

IEEE Open Lecture on Remote Medical and Industrial Conditions Monitoring Using Laser Speckle Patterns

Date and time: August 21, 12:00 p.m.

Venue: room NRG-422, TalTech's NRG building, Ehitajate tee 5/10, Tallinn

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Yevgeny Beiderman received his B.Sc. in Mechanical Engineering and M.Sc. in Intermediate studies in Engineering from Tel-Aviv University, Israel, in 1999 and 2002, respectively. Yevgeny completed his Ph.D. jointly in Math and Electro-Optical Engineering at Bar-Ilan University, Israel. He stayed later for the postdoc period at the same university.

Yevgeny filled various scientific and engineering positions in the industry for more than 15 years. His fields of interest are optical remote sensing, biomedical engineering, and machine learning / AI. Yevgeny filled many industrial roles during the last 2 decades, including the lead of the development of cutting-edge medical and industrial technologies. Yevgeny is currently a researcher at Holon Institute of Technology, Israel (HIT).

Yevgeny published more than 40 papers, 2 book chapters, and filed 8 patents. Yevgeny won various international prizes for the development of remote sensing technology applications.

Abstract

Dr. Beiderman will present his research on the different aspects of laser–tissue and laser–body interaction using speckle-based analysis of the backscattered light, enhanced by AI analysis of the reconstructed signal from the speckle pattern.

The speckle-based body movement monitoring approach is very modular and does not impose any constraints regarding the relative position of the body and the detection device. The optical setup used for detection is very simple and versatile. The setup consists of a laser and a small camera. The principle is to observe the movement of the secondary speckle patterns that are generated on the target when it is illuminated by a spot from a laser beam. These secondary speckle patterns are self-interfering, and therefore, movement detection based on phase extraction of the optical wavefront does not require an external interferometer. The temporal trajectories of the speckles captured by the camera are proportional to the temporal information. Various sound or vibration sources are imaged in different spatial pixels, making voice or movement separation a very simple task using the proposed concept.

In this talk, I would also like to introduce an AI technique for classification, recognition, and identification of the reconstructed signal obtained from the objects' reflected light. The main approach proposed is to use the uniquely extracted signature from the speckle-based signals in relation to different medical conditions of a subject using related AI-based manipulations. The real advantage of the proposed approach is that identification and classification can be achieved even in cases where the spatially captured image has low resolution and does not on its own allow the above-mentioned operations.

Among the possible medical conditions to be identified by the proposed technique, it was possible to obtain a connection to coagulation problems, diabetes, abnormal heart sounds, and other chronic conditions. Moreover, it could also be interesting to apply the proposed technique to identify acute conditions such as heart attacks, strokes, etc.

There are also some industrial applications applicable to this technique, like remote vibration monitoring, or microscopic movement extraction for various industries.