Applications of Pattern Classification for Time-Domain Signals

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ABSTRACT

Many different kinds of physics are used in sensors that produce time-domain signals, such as ultrasonics, acoustics, seismology, and electromagnetics. The waveforms generated by these sensors are used to measure events or detect flaws in applications ranging from industrial to medical and defense-related domains. Interpreting the signals is challenging because of the complicated physics of the interaction of the fields with the materials and structures under study. Often the method of interpreting the signal varies by the application, but automatic detection of events in signals is always useful in order to attain results quickly with less human error. One method of automatic interpretation of data is pattern classification, which is a statistical method that assigns predicted labels to raw data associated with known categories. In this work, we use pattern classification techniques to aid automatic detection of events in signals using features extracted by a particular application of the wavelet transform, the Dynamic Wavelet Fingerprint (DWFP), as well as features selected through physical interpretation of the individual applications. The wavelet feature extraction method is general for any time-domain signal, and the classification results can be improved by features drawn for the particular domain. The success of this technique is demonstrated through four applications: the development of an ultrasonographic periodontal probe, the identification of flaw type in Lamb wave tomographic scans of an aluminum pipe, prediction of roof falls in a limestone mine, and automatic identification of individual RFID tags regardless of its programmed code. The method has been shown to achieve high accuracy, sometimes as high as 98%.