Innovative methodology for offset wind vane alignment on the test bench

Introduction

Standard IEC 61400-12-1 Ed. 2.0 from 2017 currently requires an accuracy of 5° or better for wind direction measurements. Common procedures of wind vane alignment do not allow uncertainties significantly below that. They are human dependent and therefore intrinsically inconsistent from site to site. Kintech Engineering developed the Geovane to systematically and repetitively reduce this uncertainty. M.O.E. as an accredited IEC/ISO 17025 test lab was asked by Kintech Engineering, to carry out a validation with respect to its accuracy. The Geovane uses photosensors and the theoretical sun position to determine its own geographical orientation and can be accurately coupled to wind sensors for eliminating their offset with respect to True North.

How does the Geovane work?

The photosensors of the Geovane read the Sun's azimuth angle, when sunrays pass through the slits of its dome. Then the Geovane uses its integrated GPS to acquire local coordinates, date and time, which allows to calculate the time and the location dependent sun angle through an algorithm. The difference between the read and the calculated azimuth angles is the geographical orientation of the Geovane and, after proper alignment, the offset angle with respect to True North of the wind vane installed on top of it. The alignment between the wind vane and the Geovane is accomplished by its integrated line-laser. The scope of application is the accurate determination of true north and is used to determine the true orientation of wind vanes, wind turbine nacelles as well as LiDAR and SoDAR systems.

Our project

M.O.E. created a concept to verify and validate the function and accuracy of the Geovane. A measurement setup with a theodolite and a Geovane is used to verify the alignment. The measurement setup reaches a maximal deviation of 1 mm between the laser of the theodolite and the line-laser of the Geovane (Figure 1). Reference points at M.O.E.'s site in Itzehoe were measured via DGPS with an accuracy of 10 mm to determine True North with a lower uncertainty than the Geovane does. This setup allows us to determine the expected alignment with an uncertainty of 0.03°.

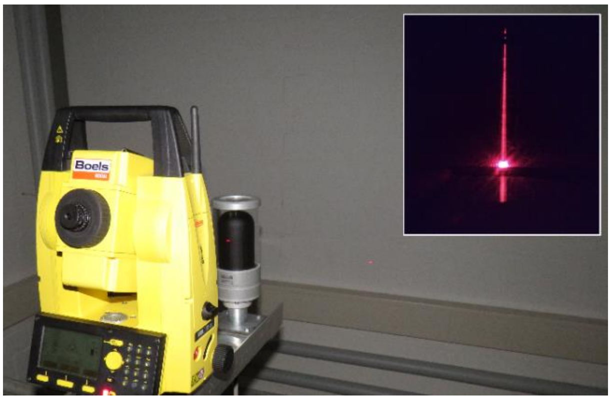

Figure 1 – Alignment between theodolite (point-laser) and Geovane (line-Laser)

After successful alignment the measurement setup is placed on P1 and the theodolite is pointed at P2 and P3 (Figure 2).

Thereby it is possible to compare the expected (orange angle) and given True North direction of the Geovane (yellow alignment) through angle calculations. During the project we were able to verify an absolute uncertainty < 1° (Figure 3).

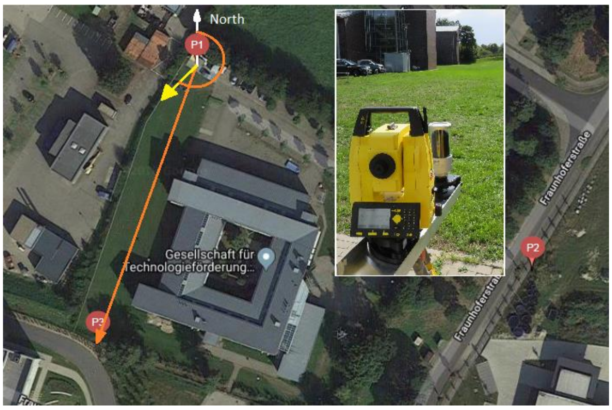

Figure 2 – Alignment of the theodolite from P1 to P3 (orange arrow) and alignment of the measurement setup (yellow arrow)

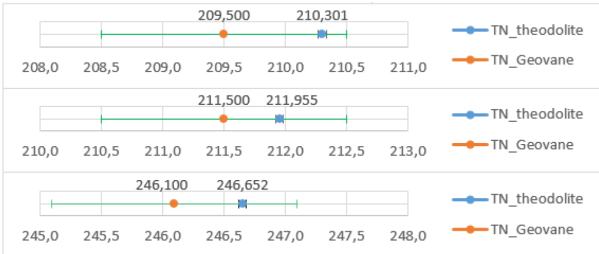

Figure 3 – Comparison between calculated (blue point) and given True North direction by the Geovane (orange point) incl. absolute uncertainty of the Geovane (green interval) and uncertainty of the calculated True North direction (black interval) with a coverage factor of k=1

Summary

The Geovane is a sensor that measures its own orientation to True North by reference to the Sun. Our tests prove, that the Geovane allows to consistently determine the true orientation of a wind vane with an uncertainty less than 1°. This is a significant improvement to existing methods, whose actual uncertainty has been so far only indirectly estimated. The application of the Geovane is the offset cancellation of wind vanes, the determination of nacelle orientation of wind turbines and also the alignment of LiDAR and SoDAR systems. In the upcoming test, additional influencing factors will be identified and improved in cooperation with Kintech Engineering.

Do you have any questions or suggestions?

We are pleased to hear from you!

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