SIGNAL AND IMAGE PROCESSING LAB

50 YEARS של הוראה

נמרוד פלג

SIPL 50 YEARS SIGNAL AND IMAGE PROCESSING LAB | הפקולטה להנדסת חשמל ומחשבים ע"ש אנדרו וארנה ויטרבי | הטכניון מכון טכנולוגי לישראל

איך סוקרים 50
שנות פעילות ?

יש למישהו רעיון ?

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מכון טכנולוגי
לישראל

אז הכי פשוט...

ההתחלה **שלי** במעבדה... 1985

עידן החמרה: מעבדי אותות

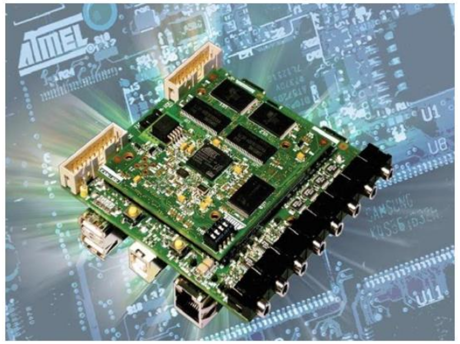
Elite Program

TMS320cxx

DSP56000

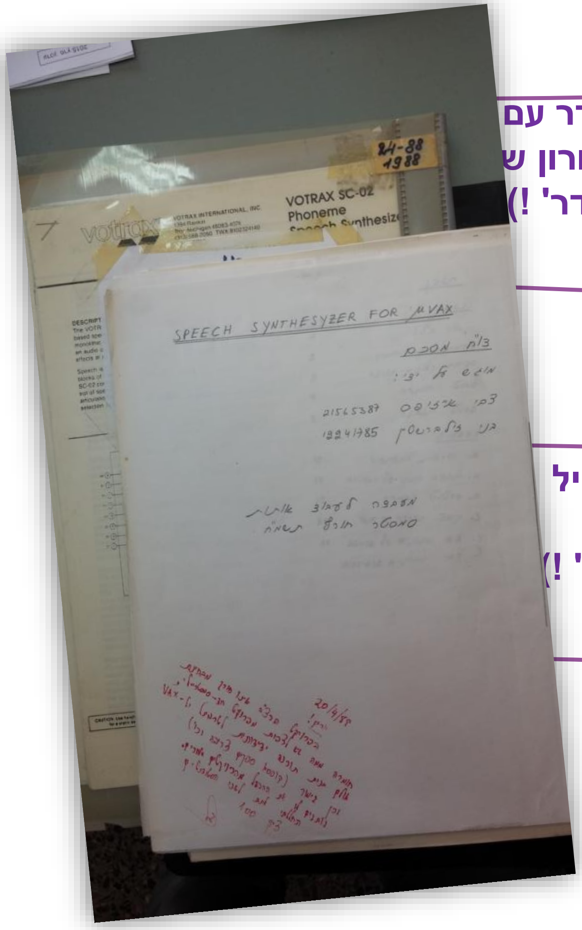
ADSP2100

Diopsis 740

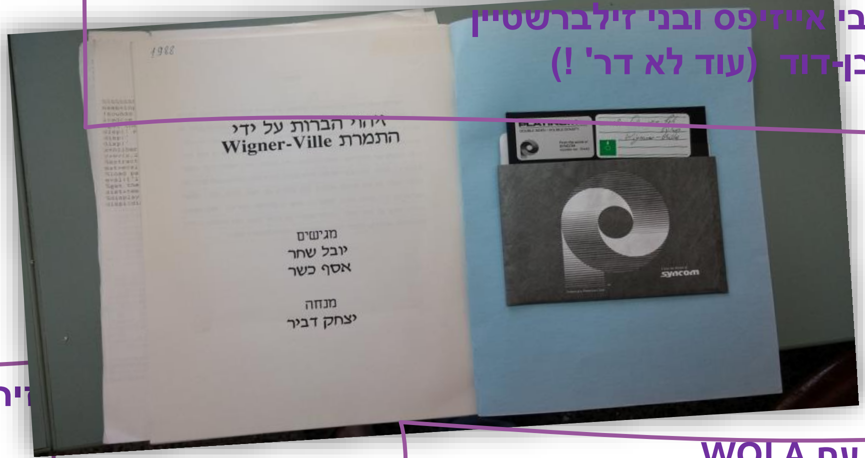


כמה דוגמאות... שנות ה - 80

מסנתז דיבור למחשב Micro-VAX (Digital) , מבוסס Votrax SC02
מבצעים: צבי אייזיפס ובני זילברשטיין
מנחה: גל בן-דוד (עוד לא דר' !)

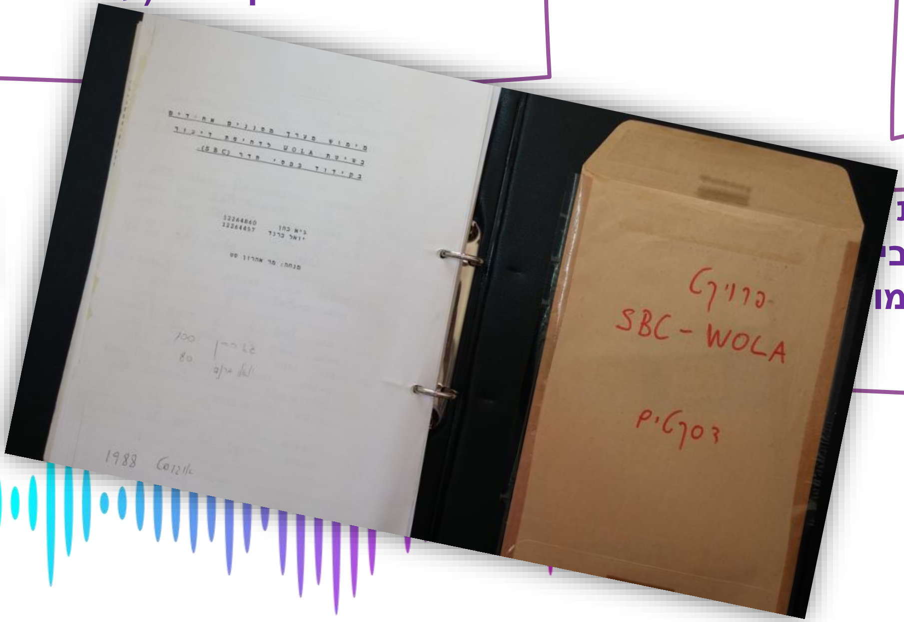


הצגת ספקטרום דיבור בפסי תדר עם
מבצעים: ירון אייזנבוד ודורון ש
מנחה: זאב רוט (עוד לא דר' !)



זיהוי הברות בעזרת התמרת וויגנר-וויל
מבצעים: אסף כשר ויובל שחר
מנחה: איציק דביר (עוד לא דר' !)

דחיסת דיבור SBC עם WOLA
מבצעים: יואל ברנד וגיא כהן (עוד לא דר' !)
מנחה: אהרון סט (עוד לא דר' !)



קידוד של סדרת
מבצע: אבי
מנחה: שמו

הטכניון מכון טכנולוגי לישראל
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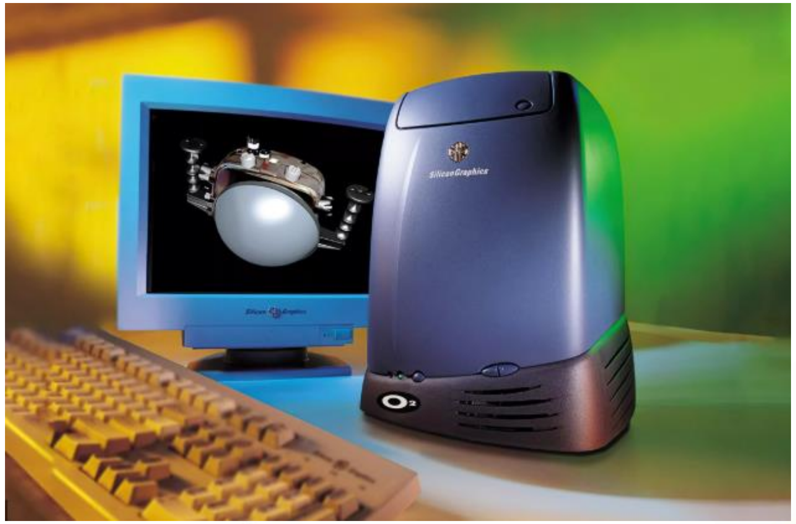
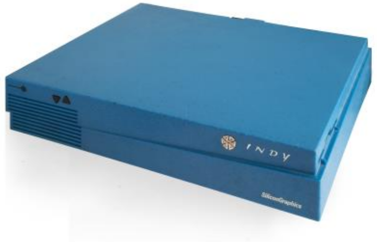
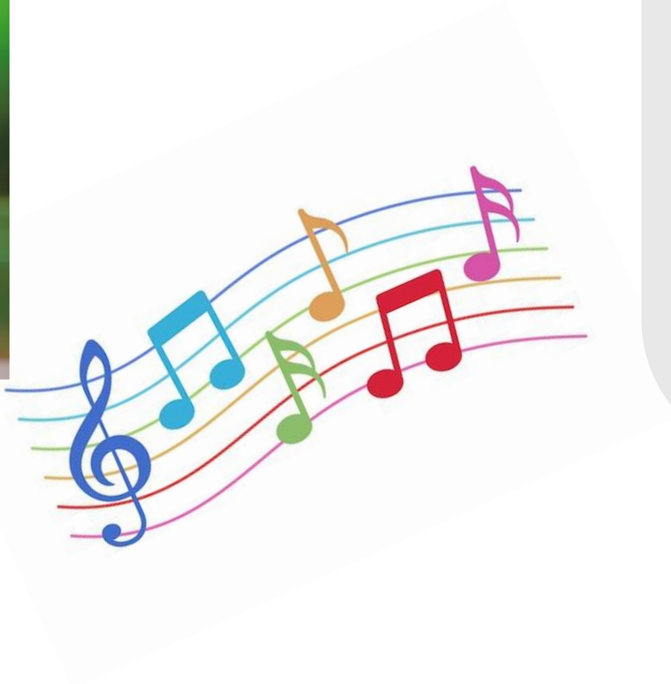
עידן ה- SGI







SiliconGraphics

2009, Chapter 11
bankruptcy ☹

כמה דוגמאות ...

Musical Signal Processing for Special Effects

Consonants of Accords

Tonal spectrum analysis for Octaves

2017 -1928

אלו ועוד רבים אחרים בהנחיית פרופ' אורי שמעוני ז"ל

ואם כבר פרויקטים בעיבוד אותות מוזיקליים

Acoustic Simulation For Earphones

Movie Subtitles Extraction

אלו ועוד רבים אחרים בהשראת ובהנחיית פרופ' בעז פורת ז"ל

1945-2015

ולא רק בתחום המוזיקלי, כמו הפרויקט הזה
בהנחייה משותפת עם (פרופ' לעתיד) מיקי אלעד:
RFI Suppression in Radiometer

עידן התפוח.... שנות ה 90

מולטימדיה ברמה אחרת !

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לישראל

עידן ארוך מאד: Matlab

MATLAB®

מאות ואולי יותר מזה פרויקטים !

עידן האלגוריתמיקה

Courtesy of

IEEE Signal Processing Society

הסתיים ?

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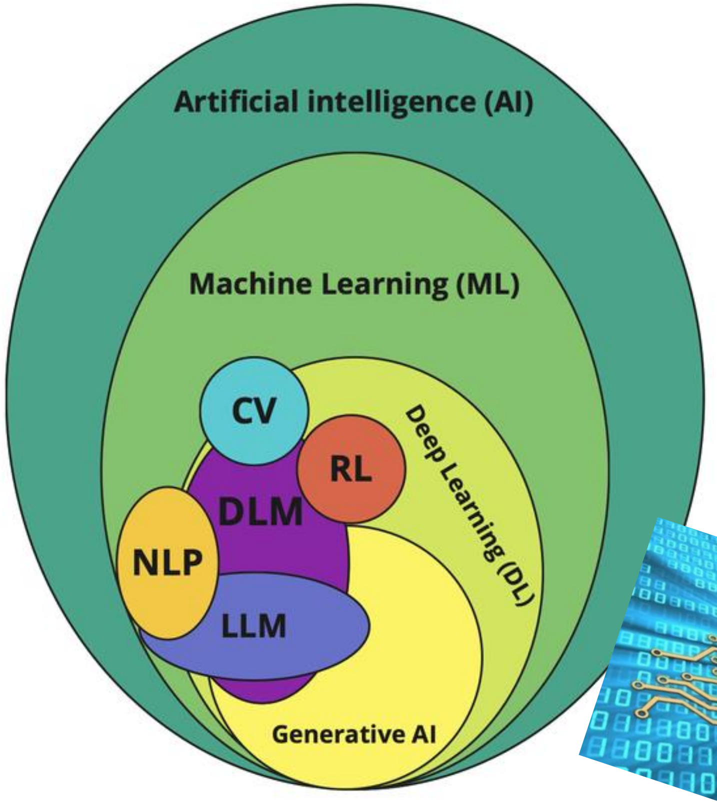
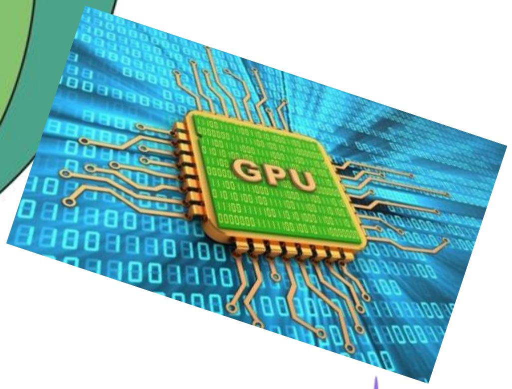
ע"ש אנדרו וארנה ויטרבי

הטכניון
מכון טכנולוגי לישראל

עידן ה - AI





IEEE Signal Processing Society

לא משנה מה הלאה-
SIPL תהיה שם !

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ניסוי מעבדה ב SIPL

Signal Processing Lab – Course No. 00450109

Through this course students become familiar with techniques for the processing of one-dimensional signals, focusing on quasi-periodic signals such as speech signals and heart signals. The first two meetings are dedicated to designing and implementing a speech compression system. The other two meeting are dedicated to the problem of heart beat rate estimation from PPG and ECG signals, using this data to diagnose heart condition.

Click here to find out more.

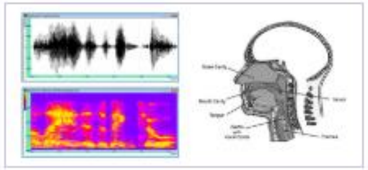


Image Processing Lab – Course No. 00450108

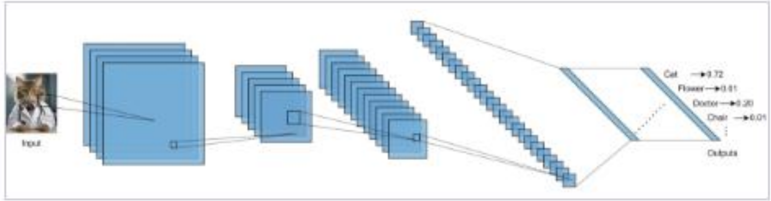
In this 4-meeting course, students acquire practical knowledge of different image processing techniques and use them for different tasks. During the course, students will apply their acquired knowledge to solve an open-ended task in image processing.

Click here to find out more.

Deep Learning Lab – Course No. 00450107

In this 4-meeting course, students acquire practical knowledge of building, training and evaluating deep-learning networks of different types and to use them for with various applications, such as text and image classification and image generation.

Click here more details.

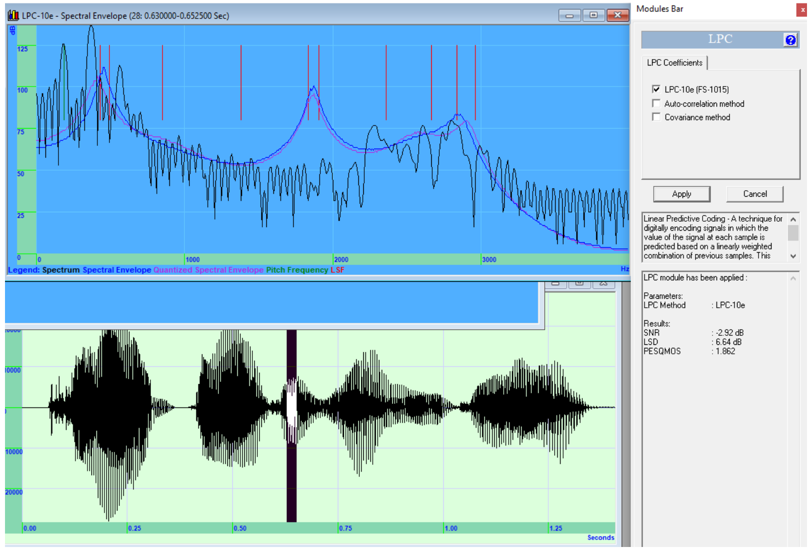


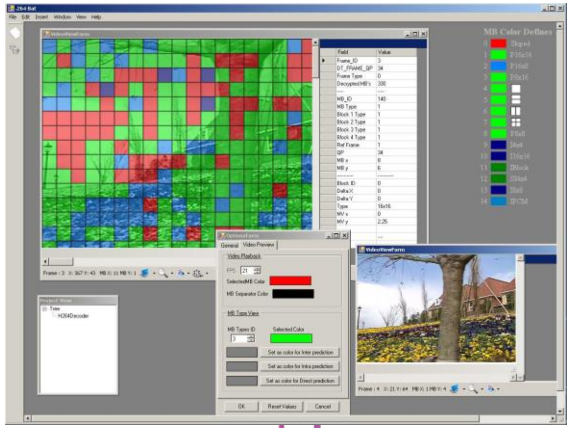
אלפי סטודנטים
החל בשנות ה - 80

כלי תכנה


SP
DEMO
Speech and Audio Processing
Learning Tool


demo
Image Compression
Learning Tool
Technion Moduls
Included


LPC-10e - Spectral Envelope (28: 0.630000-0.652500 Sec)
Modules Bar
LPC
LPC Coefficients
LPC-10e (FS-1015)
Auto-correlation method
Covariance method
Apply
Cancel
Seconds




SIPER
Signal Processing
Educational and Research Tool

פרויקטים ב SIPL

כ- 1500 פרויקטים (כ 3000 בוגרים !)

אלפי סטודנטים בקורסי מעבדה ("ניסויים")

85 מאמרים בכנסים ועיתונים מדעיים

40 פרסים טכניוניים ופקולטיים

17 פרסים בתחרויות וכנסים בינלאומיים

מעל 100 חברות בשת"פ בפרויקטים

Audio & Speech Signals

Image & Video

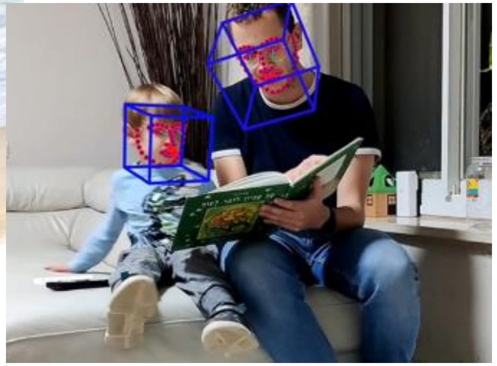
Physiological Signals

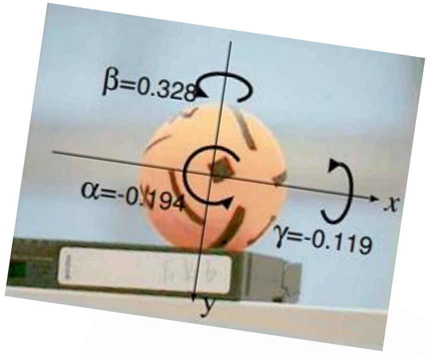
Musical Signals

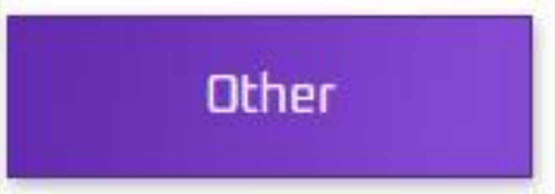
Signal Processing Theory

Machine & Deep Learning

פרויקטים ב SIPL







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פרויקטים בשת"פ

Technion

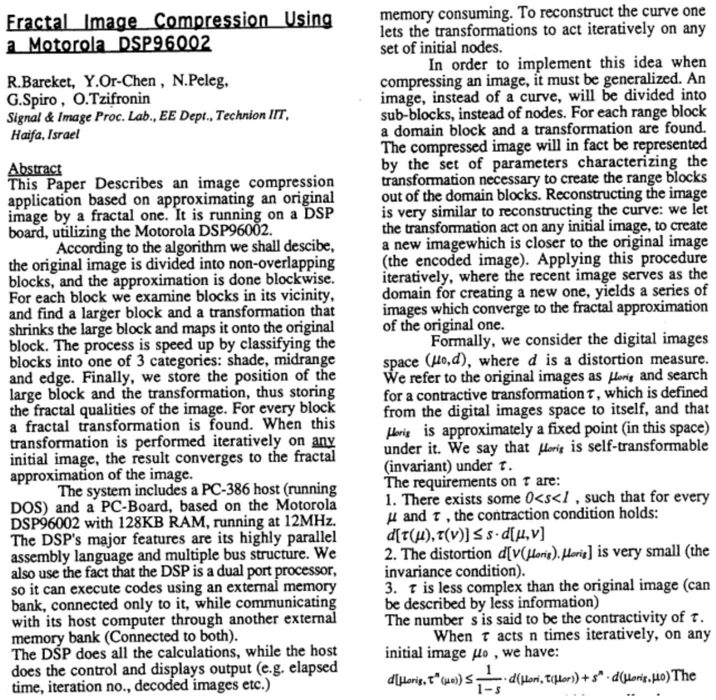
Hospitals and NPOs

Hi-Tech Industry

Academic Institutes

בחזית הטכנולוגיה

הרבה מים זרמו מאז...



Fractal Image Compression Using a Motorola DSP96002

R.Bareket, Y.Or-Chen, N.Peleg,
G.Spiro, O.Tzifronin
Signal & Image Proc. Lab., EE Dept., Technion IIT, Haifa, Israel

Abstract
This Paper Describes an image compression application based on approximating an original image by a fractal one. It is running on a DSP board, utilizing the Motorola DSP96002.

According to the algorithm we shall descibe, the original image is divided into non-overlapping blocks, and the approximation is done blockwise. For each block we examine blocks in its vicinity, and find a larger block and a transformation that shrinks the large block and maps it onto the original block. The process is speed up by classifying the blocks into one of 3 categories: shade, midrange and edge. Finally, we store the position of the large block and the transformation, thus storing the fractal qualities of the image. For every block a fractal transformation is found. When this transformation is performed iteratively on any initial image, the result converges to the fractal approximation of the image.

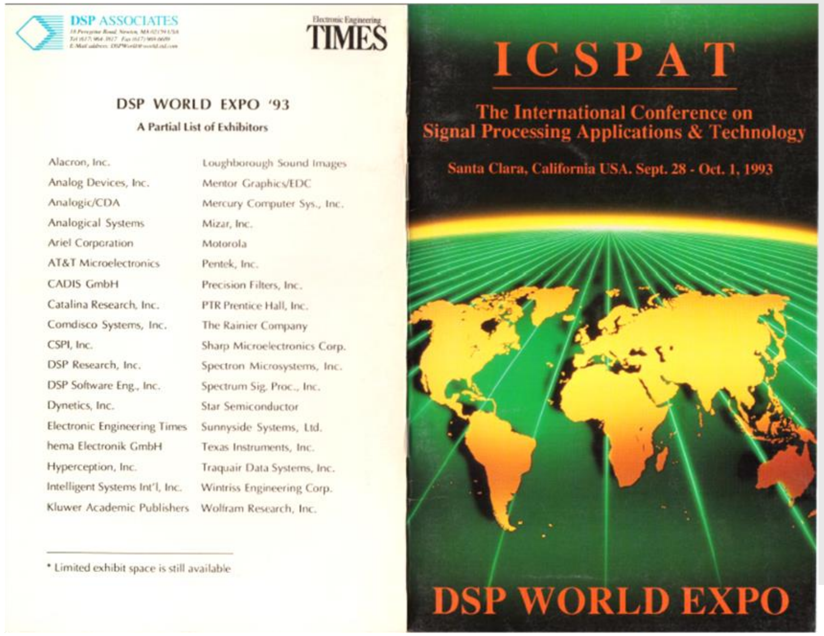
The system includes a PC-386 host (running DOS) and a PC-Board, based on the Motorola DSP96002 with 128KB RAM, running at 12MHz. The DSP's major features are its highly parallel assembly language and multiple bus structure. We also use the fact that the DSP is a dual port processor, so it can execute codes using an external memory bank, connected only to it, while communicating with its host computer through another external memory bank (Connected to both).
The DSP does all the calculations, while the host does the control and displays output (e.g. elapsed time, iteration no., decoded images etc.)

memory consuming. To reconstruct the curve one lets the transformations to act iteratively on any set of initial nodes.

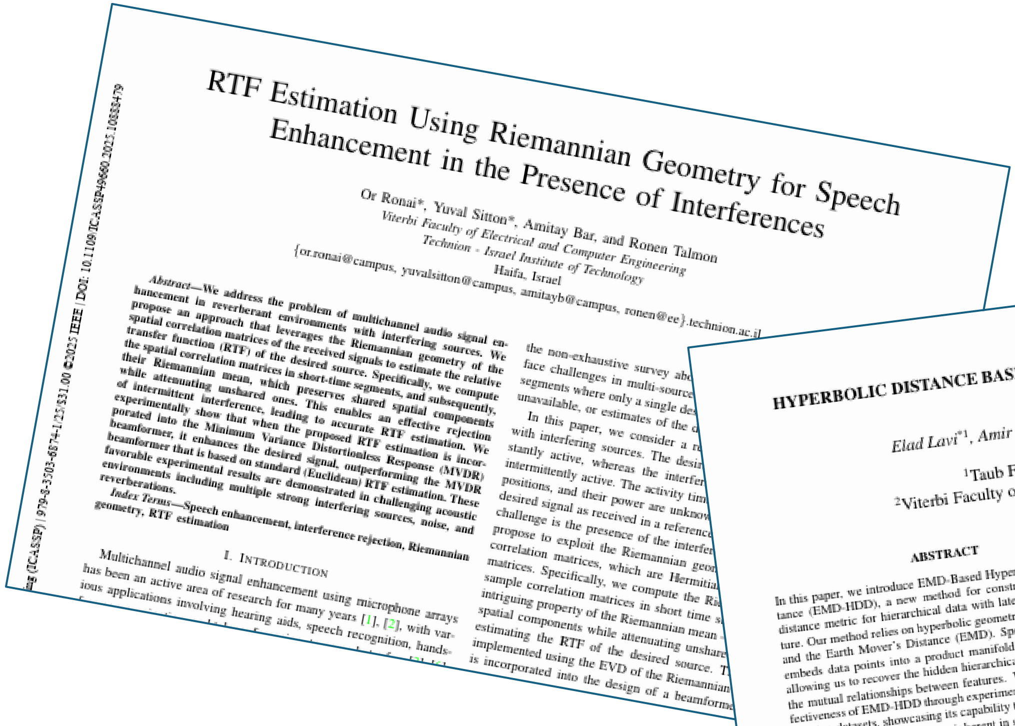
In order to implement this idea when compressing an image, it must be generalized. An image, instead of a curve, will be divided into sub-blocks, instead of nodes. For each range block a domain block and a transformation are found. The compressed image will in fact be represented by the set of parameters characterizing the transformation necessary to create the range blocks out of the domain blocks. Reconstructing the image is very similar to reconstructing the curve: we let the transformation act on any initial image, to create a new imagewhich is closer to the original image (the encoded image). Applying this procedure iteratively, where the recent image serves as the domain for creating a new one, yields a series of images which converge to the fractal approximation of the original one.

Formally, we consider the digital images space (μ_0, d), where d is a distortion measure. We refer to the original images as μ_{orig} and search for a contractive transformation τ, which is defined from the digital images space to itself, and that μ_{orig} is approximately a fixed point (in this space) under it. We say that μ_{orig} is self-transformable (invariant) under τ.
The requirements on τ are:
1. There exists some $0<s<1$, such that for every μ and τ, the contraction condition holds:
$d[\tau(\mu),\tau(\nu)] \le s \cdot d[\mu,\nu]$
2. The distortion $d[\nu(\mu_{orig}),\mu_{orig}]$ is very small (the invariance condition).
3. τ is less complex than the original image (can be described by less information)
The number s is said to be the contractivity of τ.

When τ acts n times iteratively, on any initial image μ_0, we have:
$d[\mu_{orig},\tau^n(\mu_0)) \le \frac{1}{1-s} \cdot d(\mu_{ori},\tau(\mu_{or})) + s^n \cdot d(\mu_{orig},\mu_0)$ The



וממשיכים לזרום ...



979-8-3503-6874-1/25/$31.00 ©2025 IEEE | DOI: 10.1109/ICASSP49660.2025.10888479

RTF Estimation Using Riemannian Geometry for Speech Enhancement in the Presence of Interferences

Or Ronai*, Yuval Sitton*, Amitay Bar, and Ronen Talmon
Viterbi Faculty of Electrical and Computer Engineering
Technion - Israel Institute of Technology
Haifa, Israel
{or.ronai@campus, yuvalsitton@campus, amitayb@campus, ronen@ee}.technion.ac.il

***Abstract*—We address the problem of multichannel audio signal enhancement in reverberant environments with interfering sources. We propose an approach that leverages the Riemannian geometry of the spatial correlation matrices of the received signals to estimate the relative transfer function (RTF) of the desired source. Specifically, we compute the spatial correlation matrices in short-time segments, and subsequently, their Riemannian mean, which preserves shared spatial components while attenuating unshared ones. This enables an effective rejection of intermittent interference, leading to accurate RTF estimation. We experimentally show that when the proposed RTF estimation is incorporated into the Minimum Variance Distortionless Response (MVDR) beamformer, it enhances the desired signal, outperforming the MVDR beamformer that is based on standard (Euclidean) RTF estimation. These favorable experimental results are demonstrated in challenging acoustic environments including multiple strong interfering sources, noise, and reverberations.**

***Index Terms*—Speech enhancement, interference rejection, Riemannian geometry, RTF estimation**

I. Introduction

Multichannel audio signal enhancement using microphone arrays has been an active area of research for many years [1], [2], with various applications involving hearing aids, speech recognition, hands-

HYPERBOLIC DISTANCE BASED ON EMD AND DIFFUSION FOR HYPERSPECTRAL IMAGING

Elad Lavi[*1], *Amir Bourvine*[*1], *Ya-Wei Eileen Lin*[2], *Ronen Talmon*[2]

[1]Taub Faculty of Computer Science, Technion
[2]Viterbi Faculty of Electrical and Computer Engineering, Technion

ABSTRACT

In this paper, we introduce EMD-Based Hyperbolic Diffusion Distance (EMD-HDD), a new method for constructing a meaningful distance metric for hierarchical data with latent hierarchical structure. Our method relies on hyperbolic geometry, diffusion geometry, and the Earth Mover's Distance (EMD). Specifically, our method embeds data points into a product manifold of hyperbolic spaces, allowing us to recover the hidden hierarchical structure encoded by the mutual relationships between features. We demonstrate the effectiveness of EMD-HDD through experiments on five hyperspectral imaging datasets, showcasing its capability to capture and reveal the intrinsic hierarchical structures inherent in such data.

***Index Terms*—** Hyperbolic geometry, Earth Mover's Distance, Manifold Learning, Hyperspectral Imaging

1. INTRODUCTION

Hierarchical high-dimensional data is prevalent in various fields. For example, gene expression profiles exhibit hierarchical structures formed by interactions among genes [1]. Similarly, in natural language processing, words, sentences, or documents form hierarchical structures based on linguistic categories and subcategories [2]. In

try [11], a manifold learning technique for capturing the geometric manifold structure underlying high-dimensional data, and Earth Mover's Distance (EMD), which inherently incorporates the mutual relationships between features to establish a meaningful distance between data [12]. Specifically, we construct a diffusion operator based on the EMD to learn the geometry of the data while incorporating feature mutual relations. Then, by using the EMD-based diffusion operator, we embed the data in a product manifold of hyperbolic spaces [13] based on a multi-scale diffusion process. This embedding recovers the latent hierarchical structure underlying the data, and consequently, it induces a meaningful hierarchical distance [14]. We term this new distance EMD-based Hyperbolic Diffusion Distance (EMD-HDD).

We show application to hyperspectral imaging (HSI) analysis, an area where capturing pixel hierarchy across spectral bands is critically important [15, 16]. Our method is particularly suited to HSI data, with its inherent high dimensionality and the dominant mutual relationships among spectral bands. This type of data is widely used across various fields, including agriculture and healthcare, where effective analysis can lead to significant advancements [17]. Our experiments on several HSI datasets demonstrate that the proposed EMD-HDD significantly improves classification performance in HSI tasks compared to existing methods. In addition, we conduct ablation studies to explore the contributions of each component in our

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מדריכים
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דיקנים
אנשי הפקולטה
צוות המעבדה

לדורותיהם

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