Wind Sensing Doppler LIDAR, Improving Wind Turbines

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Wind Sensing Lidar

Wind sensing Lidar is a laser based anemometer capable of remote wind measurement. The wind measurements are obtained by measuring the Doppler shift induced in scattered light from aerosols in the air. This only gives the wind speed in the direction of the light beam, and different schemes to obtain the full velocity of the wind have been developed. Some of these are shown in the figure below.

These methods are intended for ground based measurements and are used for analyzing areas for future wind farms as well as registration of wind speeds at current wind farms. A more direct way of using the Lidar for improving wind turbines is by integrating it into a wind turbine as shown below. In this manner the pitch and rotation of the wind turbine can be adjusted according to the wind and thereby maximizing the efficiency of the wind turbine.

Lightwave Synthesized Frequency Sweeper assisted Lidar

Lightwave Synthesized Frequency Sweeper (LSFS) assisted Lidar is a specific Lidar type invented by Petter Lindelöw. The motivation is to create a Lidar capable of multiple simultaneous spatial measurements. This is achieved by using a frequency stepping pulse train as laser source. Each pulse will be scattered at all heights and then interferes with the reference pulse train at a time corresponding to the height at which it were scattered.

The LSFS is setup as a ring laser with a seed laser and an Acousto-Optic Modulator (AOM) which defines the initial pulse. The ring consist of a amplifier that compensates loss in the ring, a filter that minimize noise in the ring and a AOM which induce the frequency step.

A generated pulse train and a comparison with a simulated result is shown on the figure to the right. The LSFS Lidar is an all fiber based setup due to the need for a robust and easy to use system. Another advantage of a fiber system is compatibility with telecom equipment which greatly reduces cost of the individual components. This though limits the available wavelength possible to use to around 1550 nm. This wavelength range has several advantages besides being compatible with fiber technology. The atmosphere has a transmission window at these wavelengths which is very important for functionality of the Lidar. For this high wavelength the scattering of aerosols are less than for shorter wavelengths, but at the same time one gets a higher amount of photons pr mW at higher wavelengths.

Another important aspect is eye safety. In order to get as high a return signal as possible, it is of interest to have as high an output signal as possible while still being eye safe. As it can be seen this is best achieved at a wavelength around 1550 nm, which therefore makes this choice ideal.

Further applications for Lidar technology:

- Temperature measurement by Raman scattering.
- Atmospheric composition analysis.
- Detection of CO₂ concentration.
- Ash detection.

References


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