BIOGRAPHICAL SKETCH

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NAME: Levin, Anat

eRA COMMONS USER NAME (credential, e.g., agency login):

POSITION TITLE: Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE (if applicable)	END DATE MM/YYYY	FIELD OF STUDY
The Hebrew University , Jerusalem	BS	08/2001	Computer Science and Math
The Hebrew University , Jerusalem	MS	08/2002	Computer Science
The Hebrew University , Jerusalem	PHD	08/2006	Computer Science
MIT, Cambridge, Massachusetts	N/A	01/2009	Postdoc in Computer Science

A. Personal Statement

I was trained as a computer scientist with extensive experience in algorithmic tools, particularly in computer vision, graphics, and machine learning. Driven by curiosity and a desire for new challenges, I have recently ventured into optics and biomedical imaging. My current research focuses on understanding the intriguing properties of tissue scattering and developing systems to invert scattering aberrations, enabling deep tissue imaging. This work integrates novel hardware, precise physical models, and advanced algorithmic tools, leading to the creation of innovative wavefront shaping systems capable of imaging deep into scattering tissue.

1. Aizik D, Levin A. Non-invasive and noise-robust light focusing using confocal wavefront shaping. Nature Communications. 2024 July 02; 15(1):-. Available from: https://www.nature.com/articles/s41467-024-49697-w DOI: 10.1038/s41467-024-49697-w
2. Aizik D, Gkioulekas I, Levin A. Fluorescent wavefront shaping using incoherent iterative phase conjugation. Optica. 2022 July 05; 9(7):746-. Available from: https://opg.optica.org/abstract.cfm?URI=optica-9-7-746 DOI: 10.1364/OPTICA.458454
3. Bar Chen, Alterman Marina, Gkioulekas Ioannis, Levin Anat. A Monte Carlo framework for rendering speckle statistics in scattering media. ACM Transactions on Graphics (TOG). 2019; 38(4):1--22.
4. Levin Anat, Fergus Rob, Durand Fr\'edo, Freeman William T. Image and depth from a conventional camera with a coded aperture. ACM transactions on graphics (TOG). 2007; 26(3):70--es.

B. Positions, Scientific Appointments and Honors

<u>Positions and Scientific Appointments</u>

2022 -	Professor, Technion, Israel Inst. of Technology, Haifa
2017 - 2022	Associate Prof, Technion, Israel Inst. of Technology, Haifa
2014 - 2016	Associate Prof., The Weizmann Institute of Science, Rehovot
2009 - 2014	Assistant Professor, The Weizmann Institute of Science, Rehovot

<u>Honors</u>

2024	Best student paper finalist, Optica imaging congress
2024	Eurographics Outstanding Technical Contributions Award, Eurographics
2018	Blavatnik Award, The New York Academy of Sciences

2015	M. Bruno Memorial Award, Rothschild Foundation
2013	PAMI Young Researcher Award, CVPR
2013	Krill Prize, Wolf Foundation
2010	Eurographics Young Researcher Award, Eurographics
2009	TR35 Young Innovator Award, MIT's Technology Review
2009	Best Paper Award Runner-Up, CVPR
2008	AI's 10 to Watch, IEEE Intelligent Systems magazine
2007	Best Paper Award Runner-Up, CVPR
2006	Longuet-Higgins Best Paper Award, ECCV
2002	Ben Wegbreit Best Student Paper Award Finalist, NIPS

C. Contribution to Science

1. Wavefront shaping systems:

   We developed wavefront shaping systems capable of correcting tissue scattering aberrations, enabling us to see deep into the tissue. Our fast algorithms estimate the desired modulations from weak biological data, and we have successfully demonstrated imaging weak fluorescent neurons deep within scattering brain tissue.

   a. Aizik D, Levin A. Non-invasive and noise-robust light focusing using confocal wavefront shaping. Nature Communications. 2024 July 02; 15(1):-. Available from: https://www.nature.com/articles/s41467-024-49697-w DOI: 10.1038/s41467-024-49697-w
   b. Aizik D, Gkioulekas I, Levin A. Fluorescent wavefront shaping using incoherent iterative phase conjugation. Optica. 2022 July 05; 9(7):746-. Available from: https://opg.optica.org/abstract.cfm?URI=optica-9-7-746 DOI: 10.1364/OPTICA.458454

2. Speckle simulation tools:

   We developed a computationally efficient algorithm inspired by Monte Carlo ray tracing algorithms, capable of simulating physically accurate fields resulting from the coherent propagation of light through volumetric scattering materials. Traditional tools for solving the wave equation exactly are computationally prohibitive and limited to toy problems. In contrast, our algorithm is orders of magnitude faster and scales to much larger scenes while maintaining physical accuracy and capturing all the statistical properties of such fields.

   a. Alterman M, Bar C, Gkioulekas I, Levin A. Imaging with Local Speckle Intensity Correlations: Theory and Practice. ACM Transactions on Graphics. 2021 July 15; 40(3):1-22. Available from: https://dl.acm.org/doi/10.1145/3447392 DOI: 10.1145/3447392
   b. Bar C, Alterman M, Gkioulekas L, Levin A. Single scattering modeling of speckle correlation. 2021 IEEE International Conference on Computational Photography (ICCP). 2021 IEEE International Conference on Computational Photography (ICCP); ; Haifa, Israel. IEEE; c2021. Available from: https://ieeexplore.ieee.org/document/9466262/ DOI: 10.1109/ICCP51581.2021.9466262
   c. Bar Chen, Gkioulekas Ioannis, Levin Anat. Rendering near-field speckle statistics in scattering media. ACM Transactions on Graphics (TOG). 2020; 39(6):1--18.
   d. Bar Chen, Alterman Marina, Gkioulekas Ioannis, Levin Anat. A Monte Carlo framework for rendering speckle statistics in scattering media. ACM Transactions on Graphics (TOG). 2019; 38(4):1--22.

3. Differentiable rendering:

   Many materials around us, such as food and tissue, scatter light, and their scattering properties depend on their intrinsic bulk components. We developed a system that can infer these physical properties from images of the scattered light. In our effort to measure scattering parameters, we introduced the concept of differentiable rendering.

Our goal was to capture images of scattering materials and identify material parameters that, when input into a Monte-Carlo (MC) rendering simulator, produce appearance predictions consistent with the captured images. To achieve this optimization, we needed to differentiate the MC ray tracing process. However, since the MC process is not an analytic function, this differentiation is not straightforward. We addressed this by introducing differentiable rendering and demonstrated that with simple modifications to the MC process, gradients can be evaluated as another MC process.

Beyond the state-of-the-art material acquisition results achieved in this paper, the ability to differentiate a rendering process has significant applications in training computer graphics rendering algorithms using deep networks. This concept forms the foundation for modern neural rendering approaches. Today, a Google search for "differentiable rendering" yields over 700,000 results, and differentiable rendering implementations have been integrated into popular rendering libraries such as Mitsuba 2.

a. Gkioulekas Ioannis, Levin Anat, Zickler Todd. An evaluation of computational imaging techniques for heterogeneous inverse scattering. European Conference on Computer Vision; 2016; c2016.
b. Gkioulekas Ioannis, Zhao Shuang, Bala Kavita, Zickler Todd, Levin Anat. Inverse volume rendering with material dictionaries. ACM Transactions on Graphics (TOG). 2013; 32(6):1--13.

4. A closed-form solution to natural image matting:

Our work allows the extraction of an object from an image and implanting it on a novel background, while plausibly respecting translucent components and fuzzy boundaries. While the problem was previously approached using complex non linear optimization, the elegance of our solution was by showing that this can be approached by a convex least square problem whose global optimum can be easily calculated.

a. Levin Anat, Lischinski Dani, Weiss Yair. A closed-form solution to natural image matting. IEEE transactions on pattern analysis and machine intelligence. 2007; 30(2):228--242.
b. Levin Anat, Rav-Acha Alex, Lischinski Dani. Spectral Matting. IEEE Conference on Computer Vision and Pattern Recognition; 2007; c2007.

5. Computational cameras:

I contributed to the early development of computational cameras, in particular the motion invariant camera and a coded aperture camera. Coded apertures modify the defocus blur of a camera in a way that will make it depth sensitive as well as allow a better restoration of defocus blur. During the years since, the idea was widely spread and adapted in many computational imaging systems.

a. Levin Anat, Sand Peter, Cho Taeg Sang, Durand Fr\'edo, Freeman William T. Motion-invariant photography. ACM Transactions on Graphics (TOG). 2008; 27(3):1--9.
b. Levin Anat, Fergus Rob, Durand Fr\'edo, Freeman William T. Image and depth from a conventional camera with a coded aperture. ACM transactions on graphics (TOG). 2007; 26(3):70--es.