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FBG ANEMOMETER – Ocean Optics application

Fiber optic technology comes with many advantages into field of special sensor application. A Fiber optic anemometer for wind gust measurement as a sensor does not require any power supply in the location of measurement but only connection via one optical fiber carrying an optical signal over distances of several kilometers. Its simple structure transfers bend force of air into spectral modulation of optical signal. No rotational parts are needed and sensor is built as one compact body. Combining this with standard advantages of fiber optics, sensor becomes an attractive alternative compared to common solutions.

Background

For air flow measurements, standard electromechanical anemometers are commonly used. Such anemometers usually require an electrical power source and/or an operating personnel in the place of measurement. That could cause many difficulties, especially if a long-term monitoring in harsh environment is required. Presented sensor application uses a FBG (Fiber Bragg Grating) technology. Wind gust causes bending of whole sensor structure which is transfer on FBG and causes a spectral wavelength shift of input light. This information is transported by optical signal via optical fiber to the interrogation unit based on spectrometer. Sensor measures wind gusts passively and several sensors can be together connected via same optical fiber to the unit. Interrogation unit is based on Ocean Optics USB USB2000+ Miniature Fiber Optic Spectrometer [Figure 2] which provides evaluation of spectral shift with high accuracy and reliability together with special software and allows real time air flow measurement (compared to common electromechanical anemometers). A 850 nm SLED is used as source of light. Because of high selectivity of FBG gratings, speed of measured wind gust can be estimated with resolution value under 0,5m/s.

Figure1: Used USB2000+ Spectrometer

Measurement Considerations

A long-term measurement of fiber optic anemometer in real environment was conducted. Commonly used electromechanical anemometer GIOM 3000 was used as a reference. SLED 850nm was used as source of optical signal. The USB2000+ Miniature Fiber Optic Spectrometer connected into PC evaluated the wavelength shift caused by sensor bending. Both the reference and tested fiber optic anemometer were placed outside of the building into open space [Figure 2].Tested sensor (A) was fixed with clamping structure (B). Optical signal was transfer via optical fiber (C). Reference anemometer GIOM 3000 was placed right below (D).

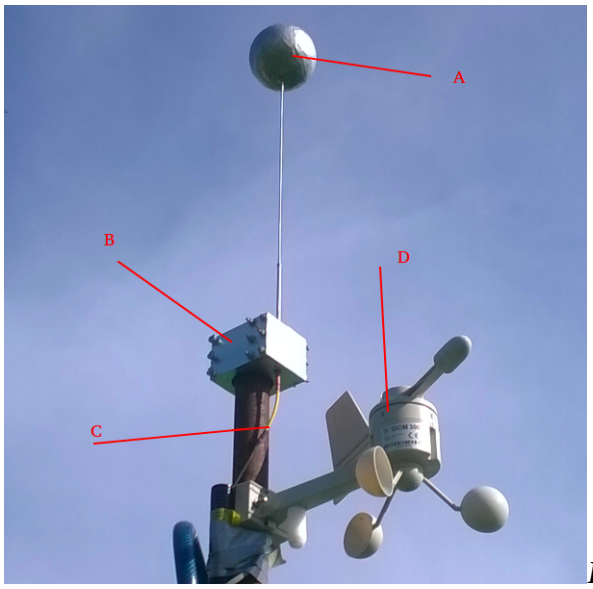

Figure 2: Measurement setup

Test results

Data from spectrometer were processed by computer algorithm into graphic form. Figure 3 shows zoomed part of graphical interpretation of signals - the comparison of results from reference electromechanical and tested fiber optic anemometers. Presented data were taken at the same time with maximal sampling frequency.

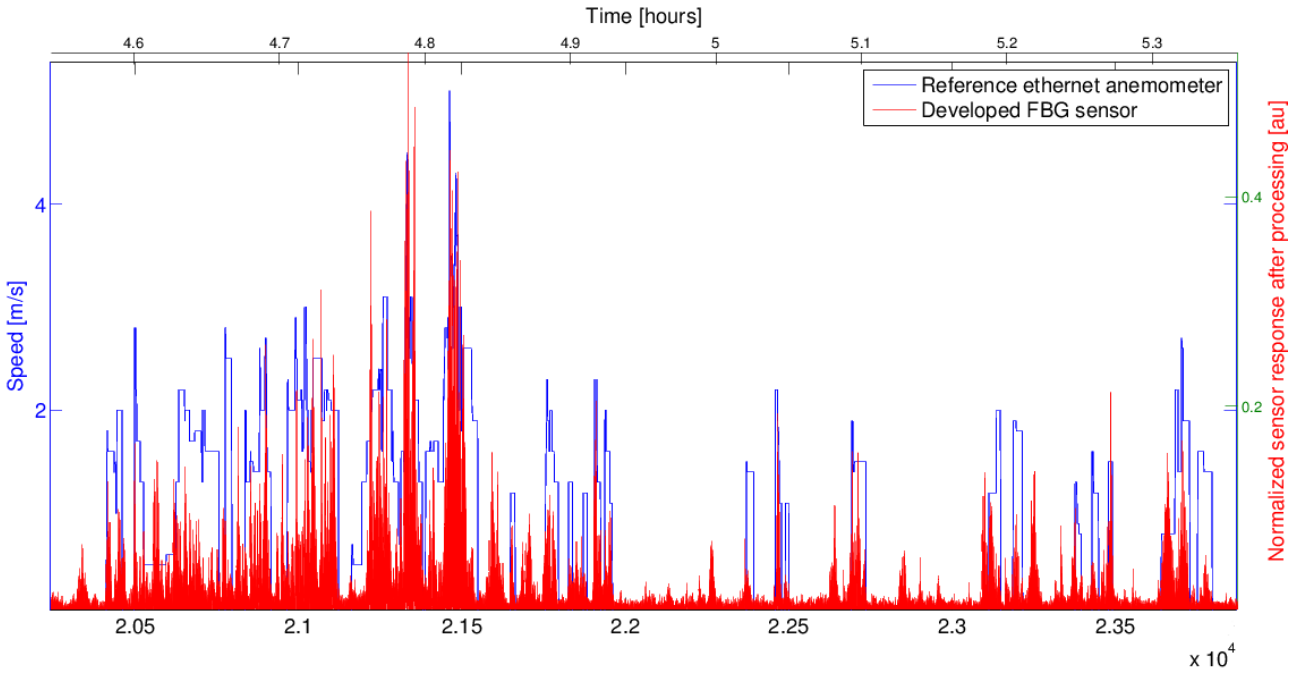

Figure 3: sensor comparison

The blue curve represents signal taken by reference anemometer. The red curve corresponds to wavelength shift caused by bending of fiber optic sensor. X-axis is marked in hours (top) or sample order (bottom).

Conclusions

Blue signal has clear value averaging (the rectangle shapes). In some places, there is no blue signal compared to red signal. That is caused by to low value of an air flow, which was not able to spin the air-screw. That concludes the sensitivity and time step resolution of fiber optic sensor are higher.

This FBG anemometer can be based on different Ocean Optics Spectrometers and different wavelengths, but 850 nm is most common (except 1550 nm). Results are comparable to commonly used anemometers and main plus is it brings all the advantages of optical fiber technology and can be combined with other FBG sensors in one network. Most importantly, it can be used in places too far from electric grid and it allows long-term measurement in harsh environment without maintenance. The 850nm SLED together with USB2000+ Spectrometer makes presented solution cost-effective.