Advancing Grape Cultivation with AI and AR: Artificial Vision and Quality Control in Smart Agriculture

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ABSTRACT

Yamanashi Prefecture is Japan's leading grape-producing region, renowned for its premium table grapes, such as the Shine Muscat variety, which enjoy a strong reputation both domestically and internationally. This exceptional quality is supported by the *takumi*—expert cultivation techniques refined over many years of experience. However, the aging of skilled growers and a declining agricultural workforce have made the transmission and efficiency of these techniques an urgent challenge.

This keynote introduces an innovative approach that leverages Artificial Intelligence (AI) and Augmented Reality (AR) to address this issue. Expert viticulture techniques were captured in video and used to train deep learning models. These models are integrated into a smart support system that analyzes images of grape clusters captured in real time by a camera mounted on an optical see-through head-mounted display. Based on the analysis, the system delivers instant visual guidance to the wearer, enabling novice growers to perform tasks with precision akin to that of seasoned professionals.

Evaluation experiments have demonstrated that new farmers using this system can achieve grape quality equivalent to that of experienced professionals. In addition to supporting new grape growers, this technology is being extended to other crops as well. It has also been successfully applied to assist individuals with intellectual disabilities in agricultural tasks. The presentation will also touch on the development of an AI-powered robotic system for grape cultivation that utilizes the trained deep learning models.

BIOGRAPHY

Dr. Xiaoyang Mao is the Executive Director and Vice President of the University of Yamanashi, Japan, where she also serves as a Professor in the Department of Computer Science and Engineering. She earned her B.S. in Computer Science from Fudan University in China, and her M.S. and Ph.D. in Computer Science from the University of Tokyo, Japan.

She has held research appointments abroad, including as a postdoctoral fellow at the State University of New York at Stony Brook and as a visiting researcher at the Computer Vision Laboratory of the University of California, Berkeley. Her research interests span image processing, computer graphics, virtual and augmented reality, and artificial intelligence, with applications in e-health and smart agriculture.

Dr. Mao has contributed to numerous international conferences, serving as Program Chair for Cyberworlds 2013, NICOGRAPH International 2016, and Computer Graphics International 2017, and as

General Chair of Cyberworlds 2024. She is also an Associate Editor of *The Visual Computer* (Springer Nature).

In recognition of her outstanding achievements and dedicated service to the computer graphics community, she was honored with the Computer Graphics International Career Achievement Award in 2018 and the CG Japan Award in 2024.