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Authors

Degges, Joey
Ahmadian, Shaun
Coe, Sharon
et al.

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Evaluation of Imagers in a Biological Sensing Deployment

Joey Degges, Shaun Ahmadian, Sharon Coe, Teresa Ko, John Hicks, Mohammad Rahimi, Michael Hamilton, Stefano Soatto, Deborah Estrin

Introduction: Discovering the biological factors that drive bird behavior

We illustrate how automated sensing and analysis alleviates manual interpretation of image sequences.

Birds are important indicators of the *health of ecosystems*. Therefore the ability to measure avian nesting patterns accurately and in a scalable manner is broadly relevant to ecosystem studies. Currently, avian biologists personally inspect nesting locations and visually log the stage of the nest for future analysis.

What they hope to find are trends and differences in behavior that ultimately influence reproductive success. Some indicator variables include the *number of eggs* that are laid and eventually hatch and the *occupancy of the nest* over the different *nesting stages*.

Problem Description: Eliminate the process of manual data collection and analysis

Collection

- Previously, there were only wired cameras installed, which severely hindered the coverage of the network.
- This new wireless Cyclops network needs to improve the coverage and allow for more widespread recordings.
- It also needs to be able to record for months at a time. Therefore, we have utilized solar panels to power the entire unit.
- As with any scalable solution, a method for easy monitoring of the network, as well as the ability to maintain the infrastructure, is essential.

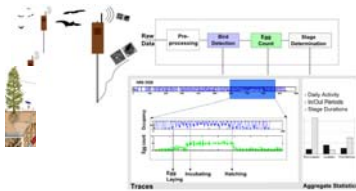
Analysis

The presence or absence of the bird carries significant meaning. This system aims at successfully identifying whether the bird is present or absent, and the current nesting period. Moreover, this can be used to derive the frequency and duration of each visit made to the nest, as well as determine which images are important and should be saved or discarded. To accomplish this, several approaches have been utilized: low-pass root mean square filtering to filter out repetitive images; edge/corner detection to identify the presence of a bird; RMS patch and macro-block differencing to locate areas of interest.

Proposed Solution: Collect and analyze sensor data for high-level biological statistics

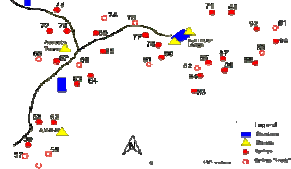
Vision System Overview

- *In situ* image collection
- Controlled sampling environment
- Back end database storage
- Image access through web interface
- Automated image analysis



Node Deployment

- Wireless/Wired deployment in James Reserve
- 25 Wired
- 11 Wireless



Low-pass root mean square filtering

- The wired cameras sampled at 1 frame per second. This RMS filtering method was aimed at discarding images that did not show the slightest difference from the previous captured frame.
- This method reduced the amount of collected data by 80% throughout the entire season, without losing any important information.

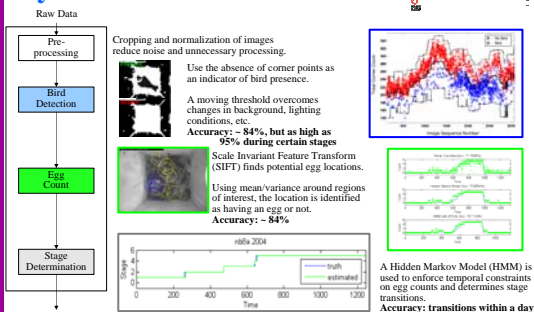
Node Deployment



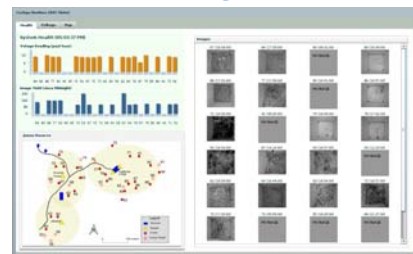
Nestbox with Cyclops, environmental monitoring sensors, and solar panel.

- Main components of nestbox:
- Cyclops
 - Extra environmental sensors
 - Battery
 - Solar panel

System Performance

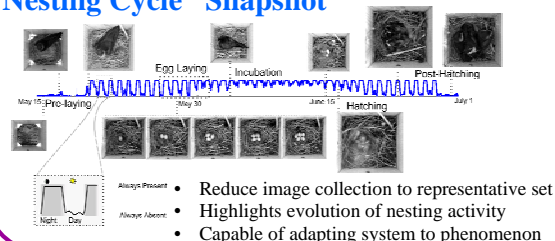


Status Monitoring Tool



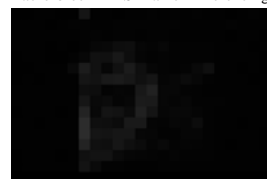
- This status monitoring web interface lets the user view the status of each Cyclops enabled nestbox
- Shows voltage graphs, humidity, and temperature.
- Keeps track of the number of images recorded each day.

Nesting Cycle "Snapshot"



Patch and Macro-block RMS Frame Differencing

Macro-block RMS Frame Differencing



Patch RMS Frame Differencing



Differences computed using 30x30 patch/macro-block