
D4.2 – DANCE System Platform, Second version

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# 1. Introduction

The *DANCE software platform,* based on the EyesWeb XMI research platform, allows synchronized recording, playback, and analysis of a multimodal stream of data. Its main characteristics have been illustrated in Deliverable 4.1. In this document we describe the improvements and extensions we introduced in the platform during the second year of DANCE. We report below the main characteristics of the platform, taken from D4.1:

- creation of a multimodal repository of recordings of movement qualities;
- fine-grain synchronization of multimodal data
- segmentation of the recordings in fragments, according to the chosen qualities
- playback and testing of the repository
- extraction of the movement features and qualities
- real-time interactive sonification
- design and development process of scientific experiments of DANCE
- design and development of the prototypes of applications
- design and development of artistic projects exploiting the results of the DANCE project (e.g., artistic performances)

In this deliverable you can find instructions to download, install and run the DANCE software platform, and details about the file data formats exploited by the platform. The most updated version of the platform can be freely downloaded from the website:

http://dance.dibris.unige.it/index.php/2017-02-08-13-44-31/dance-platform-v2

The platform is based on EyesWeb XMI, allowing users to perform synchronized recording, playback, and analysis of a multimodal stream of data.

The last version of EyesWeb is the 5.7.0.0. This version has been created for DANCE during the second year of the project. It can be downloaded from the following links:

ftp://ftp.infomus.org/Evaluate/EyesWeb/XMI/Version_5.7.x/EyesWeb_XMI_setup_5.7.0.0.exe

ftp://ftp.infomus.org/Evaluate/EyesWeb/XMI/Version_5.7.x/EyesWeb_XMI_setup_5.7.0.0_x64.exe

During the second year of DANCE, the Windows 64 bit version of the platform has been released. The software modules described in this document are available for download in the DANCE website; their compatibility is for both 32 and 64 bit versions of the platform.

During the third year of the project, the DANCE platform will be further developed by integrating:

- the final version of the software libraries for full-body expressive movement analysis (see D2.2)
- the final version of the the sonification software libraries (see D3.2)

# 2. Synchronized multimodal recording and playback

## 2.1 Architecture

The updated overall architecture for multimodal recordings is shown in the following figure:


Figure 1. The architecture of the DANCE platform.

The platform, an extension of the platform described in D4.1, can be customized and expanded. The main supported devices, usually adopted for the DANCE data recording sessions, are the following:

- Motion Capture (Qualisys)
- headset microphone, used in DANCE to record respiration
- seven Inertial Measurement Units (IMU), two on the wrists, two on the ankles, three on the spine (neck base, shoulder spine, spine base)
- two broadcast quality video cameras, one on the front and one on the side
- two Myo sensors for recording forearm muscle tension
- a "master" machine, which allows the experimenters to monitor the status of all the connected machines and sensors and to send to all the machines the "start" and "stop" commands for the recording process

Synchronization is guaranteed by the EyesWeb platform. An SMPTE clock is generated and recorded along with data streams. Details about the synchronization mechanism are reported in D4.1.

Platform extensions, with respect to the first version released in D4.1, are the following:

- platform diagnostic feedback is now provided, allowing platform users to quickly check, for example, whether sensors are correctly connected or not;
- the Myo[1] armband is now available to be recorded by the platform; it measures forearm muscle tension and sends it via Bluetooth at 40 fps;

[1] https://www.myo.com

- the trial recording number can be edited and it is automatically incremented by the platform;
- integration of the new versions of the analysis library software modules, described in separate deliverables and scientific papers, and briefly in this document in section 2.8.

The DANCE platform tools and patches are programs, written to be executed by EyesWeb, that allow the user to record, playback and analyze multimodal data (video, audio, motion capture, sensors). In the next Sections we present a few of them which are mainly updates of those provided with the first version of the platform in D4.1.

## 2.2 Master interface

Download:

http://dance.dibris.unige.it/user_files/DANCE_Platform/release_december_2016/Eyesweb_XMI_Asio_Controller_For_Recording_System_setup_5.7.0.0.exe

The main improvement of the DANCE recording and playback platform consists of a communication system for the status of the software modules attached to the platform.

As illustrated in the previous section, each software module can be run on a separate machine, while an overall clock is sent through network to each machine. This allows, for example, to easily add a new sensor to the platform by connecting a new machine to the network and by running a new software module, which will be able to synchronize to the existing ones by receiving the same overall clock. A particular machine, called "master" in Figure 1, runs a software module (the master interface) which sends the "start" and "stop" commands to all the other machines.

In the updated version of the platform, the master interface also reports the status of all the sensors and recording devices connected to the other machines. The interface is depicted in Figure 2.


Figure 2. The "master" interface.

On the right, three columns report the connected sensors and recording devices:

- ID is the label assigned by the experimenter to the sensor or recording device
- Status can assume one value between "Stopped", "Recording" or "Error"
- Data status is the frame rate of the data received from the sensor or recording device

By implementing such a status messaging system, we increase the robustness of the platform and decrease the possible data loss due to sensors or devices malfunctioning.

## 2.3 Video recorder

Download:

http://dance.dibris.unige.it/user_files/DANCE_Platform/release_december_2016/Eyesweb_XMI_Recorder_for_Dual_Decklink_Frame_Grabber_setup_5.7.0.0.exe

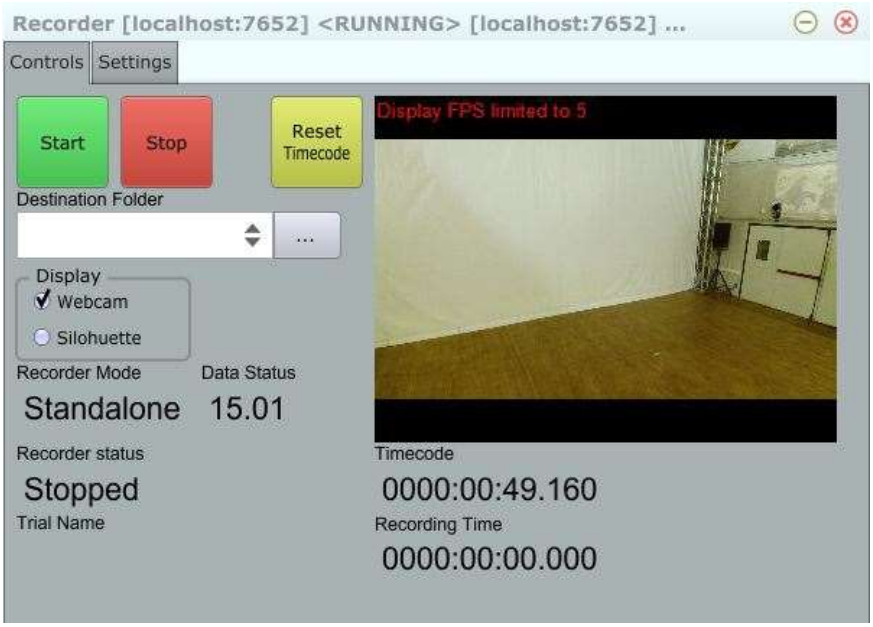
This module, depicted below, is able to record the video stream of multiple video sources. Each video source is stored in a separate video+audio (e.g., AVI, mp4). To guarantee synchronization with the other data streams, the audio channels of the generated files contain the SMPTE time signal encoded as audio. During playback, the SMPTE is decoded from audio to extract timing information and play the video stream in sync.


## 2.4 Kinect recorder

Download:

http://dance.dibris.unige.it/user_files/DANCE_Platform/release_december_2016/Eyesweb_XMI_Recorder_for_Kinect_V2_setup_5.7.0.0.exe

The Kinect recorder tool is depicted in the following picture and has very small differences compared to the previous version:



The tool shows the current framerate in the "Data Status" field (15.01 frames per second in the example), the name used for this trial (`trial_000`, progressive numbers are automatically assigned to each trial), and the value of the reference clock (`HHHH:MM:SS.mmm; 0000:00:49.160` in the above picture).

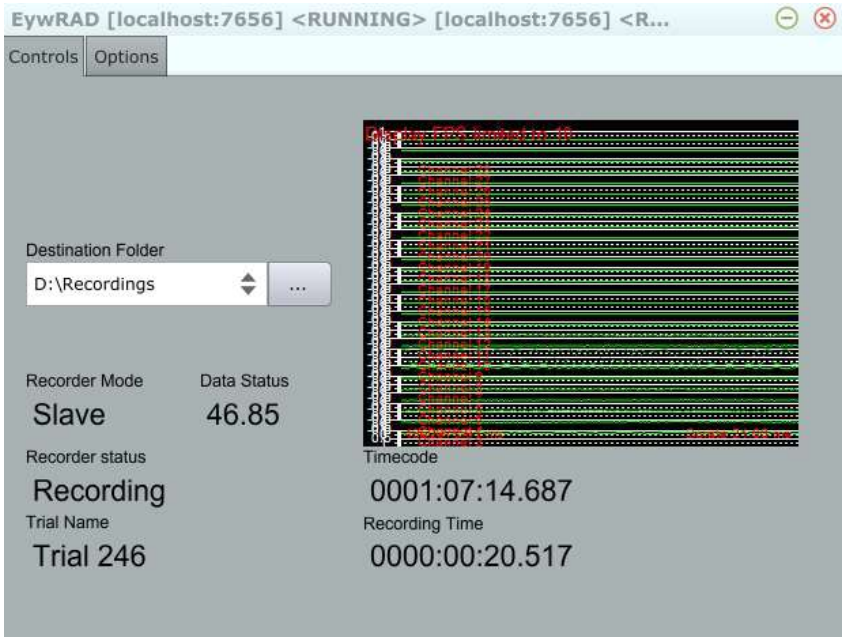
The option panel, displayed below, has been redesigned in the new version. It allows to choose which Kinect streams to record, the recording mode (standalone or slave) and to assign an ID to the recording module. The ID will be reported in the master interface, as described in the previous section.


## 2.5 Audio recorder

Download:

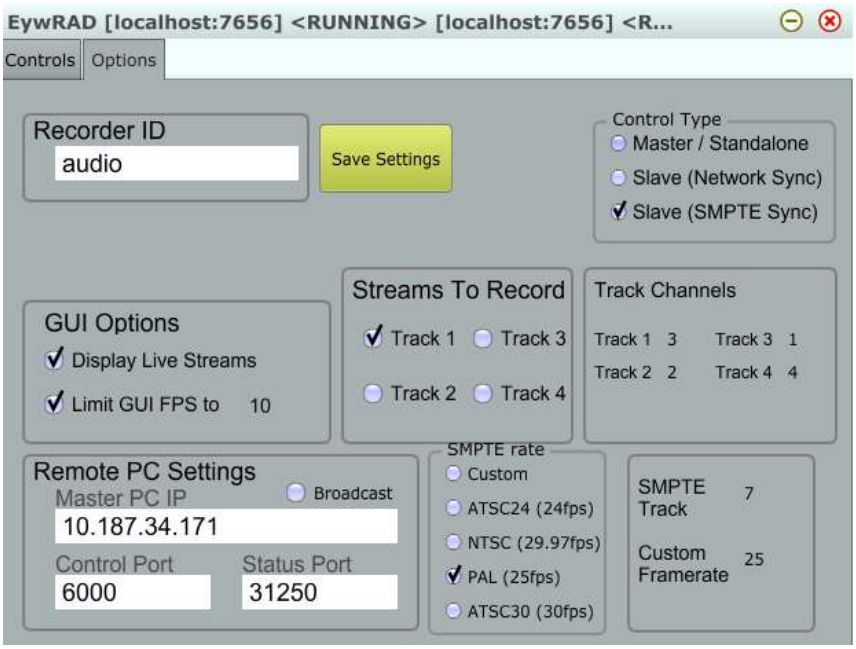
http://dance.dibris.unige.it/user_files/DANCE_Platform/release_december_2016/Eyesweb_XMI_Recorder_for_ASIO_Audio_setup_5.7.0.0.exe

The audio recorder tool is depicted in the following picture.




It has been improved from the previous version by adding the possibility of recording several stereo audio tracks at the same time. The recorder is currently limited, mainly for performance reasons, to 8 stereo tracks, that is, 16 mono channels. The recorder interface shows the input audio signals as well as the number of recorded audio buffers per second.

The options panel allows the experimenter to set the audio recorder ID and the input audio tracks to be recoded.

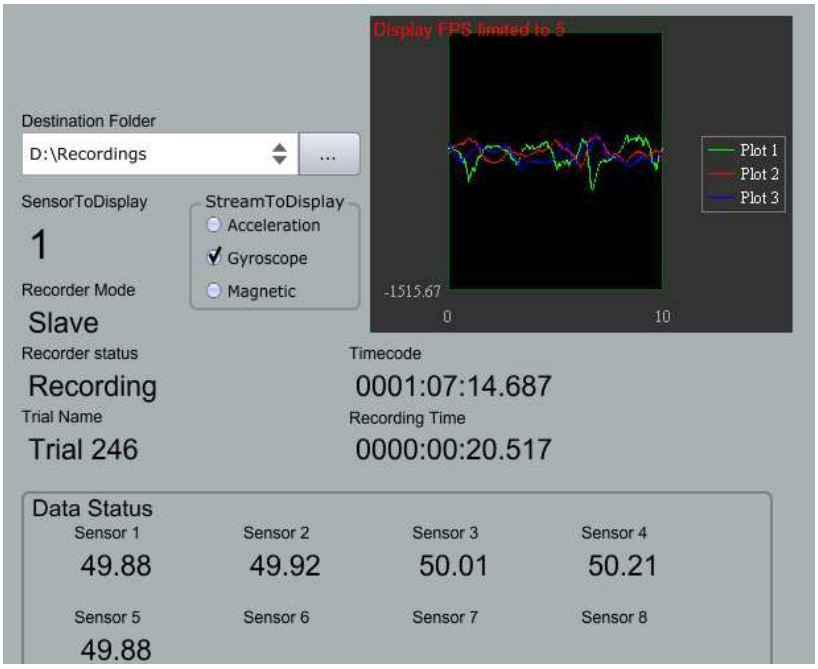



## 2.6 IMU recorder

Download:

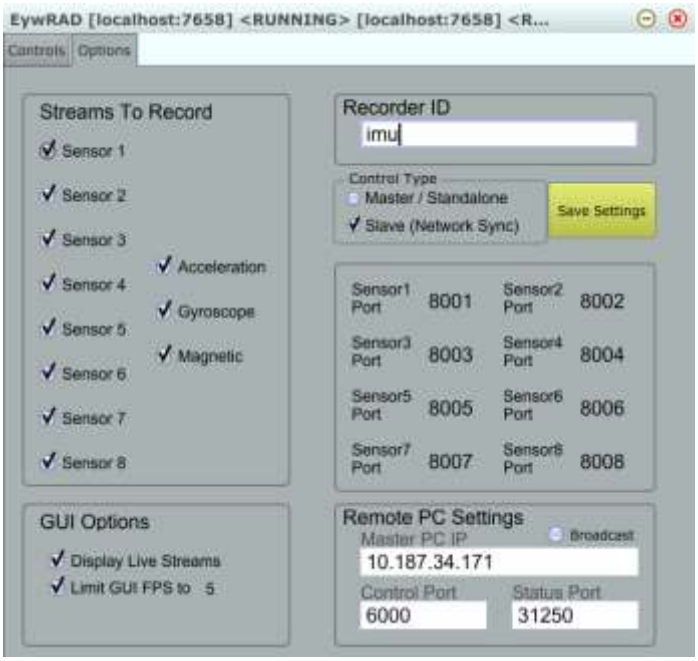
http://dance.dibris.unige.it/user_files/DANCE_Platform/release_december_2016/Eyesweb_XMI_Recorder_for_xosc_imu_setup_5.7.0.0.exe

The *IMU recorder* tool is depicted in the following picture.




The graph shows the values selected by the user (acceleration, gyroscope, or compass) for each of the four IMUs. In the lower left you may read the current framerate of each of the four sensors (49.95 samples per second). Below the graph you may see both the trial name and the reference clock.

The data is saved by the recording tool in txt files, in a format which is easy to be read by external software (e.g., Matlab), and can be of course read by EyesWeb itself for playback or analysis purposes. The options panel allows you to configure the working mode of the recorder.

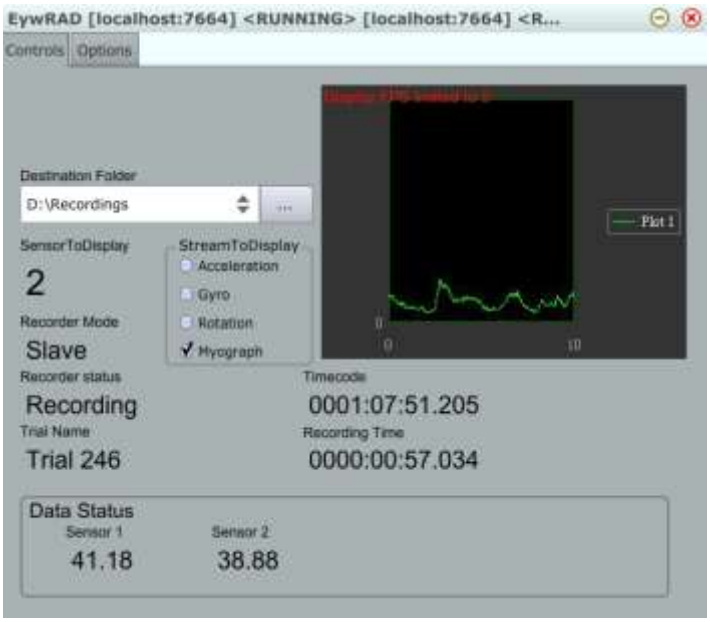



## 2.7 Myo recorder

Download:

http://dance.dibris.unige.it/user_files/DANCE_Platform/release_december_2016/Eyesweb_XMI_Recorder_for_myo_sensor_setup_5.7.0.0.exe

This tool has been added during the second year of DANCE. It allows to record data coming from 2 Myo sensors at about 40 fps. The data consists of muscle contraction (1 value between 0 and 1), acceleration, gyroscope and rotation (yaw, pitch, roll).




## 2.8 Playback and analysis tools

We provide 2 tools along with the DANCE Platform version 2:

- a data playback tool

- a quality of movement extraction tool

You can download and install them from here:
http://dance.dibris.unige.it/user_files/DANCE_Platform/release_december_2016/Eyesweb_XMI_DANCE_Platform_Tools_setup_5.7.0.0.exe

The installer contains sample data consisting in 2 trials recorded in DANCE during the months of January and February 2017. Both trials consists of multimodal data coming from Inertial Movement Units (accelerometers), Electromyographic sensors, video cameras and microphone. Each trial focuses on a single movement quality in the set of movement qualities identified by the UNIGE partner in collaboration with the choreographer V. Sieni. See Deliverable 2.2 for more details.

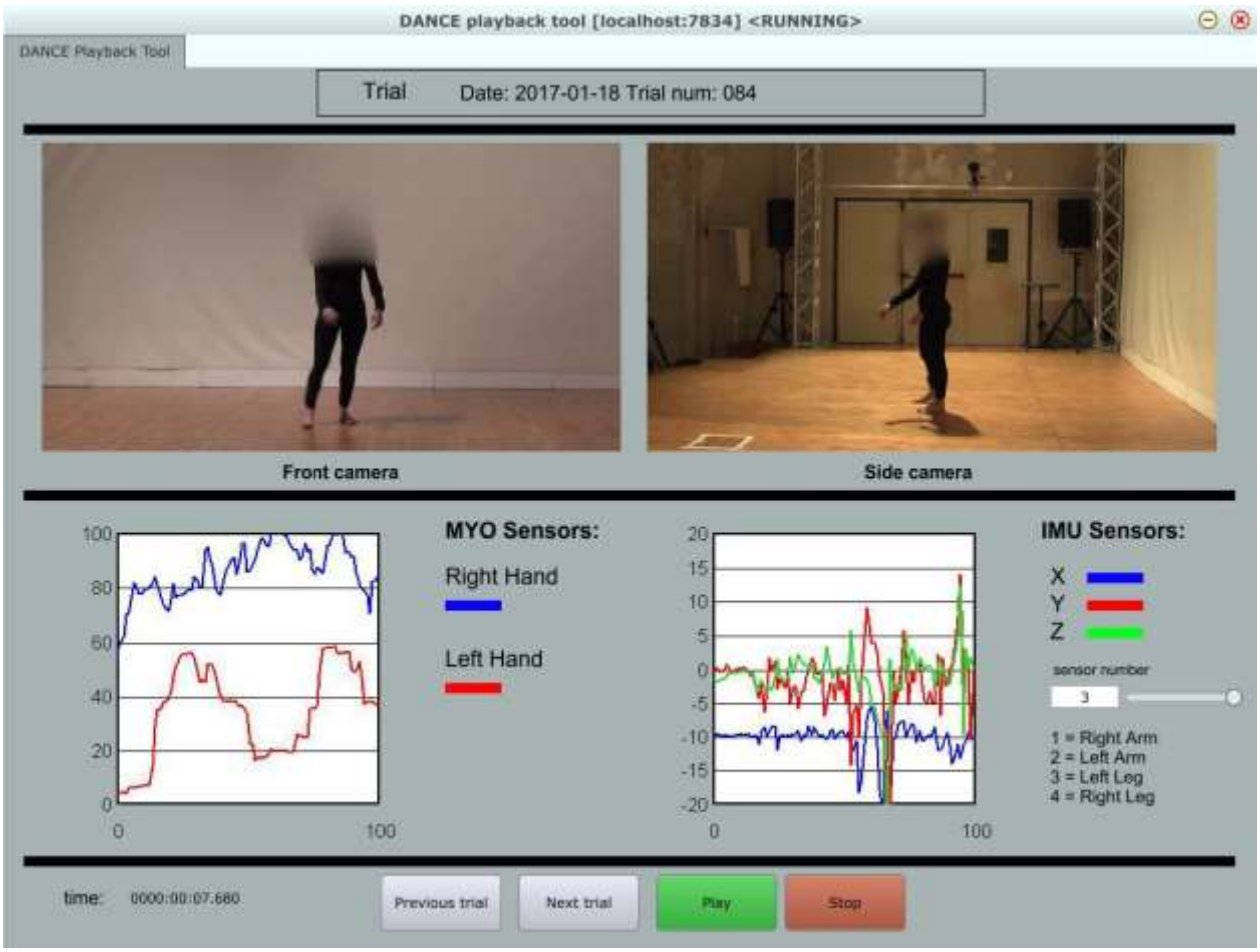
The 2 trials are:

- Trial 84: a dancer performing "fragile" movements (i.e., a sequence of non-rhythmical upper body cracks or leg releases; movements on the boundary between balance and fall, time cuts followed by a movement re-planning; the resulting movement is non-predictable, interrupted, uncertain)
- Trial 246: a dancer performing "light" movements (i.e., fluid movement together with a lack of vertical acceleration, mainly toward the floor, in particular of forearms and knees; for each vertical downward movement there is an opposite harmonic counterbalancing upward movement, simultaneous or consequent; there can be a convertion of gravity into movement on the horizontal plane using rotations and a spread of gravity on the horizontal dimension)

For a detailed description of the above and other movement qualities please refer to Deliverable 2.2.

### Playback

The tool window is depicted below:



The trial name is reported on top of the window. In the upper part of the window, the video streams are played back. In the lower part of the window, the EMG (on the left) and intertial data (on the right )is displayed in a time window of 100 samples. ON the bottom, there are buttons to move between the trials and start/stop the playback. The tool is automatically installed in the EyesWeb XMI folder, for example in `"C:\Program Files (x86)\EyesWeb XMI 5.7.0.0\DANCE_Platform_Tools"`.

The installer installs 2 example trials in the subfolders `"2017-01-18"` and `"2017-02-01"`. If more trials are found they are automatically added to the playback tool. Once started, the tools also sends the inertial sensors data through OSC messages. This data can be received by other software modules (for example, the movement features extraction tool, see below and Deliverable 2.2) to be analyzed.

### Quality extraction

In the DANCE project we aim to innovate the state of art on the automated analysis of the expressive movement. We consider movement as a communication channel allowing humans to express and perceive implicit high-level messages, such as emotional states, social bonds, and so on. That is, we are not interested in physical space occupation or movement direction per se, or in "functional" physical movements: our interest is on the implications at the expressive level. For example: a hand movement direction to the left or to the right may be irrelevant, instead the level of fluidity or impulsiveness of such movement might be relevant.

In D2.2. and [1] we propose a Multi-Layered Computational Framework of Qualities consisting of several layers, ranging from physical signals to high-level qualities and addresses several aspects of movement analysis with different spatial and temporal scales. The features computed at lower layers, contribute to the computation of the features at higher levels, which are usually related to more abstract concepts. In more details, within the framework, the movement quality analysis organized on four levels:

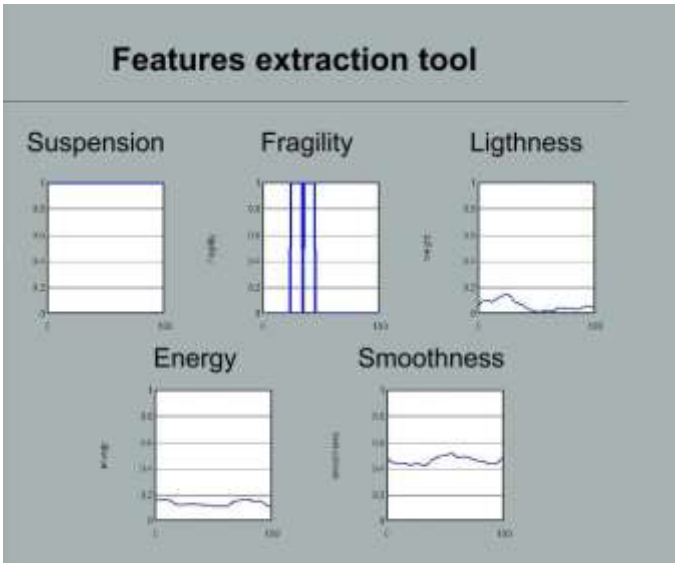
- **points: physical data** that can be detected by exploiting sensors in real-time (for example, position/orientation of the body planes)
- **frames: physical and sensorial data**, not subject to interpretation, detected uniquely starting from instantaneous physical data on the shortest time span needed for their definition and depending on the characteristics of the human sensorial channels
- **qualities: perceptual features, interpretable and predictable**, with a given error and correction, starting from different constellations of physical and sensory data from level 2, on the time span needed for their perception (for example, lightness is perceived as a delay on the horizontal plane or as a balance between vertical upward/downward pushes)
- **affects: perceptual and contextual features, interpretable and predictable**, with a given error and correction, starting from a narration of different qualities, on a large time span needed for their introjection (for example, tension created by a pressing sequence of movement cracks/releases or by a sudden break of lightness).

Along with the DANCE Platform version 2 we provide a quality of movement extraction tool capable of analyzing pre-recorded multimodal data and to extract a number of features and qualities including the following ones:

- *Suspension*: it is a non-directional retention of energy on one of the body planes. The body or some parts of it may waving or rippling, the movement are of high predictability. We detect it by checking whether the maximum of the energy is retained over a period of time on one body plan.
- *Fragility*: it is a sequence of non-rhythmical upper body cracks or sudden and short leg releases. It emerges for example when moving at the boundary between balance and fall, resulting in short movements with continuous interruption of motor plans. The resulting movement is non-predictable, interrupted. We detect irregular sequences of upper body cracks or leg releases in 1s time window as default, following experimental results.
- *Lightness*: this quality is related to the Laban's Weight quality (for details, see: Rudolf Laban and Frederick C. Lawrence. 1947: Effort. Macdonald & Evans.) It is computed by extracting the Energy vertical component

normalized to the overall amount of Energy in the movement. Recent refinements include other aspects including horizontal gravity, and body mass fall compensation.

- *Kinectic Energy* of a moving (part of) body, KE = 1/2*mass*velocity
- *Smoothness*: it is defined as the inverse of the third derivative of position




*[1] Camurri, A., Volpe, G., Piana, S., Mancini, M., Niewiadomski, R., Ferrari, N., & Canepa, C. (2016, July). The dancer in the eye: towards a multi-layered computational framework of qualities in movement. In Proceedings of the 3rd International Symposium on Movement and Computing (p. 6). ACM.*