

STSM – Scientific report

Applicant

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Period

January 9-25, 2006 (2 ½ weeks)
June 5-16, 2006 (2 weeks)

Purpose of the visit

The purpose of the short-term scientific mission (STSM) was to exchange ideas and share facilities between the *Augmented violin project* at IRCAM and the *Bostran project* at KTH. Both projects concern gestural control in violin playing. The aims were to further improve and develop methods for measuring bowing gestures in violin playing. Also a pilot experiment was planned for studying the co-ordination of bowing parameters in violin playing. The STSM was considered as a first step, leading to further co-operation between the involved groups in the future.

The STSM was subdivided in two parts. During both visits I was supervised by Frédéric Bevilacqua and worked together with Nicolas Rasamimanana and Matthias Demoucron, PhD students involved in the Augmented violin project.

Description of the work carried out during the visit

Period I

During the first week we discussed different alternatives for measuring bowing parameters in violin playing. The important parameters to be measured are: bow acceleration, bow velocity, normal force exerted by the bow on the string and the bow-bridge distance. The co-ordination of these parameters plays an important role in tone production on the violin.

The current augmented bow prototype is equipped with accelerometers for measuring bow acceleration. For measuring bow position (and velocity) electromagnetic field sensing is used, but it has proven difficult to obtain precise results with this technique. Currently, a sensor system for measuring bow force is under development at IRCAM. The

combined techniques will lead to a complete system for measuring all above mentioned bowing parameters.

As an alternative for measuring bow position (and velocity), we discussed the possibility of point tracking, using a normal video camera. With a smart setup it would be possible to obtain measures on both bow-bridge distance and bow position. We performed a simple test measurement to see how we could use video data for capturing bowing parameters. Eyesweb software was used to process the video data.

In the second week we developed a method for reconstruction of bow velocity by combining accelerometer and video data. The video data was used to detect the moments when the bow changes direction. At these moments the bow velocity is known to be zero. The bow changes were used as break-points for piece-wise integration of the accelerometer signal. At the break-points the integral is reset to zero and the trend is subtracted for each individual segment.

At the end of the second week, we performed a more elaborate pilot experiment with a professional viola player as subject. During the experiment we recorded simultaneously the acceleration of the bow and video. For the point tracking we marked two points on the bow and two points on the violin. The 2D projection can then be used to measure both bow position (for the detection of changes in bowing direction) and bow-bridge distance. The player was asked to play tones of different quality (intense and weak) at roughly three different distances from the bridge. It is hoped that the experiment will shed more light on how the player adapts bow velocity (during the steady part of the tones) and bow acceleration (during the transients) according to the different circumstances.

In the third week we started working on an evaluation of the velocity reconstruction method. For the evaluation we used motion capturing data, recorded earlier for another purpose. During this occasion a Vicon MX motion capturing system was used for tracking points in 3D with high precision, simultaneously with bow acceleration using the augmented bow. The motion capturing data provided an exact reference of bowing velocity. For honest comparison with the video data, a 2D projection of the motion capturing data was used for the velocity reconstruction method.

At the last day of my stay I had the opportunity to hold a seminar, giving an overview of the research at TMH-KTH, presenting some of my earlier research and sharing some ideas about future research on the bowed string.

Period II

The beginning of the second period of this STSM coincided with the NIME06 conference, organized by IRCAM. During the conference we presented a poster in the ConGAS session, presenting part of the work done during the first part of the STSM (see publications). Also the special session on digital interfaces for the violin family was of particular interest for my studies.

During the second week the video from the pilot experiment from January was further analyzed, providing a transcription of the discussions and a detailed description of the measurements.

In the period between the two visits, Matthias Demoucron has been further developing the bow force sensor. We developed and tested a set-up for synchronous recording of bow acceleration (augmented bow), sound, video tracking and measurement of bow force. This set-up is an important step towards the synchronous measurement of the main bowing parameters, enabling a detailed study of co-ordination of bowing parameters in violin playing.

Main results

The work done during the visit has led to a new method for reconstruction of bow velocity from an accelerometer using video processing (see *Description of the work*).

The pilot experiment performed in January resulted in a set of data, which can be used to study the co-ordination of bowing parameters by a professional viola player.

Furthermore, a set-up was tested for synchronous measurement of bow acceleration, sound, video and bow force.

Publications

Schoonderwaldt, E., Rasamimanana, N. & Bevilacqua, F., Combining accelerometer and video camera: Reconstruction of bow velocity profiles. *In Proceedings of the 2006 International Conference on New Interfaces for Musical Expression (NIME06)*, IRCAM – Centre Pompidou, Paris, France, 2006, pp. 200-203.

Future collaboration

There will be further visits and exchanges between the involved groups. Matthias Demoucron will visit Stockholm this autumn to further develop and calibrate the bow force sensing system. An experiment for measuring bow co-ordination during violin playing, making use of the *Augmented violin* is planned to be part of Erwin Schoonderwaldts PhD studies.