

Animal Tracking for Behaviour Analysis

Clas Veibäck

- 1 Introduction
- 2 Methods
- 3 Tracking of Dolphins
- 4 Tracking of Birds
- 5 Conclusions

Introduction



- Brief overview of method

Introduction



- Brief overview of method
- Tracking of dolphins

Introduction



- Brief overview of method
- Tracking of dolphins
- Tracking of birds

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Tracking using Sensor Fusion

- Many types of sensors

Tracking using Sensor Fusion

- Many types of sensors
- Model of target behaviour

Tracking using Sensor Fusion

- Many types of sensors
- Model of target behaviour
- From real world to measurements

Tracking using Sensor Fusion

- Many types of sensors
- Model of target behaviour
- From real world to measurements
- Measurements over time

Mathematics

The characteristics of the animal are modelled as

$$\mathbf{x}_k \sim p(\mathbf{x}_k | \mathbf{x}_{k-1}).$$

The measurements of the animal are modelled as

$$\mathbf{y}_k \sim p(\mathbf{y}_k | \mathbf{x}_k).$$

The characteristics are estimated over time using Bayes' theorem and the Chapman-Kolmogorov equations,

$$p(\mathbf{x}_k | \mathbf{y}_1, \dots, \mathbf{y}_k) \propto p(\mathbf{y}_k | \mathbf{x}_k) \cdot \int p(\mathbf{x}_k | \mathbf{x}_{k-1}) p(\mathbf{x}_{k-1} | \mathbf{y}_1, \dots, \mathbf{y}_{k-1}) d\mathbf{x}_{k-1}$$

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Tracking of Dolphins - Introduction

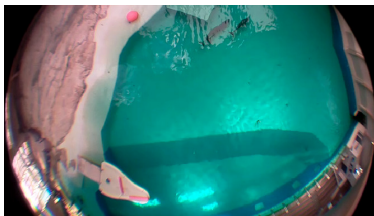
C. Veibäck, G. Hendeby, and F. Gustafsson, **Tracking of dolphins in a basin using a constrained motion model**. In *Proceedings of the 18th International Conference on Information Fusion*, Washington D. C., USA, July 2015.



- Dolphinarium at Kolmården Wildlife Park

Tracking of Dolphins - Introduction

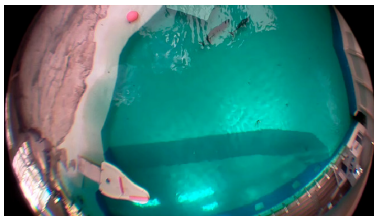
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- Dolphinarium at Kolmården Wildlife Park
- Fisheye camera with occlusions

Tracking of Dolphins - Introduction

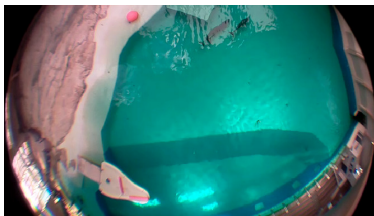
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- Dolphinarium at Kolmården Wildlife Park
- Fisheye camera with occlusions
- Reflections and changing light conditions

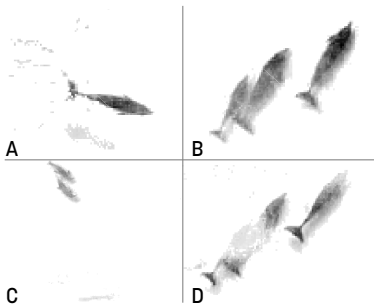
Tracking of Dolphins - Introduction

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- Dolphinarium at Kolmården Wildlife Park
- Fisheye camera with occlusions
- Reflections and changing light conditions
- Constrained to basin

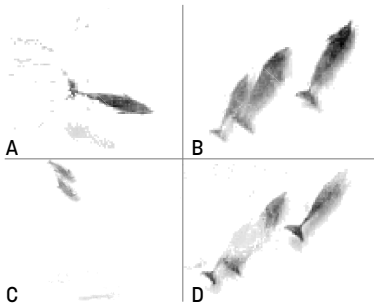
Tracking of Dolphins - Image Processing



- Background model

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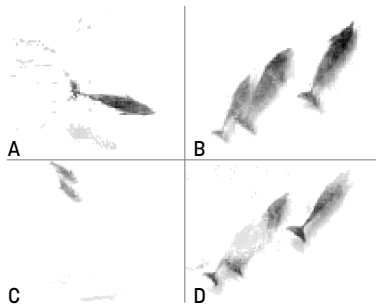
Tracking of Dolphins - Image Processing



- Background model
- Handles changing light conditions

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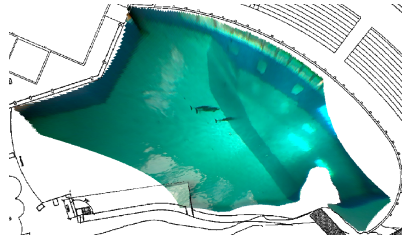
Tracking of Dolphins - Image Processing



- Background model
- Handles changing light conditions
- Handles reflections

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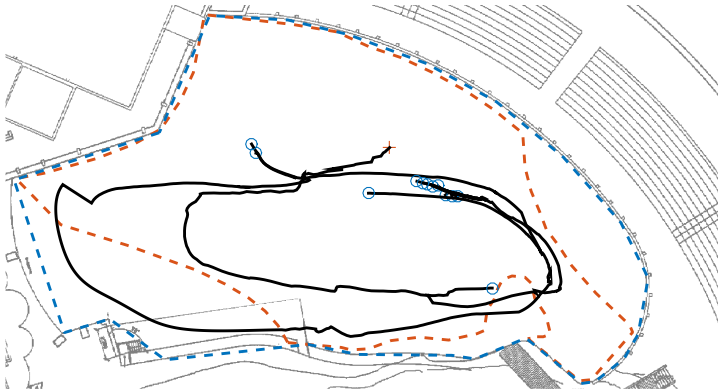
Tracking of Dolphins - Camera



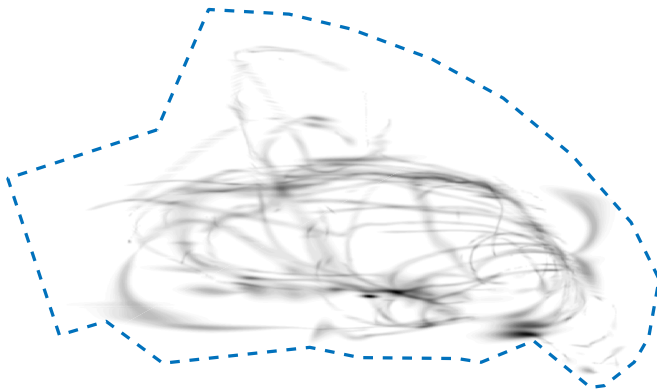
Tracking of Dolphins - Model Simulation



Tracking of Dolphins - Track



Tracking of Dolphins - Heat Map



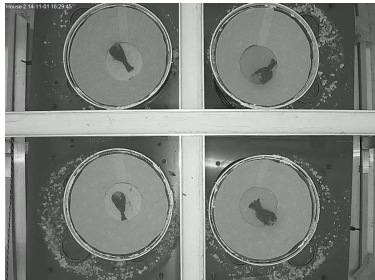
Tracking of Dolphins - Complete Framework



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Tracking of Birds - Introduction

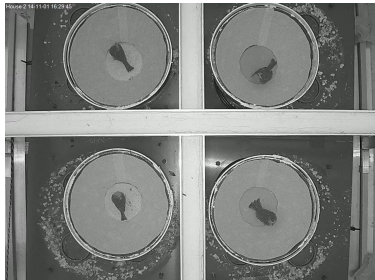
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- Collaboration with CAnMove

Tracking of Birds - Introduction

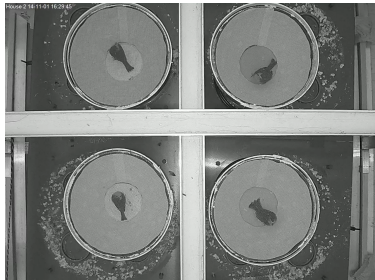
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- Collaboration with CAnMove
- Recording of birds in Emlen funnels

Tracking of Birds - Introduction

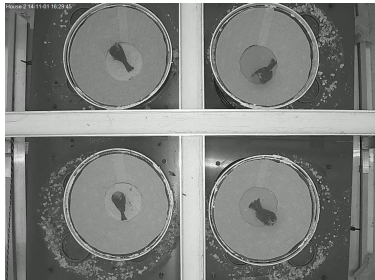
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- Collaboration with CAnMove
- Recording of birds in Emlen funnels
- Detect take-off times

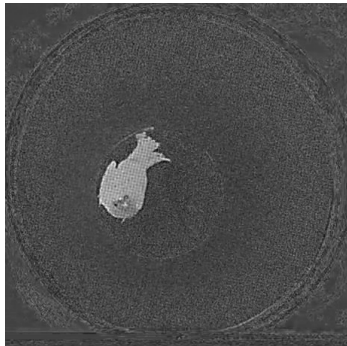
Tracking of Birds - Introduction

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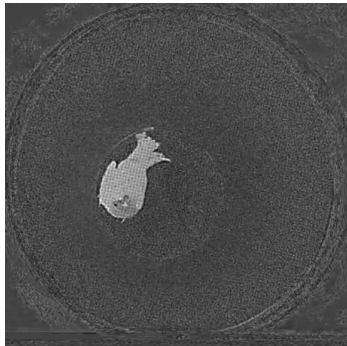
- Collaboration with CAnMove
- Recording of birds in Emlen funnels
- Detect take-off times
- Estimate take-off directions

Tracking of Birds - Image Processing



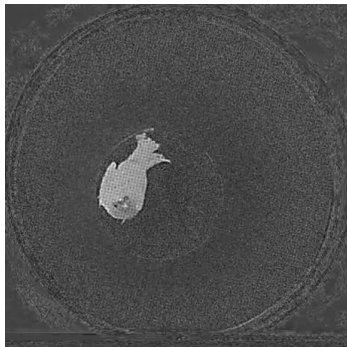
- Position

Tracking of Birds - Image Processing



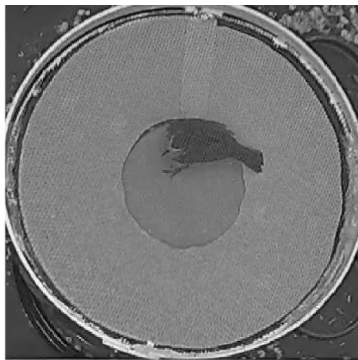
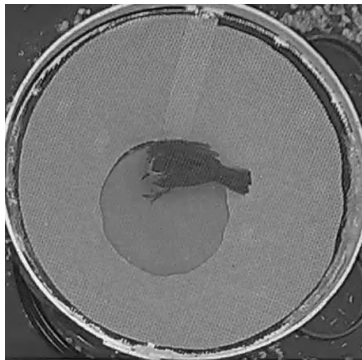
- Position
- Extent

Tracking of Birds - Image Processing



- Position
- Extent
- Blurriness

Tracking of Birds - Camera



Tracking of Birds - Models

Stationary Mode

- Small movements

Flight Mode

- Large movements

Tracking of Birds - Models

Stationary Mode

- Small movements
- Low blurriness

Flight Mode

- Large movements
- High blurriness

Tracking of Birds - Models

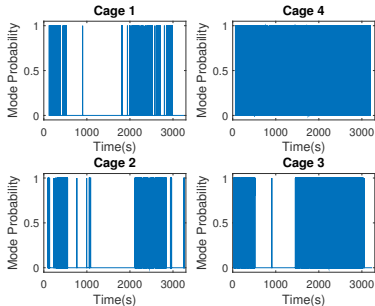
Stationary Mode

- Small movements
- Low blurriness
- Near center

Flight Mode

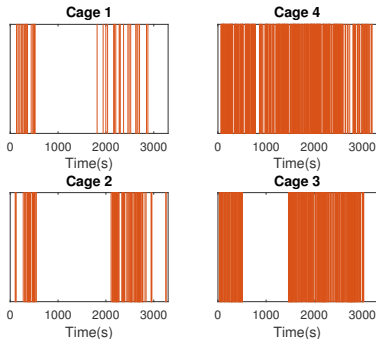
- Large movements
- High blurriness
- Near edge

Tracking of Birds - Results



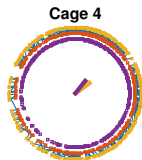
- Estimated modes

Tracking of Birds - Results



- Estimated modes
- Extracted takeoffs

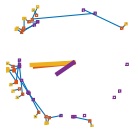
Tracking of Birds - Results



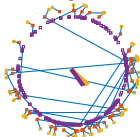
- Estimated modes
- Extracted takeoffs
- Takeoff directions

Tracking of Birds - Results

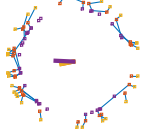
Cage 1



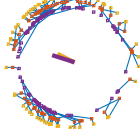
Cage 4



Cage 2

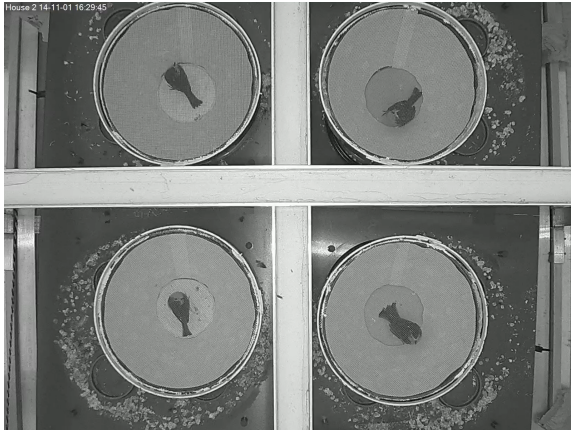


Cage 3



- Estimated modes
- Extracted takeoffs
- Takeoff directions
- Matched takeoffs directions

Tracking of Birds - Complete Framework



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Conclusions

Briefly mentioned

- Modelling of target behaviour

Conclusions

Briefly mentioned

- Modelling of target behaviour
- Modelling sensors

Conclusions

Briefly mentioned

- Modelling of target behaviour
- Modelling sensors
- Connecting measurements over time

Conclusions

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Presented two applications in animal behaviour analysis

- Tracking of dolphins in captivity

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- Tracking of dolphins in captivity
- Tracking of birds in Emlen funnels

Questions?

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