Exploring Simulation-Based Playability Metrics of 9 Perceptually Evaluated Violins

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ABSTRACT

The bridge admittance is a commonly used acoustic characterization of bowed string instrument bodies. While most studies focus on its frequency response, we analyze it in conjunction with the feedback loop created during the vibration of the string using numerical simulation. A measured admittance can be approximated in a compact form as a group of second-order resonant filters. These filters can then be incorporated into the numerical model of the bow-string interaction and of the string vibration in order to investigate how different violin bodies behave when they interact with the stick-slip motion coming from the string. As a case study we used bridge driving-point admittance measurements of 9 violins, which had previously been rated on ease of playing and dynamic range by experienced musicians during a perceptual test. Digital simulation allowed the collection of hundreds of hours worth of playback, from which we derived playability-related metrics, such as the empirical limits of the Schelleng diagram. The metrics were found to mostly differ in the minimum bow force, which was also shown to be in agreement with previously published theoretical limits that take the bridge admittance into account. Preliminary results from comparing different metrics to violinists' evaluations indicated a possible link between the simulated minimum bow force and ease of playing ratings.