Heading Solutions for Machine Control

Advanced GNSS Compass Technology

Overview

This document provides a brief overview of Hemisphere GNSS' heading solutions for Machine Control applications.

Why Is Heading Important?

Machine control applications, such as landfill management, mining, and construction have heavily adopted GNSS to streamline their operations, increasing efficiency and safety. In addition to position, many applications require that the precise heading of the machine be known. Some examples where heading solutions play an important role are pile installation for solar farms (shown below), meeting environmental restrictions at landfills, grading roads and highways to precise specifications, or optimizing mining operations to reduce operator fatigue and improve safety.

Figure 1 *– Hemisphere's heading solution at work (top center), precisely aligning piles for a solar farm installation*

How Does It Work?

Figure 2 shows a typical heading setup on a bulldozer. A heading system is made up of two antennas, a master and a slave, separated by some fixed distance. These antennas feed raw GNSS measurements into the receiver, which computes the exact orientation of the two antennas. This orientation is then transformed into the heading of the machine based on precise calibration performed beforehand. In some cases, a reference station can also be used to feed differential corrections into the heading receiver and provide centimeter-level positioning accuracy.

Figure 2 *– Vector VR500 Smart Antenna installed on a bulldozer*

The accuracy of the heading system is a function of the antenna separation between the master and

slave antenna. Figure 3 shows how the heading accuracy improves as antenna separation increases. This separation can be adjusted to meet the accuracy requirements of the application.

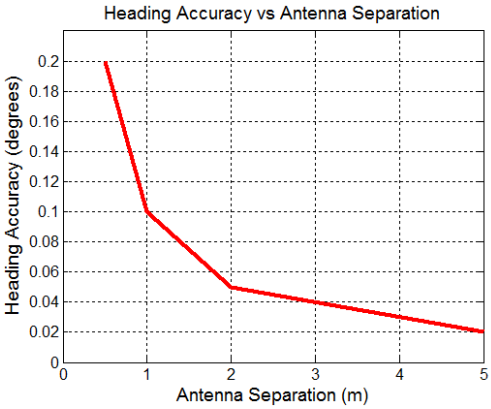

***Figure 3** – Heading accuracy vs. antenna separation*

Performance

The performance of the Hemisphere GNSS solution was tested in the field against an industry-leading brand under numerous scenarios. The tests were performed on a stationary platform with a fixed heading direction so that the quality of the results could be statistically analyzed. The figures to the right show two examples of the heading solution performance: a 2 m antenna separation in open sky (Figure 4) as well as a 0.75 m antenna separation under canopy (Figure 5). In both cases, the Hemisphere solution performs noticeably better than the competitor. In the canopy scenario, both solutions experience some drift initially but overall, the Hemisphere solution is more precise and stable.

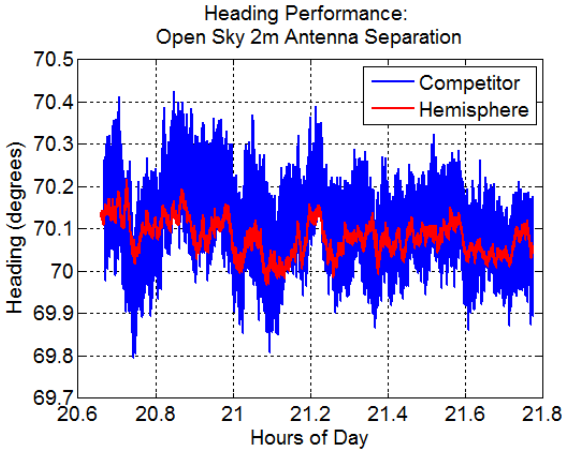

***Figure 4** – Performance comparison vs. competitor for open sky environment*

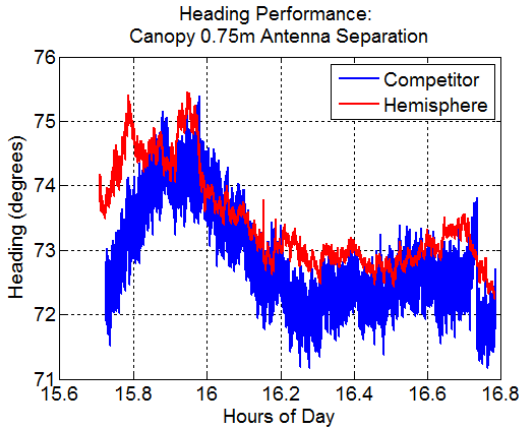

***Figure 5** – Performance comparison vs. competitor for canopy environment*

Figure 6 shows the statistics of 10 scenarios collected in both open sky and high multipath areas, such as beside buildings and near trees. This was done for both a 0.75 m and 2 m antenna separation. In all cases, the Hemisphere solution provides a more precise heading solution than the competitor.

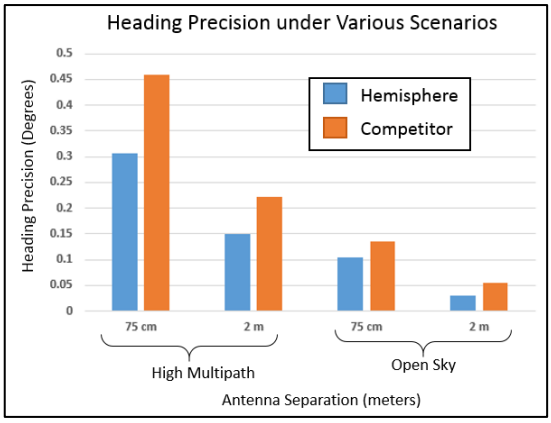

Figure 6 *– Heading performance summary: Hemisphere vs. Competitor*

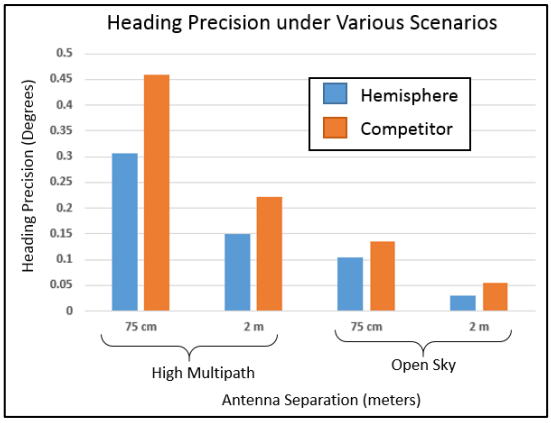

Figure 8 *– Heading performance summary: Hemisphere vs. Competitor*

Figure 7 *– Hemisphere GNSS-based technology is currently being used in Volvo CE's Dig-Assist solution*

Summary

Precise heading is critical for machine control applications. Thanks to Hemisphere's unique heading algorithms, users can expect industry-leading performance in a wide variety of environments and conditions. This level of performance allows Hemisphere and its partners to provide top quality products to their end customers.