Name(s)

Andrew Land

Project Number

S0315

Project Title

Investigating String-Bow Interactions on a Novel Optoelectronic Cello

Abstract

Objectives

Investigating correlations between the perceived quality of cello bows and rosins, and cello string behavior in the time domain. Novel optical sensors directly monitor the vibrations of each of string. If measurable criteria correlating subjective and objective observations can be established, then this will guide the development and evaluation of cello bows and rosins.

Methods

Individual string motion is measured using novel optical sensors mounted on the cello bridge (developed for last project). The sensor is a dual-segment photodiode placed close to the string, illuminated by a laser diode, with the string casting a shadow on the sensor. The differential signal across the photodiodes is proportional to the string displacement. Recorded audio files were reviewed for time domain signatures and also converted to frequency domain for comparison. Two different cello bows, one of perceived high quality and one basic, and three different grades of rosin were tested. Results were acquired from five cellists, each playing the same note repetitively using their own bows and the two experimental bows.

Results

Two different signatures in the bowed notes time envelope were measured to characterize the string-bow interaction. The optical sensor allowed the time of bow first touching the string to be observed and the time from first touch to initiation of a regular pattern of string motion to be measured. A correlation between this time delta and perceived bow quality was observed. The ability to maintain a consistent tone throughout a bow stroke is a key aspect of performance. For novice players the tone can break during the bow stroke. The fraction of bow strokes which showed tone breaks was noted for 5 cellists using 3 bows. A correlation between the ability to maintain a constant tone and perceived bow quality was observed.

Conclusions

An objective analysis of cello bow and rosin quality using an optoelectronic cello based on novel optical sensors has yielded promising results. Trends in the time domain behavior of string motion have been found which link the perceived quality of the cello bows and rosins to the time domain behavior of the string-bow interaction. Establishing measurable criteria correlating subjective and objective observations will provide guidance for the development and evaluation of cello bows and rosins.

With (perceived) higher quality bows and rosins, the transition time from bow touch to establishing stable tone is shorter, and the ability to maintain a stable tone is greater.

Summary Statement

Two distinct effects in the time-domain behavior of the bowed cello string show promising correlations with the perceived quality of the cello bows and rosins used.

Help Received

My fellow youth orchestra cellists provided willing bow strokes, and my dad helped with the analysis software and poster graphics.