50 YEARS of Research

SIGNAL AND IMAGE PROCESSING LAB

A Historical Overview

by

David Malah

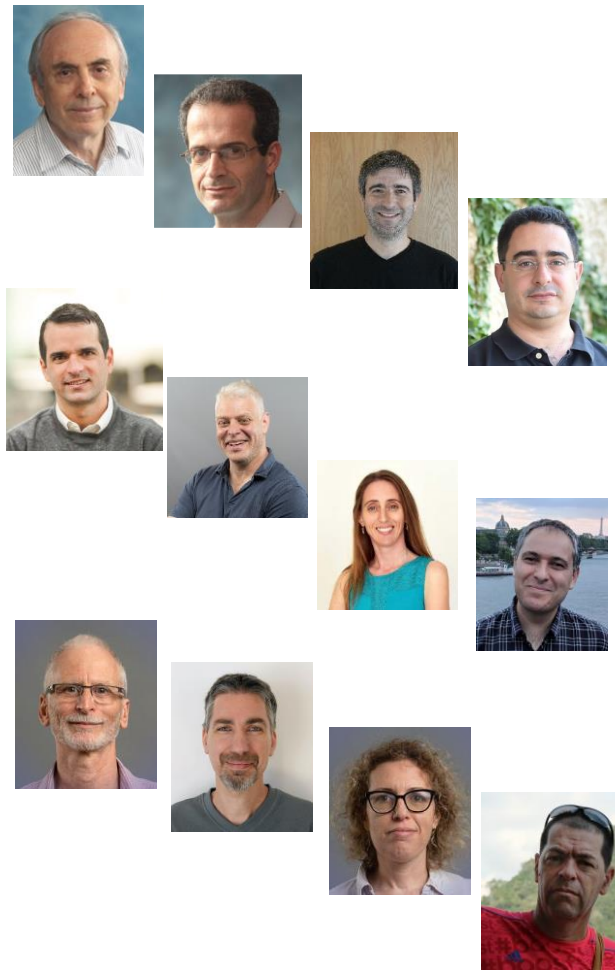
May 12, 2025

TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL SIGNAL AND IMAGE PROCESSING LAB

Lab Staff (Current)

Academic Staff

David Malah, Head	(1975)
Israel Cohen	(2001)
Ronen Talmon	(2014)
Tomer Michaeli	(2015)
Yaniv Romano	(2021)
Yossi Keshet	(2022)
Efrat Shimron	(2024)
Alejandro Cohen	(2025)

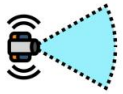


Technical Staff

- Nimrod Peleg, Chief Eng. (1986)
- Yair Moshe, Senior Eng. (2002)
- Hadas Ofir, App. Eng. (2019)
- Roy Mitrany, IT Eng. (2024)

Current and Former Chief Lab Eng. (2000)

Outline

- Founding Tale
- Digital Filters & Signal Processing Theory
- Speech and Audio Processing
- Image Processing
- Video Processing
- Remote Sensing Signal Processing 

Founding Tale

- Rapid advancement of computers and minicomputers in the 1970s.
- Central role in advancing the area of **digital signal processing** (**DSP**).
- At EE a single graduate course and no infrastructure for research.
- Closing of the Analog Instrumentation Lab in 1975 provided an opportunity of founding the Signal Processing Lab.
- Lab vision: Graduate level research, development, and implementation of DSP algorithms.

4K(g) Samples

Digital Filters

- **Design**

Wiener – Multi-echoed Decomposition (1977)

FIR - Non-Linear Phase (1979)

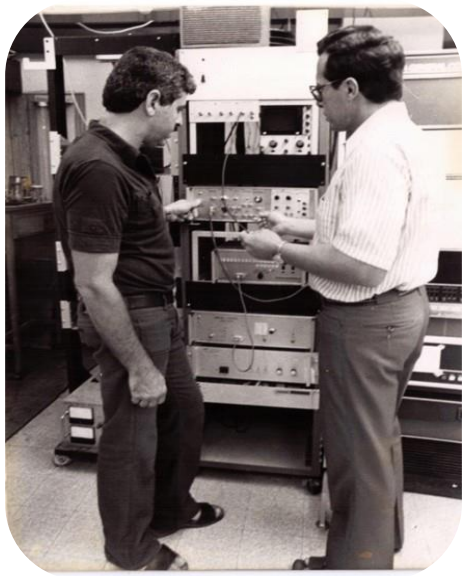
- **Real-Time Processing**

Computer Controlled DF (1977)

Hybrid Adaptive Filters (1978)

Harmonic Compression of Speech (1979)

Cyclotomic DF for Tone Detection & Location (1979)



Nova-2 Data General
64 KB, 10MB Disk

AT&T Bell Laboratories

3 AT&T Patents

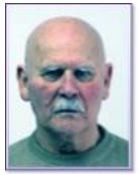
TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL 50 SIGNAL AND IMAGE PROCESSING LAB

Signal Processing Theory

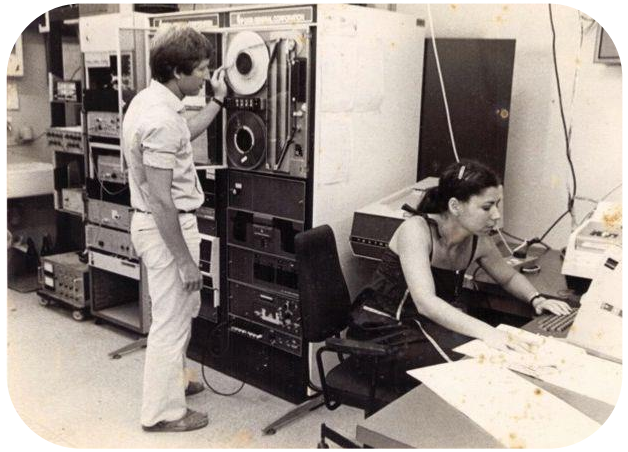
- Optimal Design of Analysis/Synthesis Filter-Banks. (1986)

State of Israel
Ministry of Communications

- Vector and Scalar Quantization under Channel Errors. (1995)



- Shift-Invariant Wavelet Packets Decomposition. (1998)



Eclipse Data General
256 KB, AP, 200 MB Disk

TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL SIGNAL AND IMAGE PROCESSING LAB

Speech Processing

- Time Domain Harmonic Scaling –TDHS (1977)

MOTOROLA AT&T Bell Laboratories

- Adaptive Filtering & Dereverberation (1979)

- **Coding**
  - Noisy Speech Coding (1984)

  - Adaptive Max. Entropy (1985)

  - Residual Coders, VQ, Subband Coding (1986-88)

  - Switched Mode ADPCM (1987)

tadiran

  - Joint Segmentation-Quant., Long-Term-Model. (2000)

  - LBR (600 bps) Temporal Decomposition (2004)

SONY TCM-353V

"TDHS Inside"

TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL SIGNAL AND IMAGE PROCESSING LAB

Speech Processing - 2

- **Enhancement**
  - Spectral Amplitude Estimators (1984)

  - Wavelet-based Denoising (2000)

- **Misc.**
  - Scrambling by STFT (1983)

  - Voice Conversion (1994)

  - AR Model with Glotal Excitation (1995)

  - Co-Channel Speech-Separation (1995)

Speech Processing - 3

- **Bandwidth Extension**

  Data Embedding In Speech Signals (2004)

  Vocal Tract Shape Est. (2012)

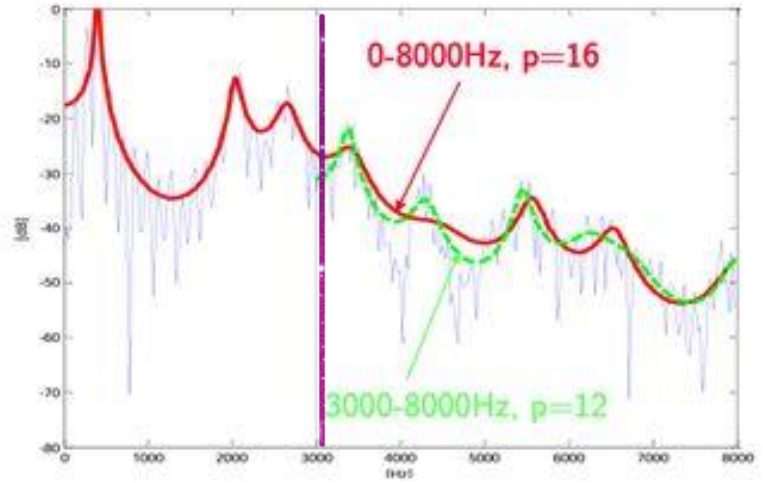
- **Text-to-Speech (TTS)**

  Hybrid TTS (2009)

  Footprint Reduction (2010)

- **Voice Conversion & Keyword Spotting**

  Statistical Methods (2010-2015)



ATMEL, DSP Design Contest 2005

Audio Processing

- **Coding**

  Wavelet-based Filter-Banks (1995)

  Improved Parametric Model (HILN) (2004)

- **Watermarking**

  Embedding & Detection (2000)

- **Audio Streaming**

  Packet-loss Concealment (2006)

Semiconductor News and Publications

Israeli Team Wins $100,000 from Texas Instruments DSP and Analog University Challenge

Grand Prize winners from Technion, Israel Institute of Technology pose with TIers: from left to right, Gene Frantz (Senior TI Fellow and lead contest judge), Nimrod Peleg (advising professor), Shay Mizrachi, Jack Kilby (TI retiree and Nobel Prize laureate), Yuval Cassuto and Michael Lustig.

DALLAS (Aug. 7, 2001) --

TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL SIGNAL AND IMAGE PROCESSING LAB

משרד המדע והטכנולוגיה

Image Processing

- **Coding**

Lossless Compression (L-Z) (1984, 87)

Dither Matrices (1985, 88)

IBM

Trellis Coding (Subband & Transf.) (1987, 88)

Ministry of Economy and Industry

Shape-Adaptive Coding (1999)

Fractal Image Coding, DWT (1993-2000)

משרד המדע והטכנולוגיה

Multimedia Applications on the Information Highway 1996 – 1999

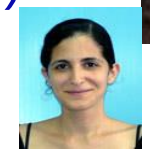
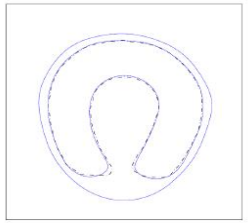
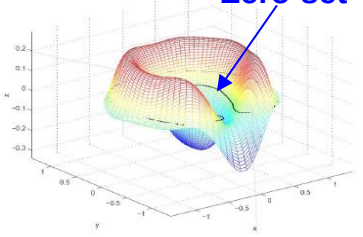
Hyperspectral 3D Coding (2000)

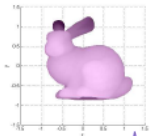
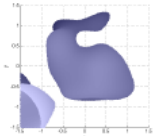
Multiple Description Wavelet Domain (2010)

TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL SIGNAL AND IMAGE PROCESSING LAB

Image Processing - 2

- **Mathematical Morphology**
  - Skeleton Representation, Geometric Sampling (1991)
  - Morphological Image Representation and Coding (1995)
  - Tree Representations for Filtering & Segmentation (2006)
- **Color Mapping:** Palletization & Compression (2000)
- **Implicit Polynomials**
  - Contour Fitting and Coding (2000)
  - 2D Object Classification (2006)
  - 3D Object Recognition (2008)

TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL SIGNAL AND IMAGE PROCESSING LAB

Image Processing - 3

- **Edge Detection**

  Evaluation of ED Algorithms (1979)

- **Restoration**

  Identification of Blur Parameters (1985)

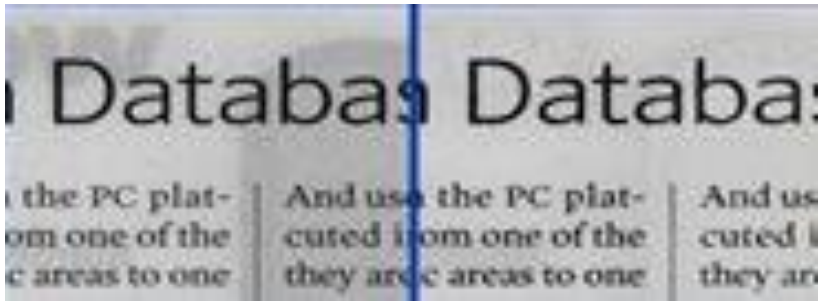
  Iterative Restoration (1988)

- **Cross-Talk Cancellation**

  Image Show-Through (2006)

- **Denoising**

  Adaptive Non-Local Means (2014)



TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL SIGNAL AND IMAGE PROCESSING LAB

Video Processing

- **Coding**
  - Switched Pred. with Motion Compensation (1988)
  - Global Motion Estimation (1991)
  - Skipped Frame Interpolation (1991)
  - Change Detection & Texture Analysis (1993)
  - Global Motion of 3D Scenes (1993)
  - Affine Motion/ Quadtree Segmentation (1995)
  - Camera Motion Tracking (2000)

Samuel Neaman Institute

Satellite Communication
1992 – 1997

Video Processing - 2

- **Transrating**
  - Optimized Requantization (MPEG-2) (2004)
  - Model-based Transrating (H.264) (2007)
- **Distributed Video Coding**
  - Modelling & Rate Control (2010)
  - Feedback-less DVC (2012)
- **Adaption to Mobile Displays**
  - ROI-based Adaptation (2009)

STRIMM

Streaming Rich Media Messaging
Magnet Prog. 2003 – 2005

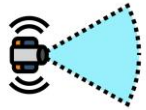
Elbit Systems

negev
THE PERSONAL VIDEO SERVICES CONSORTIUM

Next Generation Video
Magnet Prog. 2006 - 2010

TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL 50 SIGNAL AND IMAGE PROCESSING LAB

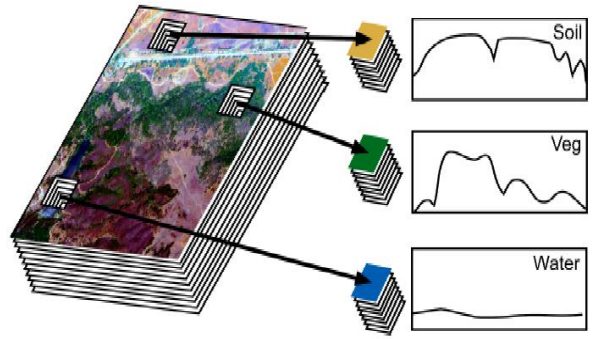
Remote Sensing Signal Processing



- **Hyperspectral**

Globally Unsupervised Anomaly Extraction (2009)

Local-Global Background Modelling



- **3D Point Clouds**

Local-to-Global Registration

Technologies of 3D analysis and understanding
Magnet Prog. 2014-2018

- **IR Sensors**

Point Targets Detection (1984)

Point Targets Tracking (1985)

Moving Targets Detection (1991)

Sensor-Level Video Signal Coding (2023)

IR sensor-level processing
Magnet Prog. 2019-2023

TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL SIGNAL AND IMAGE PROCESSING LAB

Lab Achievements

180+ Advanced Degrees Completed

12+ Professors

7 Participations in Consortia

50 YEARS

TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL SIGNAL AND IMAGE PROCESSING LAB

Summary

- A research and teaching Lab committed to excellence.
- Lab projects are inspired by cutting edge research and innovation.
- Strong, mutually rewarding collaboration with industry.
- Active participation in academic-industrial consortia.
- A Highly skilled and motivated team is at the core of our achievements.
- Attracting new researches shows continued growth and impact.

50 YEARS

Acknowledgement

I am thankful to my colleagues who served as heads of the lab during my Sabbaticals and leave of absence:

Prof. Gideon Inbar, 1979-81

Prof. Freddy Bruckstein, 1988/89

Prof. Boaz Porat, 1995/6

Prof. Shalom Raz, 2000/01

TECHNION Israel Institute of Technology | The Andrew and Erna Viterbi Faculty of ELECTRICAL & COMPUTER ENGINEERING | SIPL SIGNAL AND IMAGE PROCESSING LAB

Many Thanks

To the:

Lab Staff: Nimrod, Yair, Hadas, Roy, Yoram, Avi, Ziva, Tzipy

Current and former **Graduate Students**

Research **Colleagues**

Industry Collaborators and Supporters

50 YEARS