main approach called generalized regressive discrete Fourier series (GRDFS). The method will be applied to laser doppler vibrometer measurements on a loudspeaker. This source will be rotated to obtain continuous angle views of the acoustic field, hence eliminating the tedious process of rotating the measurement set-up. By demodulation of a measured signal, it is possible to determine the position of the loudspeaker in space. The results obtained with the GRDFS will be compared to the classical filtered back projection method.

**4:05**

**4pSPb5. Ultrasonic Doppler vibrometry using direct undersampling.** Asif Mehmood, Paul M. Goggans (Dept. of Elec. Eng., Univ. of Mississippi, Anderson Hall Rm. 302B, University, MS 38677, amehmood@olemiss.edu), and James M. Sabatier (Natl. Ctr. for Physical Acoust., University, MS 38677)

In ultrasonic Doppler vibrometry (UDV) systems, sound returned from a moving point scatterer is frequency modulated by the component of the scatterer's velocity in the direction of the system's colocated ultrasonic transducers. Because of this, time-frequency analysis of the receiver transducer output can be used to reveal the velocities of multiple scatterers moving within the sensor's field of view. This principle can be used, for example, as in [Zhang et al., EL110 J. Acoust. Soc. Am. 121 (2007)] to study human gait. Because it is band-pass limited, the received signal can be expressed equivalently in terms of low-pass limited in-phase and quadrature (I&Q) components. To reduce the amount of data to be stored and analyzed, it is advantageous to sample the I&Q signals rather than the received signal. This paper reports an implementation of undersampling [J. L. Brown, Jr., IEEE Trans. Information Theory IT−26, 613−−615 (1980)] to capture samples of the I&Q using a data acquisition card without the use of external oscillators or mixers. Undersampling yields I&Q samples that are interlaced rather than simultaneous in time. Here, a spectrogram using interlaced I&Q samples is derived using Bayesian spectrum analysis.

**4:20**

**4pSPb6. On-line failure detection of a vibrating structure: A model-based approach.** B. L. Guidry, J. V. Candy, K. A. Fisher, D. H. Chambers, and S. K. Lehman (LLNL, P.O. Box 808, L-154, Livermore, CA 94551)

Model-based failure detection is based on the principle that the MBP for a normal or pristine structure is developed first and tuned during the calibration stage assuring a statistically validated processor. Once developed, the MBP is used as the integral part in a sequential detection scheme to decide whether or not the structure under investigation is operating normally. When an abnormality is detected, a failure alarm is activated and the type of failure is classified based on a library of potential failure modes. Here we use high-order parametric models to capture the essence of the structures over a limited frequency band known to be sensitive to structural changes. These estimated or identified models for normal operations are then used to develop the MBP which in this instance is a recursive Kalman filter. The filter is known to produce zero-mean/white residuals when optimally tuned to the data. Failure is declared when these properties are no longer valid. Once the detection is accomplished, the next step is to classify the type of failure mechanism and eventually the locations. Here we show results of the designs on both simulated and measured data.

**4:35**

**4pSPb7. Fault localization of moving machinery in a noisy environment.** Jong-Hoon Jeon, Choon-Su Park, and Yang-Hann Kim (Ctr. for NOVIC, Dept. of Mech. Eng., KAIST, 373-1 Guseong-dong, Yuseong-gu, Daejeon 305-701, Republic of Korea)

Faults of rotating parts of a machine normally generate unexpected frequency band or impulsive sound, which has a period when it moves with a constant speed. The former can be detected by the moving frame acoustic holography method [S.-H. Park and Y.-H. Kim, "An improved moving frame acoustic holography for coherent bandlimited noise," J. Acoust. Soc. Am. **104**, 3179–3189 (1998)]. We have attempted to apply the method to the latter case in the test site. The keywords are, therefore, the periodic impulsive sound, which is obviously different from those which can be visualized by the method, and the signal-to-noise ratio, which determines the success of early-fault detection. This research shows how the problems related with these keywords can be resolved. The main idea is that periodic impulsive signal can be expressed by an infinite set of discrete pure tones. This enables us to obtain alot of holograms that visualize periodic impulsive sound field and noise; therefore, holograms can be averaged to improve the signal-to-noise ratio until having reliable information that exhibits where the impulsive sources are. Theory, experiment, and application results to the train on a test rig are described. [Work supported by BK21 and KRRI.]

**4:50**

**4pSPb8. Design of multi-input interleaved multisine excitation signals for ultrasonic testing.** Roberto Longo, Steve Vanlanduit, Joris Vanherzeele, and Patrick Guillaume (Dept. of Mech. Eng., Vrije Universiteit Brussel (VUB), Pleinlaan 2,1050 Bruxelles, Belgium)

Multisines are periodic signals consisting of harmonically-related sine waves. By optimizing the phases of the different sine waves, a periodic signal is obtained with a small crest factor resulting in high signal-to-noise ratios. One disadvantage of multisines when several ultrasonic actuators are used simultaneously is that, in general, it is very difficult to distinguish from a measured ultrasonic signal the contribution of the different actuators. This is easier when pulses are used and when they do not overlap. In this contribution, a new approach for periodic continuous wave signals will be presented to separate the contribution coming from the different actuators (senders) at every receiver. The proposed approach is based on the use of multi-input interleaved multisines. Interleaved multisines contain energy at different spectral lines allowing an easy separation by means of a discrete Fourier transform. The separation becomes more complex when non-linear effects are present, but even then it is possible to apply this approach by properly selecting the excitation lines. The use of multi-input interleaved multisine offers new applications for ultrasonic NDT (e.g., combined transmission and reflection measurements) as well as in the field of material identification and biomedical applications.

**5:05**

**4pSPb9. Bayesian spectrum estimation of termite signals using laser Doppler vibrometry.** Asif Mehmood (Dept. of Elec. Eng., The Univ. of Mississippi, P.O. Box 4206, University, MS 38677), Orwa M. Tahaineh, Tom Fink, Vijay. P. Ramalingam, John. M. Seiner (Natl. Ctr. for Physical Acoust., University, MS), and Alan R. Lax (USDA-ARS Southern Regional Res. Ctr., New Orleans, LA)

Laser vibrometry provides a sensitive non-invasive means of measuring substrate vibration. These measurements include landmine detection, automotive testing, production testing, aerospace, and structural testing. We employed laser vibrometry for termite detection. The vibratory signal generated by termite head banging is picked up by the laser Doppler vibrometer. In laser vibrometry, the surface motion is monitored by heterodyne laser Doppler vibrometry, and the received heterodyne signal is sampled to produce time-series data. The time-series data thus obtained is the velocity signal of the vibrating object. We consider here a statistical signal-processing approach to termite head banging data, which is based on Bayesian inference. In this approach, the quantity of interest is the frequency of vibration caused by termite head banging, while phase and quadrature amplitudes are considered nuisance parameters. We employ a single-frequency model to determine this frequency. Because of the optimal prior knowledge about the signal of interest, the frequency can be measured with much greater precision and greater noise immunity than using Fourier transform. Our results show that the Bayesian method of processing an acoustic signal exhibits excellent performance in determining the vibrational frequency.