The Effect of Spectral Content of Acoustic and Synthesized Timbre

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The timbre, or tone color, of a sound possesses unique characteristics which enable us to differentiate one musical instrument from another, even when the tones are of the same pitch. Violin tones generated by digital keyboard synthesizers are generally perceived to be artificial and unrealistic, especially their vibratos. What contributes to the perceived differences? This study aims to achieve two goals: 1) to inspect, at the macro and micro levels, the spectral harmonic and inharmonic content produced by acoustic violins and keyboard synthesizers, and 2) to enhance a synthesizer's tone by programmatically removing its unrealistic vibratos. The first goal is achieved through three-dimensional visualization of the spectral content as well as a series of ANOVA tests. The analytical results clearly show, contrary to common understanding, that inharmonic content -- not the harmonic counterpart -- contributes most significantly to the perceived differences in timbre. The second goal is accomplished through a simple yet elegant technique that adjusts the spectral content using the detailed knowledge obtained from the first goal; the modified spectral components are subsequently converted back to the time-domain audio signals. Listening tests of the modified audio and visualization of its corresponding spectrogram provide further evidence of successful removal of the vibrato.

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