

COST-287 STSM Report

Host Institution: Bielefeld University, Germany (Faculty of Technology – Neuroinformatics Group)

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Duration: 31.03.04 –18.04.04

Purpose of the meeting

The aim of my mission was to meet Dr. Thomas Hermann and the Neuroinformatics Group at Bielefeld University in Germany, in order to compare and bring together two gestural control systems –one for sonification/scientific exploration and the other for musical/artistic purposes. The first is a multi-modal system for navigation in a high-dimensional parameter space of a sonified EEG data-set. The second is a multi-modal system for the control of a high-dimensional digital audio effect.

Objectives

We believe, that the transfer of techniques and strategies from one research area to the other – related to multi-modal system architectures, I/O devices (computer vision), gesture definition, complex mappings, real-time audio synthesis & processing and control feedback – seems to have great potential for the further development of both sides.

The NEO environment developed by the Neuroinformatics Group at Bielefeld University can contribute to the analysis of data distributions related to the Reverb Control System; possible observation of clusterings may reveal obscure data regularities and structures in the feature space. This may denote the need for less controlling gestures or/and effect control parameters to be used for the same intended musical result.

On the other hand, the approach for hand-gestural control taken in the case of the Reverb Control System (gloves-motion tracking-Eyesweb) can be used and also give inspiration for an alternative way of data mining and exploration used in the case of a sonification system.

The goal we set at the beginning of this STSM was to develop a common multi-modal environment for gestural data exploration on the one hand and navigation in a sonified EEG data-set on the other.

This is how the work was carried out in practice.

Working diary

- *Wednesday, 31st March, 2004:* Travel to Bielefeld and meeting with Dr. Thomas Hermann.
- *Thursday, 1st April, 2004:* Meeting with the whole Neuroinformatics Group and the head of the department, Prof. Dr. Helge Ritter. I also had the possibility to visit some of the laboratories and facilities and discuss about projects the group is involved with. It gave me also a first taste of the very close and effective collaboration between the different groups of the Faculty of Technology. I was integrated into the iLab group very quickly.
- *Friday, 2nd April, 2004:* Agreement on working plan with Dr. Thomas Hermann and discussion of some sonification, data-mining and parameter reduction issues related to the collaboration system. As we come

from two different research areas, there was a need for a “common language”. We made an outline of the multi-modal system architecture we should succeed in developing in the available period of time.

- *Monday and Tuesday, 5th and 6th April, 2004:* Setup of the gestural control system and connection to the department’s network over OSC (Open Sound Control). Problems with the Windows operating system (running Eyesweb) caused some delay in our working plans.
- *Wednesday, 7th April, 2004:* Presentations of other group members’ running projects related to multi-modal systems and gestural control input devices and approaches for scientific data exploration. I had the chance to visit some extremely interesting laboratories and have a glance over and even try out ongoing projects, such as the GREFIT Handbox (Visual Recognition of Hand Postures) and GRAVIS (Gestural Recognition Active Vision) – Frank Roethling— and also talk about computer vision problems related to lighting conditions with Christian Lange.
- *Thursday, 8th April, 2004:* Presentation of my system to the whole workgroup – discussions and ideas, especially in the direction of computer vision. On the same day Dr. Thomas Hermann wrote an “add-on” for NEO (running under Linux) in order to enable for OSC communication with the other units of the multi-modal system.
- *Friday, 9th April, 2004:* Easter holiday, change of accommodation.
- *Monday, 12th April, 2004:* Easter holiday again for the university staff members. However, I worked with the NEO graphical programming simulation environment, in order to get familiar with it and the way we would collect and analyze the data received from my gestural control system.
- *Tuesday, 13th April, 2004:* Creation of the patch/circuits for data mapping, collection and scatter plotting in NEO. We succeeded in setting up the multi-modal system for the digital audio effect control: gestural input in Eyesweb / data mapping, collection, plotting & exploration in NEO / audio parameter mapping, processing and output in PD. The three modules could now communicate through the network over OSC.
- *Wednesday, 14th April, 2004:* Data collection of specific gestures. We recorded a series of videos that correspond to particular gestures/performances used for the control of the freeverb effect with real-time audio and visual feedback. The corresponding high-dimensional data-sets for (a) the high-level gestures (mapped to the low ones) and (b) the low-level motion parameters extracted by Eyesweb were then collected, merged and scatter plotted in 3D-graphs. At a next step we applied in NEO a PCA (Principal Component Analysis) on these data-sets and observed the new resulting scatter plots (high- and low-level gestures and principle components) and the PCA eigenvalues.
- *Thursday, 15th April, 2004:* Setup of and experimentation with the multi-modal system for navigation in the high-dimensional data representation of an EEG. We made again use of the coloured gloves and Eyesweb in order to navigate in the sonified high-dimensional parameter space of an EEG data-set collected by Dr. Hermann. We used PD in order to move in the recorded sound file in a meaningful for this purpose way.
- *Friday, 16th April, 2004:* Collection of output data and discussion on results and future possibilities.

Main Results

Some of the scatter plots of both the high-level and low-level gestural parameters tend to occupy clustered regions, which reveal the existence of dependencies between them. The results of the Principal Component Analysis for the high-level features show that the controls vary mainly along a smaller number of orthogonal independent directions (3). The corresponding PCA of the low-level gestural control feature space suggests again that only three components are independent. Reduction of data dimensionality corresponds to the use of and navigation in only a sub-dimensional manifold parameter space. From this, we may expect that the user could practically stimulate the same result with just three expressive gestures and less cognitive-load. The independent components we are extracting through this procedure are still to be found and it is also unclear whether these will be indeed more intuitive and less cognition-demanding for the user.

Although this result was expected to some extent because of the simple gestural control (basic hand gestures, without taking into account limitations/dependencies introduced between fingers), the strategy and methodology seem to have good potential for the exploration and evaluation of the effectiveness of any used gestures. A scientific publication on the outcomes may soon follow.

At the end of the STSM we agreed that the STSM was beneficial for both of us. For me, it was first of all an extremely useful and stimulating experience to work in such a lively and inspiring environment, where the different laboratories collaborate in such an effective way in common projects. It also gave me the chance to analyse and explore the gestural data I am extracting through my input-device. Unfortunately, the duration of 18 days (weekends inclusive) seem to be quite short for achieving safe and meaningful enough conclusions.

In any case they have now formed the basis for possible further collaboration with the Neuroinformatics Group in Bielefeld. The use of Eyesweb as a gestural input environment for sonification purposes on the one hand and NEO as a data analysis environment for musical purposes on the other hand are some first benefits I can see coming out through this common work. Additionally, a common publication is perhaps to be considered.