Subspace Clustering for Action Recognition with Covariance Representations and Temporal Pruning

Giancarlo Paoletti¹³, Jacopo Cavazza¹, Cigdem Beyan¹, Alessio Del Bue¹²

¹Pattern Analysis and Computer Vision, Istituto Italiano di Tecnologia
²Visual Geometry and Modelling, Istituto Italiano di Tecnologia
³Electrical, Electronics and Telecommunication Engineering and Naval Architecture Department (DITEN), University of Genova
Overview

Unsupervised Human Action Recognition

• HAR using RGB videos: a challenging task
  – Background clutter,
  – Lighting and clothing variations,
  – etc.

• Skeleton-based action sequences
  – Multi-dimensional time series of skeletal joints

• Subspace Clustering on skeleton HAR
  – How to handle temporal data?

• Temporal regularization heuristics:
  – Covariance Subspace Clustering
  – Temporal Subspace Clustering
  – Time-pruning Subspace Clustering


Subspace Clustering

• High-dimensional data represented as a union of subspaces
  – Lower dimensionality
  – Simpler geometrical structure
  – Each subspace = action class
  – Affinity matrix + spectral clustering = unsupervised action labels

• Subspace Clustering on skeleton-based HAR
  – Limitedly explored due to noisy data, missing joints, etc.

• Subspace Clustering methods to build affinity matrix
  – Self-expressiveness based Subspace Clustering
  – Dictionary based Subspace Clustering

Temporal regularization heuristics

Covariance Subspace Clustering
- Covariance encoding as descriptor to each skeleton data
- Flattened covariance as input
- Self-expressiveness based Subspace Clustering
- Spectral Clustering + Hungarian

Temporal Subspace Clustering
- Subspace Clustering as a pre-processing stage
- Fixed length action sequence compression
- Self-expressiveness based Subspace Clustering
- Spectral Clustering + Hungarian

Time-pruning Subspace Clustering
- Fixed length action sequence compression
- Dictionary-based Subspace Clustering [1]
- Normalized cuts + Hungarian
Unsupervised HAR pipeline

- Temporal information heuristics
  a) Covariance Subspace Clustering
  b) Temporal Subspace Clustering
  c) Time-pruning Subspace Clustering

- Spectral Clustering / Normalized Cuts

- Hungarian algorithm
We provide...

- Subspace clustering approaches for HAR
- Extensive experiments on skeleton-joints datasets
- Covariance representations and time-pruning strategies for temporal data
- Favorable results w.r.t. supervised state-of-the-art – ... in some cases even surpassing them!

Thank you!

Code available!