Notice and Invitation

Oral Defense of Doctoral Dissertation
The Volgenau School of Engineering, George Mason University

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Three Dimensional Pose Estimation For Mouse From Monocular Images

Friday, March 31, 2017, 2:00pm
Showcase Room, Research Hall
All are invited to attend.

Committee

Dr. Monson Hayes, Chair
Dr. Daniel Barbara
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Abstract

Action analysis for mice has garnered wide attention in biomedical research. Mice are the most common mammalian animal model used in research laboratories. In recent years, researchers and laboratory support companies have recognized the utility of automated profiling of laboratory mouse activity and behavior in the home-cage. Video-based systems have emerged as a viable solution for non-invasive mouse monitoring. Animal facilities hold large numbers of mice housed in `home-cages' densely stored within ventilated racks. Automated analysis of mice activity in their home-cages can provide a new set of sensitive measures for detecting abnormalities and time-resolved deviation from baseline behavior. Large scale monitoring in animal facilities requires minimal footprint hardware that integrates seamlessly with the ventilated racks. Compactness of hardware imposes use of fisheye lenses positioned in close proximity to the cage. With such optical configuration, scaled orthography, so widely assumed in the literature, no longer holds.

In this thesis, we outline a systematic approach to derive meaningful activity and behavior measures for compact systems suited for scalable use in animal vivaria. Our approach produces estimates of the 3D pose of a mouse. We introduce the first known dataset enabling reconstruction of mouse 3D landmark points. We develop novel methods utilizing structured forests to estimate the 3D positions of the landmarks from a single monocular image. The methods utilize classification decision trees leveraging their versatility to store arbitrary information in the leaf-nodes. During training, the samples arriving at each node are mapped from continuous pose space to discrete class labels such that similar poses are grouped in the same class. The node splitting function is then trained by optimizing a classification objective function rather than a high-dimensional regression one. The leaf-nodes store the pose parameters for the set of samples reaching the node. A prediction model preserving the structural relationships between the different landmarks constituting the pose is formed based on the samples in the leaf-nodes. To compare the method with existing algorithms, we implement a novel 3D extension of an established cascaded pose regression (CPR) algorithm that has worked reliably for mouse 2D pose estimation in scaled orthography settings. The results obtained through the structured forest method are more accurate than those obtained through the 3D CPR algorithm and those obtained via standard regression techniques. We demonstrate the utility of the pose estimates in predicting mouse behavior in continuous video.

A copy of this doctoral dissertation is on reserve at the Johnson Center Library.