Department of Systems Engineering and Engineering Management

Seminar Series

Acoustic Emission for Diesel Engine Diagnostics

Prof. Andy CC Tan

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Date: 16 May 2018 (Wednesday)
Time: 3:00pm to 5:00pm
Venue: P7303, 7/F, Yeung Kin Man Academic Building

Abstract
Diesel engines are prime movers for a range of applications, such as trains, marine ships, tanks, power generators, mining tractors and road vehicles. An unexpected failure can lead to abortion of whole military mission for tanks and navy fleets and loss of revenue and downtime for income generating items. Traditional approach is to conduct planned or preventive maintenance to endure the operation safety of the items at regular intervals. This is required mandatory replacement of critical parts without due consideration of its potential useful life, and also result in human error during the replacement process. To extend the useful life of critical parts needs precise knowledge of the health stage of the parts and its potential failure ahead of time. This requires the condition of the engine to be monitored continuously and to detect incipient failure in early stage. In diesel engines this can be done in two stages, firstly, to identify the overall health of the engine, once potential failure is identify the next stage is to pin-point the source of the cause. This presentation demonstrates an approach to separate the interference of source signals from different components of the engine in operation. The approach shows by normalizing the sensor characteristics the relative activities of different cylinders can be quantified. With this, it is then possible to separate the sources from other cylinders. This is demonstrated using the results of an experimental diesel engine test rig.

About the Speaker
Andy CC Tan received his BSc(Eng) and PhD degrees in Mechanical Engineering from the University of Westminster, London. His research interests include noise and vibration condition monitoring and sensors for active noise and vibration control. He applied adaptive signal processing and blind deconvolution algorithms to enhance the desired signals corrupted by noise for the detection of incipient faults. These algorithms together with acoustic emission sensors are used in low speed machinery condition monitoring. He expands his research into diesel engine diagnostics and prognostics; and optimisation of windfarm layout and diagnostics using vibration and electrical signals. He pioneered the artificial heart pump project in Queensland, Australia and a Professor of Mechanical Engineering at Queensland University of Technology until recently. He joined Universiti of Tunku Abdul Rahman, Malaysia to lead the research on acoustic emission for pipeline leak detection and long range condition assessment of oil pipeline. He is Chairman of the Centre for Railway Infrastructure and Engineering.
He is a recipient of QUT Award for Excellence in Academic Leadership. Nationally he is a recipient of Australasian Association for Engineering Education (AAEE) Award for Excellence in Engineering Education. He is recognised internationally for pioneering the Dual/Joint Degree Programs with Overseas Universities, awarded by INEER. In research he is a recipient of QUT, Faculty of Engineering and Science award for publishing in High Impact Journal Ranked A* or A for the purpose of ERA. Recently he received the Best Paper Award from QR2MSE 2016 International Conference.
He is a Chartered Professional Engineers and Fellow of the Institution of Engineers, Australia. He is also a Fellow of International Society for Engineering Asset Management, International Society of Acoustic Emission and Material Institute of Malaysia.

Overview of Internal Flow-Induced Acoustics in Corrugated Pipe

Dr. Yeong Jin KING (龚荣仁)

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Abstract
Corrugated pipe is one of the most important types of offshore pipeline used in oil and gas industry. Its global flexibility and local rigidity have allowed it to be used under variety of environment and condition which also simplifying the design of the pipeline in offshore industry. The growing in offshore gas production and the floating liquefied natural gas (FLNG) platform has increased the market share of the flexible pipe in the world. Corrugated pipe is one of the offshore pipes that have been commonly used in oil and gas industry as well as in other applications. Besides considering the structural strength of the pipe in the design of the corrugated pipe, the other major problem faced by the system when using the corrugated pipe is the flow-induced acoustics. Flow-induced acoustics in pipeline has been a hot topic mainly in chemical engineering industry. However, most of the researches only focus on studying the acoustics response caused by the flow through elbow, tee-joint, multiple side branch, etc for rigid pipe. There have not been many research work done been carried out in studying the effect of flow-induced acoustics based on the characteristics of internal surface of the pipe. Recently, there are number of research paper presented that the flow –induced acoustics in corrugated pipe. It shows that the flow-induced acoustics could induce high stress levels and fatigue in associated to pipe work in oil and gas industry. This could lead to fatigue failures in the pipeline as well as the failure of topside equipment and subsea equipment connected to the corrugated pipe. Those researches are still developing its theory based on the rigid pipe. Currently, there is still lack of research been carried out in corrugated pipe compare to vortex induced vibration of pipeline which has been started since 1970's. In this presentation, few of the effect of the corrugation parameters and its proposed solution will be discussed.

About the Speaker
KING Yeong Jin received his B. Eng. (Hons) Mechanical Engineering from Universiti Teknologi Malaysia, Johor, Malaysia and M. Sc. Mechanical Engineering from National University of Singapore, Singapore in 2007 and 2008. Currently, he is pursuing his PhD in Mechanical Engineering in Universiti Teknologi Malaysia, Johor, Malaysia. He is currently working as a lecturer in the Department of Mechanical and Materials Engineering under Lee Kong Chian Faculty of Engineering and Science at the Universiti Tunku Abdul Rahman.

His research area is mainly in noise and vibration related area including flow-induced acoustics of pipeline, pipeline fault detection, machine fault diagnostic, etc. He also actively involves in renewable energy research which include wave energy conversion, photovoltaic cooling, solar heating, thermoacoustics refrigerator, etc.

Application of Fiber Laser in Pipeline Leakage and Pressure Monitoring under Chaotic Condition

Dr. Chang Hong Pua

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Abstract
Pipeline monitoring has been one of the issue discuss in global crisis due to the high non-revenue water reported in the global. In this paper, the usage of an erbium doped fibre laser based sensor to monitor pipeline condition, especially leakage condition by manipulating the nonlinear laser dynamics effect is reported. Vibration of the pipeline was used as an external loss modulation to trigger the chaotic condition of the fibre sensor to induce power changes on the optical sensor. The output of the optical sensor is found to be closely related to the vibration pattern of the pipeline. Hence, by catching the abnormal vibration signal of the pipeline, the health condition of the pipeline can be predicted. The vibration signal is measured and compared with an accelerometer in time and frequency domain respectively. There are three conditions tested, including defect free pipe, near leaking point and far leaking point measurement. The experiment shows the unique responses of the sensor and analysis of signal-to-noise ratio in frequency diagram was performed. From the results, the proposed sensor offers an alternative choice from conventional accelerometer which shows a cleaner result with simpler interpretation for classifying the pipeline condition.

About the Speaker
Chang Hong Pua is an assistant professor in the Electrical and Electronic Department of Lee Kong Chian Faculty of Engineering Science at the Universiti Tunku Abdul Rahman where he has been a faculty member since 2014. He is also the chairperson for Centre of Photonics and Advanced Materials in Universiti Tunku Abdul Rahamn since 2015. Pua completed his B.Sc, M.Sc., and Ph.D. at University of Malaya at 2006, 2009, and 2012 respectively. His research interest lies in the area of optical sensors, optical waveguide, laser, nonlinear optics, and sensing system. He is currently involving in few optical sensors research projects that collaborate with industry players including Petronas, Daikin, and Ranhill Water Services. He is currently supervising 1 Ph.D. and 4 Master students.

Monitoring and Health Management of Engineering Systems and Critical Components

Dr. Dong WANG

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Abstract
Prognostics and health management is an emerging discipline to scientifically manage the health conditions of engineering systems and critical components. It mainly consists of four main aspects: construction of health indicators, fault diagnosis, remaining useful life prediction, and health management. Construction of health indicators aims to evaluate the current health conditions of engineering systems and critical components. Fault diagnosis aims to identify specific faults once any abnormal health conditions happen. Given the observations of a health indicator, prediction of remaining useful life is used to infer the time when an engineering systems or a critical component will no longer perform its intended function. Health management involves planning the optimal maintenance schedule according to the system's current and future health conditions and the replacement costs. In this presentation, Dr. Dong Wang will introduce some of his progress toward construction of health indicators, fault diagnosis and remaining useful life prediction. Scholars are welcome to give any questions, comments and suggestions to Dr. Dong Wang's research works.

About the Speaker
Dr. Dong Wang was a recipient of Hong Kong PhD Fellowship in 2012 and received his Ph.D. at City University of Hong Kong (CityU) in 2015. He was appointed as a research associate, a senior research assistant and a post-doctoral fellow at CityU from Years 2015 to 2018. Currently, he is a research fellow at CityU.

Dr. Dong Wang's research interests include statistical modeling, prognostics and health management, condition monitoring, fault diagnosis, signal processing, data mining and nondestructive testing. He has published 56 SCI-indexed journal papers (the first author for 37 SCI-indexed journal papers) and his works have been cited 1292 times (Google Scholar). 5 journal papers were selected by ESI TOP 1%. His research works appear in Mechanical Systems and Signal Processing, Journal of Sound and Vibration, ASME Transactions on Journal of Vibration and Acoustics, IEEE Transactions on Reliability, IEEE Transactions on Instrumentation and Measurement, Journal of Power Sources, Measurement Science and Technology, etc.

Dr. Dong Wang was invited to be a reviewer for 50 SCI-indexed journals and reviewed over 300 journal papers before. In recognition to his contributions to Elsevier and IEEE journals, he was awarded Outstanding Reviewer Status 13 times. He was a lead guest editor/guest editor for several SCI-indexed journals and a referee for the FONDECYT of Chile. Currently, he is an associate editor for Journal of Low Frequency Noise Vibration and Active Control and an associate editor for IEEE Access.

Matching Pursuit with Novel Dispersive Dictionary for Mode Separation in Guided Wave Signals Obtained from Pipes

Dr. Javad ROSTAMI

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Abstract
Pipes that carry gas into residential buildings are one of the most important infrastructures in cities. These pipes are prone to corrosion after a period of time because of different environmental factors. In order to avoid any pipe rupture that may cause explosion, the integrity of such pipes much be checked on a regular basis. Ultrasonic guided wave is an effective nondestructive testing (NDT) method for structural health monitoring (SHM) of plate like structures and pipes. However, the signals that are obtained from guided waves can be very difficult to interpret due to mode conversion, overlapped modes and low signal to noise ratio. In order to extract meaningful information of guided wave signals, using an advanced signal processing technique is inevitable. Most of the signal processing methods that have been developed so far, neglect the dispersion characteristic of guided waves. Dispersion means that the velocity of the propagating wave is a function of its frequency. As in most guided wave applications for inspecting pipes, we use narrowband tone-burst signal, dispersion causes guided wave signal to spread in time axis as it travels and changes its shape. Matching pursuit is one the greedy algorithm that can be used to approximate signals. This method iteratively approximates a signal by its predefined dictionary. However, the dictionary that usually contains redundant number of fundamental waveforms usually Gaussian signals may not be suitable for guided wave inspection of pipes. In this paper we designed a dictionary based on real guided wave signals by taking finite element method (FEM) approach.

About the Speaker
Javad is a senior research associate in the department of Systems Engineering and Engineering Management, City University of Hong Kong. He was recently awarded a PhD degree. His research interests include Nondestructive testing, guided waves and ultrasonic signal processing.

Laser-Based Guided Wave Propagation and Mode Decomposition in Detecting the Integrity of Structural I-Beams

Mr. Faeez MASURKAR

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Abstract
I-beams are one of the most important structural elements used in commercial and residential applications. However, during their service life, they are prone to several types of defects either through external loading or neighboring atmosphere. In order to monitor its structural integrity, to avoid sudden failure, ultrasonic guided wave technology is one of the promising technique to check the current health status. Moreover, conventional contact based sensors may not be suitable for such applications in case of less accessibility to the inspection area or if the target surface is hot. Thus, a full non-contact laser based system is used to emit and receive the guided waves propagating in the I-Beam. The experimental setup consisted of a new 3D Scanning Laser Doppler Vibrometer (3D-SLDV) used to acquire high resolution time-space guided waves that were propagating in the I-beam. A high power and pulsed Nd:YAG laser was used to emit the required guided waves. The emission and sensing of the waves were carried out simultaneously. The wave propagation data was recorded by scanning the surface of the I-beam in a sequential manner. The measured data was used to construct the wave patterns that were propagating in the I-beams at different time instants. Furthermore, as the waves in an I-Beam propagate with multiple modes even at low frequency range, filtering was carried out in the frequency-wavenumber domain in order to decompose the modes. The results presented thereby confirm that the new 3D-SLDV possesses tremendous capability in revealing the wave propagation characteristics and its interaction with defect. The capability of using such totally laser-based 3D inspection system to reveal the characteristics of ultrasonic guided waves and its interaction with defects are substantial.

About the Speaker
Faeez is a Ph.D candidate in the department of Systems Engineering and Engineering Management, City University of Hong Kong. His research interests include Nondestructive testing, Structural health monitoring using ultrasonic guided waves and signal processing.

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All are Welcome!

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