Stereo-Optic High Definition Imaging: A Technology to Understand Bird Avoidance of Wind Turbines

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Collision and Avoidance

- Terrestrial vs. Offshore
  - Collisions are frequently measured onshore but this is difficult to achieve offshore
- The scale of interaction is important:
  - Micro-scale – Turbine scale
  - Meso-scale– Among turbine scale
  - Macro-scale – Wind farm scale
- Important for regulatory and research needs
  - e.g., Band model for collision estimation

System Specifications

(2) Wide-angle Cameras (180° FOV)

Camera housing and maintenance

- Suitable for marine environment

Computer and power system for:

- Motion segmentation
- Data storage
- Transfer to remote computer for post-processing

Experimental Methods

- Long-term monitoring at three sites with eagle activity:
  - Terrestrial wind turbine in Maine
  - Coastal estuary in southern Maine
  - Reservoir in southern Maine
- Document eagles and other bird species at these sites to determine the:
  - Accuracy of the stereo-optic position estimation
  - Range of detection and identification processes for the system
  - Effectiveness of object identification via shape filtering

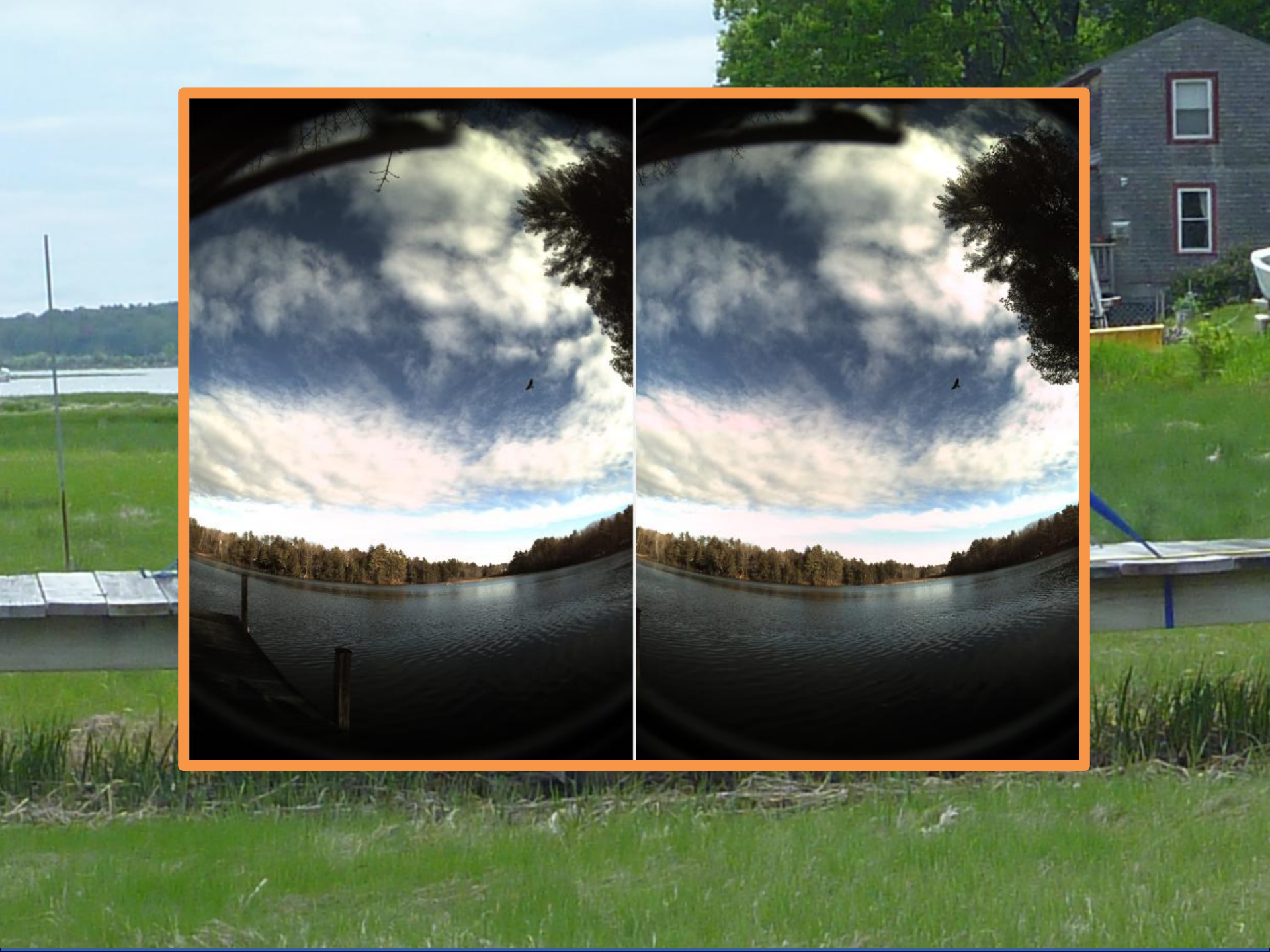
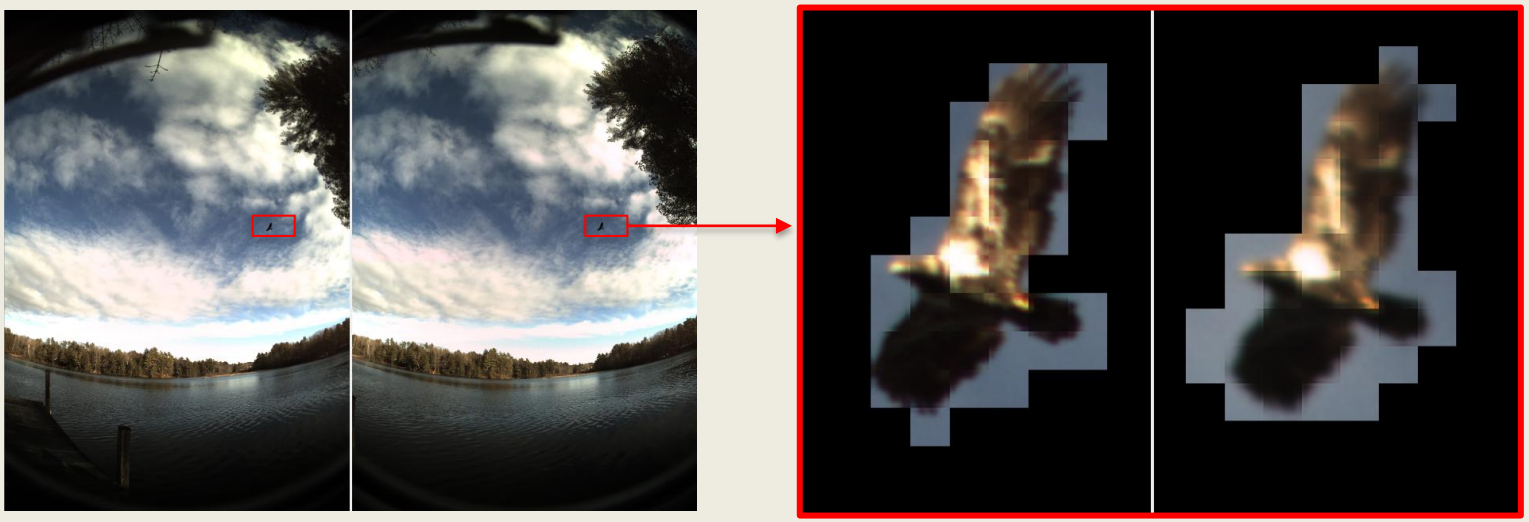


Image Processing and Video Analysis

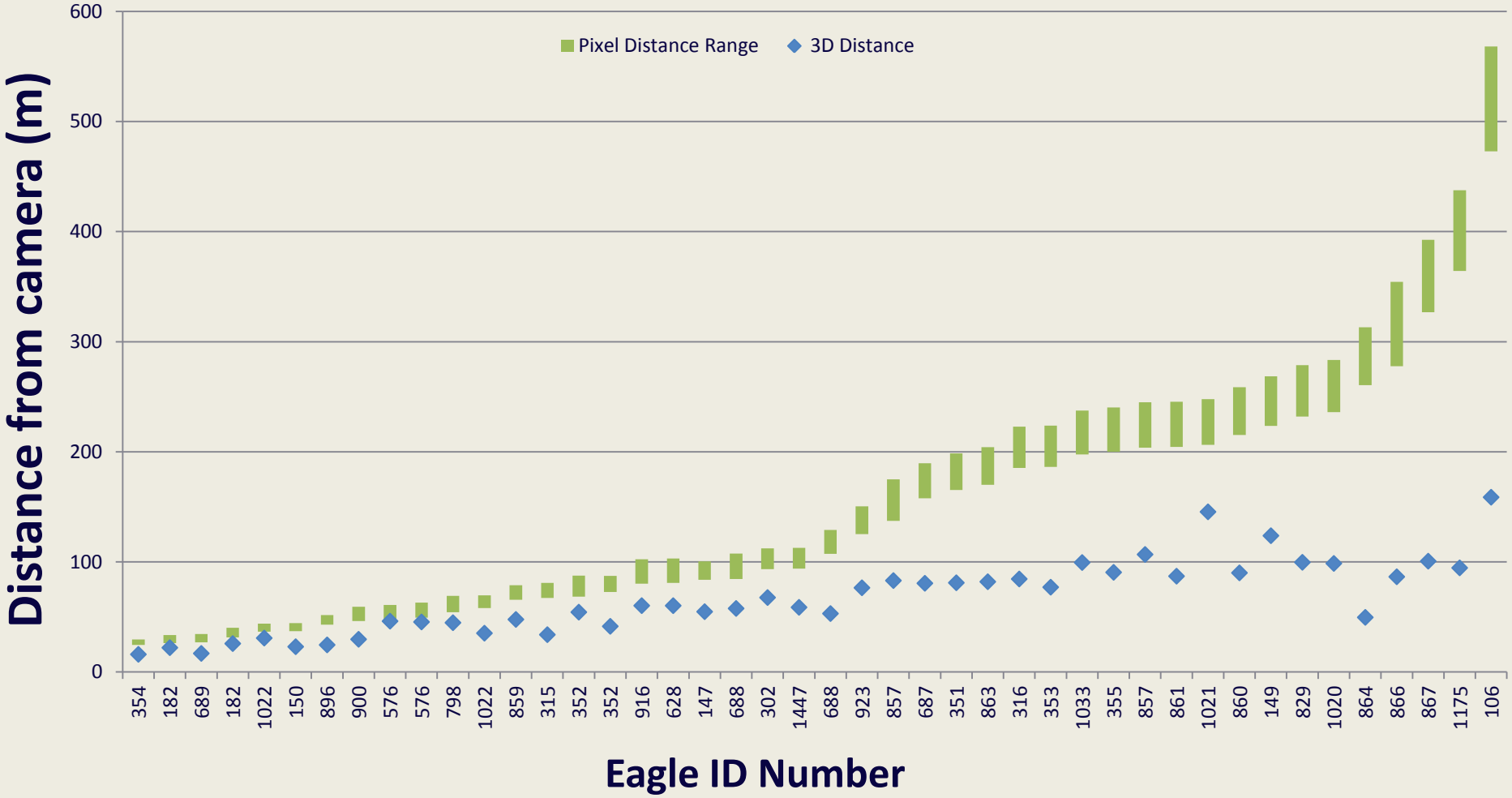
The software ignores stationary parts of the image in subsequent frames, so that only sections of the scene containing moving objects are recorded, resulting in image files that are smaller and require less bandwidth.



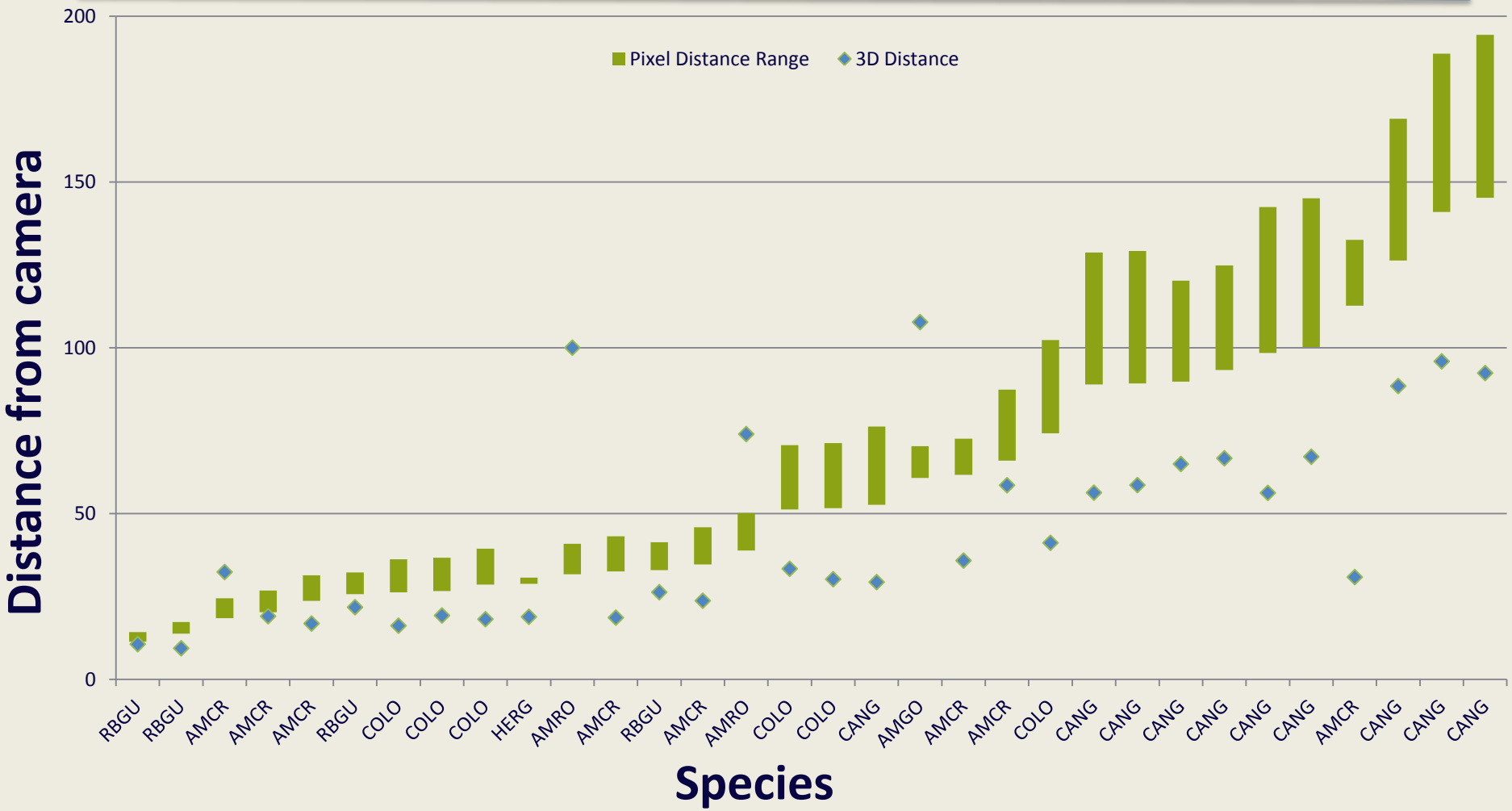
Methods: Position Estimation

- Stereo-optic position estimation
  - Using two synchronized cameras you can estimate distance when the distance between the cameras is known
  - With fisheye lenses, the image must be rectified first and this can create difficulties
- Pixel size estimation
  - Use known averages of wingspan or body length to determine how far away the animal is using a ratio between number of pixels and the size of the camera sensor
  - Reliant upon identification
- We took a subset of the data where we estimated distance both ways to compare the techniques

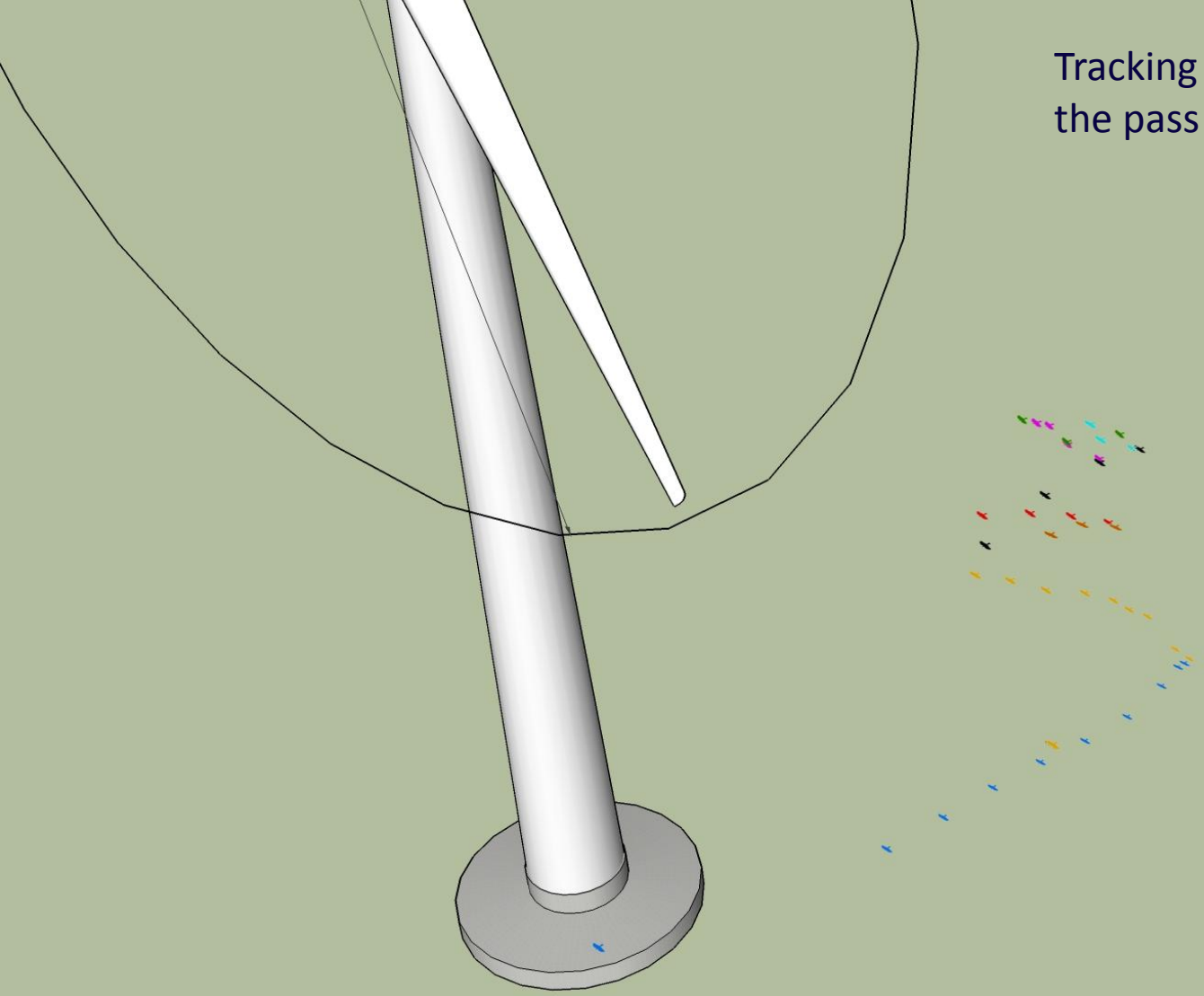
Distance of Detection: Eagles



Distance of Detection: Non-Eagles



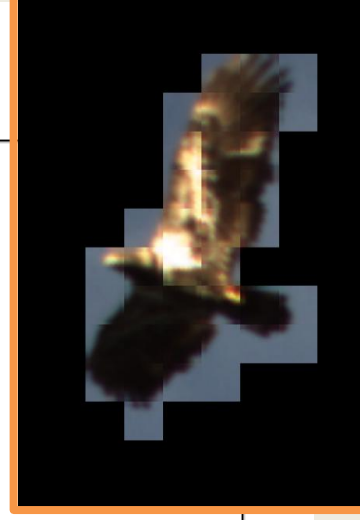
Tracking a flock of crows as the pass by a turbine



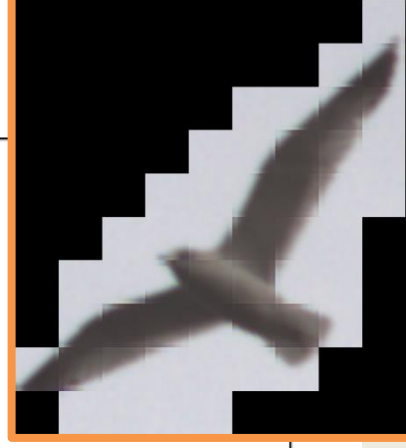
Methods: Detectability

- How do we access the efficacy of the system?
- We think about this problem like we do other kinds of point surveys: in a distance detection framework
  - The chances of detecting an animal decreases non-linearly with distance from the observer
  - See Buckland et al. (2001) for more details
- By using the distance of first detection, we can evaluate how many animals we could have seen with the system but didn't because we either:
  1. Didn't identify them and did not obtain a position estimate
  2. Were not detected via the motion segmentation

Eagle Detections

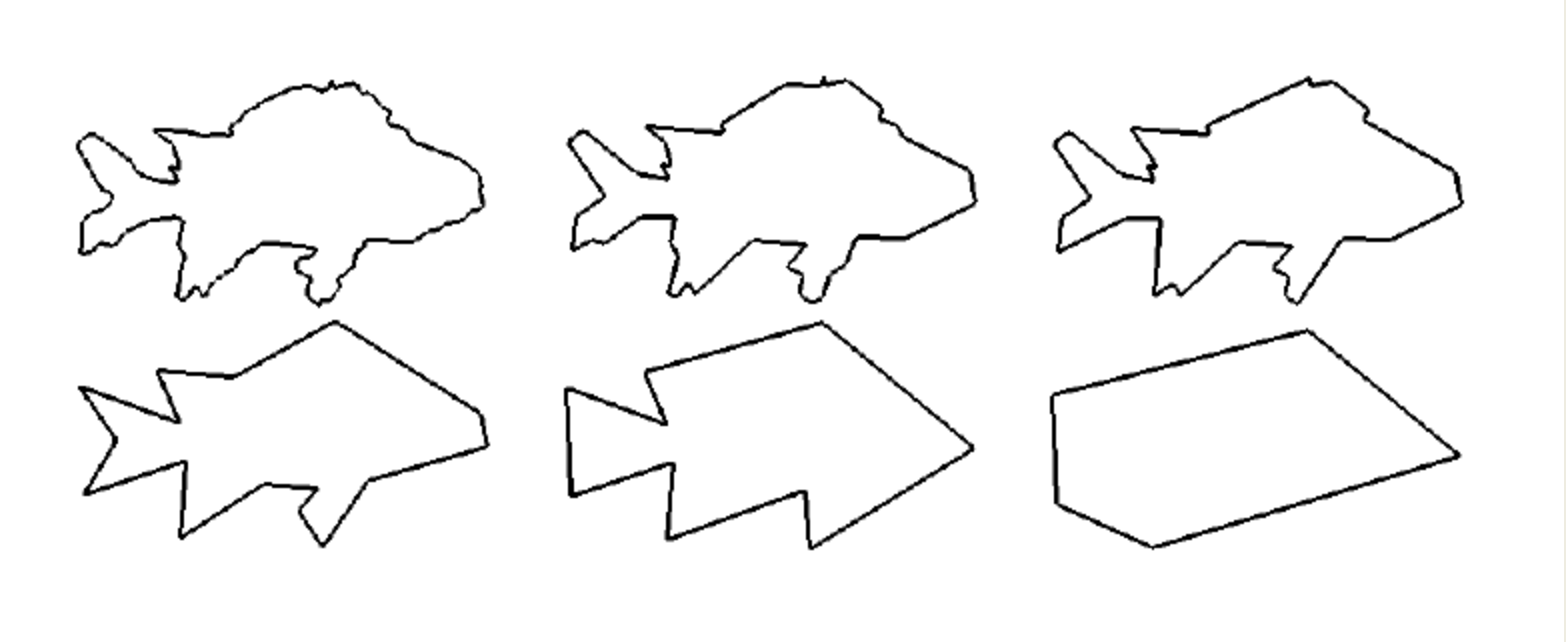


Non-Eagle Detections



Methods: Shape Filtering

- Using body size and/or shape, we can often identify animals that are highly likely to be of interest to the study



Results: Shape Filtering

Summary and Future Work

- Motion segmentation and the data storage reduction were both effective
- Position estimation needs improvement.
  - The current methods only work for identified individuals or for animals close to the camera
- Shape recognition is in the early stages but shows promise for sifting through many objects
- Additional methods for nocturnal monitoring are currently being explored in a collaboration with PNNL

Questions?

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