



E17 - Advanced Collision Detection and Site Monitoring for Avian and Bat Species for Offshore Wind Energy

Mitigate Market Barriers – Environmental Research

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Oregon State University

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FY21 Peer Review - Project Overview

Project Summary:

- Development of automated collision detection system for wind turbine blades suited for bats and small birds at offshore wind turbines
- Includes a suite of on-blade sensors and imagers to detect collisions and to record and store videos of colliding objects for identification
- Project focus is hardware and software development and lab-based testing (Task 1-2) in FY19/20, followed by field-based testing of complete integrated system (FY21)
- Field testing to be planned and conducted in close collaboration with the National Wind Technology Center at the NREL Flatirons Campus, Boulder, CO on a GE 1.5MW wind turbine over two field tests

Project Start: September 2019
Expected Completion: August 2021
Period of Performance: 1.5 years

DOE Share: \$619,609
Cost Share: \$154,904
Total Project Budget: \$774,513

Key Project Personnel: Prof. Matt Johnston (OSU), Prof. Roberto Albertani (OSU)

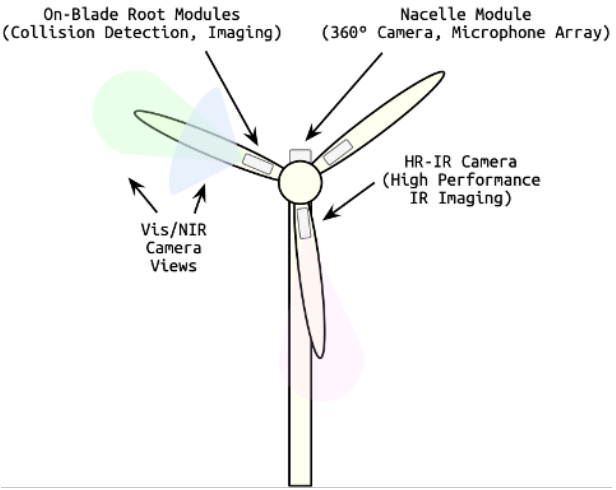
Key DOE Personnel: Jocelyn Brown-Saracino, Raphael Tisch, Naomi Lewandowski, Michael Carella, David Chen

Project Objective(s) 2019-2020:

- Design, implementation and validation of all automated collision detect system components, including sensors, software, and lab testing
- Planning and preparation for field testing, including using an unattached wind turbine blade on the ground, and up-turbine testing

Overall Project Objectives (life of project):

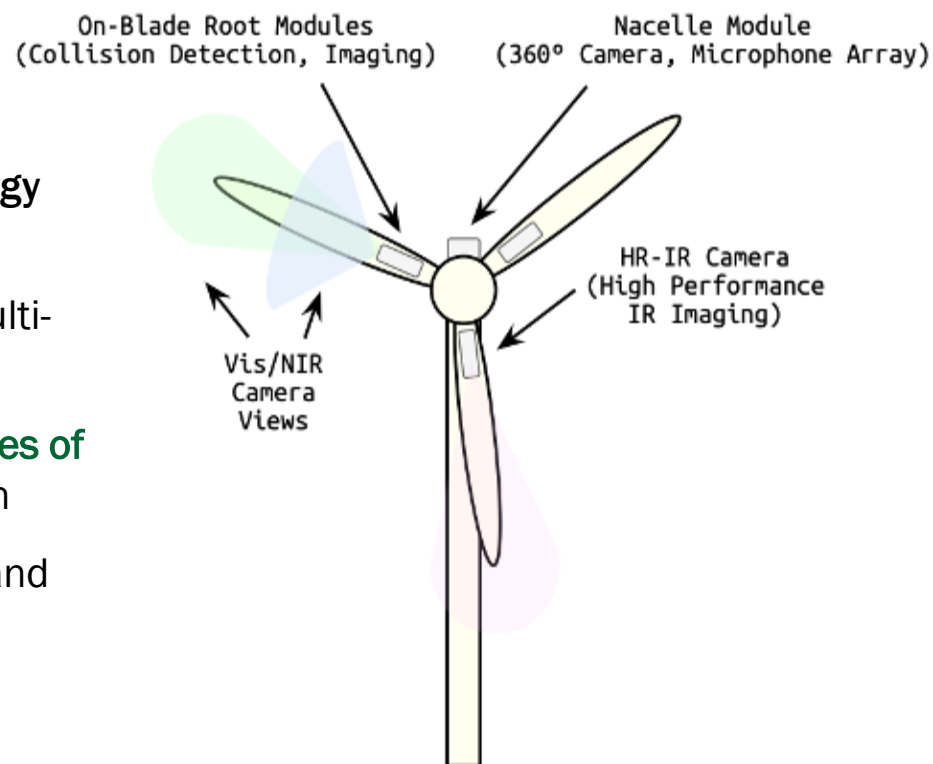
- Demonstrate an automated system for wind turbine blades to accurately detect and image collisions bats and small birds offshore



Project Impact

Addresses three primary needs for fatality monitoring and impact assessment of wind energy on bird and bat species in offshore operations:

- **Blade collision detection** using on-blade, multi-sensor module and automated algorithms
- On-blade cameras capture **videos and images of colliding objects** for analysis or identification
- **Automated operation** for long-term turbine and site monitoring without human intervention



Primary technical objectives:

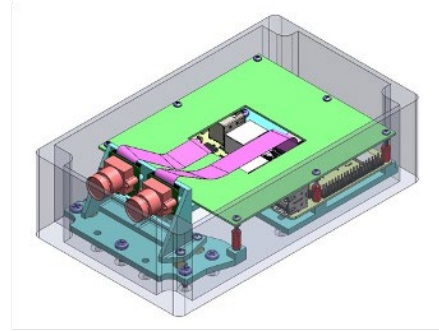
- 1) Automated detection of low energy impacts, typically involving bats or small birds. Target is detection with >90% accuracy of a blade impact energy equivalent of a rotating turbine blade striking a 10g object.
- 2) Provide visual confirmation of events in both daytime and nighttime conditions using blade-mounted cameras that automatically record videos of colliding objects as initiated by blade collision detection.

Program Performance – Scope, Schedule, Execution

Project Scope and Schedule

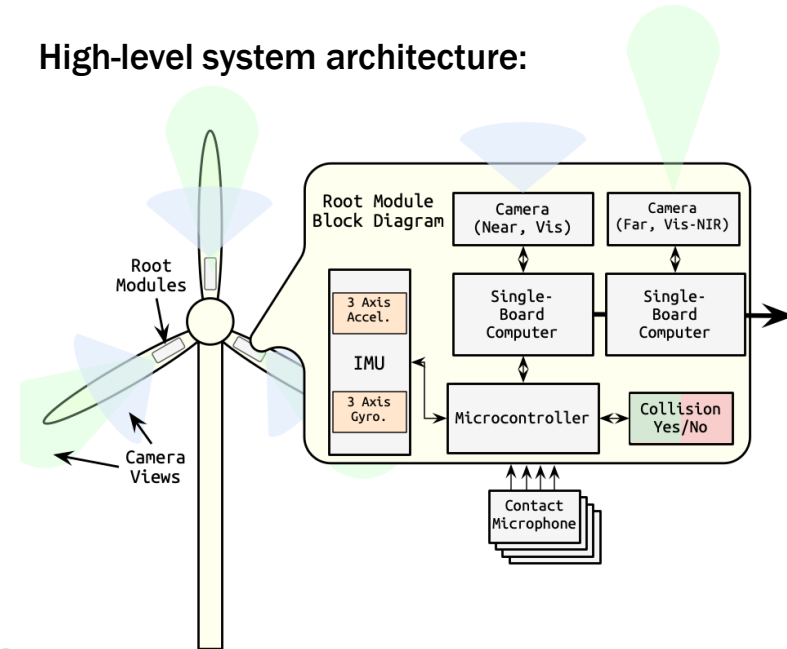
- **System Development | BP1 (FY19, FY20 – Completed Work)**
 - Development of sensor hardware and software modules
 - Validation of standalone and integrated components
 - Laboratory-based system-level validation
 - Preparation for Go / No-Go review
 - All milestones and deliverables were completed on schedule for FY19, FY20
- **Field Testing | BP2 (FY21- Upcoming/Ongoing Work)**
 - Testing on the ground (BP2 – Future Work)
 - Complete collision detection system testing and performance assessment using an unattached wind turbine blade on the ground
 - Planned for Q1FY21 (Dec 2020) at a blade storage facility near Arlington, OR
 - Testing on an operational wind turbine (BP2 – Future Work)
 - Planned field tests at NREL NWTC at NREL Flatirons Campus in Boulder, CO
 - Two planned field tests

Program Performance – Accomplishments & Progress



Multi-sensor module measures vibration for collision detection and provide on-blade image capture.

High-level system architecture:



Progress to date (Q4FY19-Q4FY20):

- On-blade impact detection and image capture ('Blade Root Module'):
 - Enhanced sensitivity through improved sensors and improved algorithms
 - Enhanced imaging using dual-vision near/far and Visual/InfraRed camera setups
- On-blade impact detection and localization ('Blade Sensor Patches'):
 - Improved sensitivity for small-mass or low-energy blade collisions
 - Low-power, small-form factor sensor 'patches' distributed along the blade length
- On-nacelle imaging, audio recording, and communication ('Nacelle Module'):
 - Integration of 360° imaging and high-bandwidth audio recording (including ultrasonic)
 - Module also provides core communication node for on-blade sensor modules and link to ground
- All development, integration, and laboratory-based validation completed on schedule

Task 1 & Task 2 Complete | Milestone 1.29, 1.49, 2.49 | Deliverable 1.79

Project Performance - Upcoming Activities

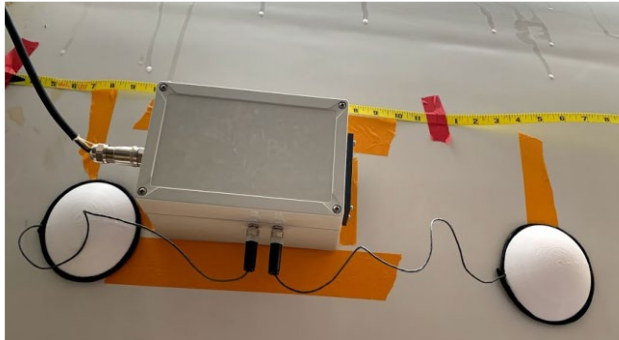
Recent Progress (FY21 Q1-Q2)

- Field test complete on schedule (Dec 2020) on unattached wind turbine blade

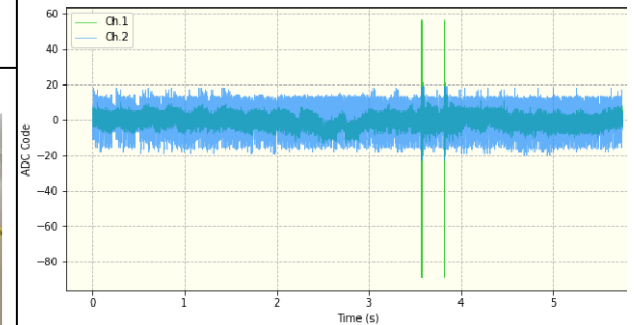
Unattached wind turbine blade marked off for testing:



Root module and contact microphone installation:



Typical sensor patch contact microphone measurement at 12.5m from blade root (near patch) from 27N impact:



- Continuation application submitted for Go/No-Go review (Dec 2020)
- 'Go' decision received (Jan 2021)
- Planning underway with NREL-NWTC for first up-turbine field test (June 2021)

Planned Activities (Remaining FY21)

- Two up-turbine field tests at the NREL Flatirons campus; planning underway
- Detailed data analysis and algorithm development is ongoing

Stakeholder Engagement & Information Sharing

Primary Collaborators

- NREL National Wind Technology Center, NREL Flatirons Campus, Boulder, CO
- Avangrid Renewables, LLC (Wind Energy Operator)

Engaged Stakeholders (FY19-FY20)

- Vestas Wind Systems A/S (Wind Turbine and Blade Manufacturer)
- Envision Energy (Wind Turbine and Blade Manufacturer)
- Additional stakeholders to be engaged in FY21

Outreach and Engagement Plan

- 2X presentations at Wind Wildlife Research Meeting (WWRM 2020)
- Planned presentations at future wind energy conferences in FY21
- Publication of system and components at technical conference and journal venues in FY21