

David Henry FRIEDMAN

8823 Mountain Path Circle, Austin, TX 78759

(H) 512 / 343-2027

512 / 343-2082 (fax)

512 / 970-7089 (cellular - preferred)

Email: dhfx@realtime.net

U.S. Citizen

Education:

Ph.D. in E.E., The Johns Hopkins University, Baltimore, MD

S.M. in E.E., Massachusetts Institute of Technology

B.E.E., Polytechnic Institute of Brooklyn, New York (now Polytechnic Inst. of NYU)

Areas of Expertise:

- **Digital Signal Processing:** development and low-level implementation in code and logic of algorithms for speech recognition, echo cancellation, FIR and IIR filtering, FFT time-frequency analysis, encoding/decoding, image analysis.
- **Software Development:** over 10 years in C under Linux, UNIX and Windows; knowledge of UNIX networking internals (socket interface); have used Visual C++, Visual Basic, Matlab, also Python and Java under Linux; developed Linux kernel modules; PHP and MySQL for Web-based applications; VHDL for digital design.
- **Data Acquisition and Analysis:** real-time measurement and event capture in industrial, neuromedical (spike sorting) and communication environments.
- **Training, Instruction, Documentation:** excellent presentation and communication skills; 15 years university teaching and research experience with publications.

Professional History: (numbers refer to publications listed at end)

INDEPENDENT CONSULTANT

2009-present

infiniRel Inc., Dallas, TX (Nov. 2009 & ongoing): Developed signal-processing algorithm for monitoring age of energy-storage capacitors in solar panel power inverters, based on observing only the input and output voltages and currents. Algorithm verified experimentally using actual inverter data.

SYMTX, INC., Austin, TX

2008-2009

Sr. Principal Engineer

Member of Advanced Engineering Group in company supplying customized digitally-controlled electronic test systems to a wide variety of customers (aerospace, medical, telecom, etc.) Specific areas of responsibility include FPGA firmware, digital signal processing, design troubleshooting, also defining and implementing company-wide design standards.

CONTRACT CONSULTING & ACADEMIC TEACHING

2001-2007

a) Symtx, Inc., Austin, TX (Apr. to Oct. 2007): Contractor on project involving system for capture and playback of Doppler radar data. Devised analog/digital scheme to accommodate signal with high dynamic range; programmed DSP down/upsampling with FIR filtering as firmware for FPGA, using Matlab, Altera DSP Builder and Quartus VHDL tools.

b) Plexon, Inc., Dallas, TX (Sep. 2005 to Oct. 2006): Contract researcher, working at company supplying electronic instrumentation to biomedical laboratories for neuroelectric research. Implemented DSP algorithms for real-time multi-neuron spike separation (see pub. 1) in Matlab for demonstration purposes, using recordings of actual data; results compared favorably with those for off-line methods.

c) Minco Technology Labs, Austin, TX (June 2004 to Aug. 2005): Contract consultant to custom semiconductor packaging house. Migrated an internal application from legacy mainframe to Web platform using LAMP (Linux, Apache, MySQL, PHP) open-source software.

d) University of Texas: adjunct lecturer at Austin and Permian Basin (Odessa, TX) campuses.

NETHEARTBEAT, Inc., Austin, TX

2000-2001

Senior Systems Architect, functioning as technical team lead

Design, implementation and development, in small startup company environment, of load-balancing solution for clusters of Web servers under Linux. Took responsibility for major system components coded in Java, also Linux kernel modules in C. Advocated systematic design procedures including writing of functional descriptions and formal design specifications. Led technical discussions to resolve design issues.

ANDREW CORPORATION, Austin, TX

1999-2000

Senior Engineer

Implementation and development of digital signal processing algorithms for cellular telephones and accessories, as member of small R&D facility doing advanced product development. Tools used include: Matlab with Simulink; Analog Devices ADSP-2181 DSP processor and associated development environment. Investigated solutions for implementing voice dialing, robust echo suppression for speakerphone adapter, etc.

SYMTX, INC., Austin, TX

1993-1999

Systems Architect

Systems Integration - Data Acquisition, Test and Measurement

Design and implementation of custom systems in project-driven small-company environment, using primarily Hewlett-Packard components (company is an H-P Channel Partner). Developed modular software (mainly in C) under MS-Windows and UNIX for system processors driving digital instrumentation in real time. Dealt directly with clients; advised on approaches to meet special requirements. Performed project-management functions; worked independently and as head of small teams (typically 4-5 junior engineers). Served as design leader on projects including the following:

- Design and development of cable-modem testers, beginning with analysis of test requirements, design and lab-bench verification of test algorithms, software implementation of tests (Visual Basic under Windows NT), and checkout using production prototypes. Significant understanding of radio-frequency signals and digital modulation schemes (QAM, QPSK) was required for this work. Personally supervised refit of one tester for customer's internal design verification work involving highly sophisticated RF measurements (e.g., cubic intermodulation).
- Generator of simulated deep-space telemetry signals to monitor receiver performance (bit error rate vs. SNR, etc.) for space-probe downlink. Complex modulation patterns digitally calculated and downloaded to real-time microwave synthesizer. Project involved extensive C coding under HP-UX for control of instruments via IEEE-488 interfaces, also development of GUI using HP VEE (an iconic language) for operator control.
- Airborne data acquisition system involving merging of multiple avionics data streams at different rates, for modeling aircraft dynamic characteristics for design of flight simulators. Instrumentation consisted of VXI-interface modules controlled by C code running on real-time UNIX computer, with operator control via C++ application running on Windows laptop PC connected in client-server mode via Ethernet socket interface. Process of development involved significant on-site interaction with client flight engineers in hangar environment.

THE MITRE CORPORATION, Bedford, MA
Member of Technical Staff (holding secret-level clearance)

1984-1992

Speech Recognition and Analysis

- Primary activity: exploring new methods of front-end signal processing with aim of improved word-recognition performance.
- Proposed the IFD (instantaneous-frequency distribution), a spectral representation inspired by knowledge of neural encoding of sound in the ear; compared isolated-word recognition scores for IFD and other approaches including linear prediction and weighted cepstrum (pubs. 11, 13, 14).
- Investigated inter-speaker normalization of vowel formant frequencies by linear-vector-space classification theory (pub. 12).
- Implemented a computational model for wave transmission in the cochlea (inner ear) using the wave-digital-filter technique, to investigate possible effects of active nonlinearity in the ear (as evidenced by recent research in auditory physiology) in enhancing speech intelligibility in noise (pub. 15).
- Also contributed to the implementation of an integrated phoneme/word parser, for project to build a complete speaker-independent continuous-speech recognition system for an actual limited-vocabulary application.

Image Processing and Computational Vision

- Provided signal-processing expertise to demonstration project to classify clouds in satellite images, using neural network trained on texture information extracted from image by 2-D wavelet functions, together with ground data.
- In above project, improved an existing X-Windows software tool to enable meteorologists to create training data by drawing on-screen color overlays to label different cloud types identified in displayed images.
- Demonstrated a speedup of approximately 15x through using a 2-D FFT for image filtering, as opposed to simple convolution as found in existing C code library.
- Developed an approach (for a proposal submitted to an outside sponsor) for classifying fingerprints, based on using wavelet functions to determine local ridge direction, and vector-field methods to detect major features.
- Experimented with innovative 2-D signal processing methods, based on Gabor and Hough-Radon transforms, for extraction of edges and object contours in noisy or blurred images.
- Studied then-current theories of object recognition in human and mammalian visual nervous-system pathways, and implementation approaches using neural-net and related techniques.

RUTGERS UNIVERSITY, Piscataway, NJ
Assistant Professor of Electrical Engineering
Visiting Asst. Prof. of Electrical Engineering

1980-1984
1981-1984
1980-1981

Research - Spectral Modal Analysis of Random Vibration

- As outgrowth of earlier speech analysis work, developed an algorithm, based on the Fourier transform, suitable for accurately estimating resonant frequencies, damping factors, and modal shapes for a multi-output system under random excitation, e.g., acceleration sensors on a vibrating structure driven by ambient forces (wind, microseismic activity, etc.), from

recorded activity over long time durations (pubs. 8-10). (Gradual changes in parameters over an extended period could indicate accumulating metal fatigue or other weakening of structural members.)

- Obtained preliminary results for above technique on actual recordings (borrowed from another laboratory) of ambient vibrations of a suspension bridge. Found general agreement with results predicted and obtained on the same data by previous researchers using more conventional methods. (This work was not conclusive because the data records were found to be too short to fully evaluate the new method.)

Courses Taught (titles to indicate content, not exact)

Digital Computer Organization (undergraduate, 3d-year)

Communication Theory (undergraduate, 4th-year)

Digital Computer Research Topics (graduate)

TEL-AVIV UNIVERSITY, Tel-Aviv, Israel

Lecturer in Electronics, Faculty of Engineering

1969-1980

(tenured 1978)

On-Line Real-Time Computing

- Starting with then-current 16-bit computer, assembled system for analog data acquisition, automation of experiments, etc., to be available as a general research facility. Designed and constructed digital hardware interface controllers; wrote utility software, including file management package; trained students in programming and use of system; advocated on-line computing among engineering faculty.
- Demonstrated use of system in data acquisition and analysis through collaboration with fluid-mechanics project involving turbulence-onset detection in air flow (pubs. 2, 3). Contributed expertise in signal processing and detection to analysis phase of project, leading to greater precision of measurement than previously considered attainable.

Independent Research - Speech Analysis

- Developed algorithm for pitch extraction based on common periodicity of envelopes at outputs of overlapping band-pass filters, implemented by Fourier transform with 4-msec window (pubs. 4-6); compared results with other schemes using speech digitized on computer system described above.

Research Support - Biocommunications Laboratory

- Worked closely with faculty and graduate students in group devoted to psychophysical phenomena in hearing. Specified and supervised installation of second on-line computer system for real-time audio stimulus generation and experiment control; supervised design, construction and installation of instrumentation; advised students in design of experiments.
- Became knowledgeable on anatomy and physiology of the ear and various perceptual effects relating to sound and speech.

Courses Taught (partial list - titles to indicate content, not exact)

Digital Systems and Switching Theory (undergrad. & graduate)

Computer Architecture (undergraduate)

Speech Processing Algorithms (graduate)

Real-Time Laboratory Computing (graduate, research-oriented)

JOHNS HOPKINS SCHOOL OF MEDICINE, Baltimore, MD **1963-1969**
 Instructor in Biomedical Engineering 1968-1969
 Research Assistant in Biomedical Engineering 1963-1968

Ph.D. Dissertation Research

- Developed technique for analyzing "spike" activity of single neurons in cerebral cortex, to discriminate among several cells recorded via same electrode according to distinct representations of waveshapes on an orthonormal basis-function set (publ. 1). Implemented scheme using on-line computer and analog filters; technique later adopted by other researchers (this work cited extensively in Abeles and Goldstein, "Multispikes Train Analysis," IEEE Proceedings, May 1977, now considered the seminal work in that field).
- On-Line Digital Computing: Contributed to assembly of real-time computer system for data acquisition, analysis and display, based on then-current 16-bit computer.
- Designed and built digital device interfaces, including direct parallel link to nearby mainframe computer. Wrote software; provided technical support.

Biomedical Instrumentation

- Designed and built analog and digital equipment for clinical laboratories and research projects, including pioneering establishment of coronary intensive care units; worked closely with medical personnel.

BELL LABORATORIES, Murray Hill, NJ **1962-1963**
 Associate Member of Technical Staff

Communications Research

- Designed digital instrumentation for neuroelectric research in animal hearing. Took over integration of system for analog data acquisition and display based on early minicomputer.
- Came into contact with now-classic pioneering work on speech analysis and synthesis (Flanagan, Kelly & Lochbaum, etc).

Other Professional and Related Activities:

IEEE Signal Processing Society

Spectral Estimation Committee: member, 1986-1989.
 ASSP Transactions: reviewer, several occasions, 1980-1990.

Boston Computer Society (now defunct)

IBM-PC Users' Group Workshop Instructor, May 1991-June 1992:
 Introduction to C-Language Programming, given 3 times yearly;
 6 weekly 2-hour evening lectures; average class 25-30 adults.
 Designed course; presented 4 times.

Significant Publications (* indicates reviewed)

- *1. Detection of Signals by Template Matching (Ph.D. dissertation published as monograph by Johns Hopkins Press, Baltimore, 1969).
- *2. (I. Wygnanski, M. Sokolov, D. Friedman) "On Turbulence In a Pipe: Part II. The Equilibrium Puff," *Journal of Fluid Mechanics*, 69, 283 (1975).
- *3. (I. Wygnanski, M. Sokolov, D. Friedman) "On a Turbulent 'Spot' In a Laminar Boundary Layer," *Journal of Fluid Mechanics*, 78, 785 (1976).
- *4. "Pseudo-Maximum-Likelihood Speech Pitch Extraction," *IEEE Transactions on Acoustics, Speech and Signal Processing*, June 1977.
- *5. "Multidimensional Pseudo-Maximum-Likelihood Pitch Estimation," *IEEE Transactions on Acoustics, Speech and Signal Processing*, June 1978.
6. "Multichannel Zero-Crossing-Interval Pitch Estimation," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP-79)*, Washington, DC, April 1979.
- *7. "On Approximating an FIR Filter Using Discrete Orthonormal Exponentials" (correspondence), *IEEE Transactions on Acoustics, Speech and Signal Processing*, August 1981.
8. "Estimation of Modal Parameters In a Noise-Driven Linear System By an Averaged Short-Time Fourier Technique," *1st International Modal Analysis Conference (IMAC)*, Orlando, FL, November 1982.
- *9. "The 'Unity-Lagged' Short-Time Spectrum of a Narrowband Gaussian Process," *IEEE Transactions on Acoustics, Speech and Signal Processing*, October 1983.
10. "A Fourier-Ratio Technique for Pole Estimation in Random-Process Modeling," *IEEE 2nd ASSP Spectral Estimation Workshop*, Tampa, FL, November 1983.
11. "Instantaneous-Frequency Distribution vs. Time: An Interpretation of the Phase Structure of Speech," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP-85)*, Tampa, FL, March 1985.
12. "On the Dimensionality of Steady-State Vowel Normalization," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP-86)*, Tokyo, Japan, April 1986.
13. "Formulation of a Vector Distance Measure For the Instantaneous-Frequency Distribution (IFD) of Speech," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP-87)*, Dallas, TX, April 1987.
14. "Detection and Frequency Estimation of Narrow-Band Signals by Means of the Instantaneous-Frequency Distribution (IFD)," *IEEE 4th ASSP Workshop on Spectral Estimation and Modeling*, Minneapolis, MN, August 1988.
15. "Implementation of a Nonlinear Wave-Digital-Filter Cochlear Model," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP-90)*, Albuquerque, NM, April 1990. Also presented at *Mechanics and Biophysics of Hearing* conference, Univ. of Wisconsin-Madison, June 1990; proceedings published in series "Lecture Notes in Biomathematics" (Springer-Verlag) as No. 87 (P. Dallos, C. D. Geisler, et.al., eds.), 1990.