Appendix A: Detailed Work Plan

The aim of the visit is to exchange ideas and share facilities between the *Augmented violin project* at IRCAM and the *Bostran project* at KTH. Both projects focus on gestural control in violin playing. During the visit I will be supervised by Prof. Frédéric Bevilacqua and co-operate with Nicolas Rasamimanana and Matthias Demoucron, PhD students involved in the Augmented violin project.

The *Augmented violin project* is part of an interdisciplinary research project involving composers, performers, musical assistants and scientific researchers on gesture in music. Specifically, this project is centred on the use of an "augmented violin", i.e. a normal acoustic violin with added gesture capture technology integrated on the bow. The general aim is to provide musicians with novel opportunities for mixed acoustic/electronic music.

The *Bostran project* (The bowed string – bow motion analysis and influence of bow properties) is a research project, financed by the Swedish research council. The aim of this project is to map the combinations of bowing parameters (bow speed/acceleration, bow-bridge distance and normal force exerted on the string) available to the violinist for tone production. This is done by systematic exploration of the parameter space, using a computer-controlled bowing machine. In the second stage of the project, it will be studied how violinists co-ordinate these bowing parameters in producing tones of different quality, and different kinds of bowing techniques. Finally, the results will be used to develop pedagogical applications for violin teaching.

During the visit we will work on three different aspects:

1. *Further development of the augmented violin*. The gesture capturing system of the current prototype can still be improved, especially concerning the measurement of bow force. Measurement of bow force is a challenging issue, and several attempts have been made to achieve this. Askenfelt developed a method for measuring bow force from the strain of the bow hair both at the tip and the frog (Askenfelt 1986, 1989). Another technique was applied in the Hyperbow, where the bow force was derived from the bending of the middle of the stick (Young, 2002). We will discuss the different alternatives, decide on which technique will be most suitable for the augmented violin and work on the implementation. This work will already be initiated this autumn, during another exchange visit between the two institutions.
2. *Development of a calibration and assessment procedure of the augmented violin, using the bowing machine at KTH*. The bowing machine can be used to perform bow strokes with known speed and force envelopes. This makes the bowing machine an ideal test bench for the gesture capturing techniques of the augmented violin under dynamic operation. During the visit we will develop a set of representative bow strokes for calibration and assessment of the augmented violin.
3. *Pilot experiment*. I will conduct a pilot experiment using the augmented violin, to measure bow force and acceleration during attacks in real violin playing. At least three violinists will participate in the experiment, of whom at least one expert performer.
   As found in earlier studies, the quality of the attack (beginning of the tone) is very sensitive to bow force and acceleration (Guettler, 2002). Bowed-string simulations have established a relation between bow force and acceleration leading to fast development of Helmholtz motion (regular stick-slip motion of the string at the bowing point). This

relation can be visualized in so-called Guettler diagrams. The pilot experiment will hopefully shed more light on the strategies of violinists to obtain good attacks, and how they are related to the Guettler diagrams. The pilot experiment will be important for the progress of my PhD studies.

References

The augmented violin:
http://recherche.ircam.fr/equipes/temps-reel/movement/projects/augmented violin.html

Bostran:
http://www.kth.se/forskning/pocket/project.asp?id=7681

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