University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Doctor of Philosophy

of

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MSCS (California State University Chico, 2000)
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"HUMAN-INFORMED ROBOTIC PERCUSSION RENDERINGS: Acquisition, Analysis, and Rendering of Percussion Performances Using Stochastic Models and Robotics"

Department of Computer Science

Monday, December 10, 2018
10:00 A.M.
Clearihue Building
Room B007

Supervisory Committee:
Dr. George Tzanetakis, Department of Computer Science, University of Victoria (Co-Supervisor)
Dr. Andrew Schloss, School of Music, UVic (Co-Supervisor)
Dr. Peter Driessen, Department of Electrical and Computer Engineering, UVic (Outside Member)

External Examiner:
Dr. Marcelo Wanderley, Music Research, McGill University

Chair of Oral Examination:
Dr. Keivan Ahmadi, Department of Mechanical Engineering, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

A percussion performance by a skilled musician will often extend beyond a written score in terms of expressiveness. This assertion is clearly evident when comparing a human performance with one that has been rendered by some form of automaton that expressly follows a transcription. Although music notation enforces a significant set of constraints, it is the responsibility of the performer to interpret the piece and “bring it to life” in the context of the composition, style, and perhaps with a historical perspective. In this sense, the sheet music serves as a general guideline upon which to build a credible performance that can carry with it a myriad of subtle nuances. Variations in such attributes as timing, dynamics, and timbre all contribute to the quality of the performance that will make it unique within a population of musicians. The ultimate goal of this research is to gain a greater understanding of these subtle nuances, while simultaneously developing a set of stochastic motion models that can similarly approximate minute variations in multiple dimensions on a purpose-built robot. Live or recorded motion data, and algorithmic models will drive an articulated robust multi-axis mechatronic system that can render a unique and audibly pleasing performance that is comparable to its human counterpart using the same percussion instruments. By utilizing a non-invasive and flexible design, the robot can use any type of drum along with different types of striking implements to achieve an acoustic richness that would be hard if not impossible to capture by sampling or sound synthesis. The flow of this thesis will follow the course of this research by introducing high-level topics and providing an overview of related work. Next, a systematic method for gesture acquisition of a set of well-defined percussion scores will be introduced, followed by an analysis that will be used to derive a set of requirements for motion control and its associated electromechanical subsystems. A detailed multidiscipline engineering effort will be described that culminates in a robotic platform design within which the stochastic motion models can be utilized. An analysis will be performed to evaluate the characteristics of the robotic renderings when compared to human reference performances. Finally, this thesis will conclude by highlighting a set of contributions as well as topics that can be pursued in the future to advance percussion robotics.