Implementation of Avian Radar-SCADA Interface to Mitigate Raptor Mortality at Windfarms

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ABSTRACT

Although wind energy is generally perceived to have low environmental impacts, a wide array of wildlife issues has been documented at windfarms worldwide and an important subset is collision fatalities of long-lived raptors and vultures. Challenges for mitigating collision risk of these types of birds include accurately identifying when raptor-type birds are at risk, minimizing wind turbine downtime, and finding a solution that is applicable to the myriad of collision causes.

An innovative way to mitigate avian collision risk while meeting these challenges is to use a radar-based mitigation system that integrates radar, capable of detecting birds at risk in real-time, with the windfarm Supervisory Control and Data Acquisition (SCADA) system, which can implement mitigation measures ranging from issuing alerts to windfarm operators to idling turbines. The technology has been successfully implemented at several windfarms since 2009 for migratory birds, however different mitigation rule sets are applied to address high-risk collision conditions for raptors and vultures. An example of this mitigation strategy applied to Griffin Vultures in Spain is presented; other potential applications include Golden Eagles, California Condors as well as other raptors. This mitigation technique minimizes raptor collision risk as well as turbine downtime.

Introduction

Raptor mortality is relatively low at most North American windfarms, but dominates at some sites such as parts of California. Studies from other counties indicate additional situations involving collision mortality of raptors and vultures, such as Griffin Vultures in Spain and White-tailed Sea Eagles in Norway. There are numerous root causes for these collisions, ranging from high prey densities and tunnel vision, to topography and thermal distribution, and include territorial disputes and even breeding displays. This wide array of causes in combination with the larger size of these birds necessitates a simple approach that can encompass all these situations.

Red-shouldered Hawk

The Technology

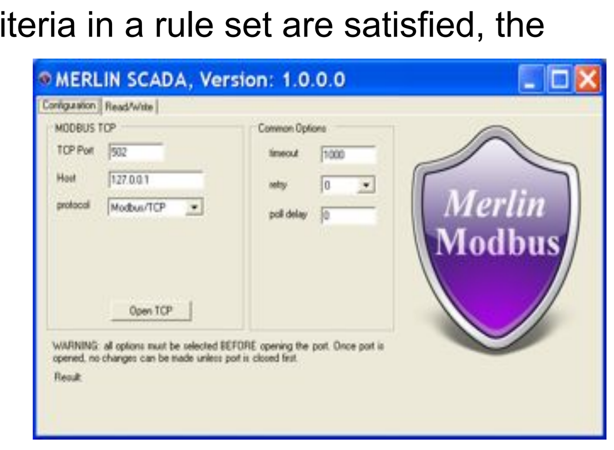
The fully automatic MERLIN radar system, originally developed for mitigating bird strike risk for the US military and NASA, precisely detects and tracks bird and bat targets in real time using simultaneous vertical and horizontal scanning radars. It has been used to conduct pre-construction surveys as well as provide data for mortality risk models at proposed windfarms throughout the U.S. and Europe since 2003.

In order to mitigate bird and bat collision mortality risk at operational windfarms, the MERLIN radar was first integrated into the Supervisory Control and Data Acquisition (SCADA) systems at two operating windfarms in 2009 to provide an automated risk management system. The resulting MERLIN *SCADA*™ system is a radar-based mitigation system that functions as a continuous monitoring and control system at operating windfarms with the added capability of activating mitigation measures in real time when high risk bird or bat strike conditions occur.

The first MERLIN SCADA radar-based mitigation installation at a windfarm in Texas, USA (2009).

Implementation

Depending on the size and layout of a windfarm, one or multiple radars can be used to monitor activity at a site. The MERLIN radar system is then connected to the windfarm SCADA system in order to communicate with the windfarm control system, obtain other sensor data (such as wind speed and direction, visibility and cloud ceiling) and directly control the wind turbine(s). The radar-based mitigation system is programmed with one or more rule sets based on high strike risk conditions established specifically for that windfarm. When all the decision criteria in a rule set are satisfied, the MERLIN software uses industry standard Modbus and OPC communication protocols to communicate with the wind turbine SCADA system to initiate a variety of pre-programmed response actions. These can range from alerting windfarm operators of the risk, to direct idling (curtailment) of a turbine or group of turbines, to activation of deterrent devices. MERLIN *SCADA*™ also logs the action, provides an operator alert via email, text messaging and/or custom remote displays at the windfarm control center (and other locations as required), and continues to monitor the bird and bat activity, providing an "all clear" response (e.g. restarting the idled turbines) once the risk level lowers. This effectively reduces the amount of wind turbine downtime to only periods of time when high collision risk is actively detected.



Raptor Application

In the raptor application of MERLIN *SCADA*™, individual wind turbines would be idled whenever a target with characteristics of the species of interest occurred within a pre-specified risk area around each wind turbine. In order to accomplish this, risk indices would be assigned to individual raptor-type targets relative to their distance and heading from each wind turbine as measured by the avian radar system. These indices could then be used to define high strike risk times while bypassing the use of real-time target coordinates that could potentially violate International Traffic in Arms Regulations (ITAR). An example of how MERLIN *SCADA*™ is being applied to a windfarm in Spain to mitigate for Griffon Vulture collisions is described below.

Griffon Vulture

Conclusions

Raptor risk is particularly prominent at wind energy developments in western North America, and the MERLIN *SCADA*™ System, with the appropriate site-specific information, provides a valuable mitigation option for sites having Golden Eagles, California Condors as well as other raptors at risk of collision with wind turbines. The application of a radar-based mitigation system requires site-specific information to develop rule sets tailored to an individual site. This data is best developed from detailed, continuous year-round, pre- or post-construction radar surveys, and therefore allows reduction of turbine downtime by targeting exact periods of known high mortality risk for a site.

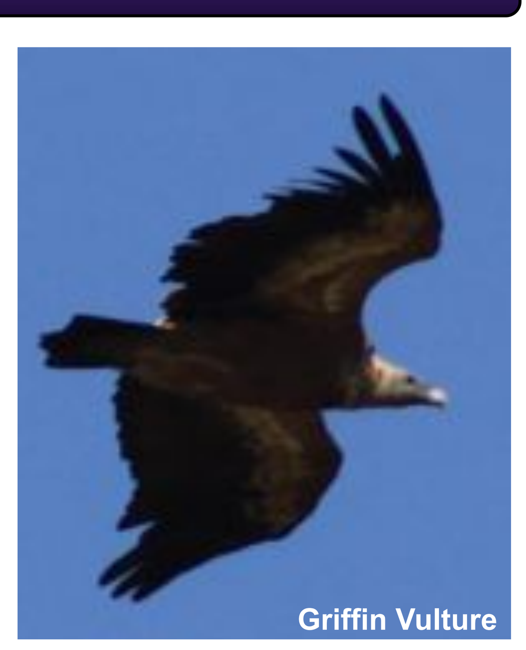
Operational experience gained on the first implementations of the MERLIN *SCADA*™ technology in 2009 for migratory birds have demonstrated the feasibility of this technology. New implementations now underway in Europe for raptors will further expand the knowledge base and allow refinement of the system. This mitigation technique is able to help keep green energy "green" by minimizing both raptor collision risk and turbine downtime and provides an important tool in the comprehensive mitigation process for windfarms.

Case Study – Griffon Vultures

The Situation

<u>The Problem:</u> Griffon Vultures are frequent collision fatalities at wind turbines at some windfarms in Spain

<u>The Solution:</u> Use the MERLIN *SCADA*™ System to develop a 2-step mitigation strategy to reduce collision risk of Griffon Vultures at wind turbines. After detection of a vulture-type target at risk of colliding with a wind turbine, LRAD (Long Range Acoustic Device) will first be used to deter the bird away from the wind turbine. If the collision risk doe not subside, then the MERLIN *SCADA*™ System will shut down the wind turbine to prevent collision.



Griffin Vulture

Merlin Avian Radar System

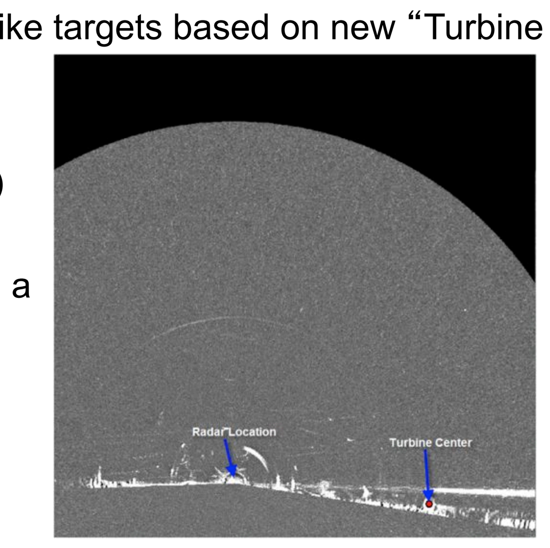
A MERLIN Avian Radar System was installed September 2009 and recorded continuous data in order to develop a vulture mortality mitigation strategy. Long Range Acoustic Devices (LRAD) were also tested for incorporation into the overall MERLIN *SCADA*™ mitigation strategy. (LRAD's are military-grade acoustic beam devices that project an intense, focused beam of sound up to 160 dB with effective range up to 1500 m.) A rule set was written for MERLIN *SCADA*™ using radar data, biologist's observations, and LRAD results and used three critical parameters: 1) detection of large soaring bird-like targets, 2) wind direction, and 3) cloud ceiling height.

LRAD Unit

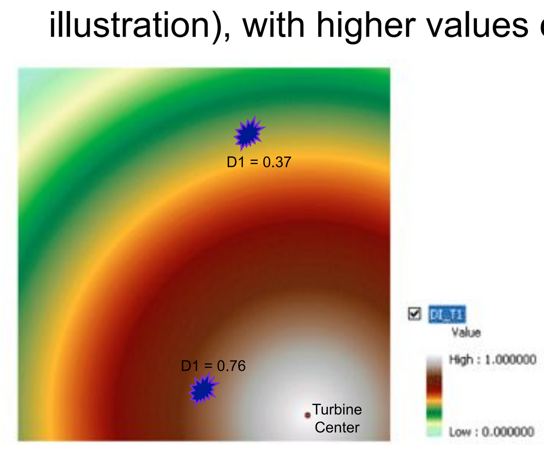
Raptor Detection

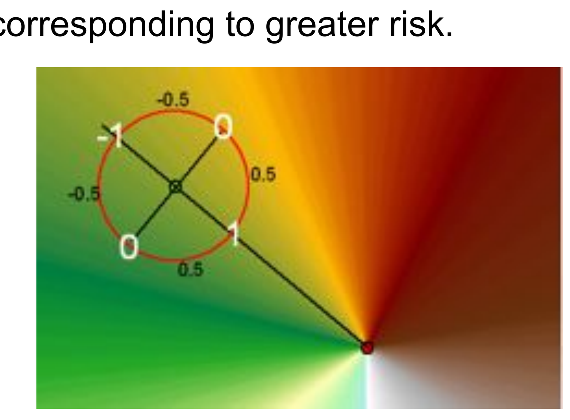
Detection of large soaring bird-like targets based on new "Turbine Centric" model.

•Vertical Scanning Radar (VSR) provides full horizon-to-horizon radar coverage of all turbines in a row as illustrated to right.



•Collision Risk is computed using two values from the VSR data, 1) distance of target relative to every turbine hub (left illustration), and 2) flight heading relative to every turbine hub (right illustration), with higher values corresponding to greater risk.





•Collision Risk is computed for every large, soaring bird-like target in real time, relative to every turbine in the row.

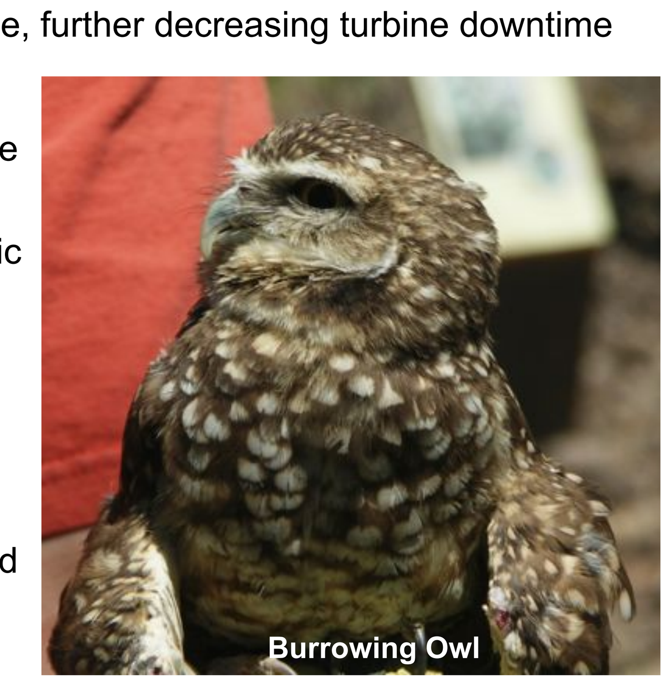
•Data from horizontal scanning radar also used to create a "3D" risk assessment.

Implications

•A key feature of the raptor application of the MERLIN *SCADA*™ System is that it allows for every target to have a calculated risk relative to every turbine, allowing curtailment of individual turbines.

•Adaptive management is an important step in this mitigation strategy, and additional site-specific information (e.g., target shape attributes, meteorological data) can refine MERLIN *SCADA*™ curtailment strategy over time, further decreasing turbine downtime and raptor collision risk.

•The raptor application of the MERLIN *SCADA*™ is flexible, and with site-specific information and appropriate data collection, can be applied to raptor issues at other sites.



Burrowing Owl

ITARS: The risk indices used in this strategy provide both an indication of risk level as well as to prevent the use of real-time target coordinates that could potentially violate International Traffic in Arms Regulations (ITAR). In order to comply with ITAR restrictions, coordinates are recorded to databases after a 2-minute delay. Although this prevents their use for real-time mitigation, they can later be used for re-analysis and further refinement of risk criteria.

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