CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

36620

Project Title

A Novel Method for Diagnosing Mechanical Component Failure Using Sound

Abstract

Objectives/Goals

Effective mechanical component failure diagnosis for consumer applications is an ongoing need in the automotive industry. The goal of my project is to prove the effectiveness of a system that is able to detect and categorize various mechanical component failures through audio analysis and serve as a simple early diagnostic tool for consumers and mechanics.

Methods/Materials

The apparatus consists of a commercially available USB microphone and a sound-card oscilloscope program, Soundcard Scope, built by National Instruments and accessed using an educational license, operating on a laptop computer. Readings are taken using the microphone, and the audio waveform is then transferred to the frequency domain using the oscilloscope analysis software. The failure signature is isolated by subtracting the Fourier Transform of the waveform of the correctly functioning component from a transform of the waveform collected for a failing component, and the signature is compared to previously collected signatures to diagnose the failure.

Results

The distinct frequency signatures of mechanical failures including worn brake pads, ruptured vacuum hoses, worn serpentine belts, and loose dust covers were successfully characterized. The apparatus was able to accurately detect and isolate frequency peaks across the entire frequency range corresponding to each mechanical failure, and spectrum broadening in a revving engine's sound profile was also characterized.

Conclusions/Discussion

The study validated the potential for this audio signature analysis method in automobile failures. A similar technique can be extended to various other mechanical systems in consumer applications as well as industrial settings. Basic audio diagnosis can be accomplished by ordinary consumers through a smartphone application. In more sophisticated industrial settings, the technique can be applied for early detection of failures and system monitoring.

Summary Statement

A novel sound-based method for diagnosing mechanical component failure using a simple microphone # oscilloscope apparatus was developed and successfully used to categorize mechanical failures based on audio frequency signatures.

Help Received

Guidance in understanding mathematical and physical principles of the project was provided by Mr. Greg Burroughs, my calculus teacher and the mentor of the Homestead FIRST Robotics Team, of which I am a member.