Biologically-driven musical instrument

Team 3

Final presentation

Our objectives

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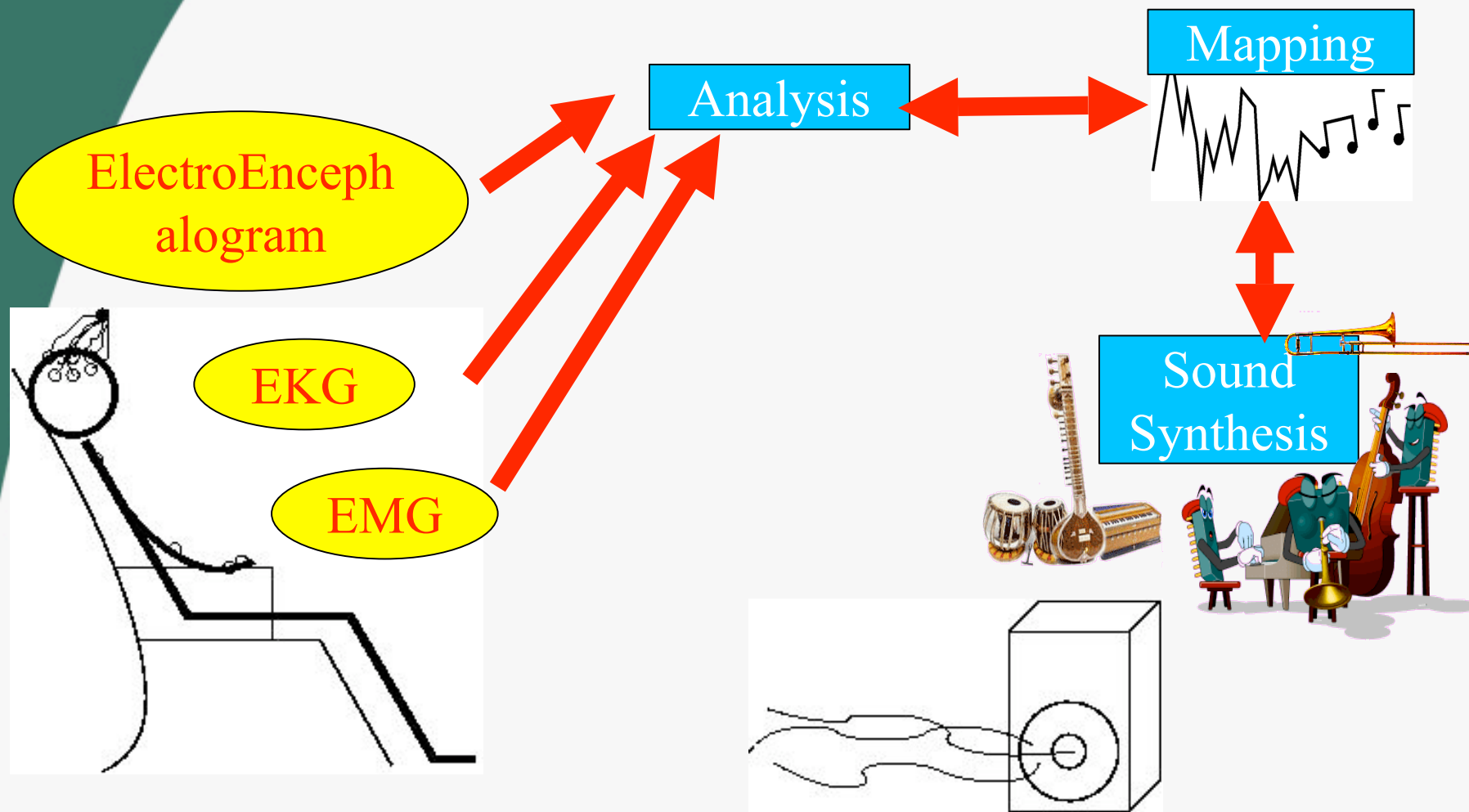
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System Architecture

EEG Recording-Training

- EEG recording is time consuming
  - Setting up the cap takes 30 min
  - The cap is not very comfortable

- Training is important for EEG control
  - The user needs to be calm with little noise surrounding
  - Stress/fatigue/concentration have influence
  - Julien gained experience!

- Tasks detected
  - No imagination but real movements
    - Þ Left and right hand movements
    - Þ Detection of the state of the eyes (closed/open)

EEG Analysis

- Wavelet Transform

    – Time-frequency analysis

    Þ EEG decomposed into frequency subbands corresponding to different rythm (alpha,mu,beta…)

    - **Asymmetry ratio**

$$\Gamma_{BP} = \frac{(NWP_{C3,mu} - NWP_{C4,mu})}{(NWP_{C3,mu} + NWP_{C4,mu})}$$

Drawback : only two electrodes at a time
=>Use of spatial analysis

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Common Spatial Subspace Decomposition(CSSD)

- – Calculation over all the electrodes
- – Recognition of specific states
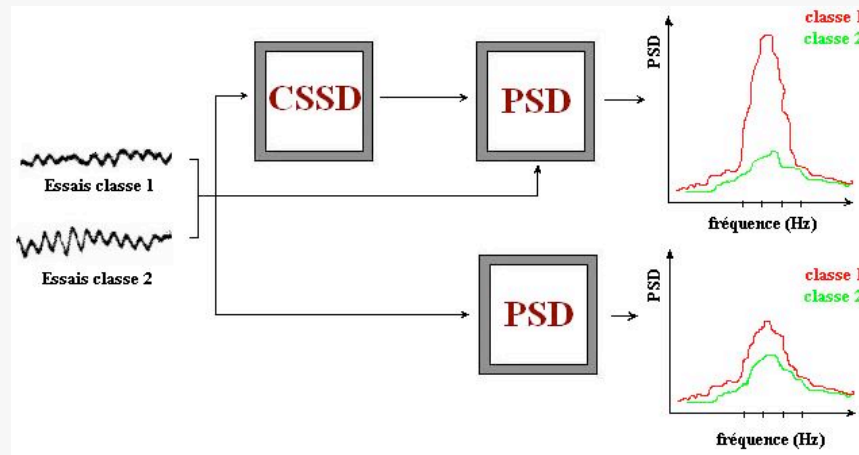
- – Drawbacks : Learning phase required to build spatial filters and spatial factors
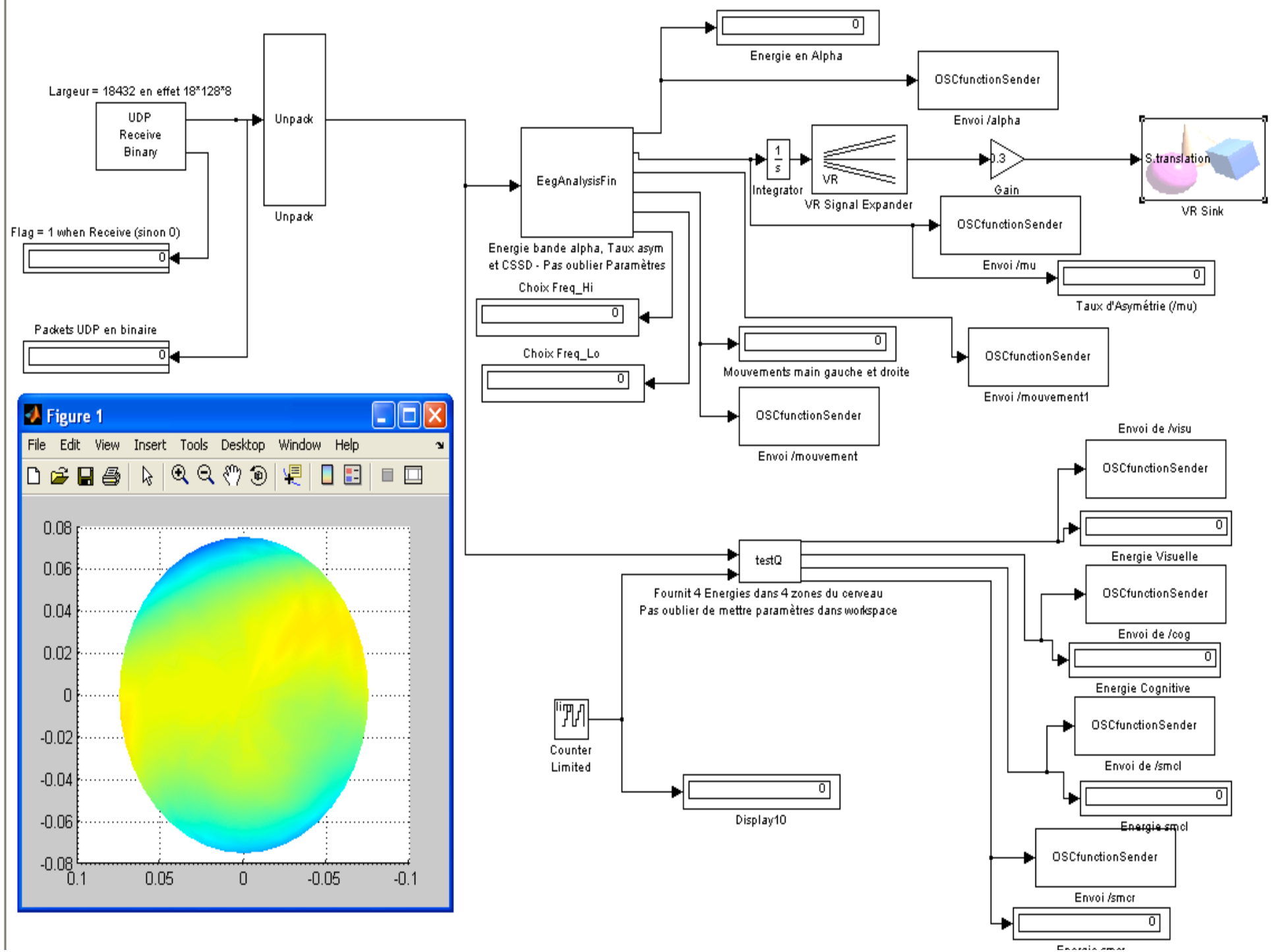
Data Transfer

- Softwares
  - Biodata acquisition -> *Medical Studio* (Linux)
  - Biodata analysis -> *Matlab* (Linux)
  - Sound synthesis -> *Max/MSP* (Mac OSX)

- Data exchange

  = real-time communication between **Matlab** to **Max/MSP** via **OSC (Open Sound Control)** protocol.

    => reusable in numerous other projects

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Musical synthesis

- Three instruments :
  - Instrument 1 : Midi instrument (sound synthesis with Absynth VST-plugin) driven by EEG analysis and infrared sensor.

  - Instrument 2 : granularization/processing of accordion samples, driven by EMG data.

  - Instrument 3 : sound spatialization and visual feedback driven by EEG data.

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EEG-driven Instrument

DATA EEG
UDP/OSC

Alpha Bandwith

Mu Bandwith

Alpha < 0.5
(while moving)

Alpha > 2
(eyes shut)

1 : Right body part movement
-1 : Left body part movement

Triggering of notes corresponding to Alpha value

Beginning of a 7 notes cycle

Rotation direction

Pan

VST
Virtual instrument

Resonant Filter

Cycle speed

Switch

Infrared DATA Sensor
MIDI

Distance

MIDI Events

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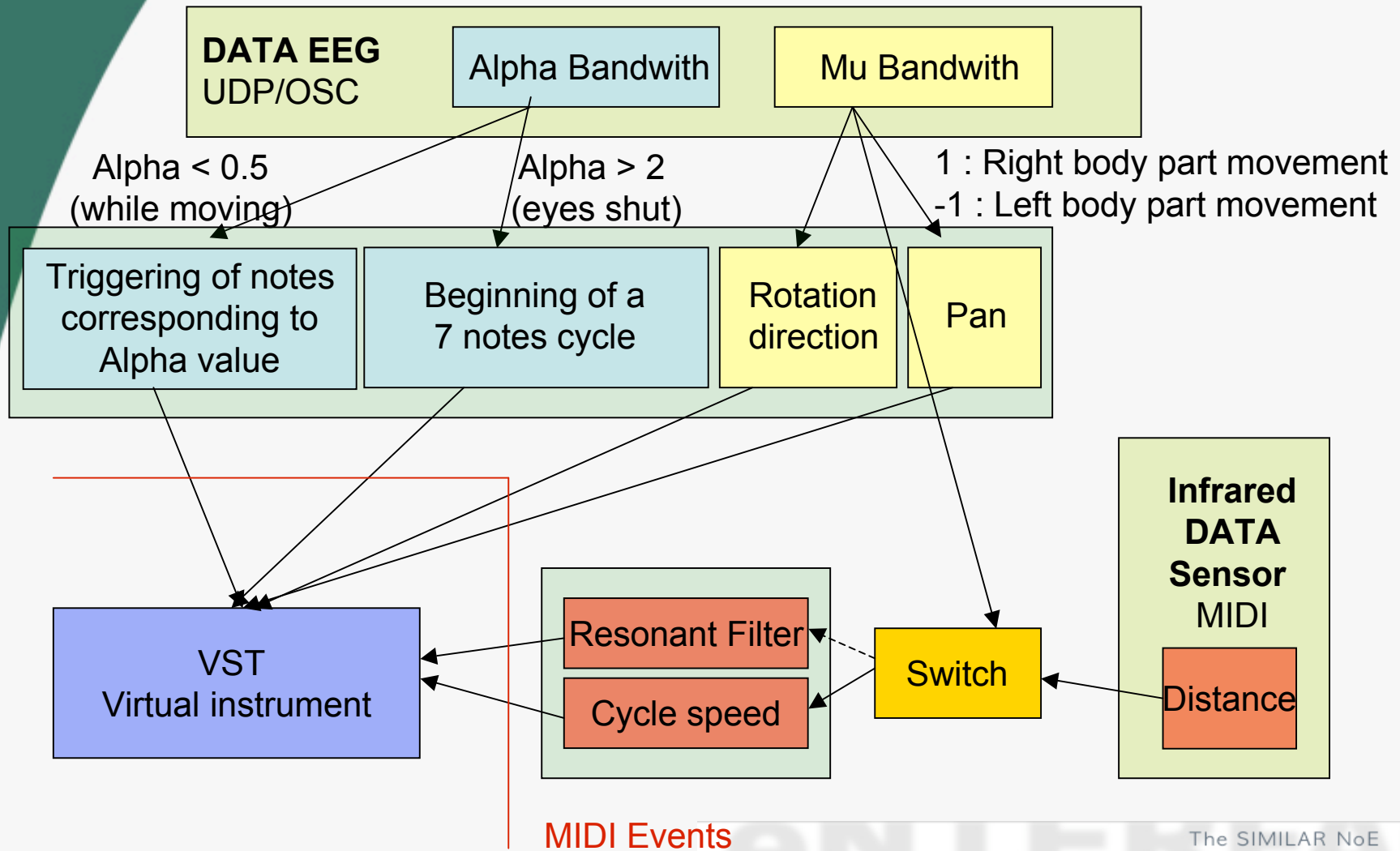
EMG-driven instrument

- Granularization and filtering of accordion samples

- Driven by EMG data :
  - Contraction of right/left arm muscles to modulate sound synthesis parameters
  - Only two control parameters
  - Expressive gestures

- Additional MIDI controller to extend possibilities for live musical interpretation

Sound spatialization

- Spatialisation parameters :
  - Azimuth : angular distance
  - Distance : simulated distance from the listener relative to speaker
  - Delta time : time to transition to given azimuth
  - Reverberation
  - Intensity

- Real-time spatial effects by controlling these parameters from EEG analysis

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Project evaluation

- Knowledge acquired
  - Hardware knowledge
  - Signal recording and analysis experience
  - « Digital lutherie »
  - Team working
  - Skills mixing (biological signal processing/sound synthesis)

- Troubles
  - User training
  - Some misunderstanding between specialists of two very differents fields (biological signal processing/sound synthesis)

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Future...

- Biodata analysis
    - Better user training
    - Using imagination of movement than movement itself

- Sound synthesis
    - Enhancement on sound processing, mapping and visual feedback
    - Need practice for instrument appropriation (like traditional musical instruments learning)
    - Loop biodata <=> music ?

- Publications ?
    - NIME '06 (New Interface for Musical Expression)
    - Enterface '06 ?

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Thanks for your attention !!!

Enterface '05 Team

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