CPS: Small: Mechanical Vibration Based Prognostic Monitoring of Machinery Health with Sub-millisecond Accuracy Using Backscatter Signals

Submitted by alexliu@cse.msu.edu on Thu, 04/25/2019 - 4:40pm

Project Details

Lead PI:	Alex Liu
Co-PI(s):	Guomin Zhu Yunhao Liu
Performance Period:	01/01/19 - 12/31/21
Institution(s):	Michigan State University
Sponsor(s):	National Science Foundation
Award Number:	1837146

Abstract: This project aims to develop non-intrusive and universal vibration sensing schemes that can detect the abnormal vibrations of a running machine. Towards this goal, the researchers propose a system that first uses the backscatter signals in commercial off the shelf RFID systems to accurately measure machine vibrations, and then uses machine learning and signal processing techniques to detect abnormal machine vibration patterns so that machine operators can be alerted to take actions before the machine fails. This project represents an emerging space driving new CPS and Internet of Things concepts for machinery safety. It can be used for the prognostic monitoring of not only indoor machines, but also outdoor appliances and civil infrastructures, such as drilling system monitoring, pumping system monitoring, pipeline system monitoring, and bridge monitoring. The proposed system is expected to impact manufacturing and economy. This project will bridge the communities between Computer Science and Mechanical Engineering; and foster interaction and communication among them. It will also facilitate the effort of the researchers on attracting and mentoring undergraduate students and underrepresented graduate students in research. Furthermore, the researchers will integrate the research results from this project into both undergraduate and graduate curricula. This project has two key technical objectives: to develop vibration measurement schemes using RFID systems and to develop abnormal vibration pattern recognition schemes based on the measured vibration signals. For vibration sensing, the basic idea is to measure the machine vibrations through random and low-frequency readings of the tag using the RFID reader, where

each reading is viewed as one sampling of the vibration. For abnormal vibration pattern detection, the basic idea is to build base line models based on the measured vibration readings and then classify real time vibration readings of a running machine as being either normal or abnormal. The proposed system would have several advantages over prior art in machine health monitoring , e.g., nonintrusive, inexpensive, accurate, and easily deployable including in non-line-of-sight scenarios.