Announcing the Final Examination of Imran Saleemi for the degree of Doctor of Philosophy

Time & Location: March 24, 2011 at 11:00 AM in HEC 101
Title: Patterns of Motion: Discovery and Generalized Representation

This dissertation addresses the problem of discovery and representation of motion patterns in a variety of scenarios, commonly encountered in vision applications. The overarching goal is to devise a generic representation, that captures any kind of object motion observable in video sequences. Such motion is a significant source of information typically employed for diverse applications such as tracking, anomaly detection, and action and event recognition. We present statistical frameworks for representation of motion characteristics of objects, learned from tracks or optical flow, for static as well as moving cameras. We experimentally demonstrate the feasibility of application of the proposed motion pattern models and learning methods for solution of a variety of problems.

First, a novel method to model and learn the scene activity, observed by a static camera is proposed by modeling motion patterns of objects as a multivariate non-parametric probability density function of spatio-temporal variables. KDE is used to learn this model and a unified Markov Chain Monte-Carlo (MCMC) based framework is proposed for generating the most likely paths in the scene, improving foreground detection, persistent labeling of objects during tracking, and anomaly detection. Experiments with real world videos are reported which validate the proposed approach.

Second, a superior framework is proposed for the discovery and statistical representation of motion patterns in a scene, which has two main advantages over the first approach: first, this model is applicable to scenes of dense crowded motion where tracking may not be feasible, and second, it distinguishes between motion patterns that are distinct at a semantic level of abstraction. A mixture model representation of salient patterns of optical flow is presented, which exploits hierarchical clustering of flow vectors using K-means, spatio-temporal affinity based constraints, and KL divergence. Finally, a pixel level representation of motion patterns is proposed by deriving conditional expectation of optical flow. Results of extensive experiments are presented for multiple surveillance sequences containing numerous patterns involving both pedestrian and vehicular traffic, in static as well as aerial cameras.

Finally, the motion patterns framework is exploited as a new representation for articulated human actions. The proposed method works in a completely unsupervised fashion, and in sharp contrast to state of the art representations like bag of video words, provides a truly semantically meaningful representation. Sequences of primitive actions are discovered in videos, and represented as strings. Experiments on supervised and unsupervised classification are reported for multiple human actions data sets, which confirm the validity, simplicity, and semantically meaningful nature of the proposed representation.

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Approved for distribution by Dr. Mubarak Shah, Committee Chair, on March 7, 2011.
The public is welcome to attend.