

DEVELOPING A MACHINE/DEEP LEARNING FRAMEWORK TO MONITOR AVIAN-SOLAR INTERACTIONS

CHALLENGE

Accurate understanding of interactions between birds and solar energy infrastructure is important for continued deployment of utility-scale solar energy facilities. Current monitoring methods for avian-solar interactions that rely on periodic surveys for bird carcasses are costly, infrequent, spatially constrained, and subject to errors related to searcher efficiency and carcass predation. These methods account for collision but do not consider other avian-solar interactions such as perching and fly-through that could provide information on the occurrence and intensity of bird attraction to solar energy facilities.

GOAL

The goal is to develop an automated monitoring technology for avian-solar interactions (e.g., perching, fly-through, and collisions,) using a machine/deep learning (ML/DL)-computer vision approach that is executed on a high-definition video camera. Objectives are to:

- Develop ML/DL models that detect birds and classify their interactions with solar energy infrastructure using video.
- Design and assemble camera systems that enable continuous video collection and execution of avian monitoring ML/DL models.
- Test the avian monitoring system for its accuracy in detecting birds and classifying their interactions with solar energy infrastructure.

By the early 2023, avian monitoring systems with a collision notification feature that is supported by ML/DL models and edge computing will be ready for systematic field trials in subsequent years.

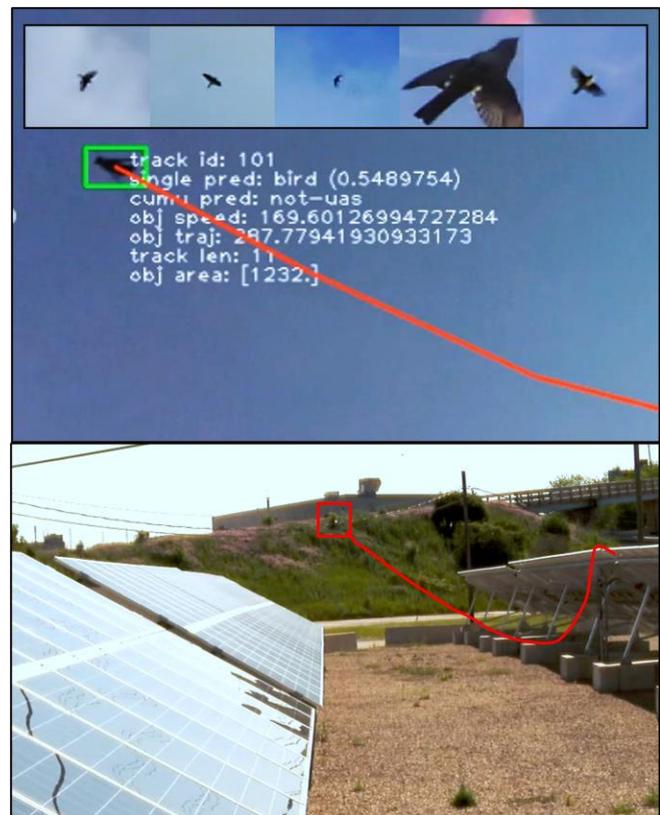


Fig. 1 Argonne's flying object detection machine/deep learning (ML/DL) model and training data collection. The ML/DL model tracking a detected moving object in video and variety of birds recognized in previous training data (top). A bird spotted and tracked at solar panels at the Argonne site (indicated with a red box and line; bottom).

APPROACH

3-Stage Approach

We are developing ML/DL models by employing the three stages of modeling objectives (Fig. 2):

- Stage 1: Detection of moving objects in video
- Stage 2: Recognition of birds among the moving objects detected
- Stage 3: Classification of bird interactions with solar energy infrastructure

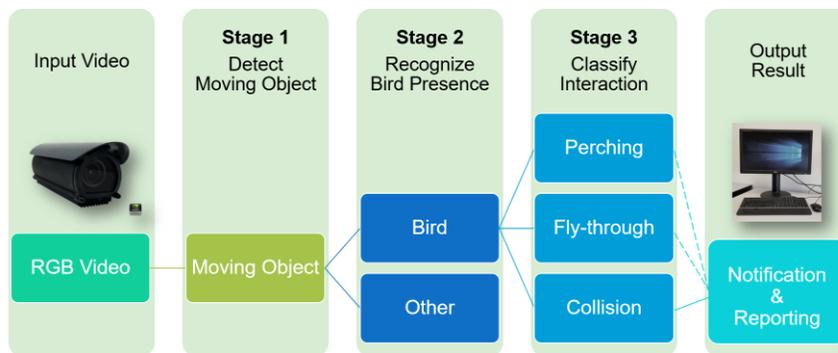


Fig. 2 Three-Stage Model Development Objectives. (Image credit: Boulder AI)

For collisions detected in Stage 3, we design the system to notify solar facility staff of the collision location shortly after the occurrence is detected in order to support identification of collision-induced avian fatalities.

Iterative Model Development

Each stage of the modeling objectives is accomplished by iterating over two phases (Fig. 3): (1) training and testing of the ML/DL model using prepared datasets to develop a deployable model and (2) deployment of the trained model and evaluation of detection and classification to validate performance of the model. For the training-testing phase, we code, train, test, and tune ML/DL models. To achieve the best prediction accuracy, we explore and select the optimal DL model and perform model-specific optimization. For the deployment-evaluation phase, we deploy trained ML/DL models at solar facilities and assess detection and classification accuracy for avian-solar interactions under operating conditions.

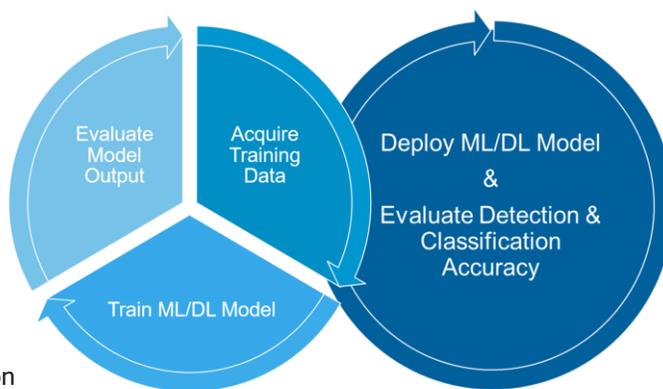


Fig. 3 Iterative DL Model Development.

IMPACT

The automated avian monitoring technology will improve the ability to collect a large volume of avian-solar interaction data to facilitate an understanding of potential avian impacts associated with solar energy facilities. The use of an automated method is perhaps the only feasible option for collecting a large volume of accurate data on avian-solar interactions across large areas in a timely and cost-effective manner.

TEAM & CONTRIBUTORS

Argonne National Laboratory is developing the avian monitoring technology in collaboration with Boulder AI. Project contributors include Northwestern University; University of Chicago; the Cornell Lab of Ornithology; University of California, Los Angeles; Invenergy; Duke Energy; California Energy Commission; National Audubon Society; Arizona Game and Fish Department; California Department of Fish and Wildlife; USGS; DoD; and environmental consulting firms.

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