

Motion Retrieval for Security Applications

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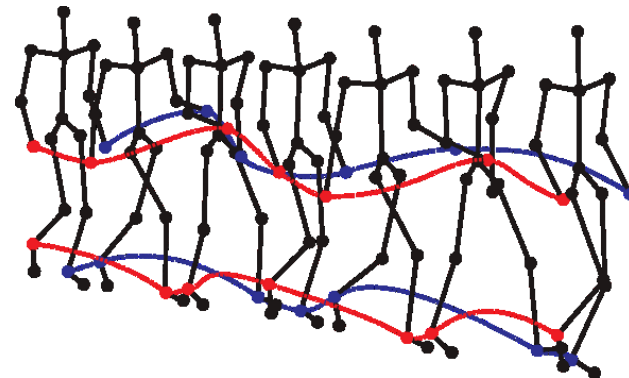
- **Motion capturing devices**

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

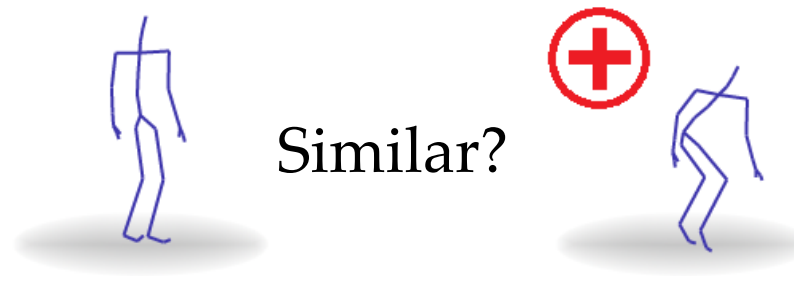


- **Motion capture data**

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



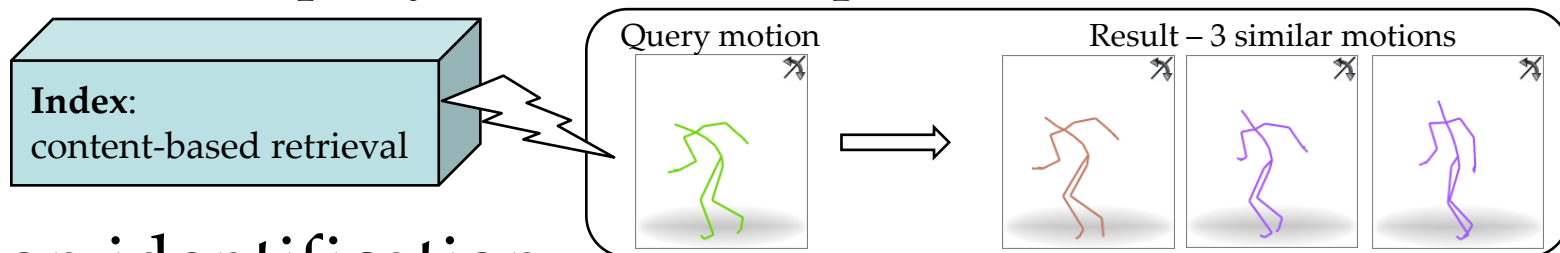
- Analysis of recorded motion data in various areas:
 - Health care – success of rehabilitative treatments
 - Sports – performance aspect comparison
 - Security – person identification, event detection
 - Computer animation – realistic motion synthesis



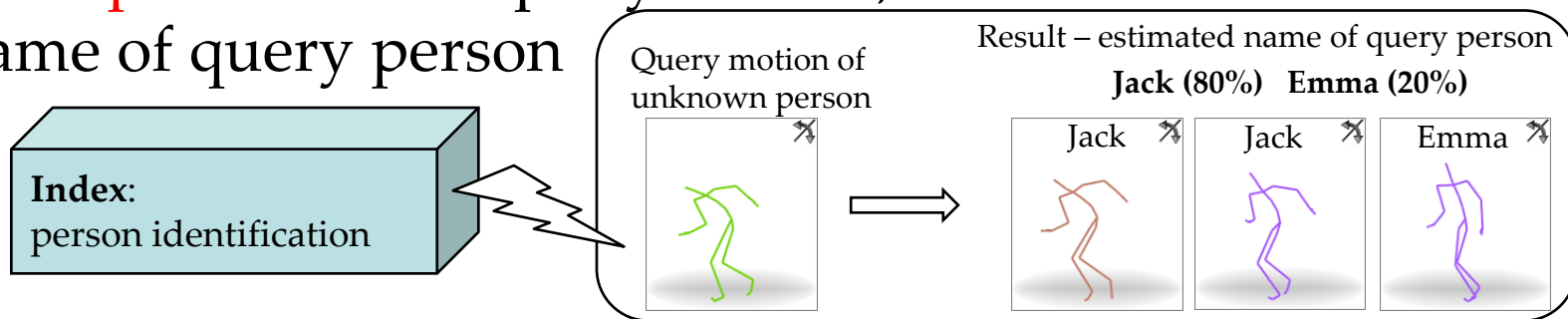
- **Aspects:**

- Motion features
 - Similarity comparison
 - Indexing & searching
- } Similarity model – depends on the application purpose

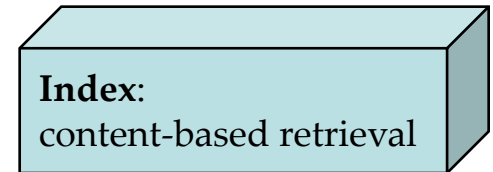
- Content-based (sub-)motion retrieval:
 - Search for (sub-)motions in a database that are **visually similar** to a query motion example



- 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:
 - **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:

- 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.)

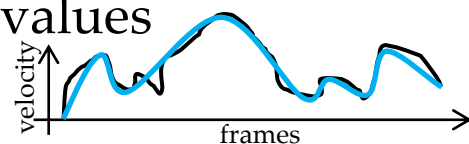
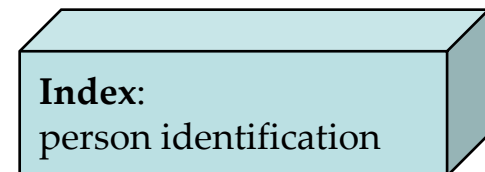
- Walking cycle = matrix 21x10 of transformed values

- Motion similarity comparison

- Matrices of walking cycles compared by a weighted L_1 metric
 - Combination of skeleton proportions and walking cycles (matrices)

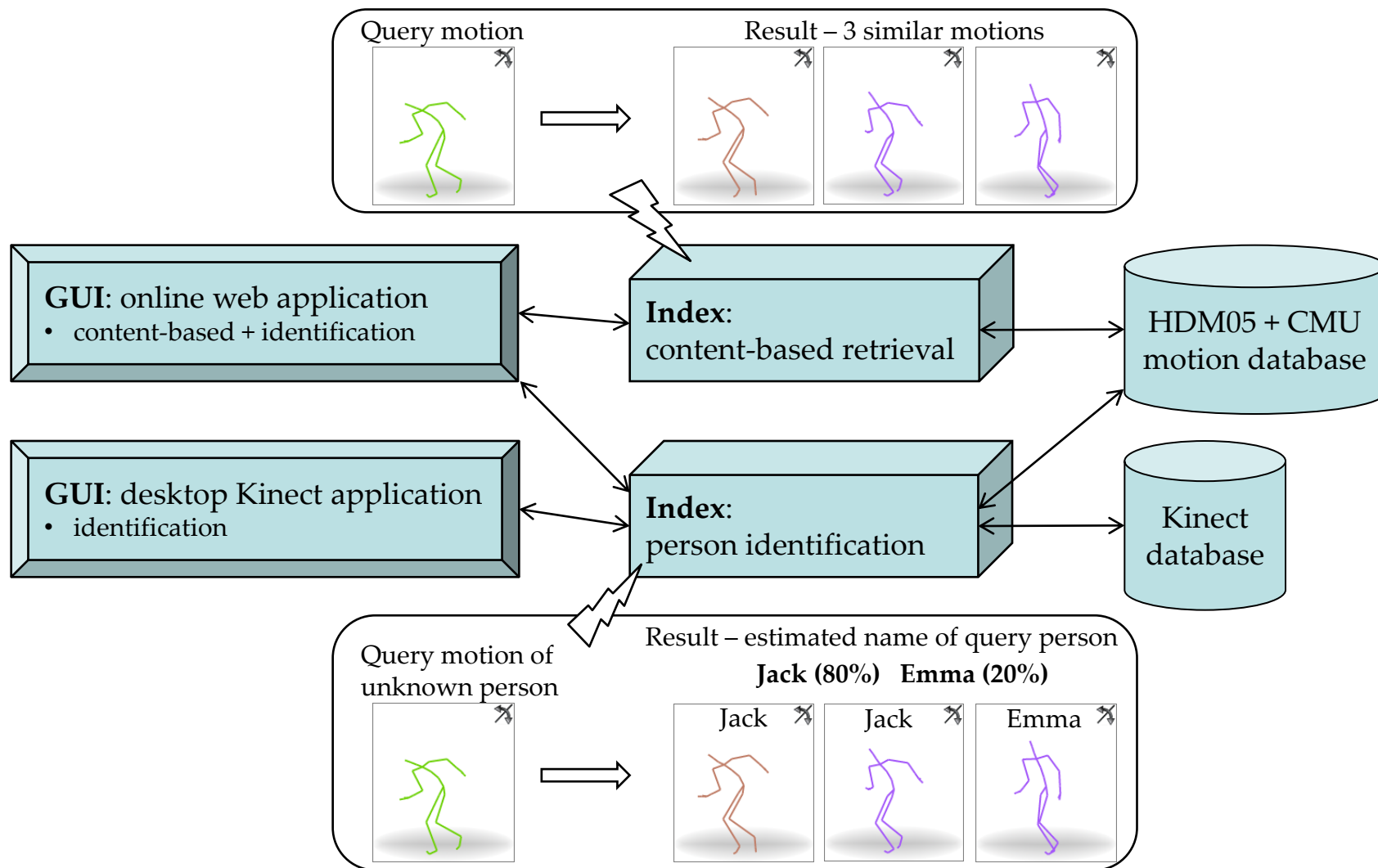
- Indexing & searching – parallel sequential scan

- KNN classification for estimating person name from the most similar retrieved walking cycles



Architecture of Retrieval System

DISA
2014



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

MotionMatch Motion Retrieval and Human Identification System
Developed under: Laboratory of Data Intensive Systems and Applications (DISA)
Faculty of Informatics at Masaryk University
Brno, Czech Republic
Funded by: Ministry of the Interior of the Czech Republic (BV II/2-VS)

Browsing CMU & HDM05 motion capture databases (2,515 sequences ~ 5,357,640 frames ~ 12 hours of video)

Load some random motions | Load specific motion: 1000 | Ok | Load movements of specific type: hdm05_cartwheel | Ok

Movements retrieved as similar to the query movement

Query movement

Identification of person
Identify person based on the way they walk

Retrieval of similar movements
Play the selection 0 - 100 frames
Retrieve sub-motions similar to the selection

Person name: 143
1420-1520 frames cropped from motion 3284 (HDM05 db)

Relevance score: 0.0

Identification of person
Identify person based on the way they walk

Retrieval of similar movements
Play the selection 0 - 100 frames
Retrieve sub-motions similar to the selection

Person name: 143
1420-1511 frames cropped from motion 3284 (HDM05 db)

Relevance score: 196.0061

Identification of person
Identify person based on the way they walk

Retrieval of similar movements
Play the selection 0 - 100 frames
Retrieve sub-motions similar to the selection

Person name: 143
982-1090 frames cropped from motion 3337 (HDM05 db)

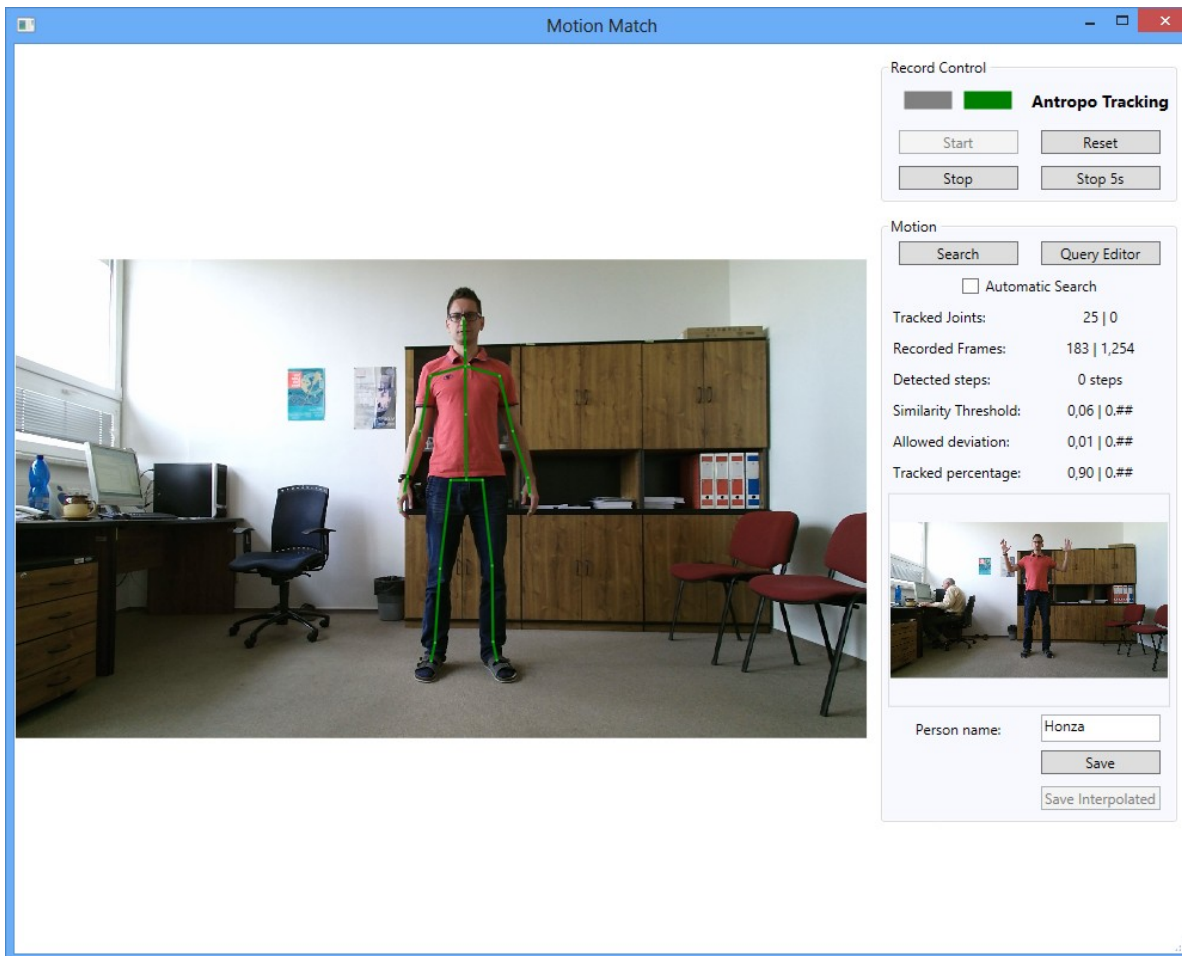
Relevance score: 204.92058

Identification of person
Identify person based on the way they walk

Retrieval of similar movements
Play the selection 0 - 100 frames
Retrieve sub-motions similar to the selection

Person name: 143
857-940 frames cropped from motion 3344 (HDM05 db)

- Database has to be created



- **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

Thank you for your attention.

Try our online demo:

<http://disa.fi.muni.cz/motion-match/>