PLAYING BY FEEL: INCORPORATING HAPTIC FEEDBACK INTO COMPUTER-BASED MUSICAL INSTRUMENTS

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To my Parents

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When musicians play instruments, they perform certain actions with the expectation of achieving a certain result - a musical performance. As they play, they monitor the behavior of their instrument and, if the sound is not quite what they expect, they will adjust their actions to change it. In other words, they have effectively become part of a control loop, constantly monitoring the output from their instrument and subtly adjusting bow pressure, breath pressure, or whatever control parameter is appropriate.

Sophisticated sound synthesis techniques such as "Physical Modeling" provide composers and performers with the opportunity to change any aspect of their instrument, often in real time. Potentially, a player can alter the size, shape and even the material composition of an instrument as they play. The challenge presented by such flexibility is how to provide the performer with access to appropriate control parameters. The solution proposed in this work is to leverage off the musician's existing sensitivity to the relationship between an instrument's "feel" and its sound.

This dissertation presents the results of a series of experiments in which experienced musicians played virtual musical instruments with both haptic and auditory feedback. My objective was to discover whether adding haptic feedback to these instruments would improve their playability. The results of these studies indicate that the presence of haptic feedback can improve a player's ability to learn the behavior of a virtual musical instrument. If haptic feedback is designed to simulate the "feel" of a real instrument, then the simulation must be of high quality if it is to promote transfer of skill from the real to the virtual domain.

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