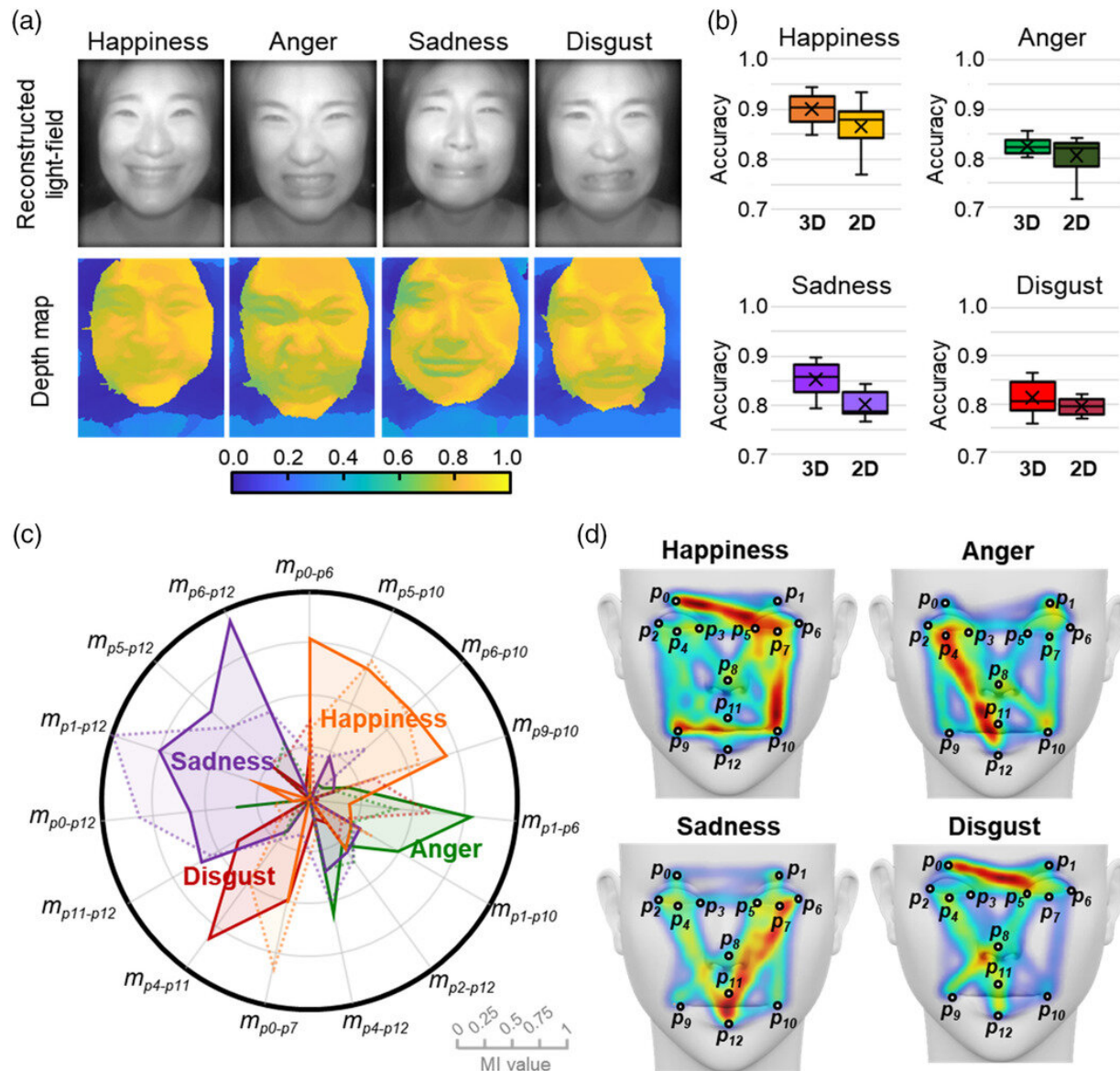


AI light-field camera reads 3D facial expressions

January 21 2022



Facial expression reading based on MLP classification from 3D depth maps and

2D images obtained by NIR-LFC. Credit: KAIST

A joint research team led by Professors Ki-Hun Jeong and Doheon Lee from the KAIST Department of Bio and Brain Engineering reported the development of a technique for facial expression detection by merging near-infrared light-field camera techniques with artificial intelligence (AI) technology.

Unlike a conventional [camera](#), the light-field camera contains micro-lens arrays in front of the image sensor, which makes the camera small enough to fit into a smart phone, while allowing it to acquire the spatial and directional information of the light with a single shot. The technique has received attention as it can reconstruct images in a variety of ways including multi-views, refocusing, and 3D image acquisition, giving rise to many potential applications.

However, the optical crosstalk between shadows caused by external light sources in the environment and the micro-lens has limited existing light-field cameras from being able to provide accurate image contrast and 3D reconstruction.

The joint research team applied a vertical-cavity surface-emitting laser (VCSEL) in the near-IR range to stabilize the accuracy of 3D image reconstruction that previously depended on environmental light. When an external light source is shone on a face at 0-, 30-, and 60-degree angles, the light field camera reduces 54% of image reconstruction errors. Additionally, by inserting a light-absorbing layer for visible and near-IR wavelengths between the micro-lens arrays, the team could minimize optical crosstalk while increasing the image contrast by 2.1 times.

Through this technique, the team could overcome the limitations of existing light-field cameras and was able to develop their NIR-based light-field camera (NIR-LFC), optimized for the 3D image reconstruction of [facial expressions](#). Using the NIR-LFC, the team acquired high-quality 3D reconstruction images of facial expressions expressing various emotions regardless of the lighting conditions of the surrounding environment.

The facial expressions in the acquired 3D images were distinguished through machine learning with an average of 85% accuracy—a statistically significant figure compared to when 2D images were used. Furthermore, by calculating the interdependency of distance information that varies with facial expression in 3D images, the team could identify the information a light-field camera utilizes to distinguish human expressions.

Professor Ki-Hun Jeong says that "the sub-miniature light-field camera developed by the research team has the potential to become the new platform to quantitatively analyze the facial expressions and emotions of humans." To highlight the significance of this research, he added, "it could be applied in various fields including mobile healthcare, field diagnosis, social cognition, and human-machine interactions."

This research was published in *Advanced Intelligent Systems*.

More information: Sang-In Bae et al, Machine-Learned Light-Field Camera that Reads Facial Expression from High-Contrast and Illumination Invariant 3D Facial Images, *Advanced Intelligent Systems* (2021). [DOI: 10.1002/aisy.202100182](https://doi.org/10.1002/aisy.202100182)

Provided by KAIST

Citation: AI light-field camera reads 3D facial expressions (2022, January 21) retrieved 24 April 2024 from <https://techxplore.com/news/2022-01-ai-light-field-camera-3d-facial.html>

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