Wind Turbine Blade Deflection Measurement System

Amy Seier, Christopher Brown, Abdullah Al Abri, Milo Beall, Blake Martinez, Al-Khalil Al-Habsi, Blake Maly, Jacqueline Padilla

DESIGN CENTER COLORADO
DESIGN • BUILD • INVENT

SIEMENS Gamesa
RENEWABLE ENERGY

Background

- Wind turbine blades experience unmonitored deformations during transportation from factory to the wind farm
- Tracking the deflection of the wind turbine blade tip can inform blade load states and fatigue
- Ultra-Wideband technology has been used in other tracking applications. Siemens Gamesa Renewable Energy tasked the team to assess its feasibility for use in the blade transportation application.

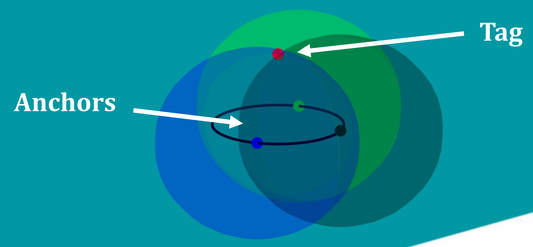
Objectives

- Design UWB system to characterize limitations of the technology
- Determine if UWB technology should be used to monitor structural displacement of turbine blades
- Implement a measurement validation system to compare to UWB results: image tracking chosen

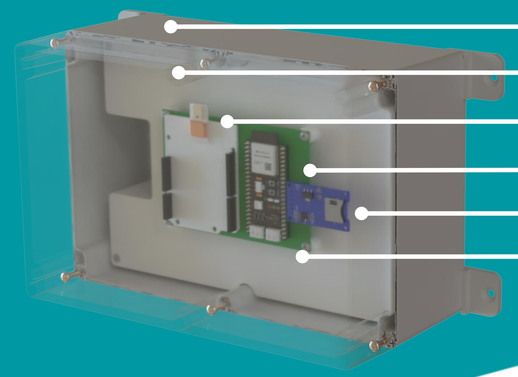
Ultra-Wideband (UWB)

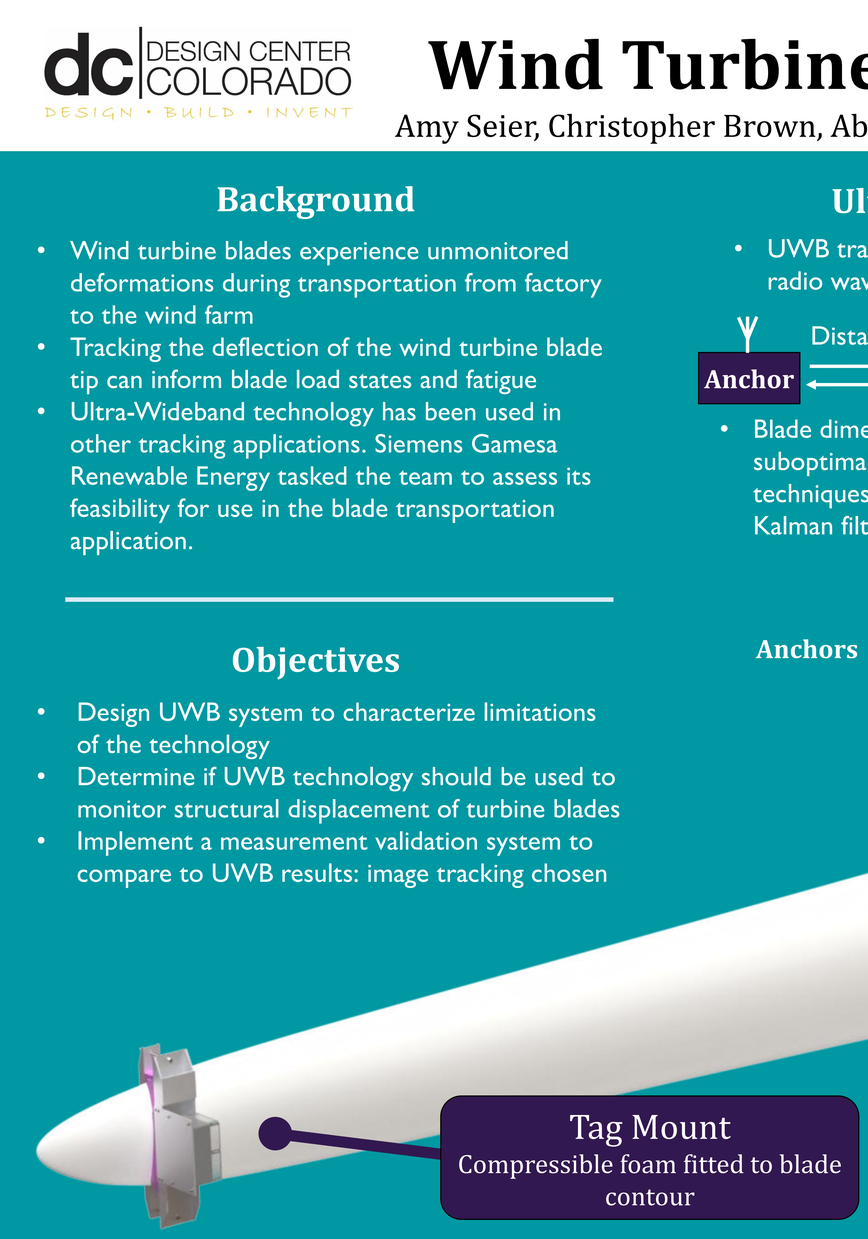
- UWB transceivers send and receive short pulses of radio waves to determine their separation distance

- Blade dimensions constrain the system to a highly suboptimal geometry, requiring additional post-processing techniques such as constraining the solution space and Kalman filtering



Electronics

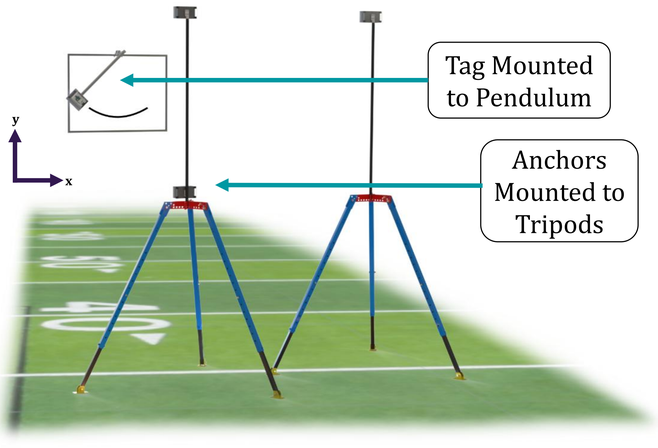




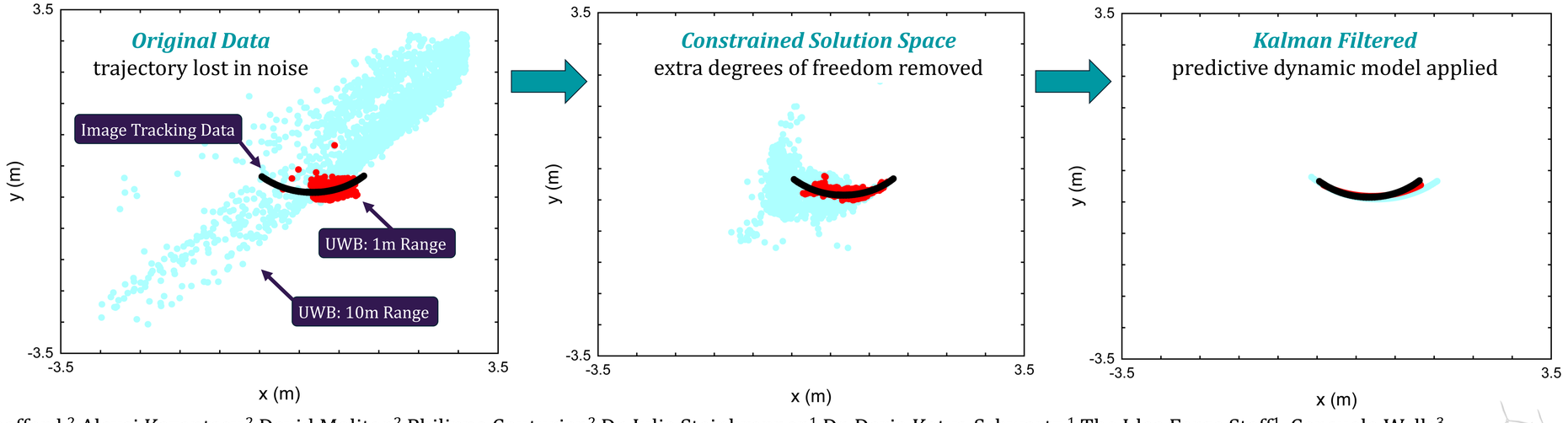
Key Takeaways & Next Steps

- UWB accuracy is dependent on anchor geometry
- The application of UWB is unideal for wind turbine blade transportation due to geometric constraints
- Methods such as Kalman filtering and solution space constraints improve results
- Range is affected by multipath interference and additional parameters such as line of sight
- Tag motion increases noise in data
- With advanced data processing methods, UWB could be a cost-effective solution for this application

Test Setup



Dynamic Blade Model: Pendulum Test



Acknowledgments: Dr. Paul Ibanez,[1] Austin Spafford,[2] Alexei Kazantsev,[2] David Molitor,[2] Philippe Couturier,[2] Dr. Julie Steinbrenner,[1] Dr. Daria Kotys-Schwartz,[1] The Idea Forge Staff[1], Consuelo Wells[3]

[1]*University of Colorado Boulder* [2]*Siemens Gamesa Renewable Energy* [3]*National Renewable Energy Laboratory*