Tracking of Animals using Imaging Sensors

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Tracking of Dolphins

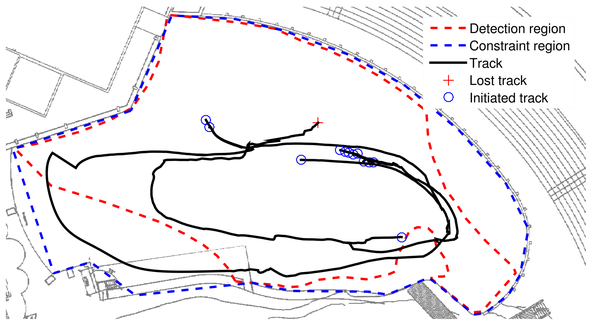
The behaviour of dolphins is studied using imaging sensors, and to improve on the method automatic extraction of trajectories in the image has been developed. The complete pipeline of image processing, tracking and filtering results in dolphin tracks.

Constrained Motion Model

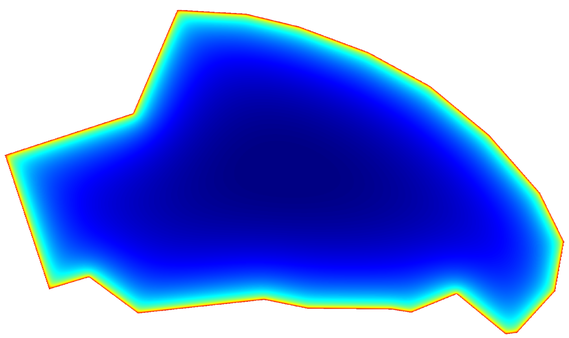
To handle occlusions and constraints of the basin, a constrained motion model is used, based on the coordinated turn model with predicted turn rate

$$\omega(\mathbf{x}) = d_r(\mathbf{x}) \int_{\mathbf{N}} \big(\beta_d + \beta_a(\dot{\mathbf{p}}_\perp \cdot \mathbf{l}(\mathbf{n}))\big) w(\mathbf{x}, \mathbf{n})\, d\mathbf{n},$$

where $w(\mathbf{x}, \mathbf{n})$ is the influence of the walls, which can be visualised as a potential field.



Trajectory of a group of dolphins.



Potential field for basin.

Tracking of Birds

Traditionally, behaviour studies on birds use funnels with scratch-sensitive paper to determine take-off directions. By introducing imaging sensors, distinct take-offs can be measured in both direction and time, as well as its prior orientation.

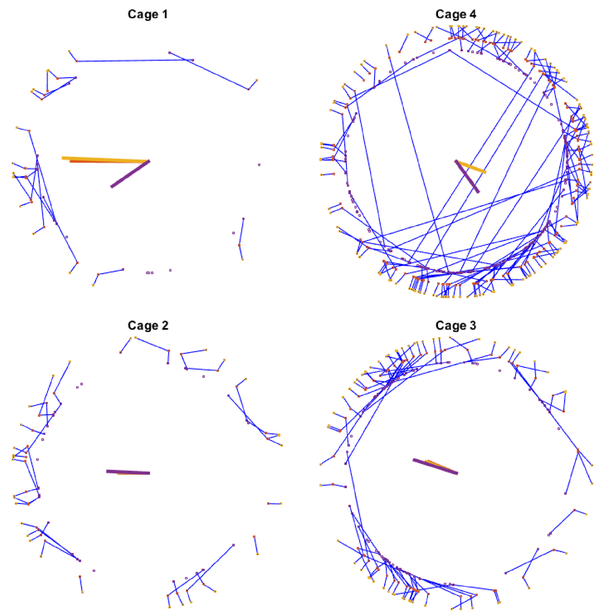
To determine whether a bird is stationary or in flight, a jump Markov model is used. Additionally, measurements generated from image processing, e.g. blurriness, are also incorporated to improve the mode estimate.

Weight Update

Given a new set of measurements, the weight is updated as

$$w_k = p(\delta_{1:k}|y_{1:k}, z_{1:k}) \propto \Pi^{\delta_k,\delta_{k-1}} w_{k-1} \mathcal{N}(y_k; \hat{y}_k, S_k) p(z_k|\delta_k),$$

where δ_k is flight mode, y_k are observations dependent on states and mode and z_k are measurements following a mode-dependent distribution.



Match of automatically extracted and hand-annotated take-offs.

Tracking with Radar

As part of a complete solution for the protection of a national park, the ambition is to use Doppler radar to both track animals as well as to detect intruders. Data has been collected at Kolmården with an intruder roaming the edge of the forest. The radar is able to detect the human, whose ground truth is shown in red, but also generates a significant amount of clutter, requiring modelling and advanced target tracking methods.

Tracking of walking human with radar.

Future Work

- Long-term focus is on ground surveillance using airborne imaging sensors and radar.
- Permission has been obtained for unmanned flights within Kolmården wildlife park and it will continue as a test site.
- SAAB Aeronautics has made data recorded during unmanned flights available for research.

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