Locating sound sources inside a solid enclosure

Sean F. Wu
Department of Mechanical Engineering, Wayne State University
Detroit, MI 48202, U.S.A.
sean_wu@wayne.edu

Cameron Ernest
Department of Mechanical Engineering, Wayne State University
Detroit, MI 48202, U.S.A.
fy2767@wayne.edu

Antonio F. Mombela
The Timken Company
North Canton, OH 44720, U.S.A.
aq5476@wayne.edu

Yazhong Lu
School of Mechanical Engineering, Zhejiang University
Hangzhou, Zhejiang 310058, P. R. China
ylu7350@163.com

Lingguang Chen
Signal-Wise LLC
Troy, MI 48098, U.S.A.
LGchen@signal-wise.com

Karam Kajah
Department of Mechanical Engineering, Wayne State University
Detroit, MI 48202, U.S.A.
hi3839@wayne.edu

and

Yang Zhao
Department of Electrical and Computer Engineering, Wayne State University
Detroit, MI 48202, U.S.A.
aa3606@wayne.edu

The underlying principles of all state-of-the-art sound source localization methodologies are built on the assumption that the line of sight between any sound source and sensor is not blocked. If this assumption does not hold true, source localization cannot be done. This restriction has necessarily limited sound sources localization in open space up to an obstacle or a boundary surface. Meanwhile, the root causes of all noise and vibration issues are housed inside a solid structure, making noise diagnosis and mitigation very challenging. In this presentation, a laser-assisted see-through technology is developed and the feasibility of using this new technology to locate sound sources inside a solid structure made of plexiglass of dimensions $64 \times 64 \times 64$ cm^3 of a thickness of 1 cm is examined. The reason for using plexiglass is to make it easy to monitor the accuracy in source location. The hardware of this

see-through technology consists of six lasers to measure the normal component of the velocity on the surface of a solid structure from certain distances in a non-contact manner. Input data is then fed to SODAR (SOnic Detection And Ranging) algorithms to determine the location of a sound source inside. SODAR can be likened to radar, except it utilizes the sound waves rather than radio waves to determine the coordinates of multiple sound sources in free space simultaneously. Therefore, in essence, this laser-assisted see-through technology bypasses a solid structure to locate sound sources inside, as if the line of sight is not blocked by the solid enclosure.