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New attempt to suppress scattering effect in trans-body imaging of animal bodies

Abstract: Near-infrared (NIR) light experiences relatively low attenuation when passing through animal bodies compared to other wavelengths. Using a high-performance imaging system, transillumination images can be obtained with this light. However, NIR transillumination images are significantly blurred due to light scattering within body tissues. To address this issue, we have developed techniques to suppress scattering and deblur images. These include the extraction of near-axis scattered light from diffuse light, deconvolution with a point spread function, time reversal using phase-conjugate waves, and the application of deep-learning neural networks in image processing. With these methods, we can create a practical imaging system that enables noninvasive visualization of the macroscopic structure of internal organs. Additionally, the degree of blurring in the images correlates with the depth of the light-absorbing object. By using this blur as an indicator of depth, we can identify the depth of each absorber element through deep-learning techniques. Building on this concept, we have developed a new technique to reconstruct clear three-dimensional images of absorbers within turbid media from a single two-dimensional blurred transillumination image. Moreover, this technique can be applied to visualize various physiological functions in vivo using the rich knowledge base of spectroscopy. For instance, we have successfully visualized changes in kidney circulation and brain activation in response to somatosensory stimulation. This technique offers a new imaging modality for biological experiments without the need for sacrificing experimental animals.

Keywords: Near-infrared, trans-body imaging, transillumination, scattering suppression, 3D imaging, functional imaging.

Biography: Koichi Shimizu received M.S. (1976) and Ph.D. (1979) degrees, from University of Washington, Seattle, USA. He was Research Associate in University of Washington 1974-79. He was an Assistant-, an Associate- Professors, and a Professor in Hokkaido University, Sapporo, Japan in 1979-2016. He is currently a Professor Emeritus of Hokkaido University, Japan, an Invited Research Professor of Waseda University, Japan and a Professor of Xidian University, Xi'an, China. He served as an associate editor of IEEE Trans. ITB in 1999-2007. He has been a Fellow of the Electromagnetics Academy, and an editorial board member of Scientific Reports, Nature.