MULTIPLE OBJECT TRACKING WITH SIMILAR APPEARANCE

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Abstract

We investigate the feasibility of a long term multi object tracking based on recordings of an Adélie penguin colony in Antarctica. The optical tracking, in combination with the existing infrastructure to identify individuals via RFID tags, could lead to unique insights regarding social behavior, hierarchical structure and breeding site selection. The targeted track lengths of several hours, the large number of objects (20-500) and similar appearance of each individual pose an interesting challenge.

Material & Methods

Visual data is recorded with a 11 Mpx Allied Vision GE 4000 C and a 50 mm lense at 5 frames per second. The raw data is debayered and stored as h264 movie files for later evaluation.
While tracking in general is handeled as a „solved problem“, this task displays some differences to common tracking scenarios (pedestrians, cars or birds):

- **number of objects**
  Over the season the number of objects varies between 20-500
- **individuals are not distinguishable**
  Adélie penguins do not express distinguishable patterns, markers or color for re-identification.
- **targeted track length / duration**
  The average retention time inside the confined area varies between a few minuts to several days.
- **changes in illumination**
  Based on the targeted time frame, illumination can change drastically.
- **occlusion / interaction**
  Based on the rocky terrain occlusion by environment and other animals happens frequently.
- **non balistic / erratic motion**
  Penguins do not always display persistent movements. Periods of inactivity are interupted by fast movements (figure 2).
- **low temporal resolution**
  The lowe frame rate complicates tracking of fast moving individuals, especially in crowded scenes

Fig 1: Sample images from Nov 2013
the area marked in red is displayed in figure 3

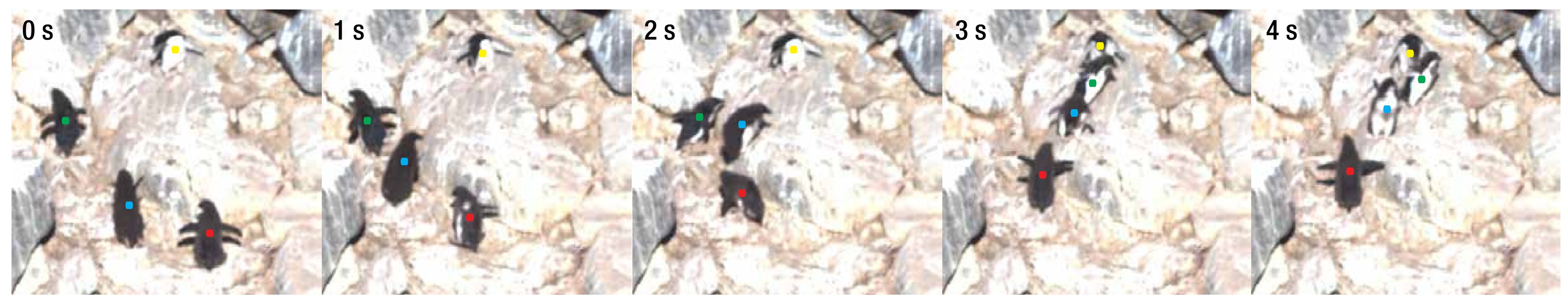

Fig 2: Abrupt motion after serveral minuits of inactivity

We use a track-by-detection approach as displayed in figure 3.

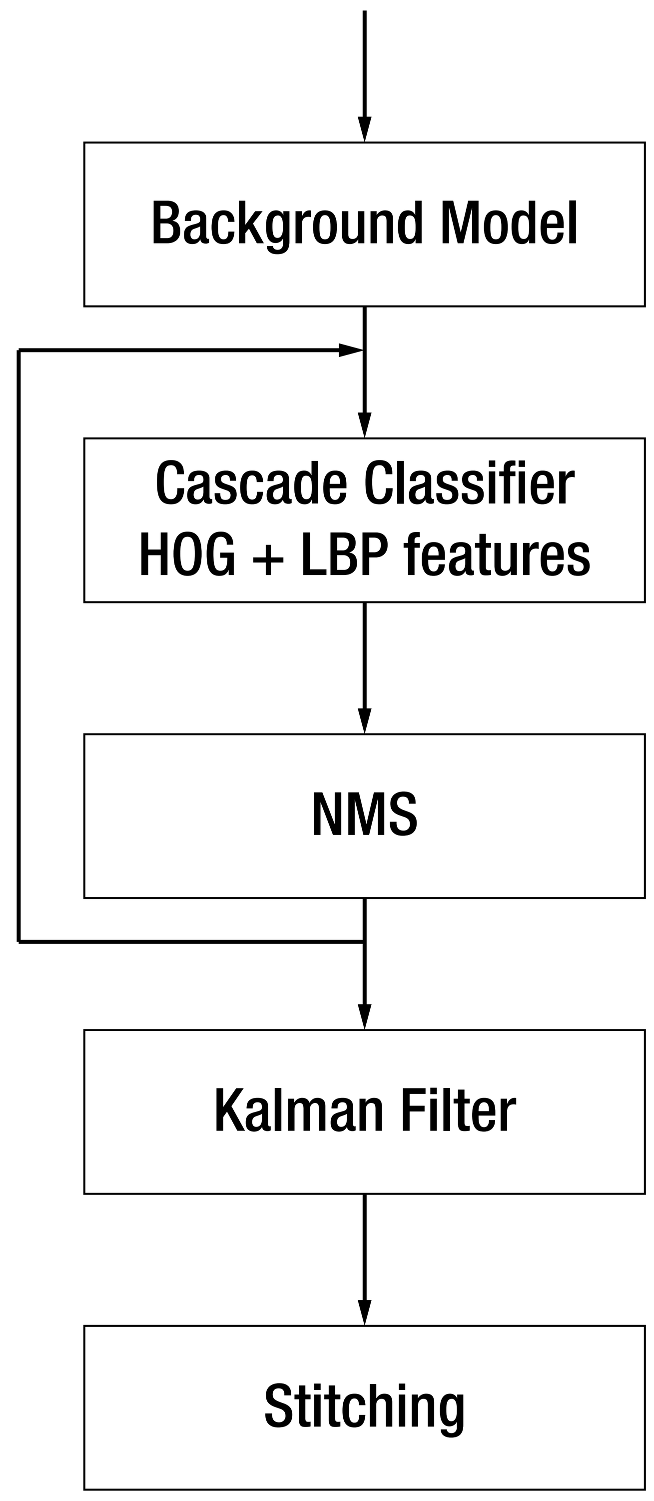

Fig 3: Tool chain

A background model[1] is used to focus evaluation on areas that contain motion.
Classification is done by a boosted cascade-classifier wich uses a combination of HOG- and LPB-features. Following a standard non maxima supression step, positive classified tiles are feed forward to be evaluated again in the next step. By this procedure we limit the initialization of tracklets to moving objects, but continue to track when they stop.
The tracklet generation is based on a Kalman filter approach. Due to the use of a stitching step, motivated by the work of Dicle et all[2], the KMF can be parametrized very conservatly, resulting in short but reliable tracklets. Thereby reducing miss assignemnts and track missmatches.
Figure 3 depicts the track of a penguin leaving the area through the upper gate. The track is broken into three tracklets due to occlusion.

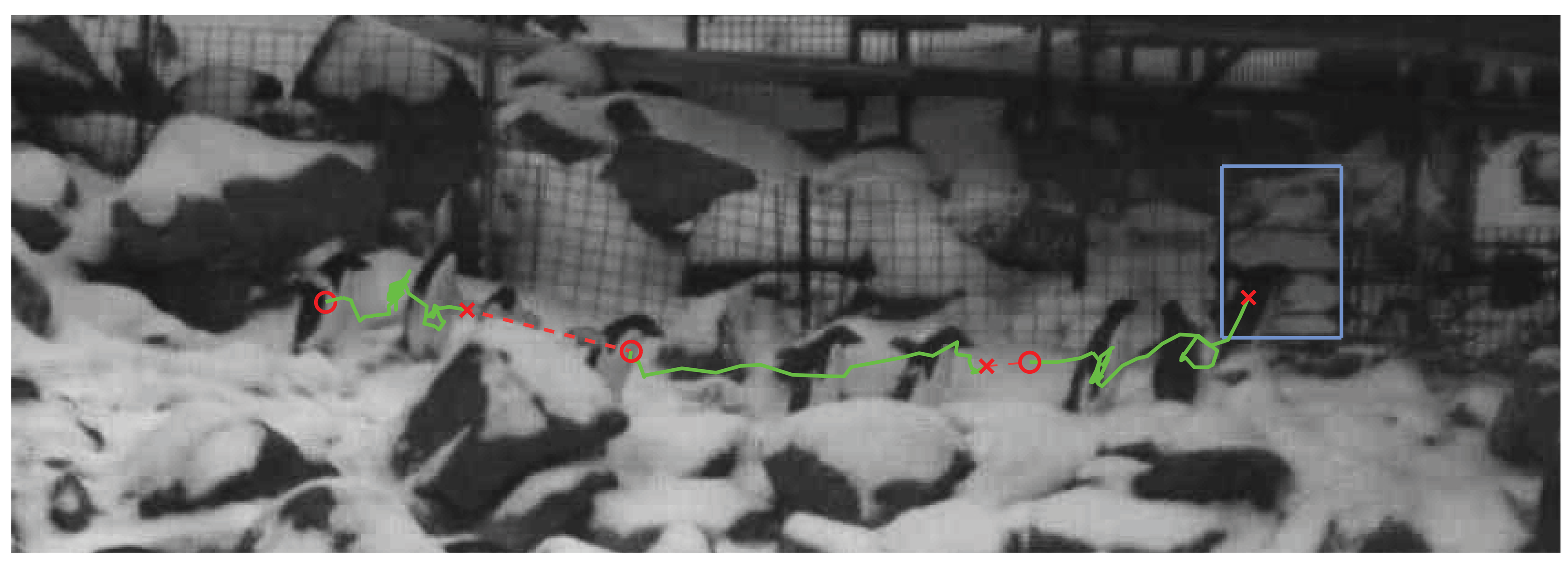

Fig 4: Conservative tracklets are stitched to longer tracks to handle occlusions and missed detections

Outlook

Based on the experience with the current hardware setup we plan to add aditional cameras to minimize occlusions and increase the frame rate to reduce the displacement per frame.
Our objective is to use the trajectories in conjunction with the RFID identification to learn and recognize interactions and behaviour on an individual basis. For example the choice of paths depending on the positions of other animals or simple interactions like „face“, „defend“ or „chase“.

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[1] Barnich, O.; Van Droogenbroeck, M., “ViBe: A Universal Background Subtraction Algorithm for Video Sequences,” Image Processing, IEEE Transactions on , vol.20, no.6, pp.1709,1724, June 2011 doi: 10.1109/TIP.2010.2101613
[2] Dicle, C.; Sznaier, M.; Camps, O.,“The Way They Move: Tracking Multiple Targets with Similar Appearance“, ICCV 2013