COST 287 – STSM – Scientific report

Host institution

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Mission period

May 24th – June 10th 2007

Purpose of the visit

The relevance of mixing sensors acquisition and video analysis for studying bow gestures of violinists have been shown during previous collaborations (Frédéric Bevillacqua and Nicolas Rasamimanana's stay at IDMIL [1] and Erwin Schoonderwaldt's stay at IRCAM [2]). This STSM aimed at combining sensors used at Ircam to study some features of violinist's control on its instrument (accelerometers [3], bow pressure sensor [4]) and setup dedicated to motion capture that IDMIL laboratory applies to study musical gestures. The main purpose of this work consisted in developing a complete and practical setup dedicated to playing parameters acquisition. Additionally, the setup had to be tested in order to get a large set of data related to bowing techniques. Another purpose consisted in combining the bow position that can be deduced from the motion capture device and the signal given by the custom bow pressure sensor, so as to increase the accuracy of the sensor. Some tests had to be done to validate a calibration procedure depending on bow position and its application to the measurement of bow pressure during real performance.

Description of work carried out

The first week was dedicated to the preparation of the recording sessions. The first step consisted in finalizing the bow pressure sensor that had been previously prepared for the experiment. It had mainly to be adapted to the bow that would be used by the violinist. Its

calibration required special care. The force transducer on which the bow presses during this operation had to be prepared: connection, electronic treatment of the signal and building of the metal piece that is fixed on its force introduction thread and on which the bow presses. Some tests dedicated to the calibration of the bow pressure sensor have led to the definition of the calibration procedure that has to be used during the recording sessions. Finally, some preliminary experiments have been done in order to study the influence of different factors that can harm the measurement accuracy (tilting of the bow, bow angle, variation of bow-hair tension).
At the same time, we had to choose a way to acquire the sensors signals and to synchronize them with motion capture data. The laboratory offered different possibilities that have been tested and compared, mainly concerning the noise signal ratio and the practical aspect of the synchronisation. Finally, a National Instrument card has been chosen, the synchronisation being done using an extra synchronisation signal sent both to the National Instrument card and the Vicon card.
Concerning motion capture it was first necessary to decide where to place the markers on the bow and the violin. Based on the marker positions template models were developed in Vicon of the bow and the violin. The models are necessary for identification of the markers (labelling) and facilitate gap filling using a kinematical model in the Vicon software. The models are also used to reconstruct the position of virtual markers on the bridge, the nut, the frog and the tip, where it would be difficult to place physical markers. Finally, the models make it possible to calculate both the position and the orientation (6 DOF) of the bow.
A first recording session on June 5th permitted to test the complete measurement setup and the acquisition protocol. Finally, on June 7th, an advanced violin player was invited for the final session. The experiment focused on the achievement of similar bow strokes using different dynamics and/or different bowing techniques. He was asked to play different bow strokes such as *detaches*, *martelés*, tremolos, with different accentuations or articulations. Then he had to perform musical examples that use the same kind of bowing gesture in order not to stay in a purely technical field and place them in a musical context.
Finally, the last days where dedicated to discussions about the post-treatment of data and the coordination of our respective works on them.

Main results

The purpose of the STSM consisted in collecting a large set of gesture data to work with. The combination of motion capture and sensors data permits to obtain a very complete and accurate description of violinist's bowing parameters during real performance. Motion capture allows measurements of gesture components that can't be easily acquired with sensors, such as bow speed. On the other hand, accelerometers have been used to complete these measurements and to offer the possibility of examining more accurate data when needed (for instance during attacks or transitions between two notes). Finally, the use of bow position measured with the Vicon system permits to deduce bow pressure at the bowing point from the bow pressure sensor with a good accuracy.
During this STSM, we have putted down the bases for the development of an "easy to use" and "comfortable" setup dedicated to the measurement of bowing parameters. Since Erwin Schoonderwaldt, with whom this STSM work has been done, is staying at IDMIL laboratory until the end of the year, it will be possible to improve again the system and make additional recordings.

Projected publications

The description of the setup and the method used to reconstruct bowing parameters from motion capture raw data should lead soon to a publication. This one will focus on the combination of motion capture and sensors data to get accurate measurements of a large set of these bowing parameters.
The analysis of collected data should lead to other publications that still have to be discussed.

[1] N. Rasamimanana, D. Bernardin, M. Wanderley, F. Bevilacqua, (**2007**) "String Bowing Gestures at Varying Bow Stroke Frequencies: A Case Study (abstract)", *Proceedings of the 7th International Wokshop on Gesture in Human-Computer Interaction and Simulation, Lisbon, Portugal.*

[2] Schoonderwaldt, E; Rasamimanana, N.; Bevilacqua F. ,(**2006**), "Combining accelerometer and video camera: reconstruction of bow velocity profiles", *Proc. Of the 2006 Intern. Conf. on New Interfaces for Musical Expression*, pp. 200-203

[3] F. Bevilacqua, N. H. Rasamimanana, E. Fl ety, S. Lemouton, and F. Baschet (**2006**). The augmented violin project: research, composition and performance report. In NIME Proceedings, pages 402–406, 2006.

[4] Demoucron, M.; Askenfelt, A.; Caussé, R. (**2006**), "Mesure de la 'Pression d'Archet' des Instruments à Cordes Frottées, Application à la Synthèse sonore"**,** *8ème Congrès Français d'Acoustique,* pp. 475-478