The Johns Hopkins University

Whiting School of Engineering

Department of Electrical and Computer Engineering

Human Action Recognition from Active Acoustics: Physics Modelling for Representation Learning and Inference Using Generative Probabilistic Graphical Models

Dissertation Defense by

Thomas Murray

Graduate Research Assistant

Electrical and Computer Engineering

Abstract

This dissertation explores computational methods to address the problem of physics-based modeling and ultimately doing inference from data in multiple modalities where there exists large amounts of low dimensional data complementary to a much smaller set of high dimensional data. In this instance the low dimensional time- series data are active acoustics from a micro-Doppler sensor that include no or very limited spatial information, and the high dimensional data is RGB-Depth skeleton data from a Microsoft Kinect sensor. The task is that of human action recognition from the active acoustic data.

To accomplish this, statistical models, trained simultaneously on both the micro-Doppler modulations induced by human actions and symbolic representations of skeletal poses, are developed. This enables the model to learn correlations between the rich temporal structure of the micro-Doppler modulations and the high-dimensional motion sequences of human action. During runtime, the model then relies purely on the active acoustic data to infer the human action. In order to adapt this methodology to situations not observed in the training data, a physical model of the human body is combined with a physics-based simulation of the Doppler phenomenon to predict the acoustic data for a sequence of skeletal poses and a configurable sensor geometry. The physics model is then combined with a generative statistical model for human actions to create a generative physics-based model of micro-Doppler modulations for human action.

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