

# Wildlife Surveillance Using GPS: From Movement Tracking to Behavior Recognition

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### ABSTRACT

Understanding the individual and social behavior of wild animals in the context of their habitat is imperative to protect and increase biodiversity. Our ability to observe individuals in the wild has increased exponentially with the availability of GPS. The increased miniaturization and prolonged operation time of GPS receivers and loggers allows us to consider new ways of analyzing and influencing animal behavior. This workshop brings together researchers, practitioners and technology providers discussing requirements for wildlife movement tracking, data processing and analysis. We will present the state-of-the-art, exchange practical experiences and discuss future challenges.

### Author Keywords

GPS, movement tracking, behavior recognition, feedback, intervention, wildlife management, software systems.

### INTRODUCTION

Around the globe, initiatives are undertaken to protect and - where possible - increase biodiversity. The declaration of 2010 as the International Year of Biodiversity by the United Nations illustrates that governments support the importance of biodiversity as a prerequisite for science, economy and society. For example, 'ecological corridors' and 'ecoducts' are constructed to increase freedom of movement for wildlife, to prevent splitting of populations, and to optimize the integration of nature conservation, agriculture and

recreation. However, this can also lead to unwanted confrontations between humans and animals (e.g. traffic incidents), damage to crops, and the spreading of diseases between wildlife and farm animals.

Until recently, available technology (like radio tracking and satellite tracking techniques) suffered from limited temporal and spatial resolution, resulting in position data that are too coarse to determine how animals behave relative to the environment and each other. In other words: it tells you where the animal is but not what it is doing. Furthermore, the size and weight of transmitters and batteries made them unsuitable for small animals.

### WORKSHOP OBJECTIVES

GPS technology allows moving objects to be tracked at small time intervals, and spatial resolution has improved dramatically over the years. However, analysis tools able to process large streams of GPS data and to convert spatial coordinates into behavioral parameters are still lacking. New approaches to extracting information and transforming it into knowledge have to be found. Furthermore, by adopting concepts from the field of artificial intelligence, GPS tracking can be extended with real-time data processing, interpretation and feedback, offering fascinating new opportunities for wildlife management and disease control. The objective of this workshop is to discuss the state-of-the-art, exchange practical experiences and define a first set of requirements towards a GPS-based behavior recognition and wildlife management system.

### WORKSHOP PROGRAM

The workshop will consist of four technical topics:

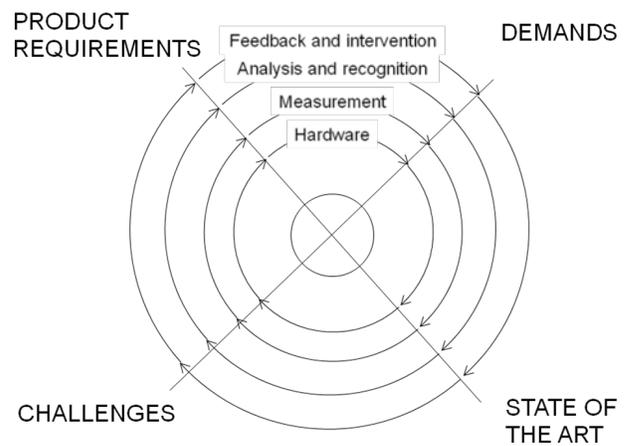
1. **Measurement:** what to measure (location, time, physiological signals, ambient variables) and how
  - Possibilities of GPS relative to radio tracking and satellite tracking

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- Logging versus real-time transmission of location data
  - Temporal and spatial resolution: what can be achieved?
  - GPS tracking under challenging conditions
  - Integration of movement data with ambient parameters or physiological signals
2. **Analysis:** processing of position data and other variables into behavior recognition
    - Algorithms for location-based event recognition
    - Algorithms for behavior recognition and movement track segmentation
    - Integration of GPS data analysis and GIS systems
    - Software tools for analysis of movement patterns, individual behavior and interactions
  3. **Feedback & Intervention:** closing the loop, from real-time processing to feedback, guidance and control
    - Real-time data reduction, analysis
    - Feedback to the animal, guidance systems
    - Feedback to the environment: control systems
  4. **Hardware aspects:** energy issues, robustness, size (miniaturization), weight, etc.
    - Size and weight of GPS loggers
    - Battery life, duration of measurements
    - Impact of hardware on animal behavior and welfare

Each topic is important for GPS-based behavior analysis and guidance systems, but has individual characteristics and progress. Prior to the workshop a market survey is performed to gather information about current practices, experiences, applications, and requirements for future technology. The discussion of each topic will start with the analysis of the market survey. This is followed by a discussion on the state-of-the-art in this topic: where do we stand today, what is technically possible? Based on this the challenges based on user needs are defined: what lies ahead of us, which questions need to be answered, which technical hurdles must be taken? These are translated into the final step: product requirements for GPS based behavior measurement, analysis and feedback systems. What should a measurement, analysis of feedback system be able to do?



**Figure 1. The workshop topics (hardware, measurement, analysis and feedback) are all discussed in 4 aspects: Demands, state-of-the-art, challenges and product requirements.**

#### WORKSHOP SCOPE

Although the workshop is primarily targeted at wildlife, advances and lessons learned in animal husbandry and free-ranging cattle among others are welcomed as that application domain has similar requirements towards the behavior analysis system.

#### WORKSHOP AGENDA

- Welcome and introduction (15 minutes)
- Topic 1: Measurement (45 minutes)
- Topic 2: Analysis (45 minutes)
- Demonstrations of hardware & software (30 minutes)
- Topic 3: Feedback & Intervention (45 minutes)
- Topic 4: Hardware aspects (45 minutes)
- Wrap-up: conclusions and follow-up activities (15 minutes)

#### TARGET AUDIENCE

This workshop brings together researchers, practitioners and technology providers discussing their needs for wildlife movement tracking, data processing and analysis. The organizers hope to initiate a lively discussion on the topics listed above. Attending this workshop will provide participants with a better understanding of the possibilities, limitations and future research directions of wildlife surveillance using GPS technology.