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Posters

Title

Sensor Arrays for Acoustic Monitoring of Bird Behavior , Diversity

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Authors

Charles E. Taylor
Edward P. Stabler
Martin Cody
et al.

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Sensor Arrays for Acoustic Monitoring of Bird Behavior & Diversity



Great Antshrike

Charles E. Taylor, Edward P. Stabler, Martin Cody, Kung Yao,
Edgar E. Vallejo, Yuan Yao, Alex Kirschel, Ying Lin, Travis C. Collier



Acorn Woodpeckers

Introduction: Embedded Sensors for Population Biology and Ecology

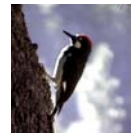
The Promise of Sensor Networks

“Increasingly, a spatially extended network of multivariable intelligent sensor arrays are seen as revolutionary tools for studying the environment. The temporally and spatially dense monitoring afforded by this technology portends a major paradigm shift in environmental science and engineering. Realizing this vision will require new cyber-infrastructure capabilities, methodologies, middleware, deployed infrastructure and a community of multidisciplinary scientists and engineers equipped to pose newly-enabled scientific questions.”

- 2003 NSF workshop (www.LTERNET.edu/sensor_report)

Goals

- Birds as a first application
 - Well studied
 - Important for biodiversity
- Automated acoustic observation
 - Identify species and/or individual
 - Localize (determine the point in space a sound is coming from)
 - Correlate with abiotic observations
 - Observe social interactions among individuals
- Develop and test newly enabled hypotheses



Acorn Woodpecker

Problem Description: Observing Bird Behavior in the Environment

Filtering, Identification, and Localization

- The natural environment is often a cacophony of noise
 - Current acoustic observations rely on directional microphones to minimize noise, but are clumsy and require actively locating and pointing at a single source
- Rare but important events are often missed
- Birds are often hidden from view, and hard to observe in many environments

Observing Social Interactions

- The social context of vocal behavior requires tracking the location and calls of multiple birds simultaneously
- Calls and songs are typically classified only as territorial or mating, but many species exhibit a variety of vocal behaviors beyond this that are not well understood

System Design: Acoustic Monitoring Sensor Arrays

Develop the ability to:

- Filter out noise
 - Characterize the acoustic background
 - Use information from identification and classification to focus on sounds of potential interest
- Identify
 - Identify species of antbirds and wrens at field stations in Chiapas
 - Identify individual acorn woodpeckers at the UC Hastings Reserve and James Reserve
- Correlate the presence of species/individuals with temporal abiotic information
- Localize
 - Use beamforming techniques to determine the point in space a sound is coming from

UC James Reserve

- Already highly instrumented, including several large CENS deployments, weather monitoring, and existing Acorn Woodpecker monitoring
- Full time staff is extremely knowledgeable and involved with sensor array technology



Illustration of sensor types [right]
(5-9-05 NY Times article)

Field Locations

UC Hastings Reserve

- Definitive studies of highly social Acorn Woodpeckers were conducted here
- All individuals known and banded
- Several neighboring groups allows for inter-group behavior studies



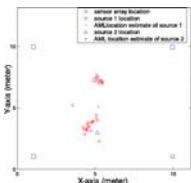
Acorn Woodpecker populations at Hastings

Montes Azules Biosphere Reserve, Chiapas, Mexico

- Neo-tropical rainforest with a large diversity of species

Technologies

- Hidden Markov Models for Identification
 - Successful in identifying individual Acorn Woodpeckers
- Localization and Beamforming
 - Direction of Arrival (DOA) localization using narrow band sources has been successful



4 microphone sensor node

