Motion Retrieval for Security Applications

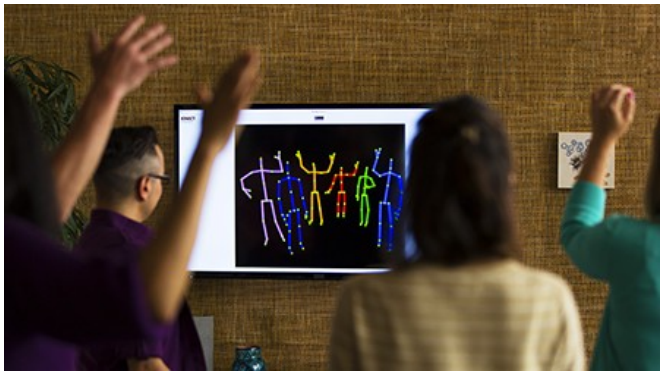
Jan Sedmidubsky
Jakub Valcik
Pavel Zezula

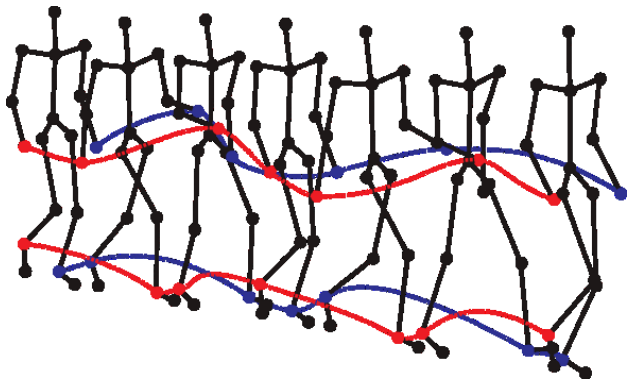
Faculty of Informatics
Masaryk University
Brno, Czech Republic

Introduction

- Motion capturing devices
  - Record and digitize human movement into motion capture data in real time
  - Examples: Microsoft Kinect, ASUS Xtion

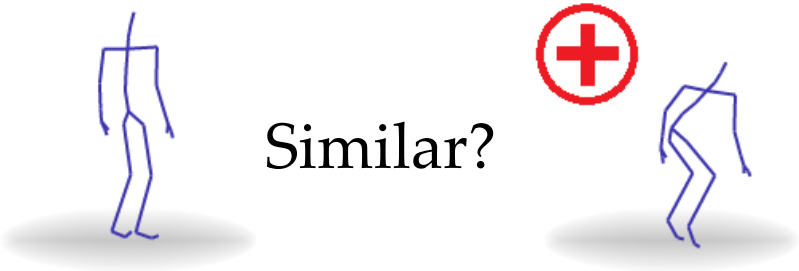
- Motion capture data
  - 3D joint coordinates estimated for each video frame
  - e.g., Microsoft Kinect v2: skeleton model with 25 joints





Introduction

- Analysis of recorded motion data in various areas:
  - Health care – success of rehabilitative treatments
  - Sports – performance aspect comparison
  - Security – person identification, event detection
  - Computer animation – realistic motion synthesis

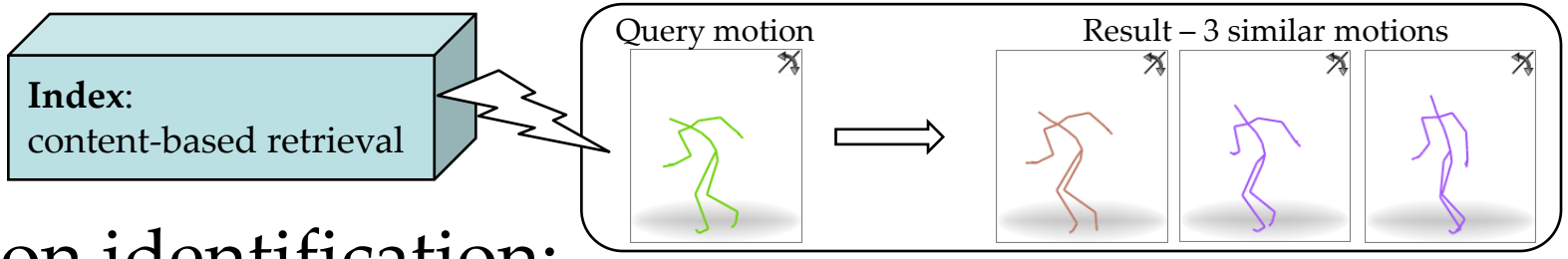


- Aspects:
  - Motion features
  - Similarity comparison
  - Indexing & searching

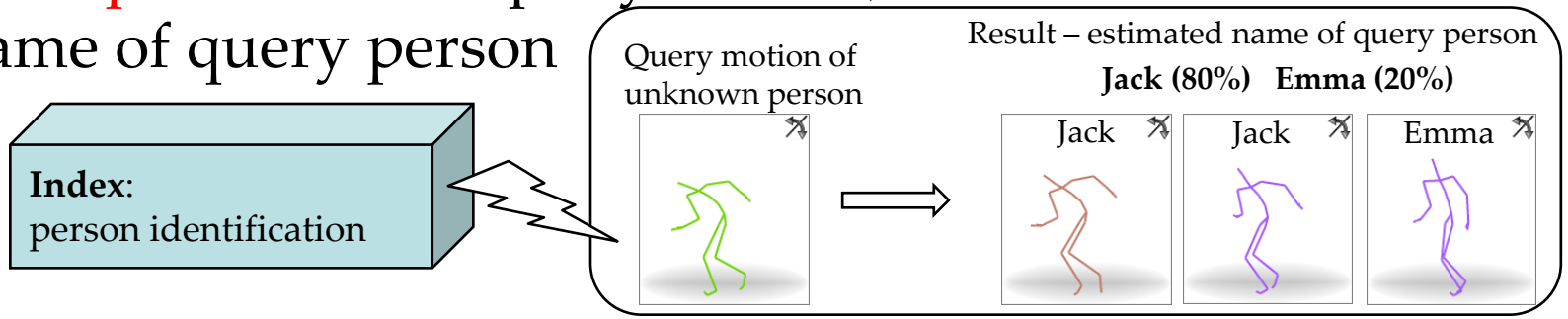
} Similarity model – depends on the application purpose

Applications We Focus on

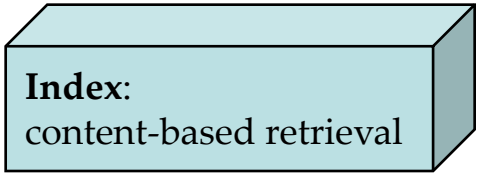
- Content-based (sub-)motion retrieval:
  - Search for (sub-)motions in a database that are visually similar to a query motion example



- Person identification:
  - Search for database motions that should belong to the same person as the query motion, in order to reveal the name of query person



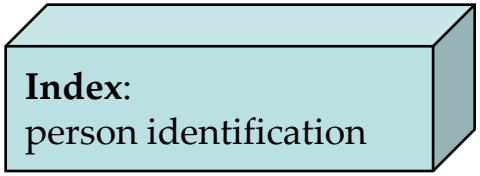
Content-based Retrieval Index

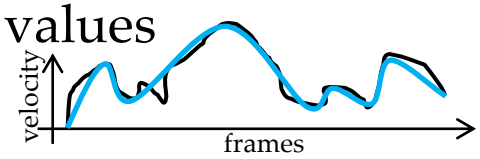


- Content-based retrieval index:
  - Motion features – joint-angle rotations
    - Each frame = 28-D vector of angles of joints
    - Individual frames compared by the L_1 metric
  - Motion similarity comparison
    - Average distance between selected key frames
  - Indexing & searching
    - A specialized key-frame retrieval algorithm
    - Sedmidubsky, J., Valcik, J., and Zezula P. A Key-Pose Similarity Algorithm for Motion Data Retrieval. In *12th International Conference on Advanced Concepts for Intelligent Vision Systems (ACIVS 2013)*. Springer, 2013.

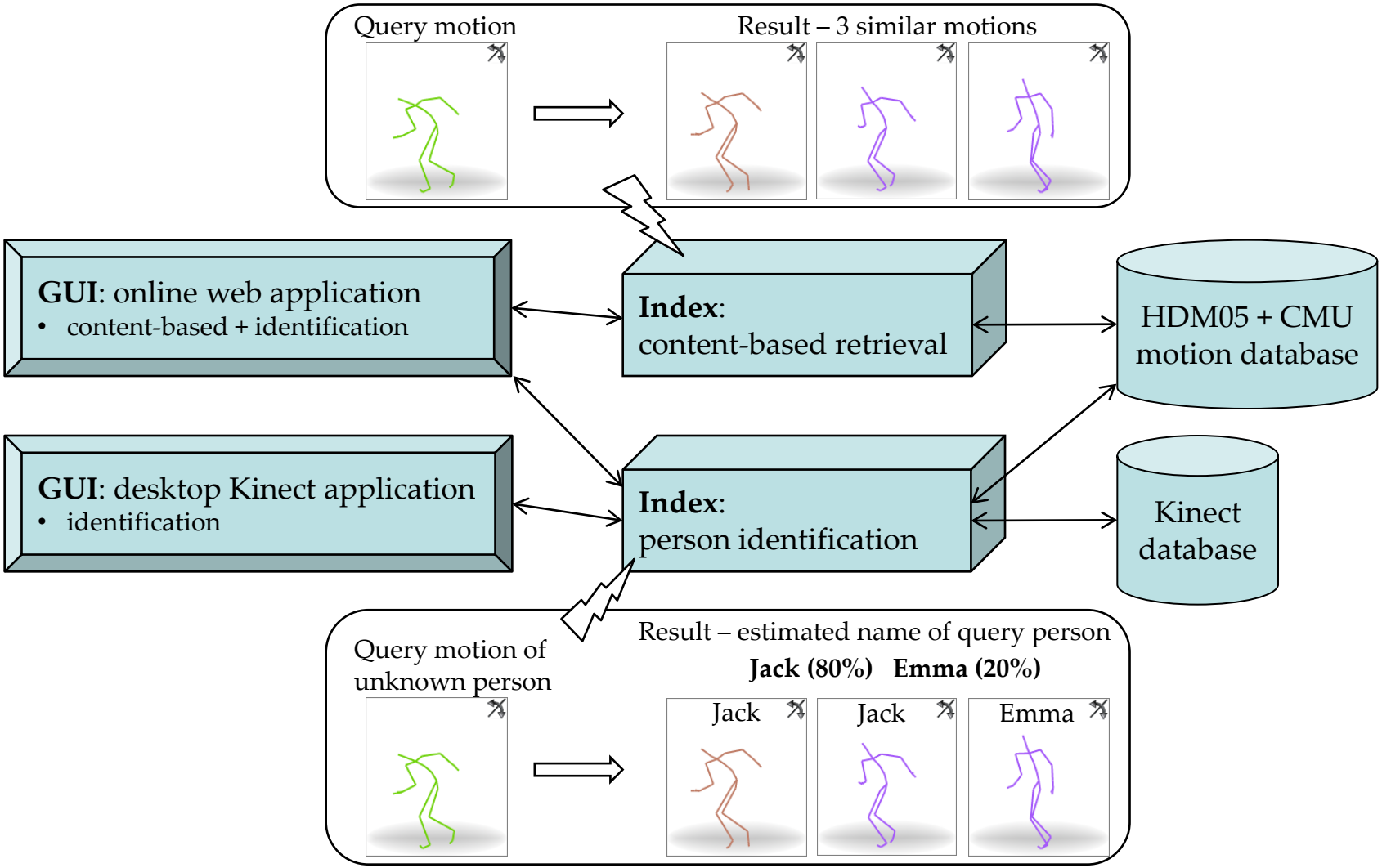
Person Identification Index

- Person identification index:
  - Motion features
    - Extracted separately for individual walking cycles
      - Each frame = 21-D vector of relative velocities of joints ~ each walking cycle represented by 21 time series
      - Each time series smoothed by Fourier transform. (10 harm.)
    - Walking cycle = matrix 21x10 of transformed values
  - Motion similarity comparison
    - Matrices of walking cycles compared by a weighted L_1 metric
    - Combination of skeleton proportions and walking cycles (matrices)
  - Indexing & searching – parallel sequential scan
    - KNN classification for estimating person name from the most similar retrieved walking cycles



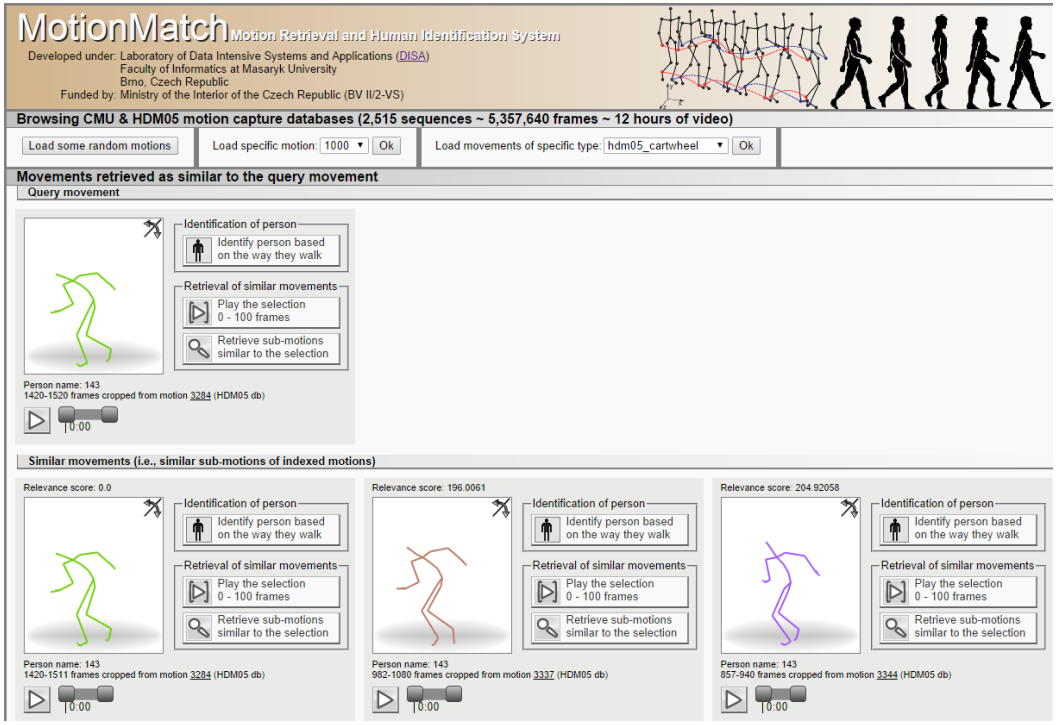


Architecture of Retrieval System



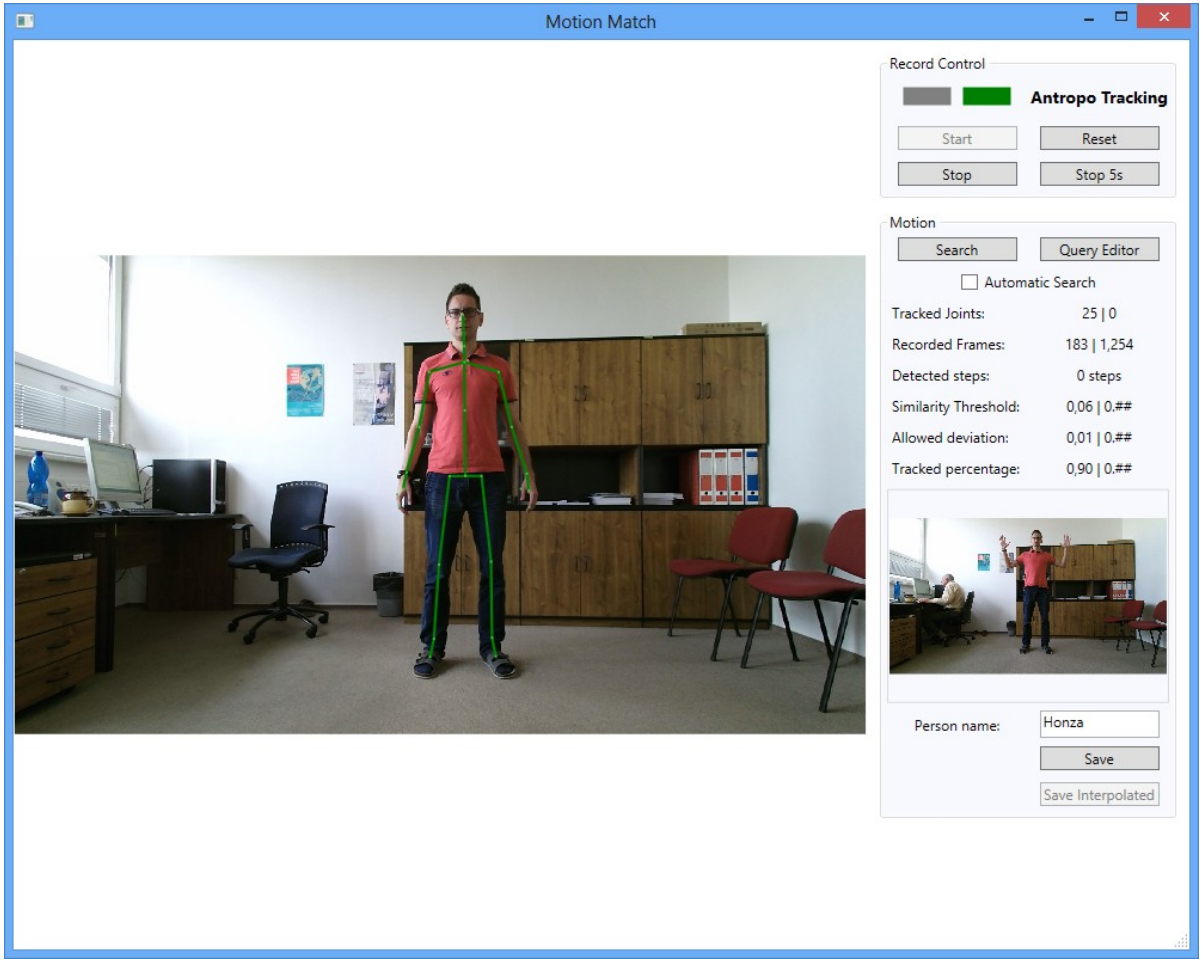
Online Web Application

- Online demo: http://disa.fi.muni.cz/motion-match/
- HDM05 + CMU motion databases:
  - 2,515 motions of 5.4M frames ~ 12 hours of video



Desktop Kinect Application

- Database has to be created



Future Work

- Future research directions:
  - Developing new similarity models to achieve better retrieval effectiveness
  - Developing more efficient retrieval algorithms to speed up the search process
  - Fusing face and motion recognition methods to improve the quality of person identification
  - Creating a larger database of different kinds of motions by the Kinect device

⟹ bachelor and master theses

Questions?

Thank you for your attention.

Try our online demo:
http://disa.fi.muni.cz/motion-match/