Detecting Damage in Strings Using Acoustic Inharmonicity and Damping Coefficients

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Damage to musical strings can degrade sound quality or even cause sudden failure during a musical performance. For large wire-cables, complex methods measuring the propagation of vibrations can detect flaws. For smaller strings, however, microphones can more simply detect vibration through acoustic spectra—representations of sound pressure varying with frequency and time, respectively. This study thus investigates whether acoustic spectra can be used to detect physical flaws in musical strings. To test this, two numerical descriptors of the strings' audio were analyzed: inharmonicity, the deviation of the expected to measured harmonics, and quality factor, a measure of how slowly vibrations dissipate. These parameters were then measured for guitar strings damaged in two ways: abraded by sandpaper to simulate wear and loaded with a few small putty beads to simulate debris. Results showed that when the string was abraded, and no putty was present, inharmonicity was lower and quality factor was higher. When putty was added to the string, this correlation disappeared for inharmonicity. These correlations were supported by analysis of variance tests and post hoc t-tests that found statistically significant differences in inharmonicity and quality factor between abraded and non-abraded strings. Large standard deviations were observed for several data groups and attributed to imprecision in instrumentation. The experiment indicates that sound analysis could become a simple, low-cost way to detect damage to musical strings. This concept may be extended to larger, load-bearing wires and cables, and future experimentation should use more precise tools to observe such structures.

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