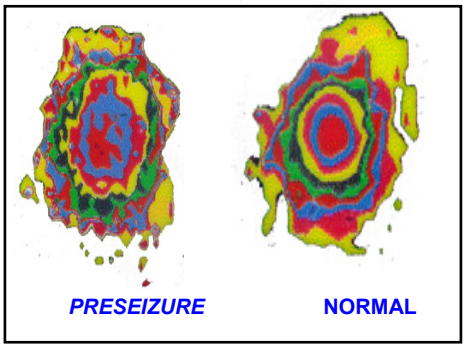
Scientific Computing Within the ORNL Modeling & Simulation Group: Biomedical Simulation-Medical Diagnostics Using Chaotic Time Serial Data

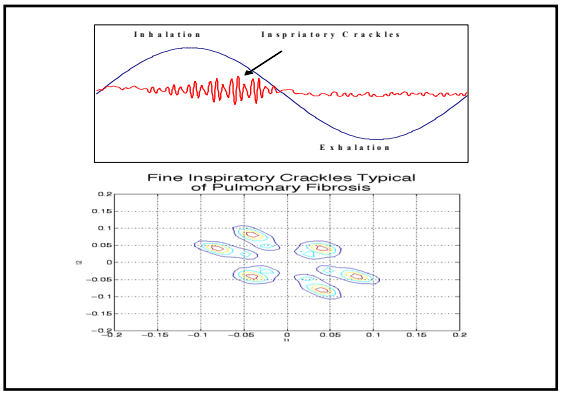
The ORNL Modeling and Simulation Group (MSG) develops sophisticated numerical solutions for a wide range of scientific, engineering, and operational applications. MSG's core competency is computational physics and engineering, and within our biomedical simulation focus area we have extensive expertise utilizing chaotic non-linear time-serial physiological data to diagnose a wide range of medical conditions. To support this activity, MSG has developed a suite of problem-specific diagnostic software that utilizes physics-based mathematical models such as phase-space analysis, higher-order spectral analysis, Bayesian parameter estimation, principal component analysis, and wavelets. Additionally, these software tools were designed to utilize a wide variety of data sources including acoustic, mechanical accelerations and forces, as well as electrical and electromagnetic signals. Prior applications include the following.

- Epileptic seizure forewarning from scalp EEG data.
- Classification of lung sounds for the purpose of diagnosing pneumonia, fibrosis, chronic obstructive pulmonary disease, and pneumothorax.
- Characterization of infant health from acoustic lung sounds.

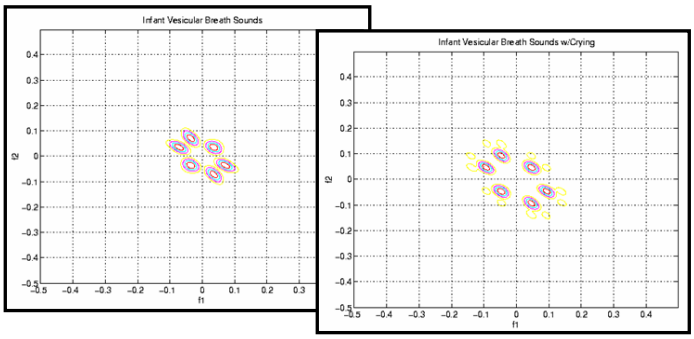
The ability to accurately classify physiological conditions using easily accessible data enables a wide range of R&D, industrial, homeland defense, and military applications such as alertness assessment and hands-free computer control using EEG data, voice signature analysis for terrorist identification, as well as detection of CBW exposure and determination of cognitive readiness by monitoring the central nervous system. We welcome the opportunity to discuss your potential applications and ways MSG can contribute to a solution.



MSG developed software to predict epileptic seizures using scalp EEG data & nonlinear phase-space analysis



MSG classified pulmonary fibrosis using inspiratory crackles & higher order spectral analysis



MSG used higher order spectral analysis of crying infant lung sounds to differentiate normal & abnormal vocalizations

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