Time-Frequency Acoustic Processing and Recognition: Analysis and Analog VLSI Implementations

by

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Abstract

Time-frequency analysis techniques, such as wavelet decomposition and Gabor filtering, are a tool for efficient coding of short-term acoustical features, and so are fundamental to acoustic pattern classification and speech recognition.

This thesis addresses issues of efficiency and robustness in the design and implementation of acoustic signal processors and small-vocabulary speech recognition systems for applications where power dissipation and integration density are primary design constraints. We couple time-frequency signal representations with massively parallel architectures using analog VLSI technology to design compact special-purpose systems with power efficiency surpassing conventional DSPs.

We present the design of, and results from, several prototyped VLSI systems, including processors for time-frequency decomposition and template-correlation-based acoustic transient pattern classification. We present methods for automatically training a template correlator and discuss potential research directions for this architecture, including biological modeling and continuous-speech recognition.

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R. Timothy Edwards received the degree of Bachelor of Science in Electrical Engineering (BSEE) from Duke University, Durham, North Carolina in 1990, graduating Summa Cum Laude and with Honors. In 1992, he received the degree of Master of Science in Electrical Engineering (MSEE) from Stanford University, Stanford, California. In 1993, he came to Johns Hopkins University to pursue a Ph.D. degree in the department of Electrical and Computer Engineering, Whiting School of Engineering, under the direction of Professor Gert Cauwenberghs. He is currently employed as a senior staff researcher in the Space Department at the Johns Hopkins University Applied Physics Laboratory.