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Thesis Abstract

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Thesis Title

Real-time Acoustic Vibration Detection and Recovery Method by Performing High-speed Image Processing on Laser Speckle Images

Thesis Summary

Vibration is ubiquitous in nature and human’s daily life. The monitoring and measurement of vibration is of great significance. Among the many vibration measurement techniques, optical vibration measurement offers advantages such as non-contact, no harm to the object's structure, and high accuracy. Compared to the contact measuring method which uses an electric sensor, the optical method offers a broader application base.

Sound, as a special kind of vibration, can also be measured with optical approaches. The optical sound measurement method uses optical instruments to measure the status of the vibrating sound source or objects actively and directly, thus, it can avoid crosstalk of different sound source signals, as opposed to traditional electric microphones; Furthermore, the optical measurement method offers a longer measurement distance, thus it can extract the sound of targets with a long distance. In the past, many optical-based audio signal measurement methods have been proposed. Among them, the method based on laser speckle and image sensor is an ideal solution since it has the characteristics of high measurement accuracy, long detection distance, and ability to work in dark environment. However, since the frequency of audio signal is usually much higher than the image processing speed, the real-time restoration of audio signals has never been realized.

In this research, a real-time acoustic vibration detection and recovery method by performing high-speed image processing on laser speckle images has been proposed. The proposed method can detect sound vibration of object and recover the audio signal in real time. Compared with the previous speckle sound measurement research which mainly focused on applications of non-real-time sound recording, our research allows real-time recovering of audio signals, making it suitable for applications such as visual

microphones and vibration monitoring usages.