Capability

Wind Turbine Structural Health Monitoring

Applications:

- Wind turbine structural health monitoring
- Individual turbine maintenance
- Wind farm energy production optimization

Benefits:

- Real-time blade damage sensing
- Data input for active control in the field
- Limit damage propagation and maintenance costs
- Maximize return on investment
- Retrofit existing wind farms

Other Demonstrated Applications:

- Bridge and building infrastructure management
- Munitions investigations

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Summary:

As wind turbines age, operational and maintenance costs can increase to between$15 and $20 per megawatt-hour on average, significantly reducing the return on investment expected from a wind farm operation in the aggregate. Los Alamos National Laboratory (LANL) researchers believe that particularly susceptible turbine components such as the gearbox, generator, rotor blades, bearings, and shaft are not specified, constructed, and integrated according to realistic wind loading conditions, which may contribute significantly to the incidence of unplanned maintenance and turbine failure. The goal of the U.S. Department of Energy is to reduce these unplanned costs by 40%.

LANL is currently involved in a well-funded effort to leverage its experience in structural health monitoring applied to nuclear stewardship and bridge infrastructure maintenance to wind turbine design and optimization. A multi-scale prognostic sensing system will be an essential component in all aspects of the research effort: a) local and active sensing to monitor previously existing and propagating damage, b) global sensing to assess operational conditions, c) sensing to maximize observation and understanding of degradation and failure mechanisms, and d) implementation of new algorithms for efficient and timely application of operational controls in the field.

LANL's wind turbine sensors are robust, non-intrusive, provide distributive sensing capabilities, transmit data wirelessly, and use minimal energy. Sensor node modules will be integrated with system state-awareness techniques for rapid condition assessment of both local (blade, hub, gearbox, etc.) and global (system operation and energy production) aspects of turbine system management.

The data obtained from this multi-scale sensing capability will be fully integrated with modeling and simulation techniques for data interrogation and prognostic decision making. Successful completion of this first-of-a-kind monitoring method will result in a system capable of predicting the behavior of damaged components in wind turbines and the implementation of that damage on system performance.

Status: LANL researchers are developing unique sensors in tandem with proprietary high-fidelity finite element models as well as the LANL WindBlade modeling and simulation capability that couples aeroelastic dynamic force loads with atmospheric wind conditions and system environment. The LANL Intelligent Wind Turbine Program is seeking dialogue with potential industrial collaborators to discuss long-term partnership opportunities.

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