Deep-Tracking: Precise Behavior Tracking with Deep Learning

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(Meet us at the poster of our other project "ROTAH")

Behavior Task

- rat reaching for sugar pellets
- marker free behavior tracking using deep neural networks
- real time tracking for online optogenetic manipulation
  (high speed cameras - up to 750 fps)
- electrophysiological recordings of cortical activity

Deep Neural Network

- Semantic Segmentation is the state of the art technique for determining what is seen in an image and where it is seen:
  - pixel to pixel training
  - only a single forward pass is needed for image analysis
  - fast processing and real time application feasible
- Implementation:
  - feed forward network of artificial neurons (neural network)
  - convolutional neural network (VGG16 without fully connected layers)
  - combined with upconvolutional layers

1. Data Annotation

Objects or body segments are manually annotated to generate labeled data for the neural network training. We made our annotation tool freely available (open source, MIT license).

2. Network Prediction

Supervised Neural Network Training

The neural network learned to precisely identify body segments, i.e. mapping the input image to training annotation.

Validation Set

The neural network is able to identify body segments in unknown videos, i.e. generalization to different background, light conditions and angle of view.

3. Results

Deep Tracking: Proof of Concept

We demonstrate that different body segments can be reliably tracked after minimal (re-) training a feed forward neural network (proof of concept, only 2000 annotated frames with 5 labels each (face, left ear, both paws and left foot)). We further show that real time tracking is feasible. High speed camera (Basler acA640, max 750fps) input is processed with the Caffe deep learning framework. With GPU acceleration (NVIDIA TitanX) the setup is fast enough for online optical stimulation at specific points during the reaching trajectory. Such precisely timed optogenetic manipulation of cortical activity will allow us to investigate the underlying neural mechanisms and neural circuits in the future.

Tracking of a Rat’s Paw

(no video available online)

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