Practical block III: Human Behavior Analysis

Interacting with computers using human motion is commonly employed in human-computer interaction (HCI applications). One way to incorporate human motion in HCI application is to use a predefined set of human joint motions i.e., gestures. Gesture recognition has been an active research area.

A variety of methods have been proposed for gesture recognition, ranging from the user of Dynamic Time Warping to Hidden Markov Models. DTW measures similarity between two time sequences which might be obtained by sampling a source with varying sampling rates or by recording the same phenomenon occurring with varying speeds. For example, DTW is used in speech recognition to warp speech in time to be able to cope with different speaking speeds. DTW is also used in data mining and information retrieval to deal with time-dependent data. In gesture recognition, DTW time-warps and observed motion sequence of body joints to pre-stored gesture sequences (or some other defined human pose features).

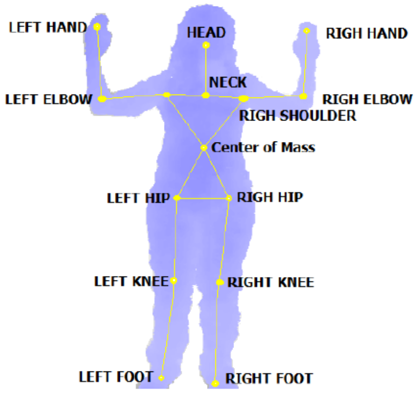
The conventional DTW algorithm is basically a dynamic programming algorithm, which uses a recursive update of DTW cost by adding the distance between mapped elements of the two sequences at each recursion step. The distance between two elements is oftentimes the Euclidian distance, which gives equal weights to all dimensions of a sequences sample. However, depending on the problem a weighted distance might perform better in assessing the similarity between a test sequences and a reference sequence.

In this practical work we are going to use DTW as a template matching algorithm, in order to find the best match for a test pattern out of the reference patterns, where the patterns are represented as a time sequence of measurements or features obtained from measurements.

Dataset:

The Microsoft Research Cambridge-12 Kinect™ gesture data set consists of sequences of human movements, represented as body-part locations, and the associated gesture to be recognized by the system. The data set includes 594 sequences and 719,359 frames-approximately six hours and 40 minutes-collected from 30 people performing 12 gestures. In total, there are 6,244 gesture instances. The motion files contain tracks of 20 joints estimated using the Kinect™ Pose Estimation pipeline. The body poses are captured at a sample rate of 30Hz with an accuracy of about two centimeters in joint positions (http://research.microsoft.com/en-us/um/cambridge/projects/msrc12/):

The articulated human model is defined by the set of 20 reference points show in the next image:



The gestures can be categorized in the following categories:

1. Crouch or hide (G2)
2. Shoot a pistol (G6)
3. Throw an object (G8)
4. Change weapon (G10)
5. Kick (G12)
6. Put on night vision goggles (G4)
7. **Start Music/Raise Volume (of music) (G1)**
8. Navigate to next menu (G3)
9. Wind up the music (G5)
10. Take a Bow to end music session (G7)
11. Protest the music (G9)
12. Move up the tempo of the song (G11)

Matlab files:

1. LOAD_FILE -- Load gesture recognition sequence

```
% Input
% file_basename: sequence name such as 'P1_1_1A_01'.
% discard_zero_frames: (optional), if >0, no-skeleton frames at the
% beginning of the sequence are discarded. Default: 1.
%
% Output
% X: (T,80) skeletal frames.
% Y: (T,GN) 0/1 encoding of gesture presence.
% tagset: (1,GN) cellarray of gesture names.
```

X contains all the information about the joints position (x,y,z world coordinates) during *N* frames making different gestures recorded in that sequence. If we want to obtain the length of sequence in frames we can use *T=size(X,1)*. Each column from *X* corresponds to a matrix composed by 80 values composing the skeletal model. The x,y,z,v values (*v* is not used in this practical work) of the joints is stored in the following order:

1. HipCenter
2. Spine
3. ShoulderCenter
4. Head
5. ShoulderLeft
6. ElbowLeft

7. WristLeft
8. HandLeft
9. ShoulderRight
10. ElbowRight
11. WristRight
12. HandRight
13. HipLeft
14. KneeLeft
15. AnkleLeft
16. FootLeft
17. HipRight
18. KneeRight
19. AnkleRight
20. FootRight

For example if we want to extract the information relative of the Hip-Center in the frame 10 we will use: X(10,(1:4))

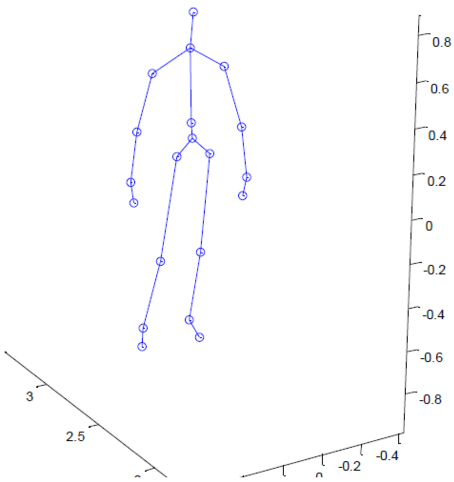
2. GESTURE_CUTS –It extracts the start and finish time (in frames) of each gesture recorded in a sequence.

```
% Input
% X: (T,80) skeletal frames.
% Y: (T,GN) 0/1 encoding of gesture presence.
%
% Output
% gestures: type and action time of each gesture divided
% ngestures: Number of gestures in the sequence
```

Gestures is a matrix composed by ngestures rows and 3 columns. In the first column there is the start time of the gesture (in frames), in the second column there is the finish time, and in the third column there is the gesture type.

3.SKEL_VIS-We can show the position of each joint in a specific frame position.

```
% SKEL_VIS -- Visualize a skeleton in 3D coordinates.
%
% Input
% X: (T,4*NUI_SKELETON_POSITION_COUNT) matrix from load_file.
% tidx: time index >=1, <=T.
% h: (optional) axes handle to draw in.
```



Suggestion: In order to perform the alignment between two patterns, we can employ the command:

```
imresize
B = imresize(A, [numrows numcols])
```

Tasks:

1. Code: DTW matlab implementation using Euclidian distance as cost function.

2. Code: Write a matlab demo file for loading a model of a gesture category and showing its correct recognition using the **Microsoft Research Cambridge-12 Kinect™ gesture data**. This means defining a model of a category and then test this model against samples of the different categories, showing how DTW recognize the correct gesture for a given threshold value.

3. Report: short report just describing implementations 1 and 2. Must include experimental settings and results analysis.

Deadline 24th May 23:55h

Upload a ZIP file to the PR2 activity in the RACO page with:

- **README.TXT: Names of the team (max 2 persons)**
- **Report.pdf: Report**
- **Src: Folder with all the files for tasks 1 and 2**