Two Novel BatCams for Censusing Small Colonies of Bats

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Abstract

We developed two infrared BatCams capable of censusing emerging bats—a remote controlled, pan-zoom-tilt camera, and a fixed focal-length lens camera. The remote-controlled BatCam consists of a small, weatherized Internet camera connected to a local video server and gateway for Internet access. The server enables video recording at predetermined intervals corresponding to expected nightly emergence. Internet connectivity allows sampling the real-time video from off-site. A second BatCam mounted inside a small, weatherized, transparent Pelican case recorded data directly to a laptop computer. Using both BatCam's, we successfully censused a small bat colony of little brown myotis (*Myotis lucifugus*) that emerged nightly through two small portals. Bats in each video frame were first detected using custom-designed computer vision algorithms using background modeling that first compared bats with an estimate of the background images. A second algorithm tracked each newly detected bat through the camera's field of view. Advantages and disadvantages of each camera system are considered.

Introduction

From management and conservation perspectives, it is essential to understand factors that may cause bat colonies and populations to vary seasonally and annually, and further to understand the processes that govern the regulation of long-term population trends (Kunz et al. in press). This latter goal can best be achieved if accurate and reliable census methods are developed and employed. In an effort to address this latter goal, we developed two automated methods for censusing small bat colonies that roost in buildings. These two methods hold promise for remotely censusing small bat colonies that roost in buildings, tree cavities, caves, and mines.

Methods

Study Site

We designed and evaluated two low-cost infrared BatCams for censusing a small maternity colony of little brown myotis (*Myotis lucifugus*) at Moore State Park, Paxton, MA. The colony roosts in a shed that was designed specifically to house bats. During warm months, the colony occupies modular crevices installed in the attic. Bats gain ingress and egress through a small window frame, and an open space beneath the eaves directly above the window.

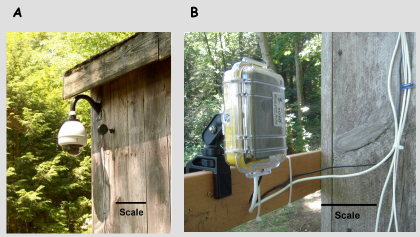

Figure 1. **A**. Remote-controlled BatCam and infrared light mounted on side of shed (scale = 20 cm).
B. Fixed focal-length BatCam (scale = 10 cm).

BatCam Design and Implementation

The remote-controlled BatCam consists of a pan-zoom-tilt camera using an Internet or 'IP' based framework. A second, BatCam has a fixed focal-length lens and recorded data directly to a laptop computer (**Figure 1**).

The IP camera was selected for its ability to stream digital video over an Internet connection. For maximum data rates and video quality we located a video data logger (server) near the camera. Video data were logged into the local video server and optionally streamed to browsers connected to the Internet (**Figure 2**).

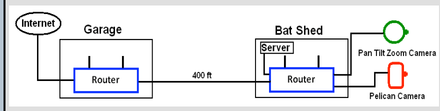

Figure 2. Internet framework.

Detection

- Bats in each video frame were first detected by an algorithm using background modeling, in which an observed image frame was compared with an estimate of the background images without bats.
- Groups of pixels whose value deviated from the estimated background value above some threshold were considered as candidates for detectable bats.
- This analytical method is known as background subtraction in the computer vision literature (Betke et al. 2008).

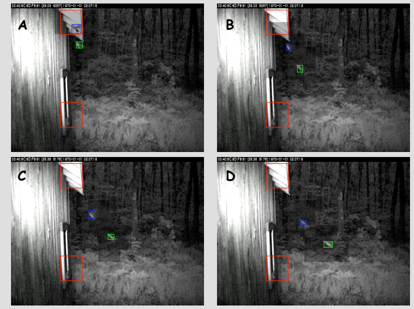

Figure 3. Two bats emerged from the beneath the eaves; blue and green rectangles bound boxes of the tracked bats; red rectangles are possible regions where bats appear in the first frame.

Tracking

- Trackers (with different colored labels) were generated each time a different bat appeared in a frame for the first time (**Figure 3**).
- To associate this tracker to the bat in consecutive frames, we predicted a bat's position in the current frame by using the speed computed in the previous frame, and assigned the tracker to the newly detected bat in the current frame based on the minimum distance between predicted and detected positions.
- The latter step was repeated until the detected bat moved out of the camera's field of view.
- This tracking method is described as nearest-neighbor filtering in the computer vision literature (Betke et al. 2008).

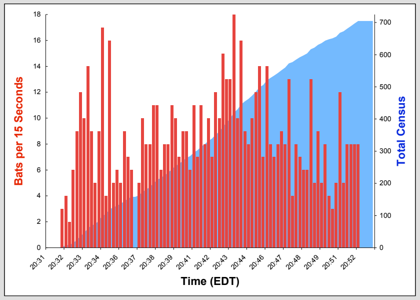

Figure 4. Emergence pattern and census of little brown myotis at Moore State Park, Paxton, MA (15 June 2008).

Results and Discussion

Censusing

- Tracked bats were counted during ~30 minute emergence periods.
- The automated computer vision algorithm yielded estimates of ~600 bats on 13 June and ~700 bats on 15 June.
- The example of a nightly bat emergence (**Figure 4**), recorded every 15 seconds, also provides a cumulative count, or census.
- We also manually recorded emergence sequences by visually counting the bats in each video stream.
- Automated counts averaged ~5% higher than manual counts.
- The higher numbers counted using the automated tracking algorithm likely reflects the detection of flying insects in the field of view and some additional background noise that caused false positive detections.
- Further adjustments in threshold filtering are needed to correct for false positives.
- The remote-controlled BatCam, with a pan-zoom-tilt lens and an IP based framework has both advantages and disadvantages.
- The stationary BatCam, fixed focal-length lens, with data recorded directly to a laptop computer may provide the most reliable and consistent data for censusing in the absence of Internet services.

References

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