Design of a Launcher for Wildlife Collision Simulation on Wind Turbines To Validate Strike Detection Systems

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Overview of Launcher and Need

Wildlife collisions with wind turbines are difficult to quantify because carcasses cannot be counted in a timely and accurate manner. This is especially true in an offshore environment where a carcass will sink or float away after colliding with a turbine. Some technologies in development are designed to detect wildlife collisions immediately upon blade impact and someday may be able to classify the species of bird or bat involved in the collision. These systems must be validated to determine their accuracy before they can reliably monitor wildlife at wind farms.

From 2020 to 2022, NREL was tasked with validating two of these technologies on the DOE 1.5-MW wind turbine at NREL's Flatirons Campus. To accurately simulate bird and bat collisions, a team at NREL developed a pneumatic launcher and custom projectiles.

Design constraints for the launcher evolved as it was used on various projects. However, final constraints included a vehicle/hitch mount, use of a self-contained compressor powered by a self-contained gasoline generator, and custom projectiles that not only flew straight but had realistic impact characteristics. Tennis balls were also used for certain tests.

Launcher Design

Mechanically, the launcher system consists of several components:

- Off-the-shelf, self-contained compressor
- Off-the-shelf, self-contained gasoline generator for power
- Launcher electronics in a Pelican case
- Launcher, consisting of a CH-5AL Tire Cheetah, various pneumatic fittings and valves, and custom aluminum barrels of various calibers

The launcher trigger mechanism comprises a servo motor coupled to a butterfly valve using a belt drive. The speed and displacement of the valve opening is controlled by the launcher electronics. Coupled with launch pressure, these parameters allow for precise control of projectile velocity. The launcher electronics include:

- NI myRIO-1900 embedded device running LabVIEW
- Solenoid valve controlling pressure in the tank
- Power supply
- Wi-Fi router
- Controller for the servo motor

The entire launcher is controlled using a Dell touchscreen tablet running LabVIEW and a custom user interface. The launcher's LabVIEW control is coupled with the turbine data acquisition system, providing real-time updates of azimuth and RPM to the launcher over Wi-Fi. This configuration enables the launcher to time its launches with blade passage, which significantly improves repeatability and hit percentage. The launcher interface has an adjustable time-delay feature to precisely tune the launch time.

Projectile Design

Projectiles were sized 8 g, 25 g, and 250 g. They were constructed of unflavored gelatin and laser-cut balsa wood to simulate flesh and bone while having aerodynamic characteristics that would allow for repeatable flight trajectories. The gelatin mixture also contained a trace amount of concentrated coyote urine to deter wildlife from consuming the projectiles on the ground before they could decompose.

Applications for Environmental Research

This launcher was critical to the success of two projects conducted at NREL on the DOE 1.5-MW wind turbine, both under DOE FOA 1924.

1. *Advanced Collision Detection and Site Monitoring for Avian and Bat Species for Offshore Wind Energy*: Oregon State University collaborated with NREL to place sensors on the outside of the wind turbine blades at the root. Tennis balls and 20–40-g projectiles were used to determine if the sensor and camera arrangement could accurately record collisions.
2. *A Multi-Sensor Approach for Measuring Bird and Bat Collisions with Wind Turbines*: Western EcoSystems Technology Inc. (WEST) led a project in collaboration with NREL and the Netherlands Organisation for Applied Scientific Research (TNO) in which sensors were placed inside the blades, and camera systems were installed around the base of the turbine. Small, medium, and large (8-g, 25-g, and 250-g) projectiles were used in the study. The launcher's proven reliability and hit percentage make it a powerful tool for future wildlife collision studies.

Further research could investigate the similarity in impact energy between the custom projectiles and a real carcass.

Hit Percentages and Results

The combined capabilities from azimuthal launch control, repeatable launch parameters, custom projectiles, and precision aiming led to an overall hit percentage of 35%. This hit percentage allowed for an unprecedented number of direct blade strikes during both studies conducted at NREL. Both systems were able to detect the simulated wildlife impacts, and the team learned a lot from each study.

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