATT NMEA messages at 2Hz),

- an Orientus OEM MRU unit that receives external heading messages from the µController at 2Hz and sends the Euler orientation messages at 10Hz to the µController,

- and just for the test: an optical coder mounted on the yaw axis in order to get a reference measurement, this is an absolute coder with 18 bits resolution (LSB= 0.0014°!).

The µController receives the RTK heading at 2Hz, it checks the consistency in order to adjust the external heading standard deviation (mainly using the brms value included in the $ATT messages) and send the external heading message to the ORIENTUS MRU. For each reception of RTK heading, the µController also collects synchronously the ORIENTUS Yaw and the optical coder Yaw, then transmits it to the test PC through the USB port.

A specific test tool has been built for this test:

Heading Test tool

The heading test tool mechanical frame is made of aluminum rigid structural profiles (REXROTH), a tuning mechanism allows to level the frame, the sensor is mounted on a vertical axis with two bearings, the optical sensor is attached to the bottom of the vertical axis and accurately measures the Yaw angle from a reference orientation (the bias between the true north and this optical sensor Yaw is measured during a stable measurement by comparison with the RTK heading averaged over several seconds).

During the test, the following parameters were recorded in a text file at 2Hz:

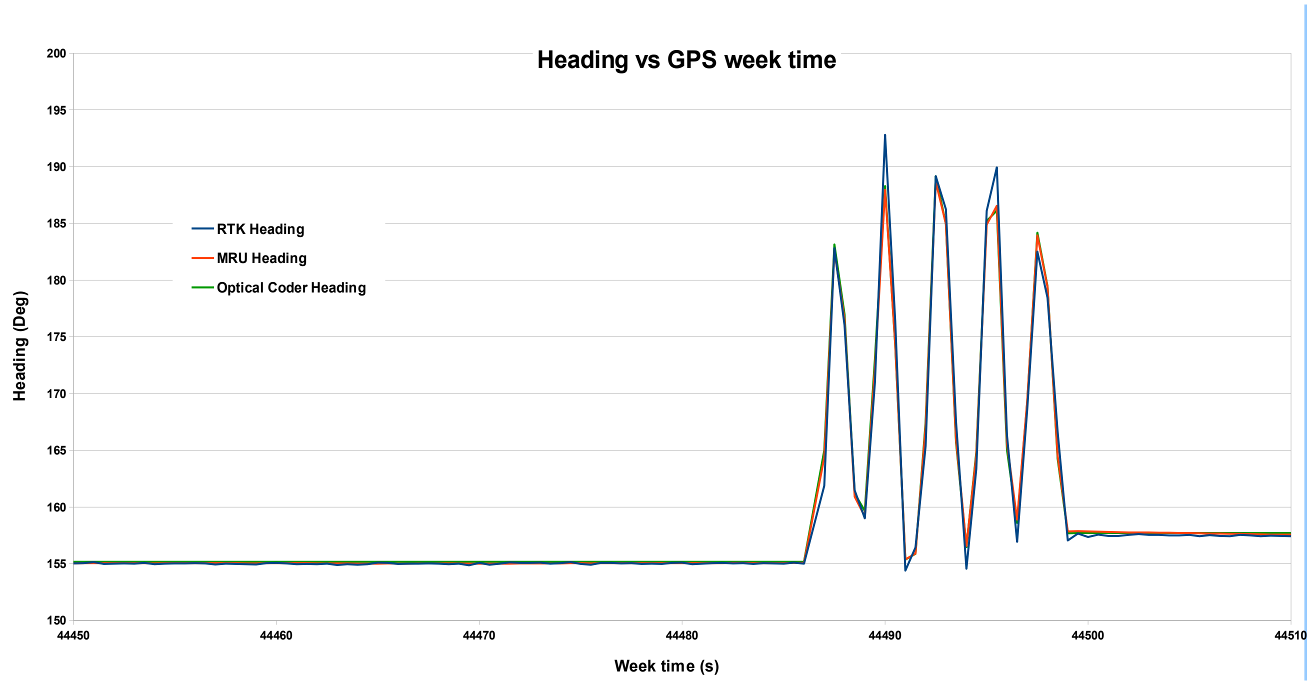
- the MRU's pitch/Roll/Yaw,

- the RTK heading, the type of solution (float RTK or fixed RTK), the brms parameter (estimated baseline rms error),

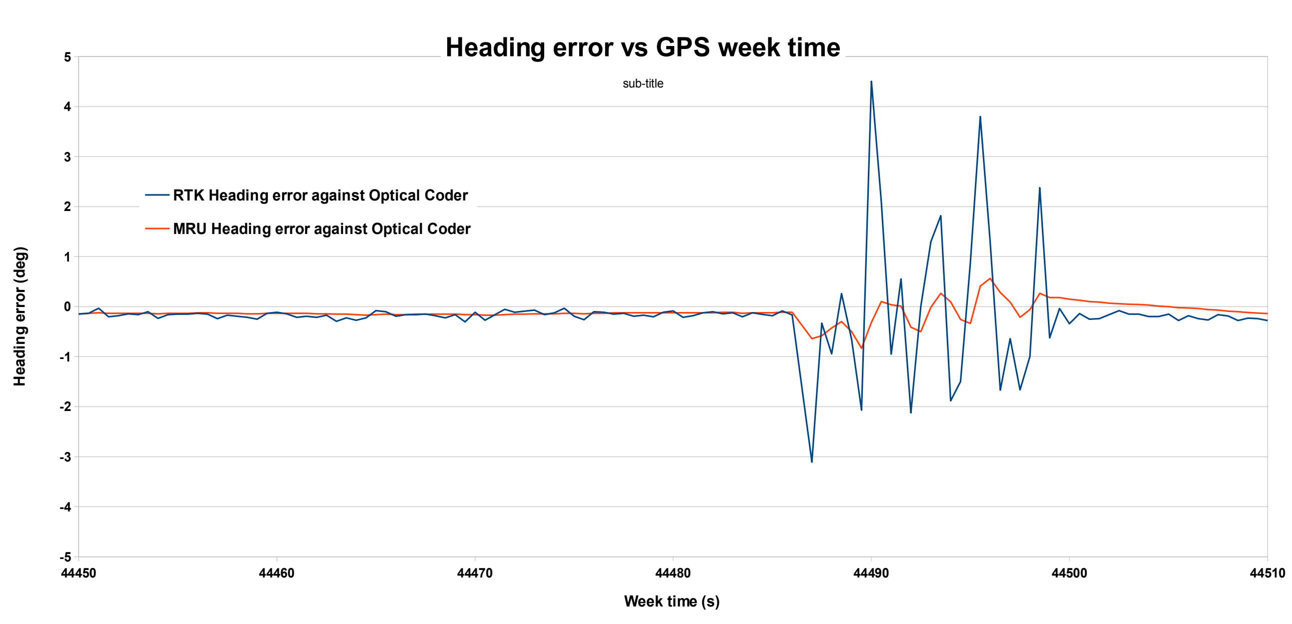
- the GPS week time in seconds,

- the optical coder Yaw angle,

The following diagram presents the RTK heading, MRU heading and Optical Coder heading versus GPS week time for a steady state lasting 35 seconds, followed by a dynamic oscillation of amplitude 40 degrees at 0.5Hz for 12 seconds, then ended by another 10s steady state.



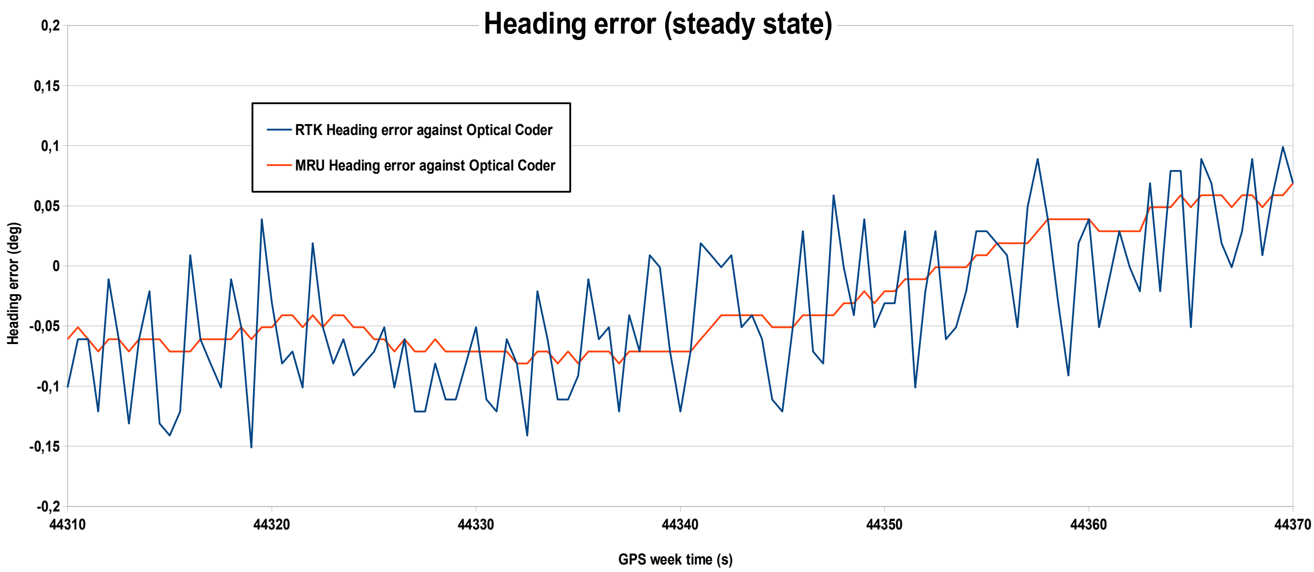
The resulting heading error of the RTK and MRU against the optical coder (the reference) appears on the next diagram:



The results show that the heading accuracy in dynamic conditions is greatly improved by the Orientus MRU, it must be noted that the relatively poor RTK heading accuracy in this case is due to the fast RTK mode used that delivers heading at very low latency, instead of time tagged mode that delivers heading with a better accuracy but with 100ms latency.

Heading smoothing

One of the major benefit of the RTK heading fusion with the MRU Yaw is the smoothing of the final true heading compared to the raw RTK heading input.
The following diagram shows a 1 minute recording heading error in a fully steady state (no angular rotation):



The heading noise standard deviation has been reduced from 0.05° down to 0.01° and the peak to peak noise from 0.2° down to 0.04°, which is a great improvement.