GALLOGLY COLLEGE OF ENGINEERING
STEPHENSON SCHOOL OF BIOMEDICAL ENGINEERING
The UNIVERSITY of OKLAHOMA

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3D IMAGING AND COMPUTATIONAL MODELING FOR SURGICAL PLANNING, INTRAOPERATIVE GUIDANCE, AND SHARED DECISION-MAKING IN BREAST RECONSTRUCTION

Fatima Merchant, Ph.D.
Professor of Biomedical Engineering
University of Oklahoma

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Gallogly Hall, Room 126

ABSTRACT

Breast reconstruction is a central component of the breast cancer treatment process for many women. The purpose of breast reconstruction is to recreate a breast form that is satisfying to the patient, facilitating her psychosocial adjustment of living as a breast cancer survivor. Breast reconstruction is a complex, data-limited surgical problem that requires translating patient-specific anatomy and aesthetic preferences into reproducible surgical outcomes. Current clinical workflows rely heavily on qualitative assessment and clinical photographs (2D), which inadequately capture 3D breast geometry and limit both patient–surgeon communication and objective surgical planning.

This work addresses these gaps through the development of integrated computational frameworks grounded in three-dimensional (3D) surface imaging, statistical shape modeling, and machine learning. Supported by NIH funding, we have established a longitudinal dataset of 500 breast reconstruction patients and developed methods for extracting quantitative descriptors of breast morphology from stereophotogrammetry. These data are used to construct parametric 3D models that capture population-level variation and enable patient-specific shape representation.

Building on this foundation, we present three translational components: (1) automated breast morphometry for objective and reproducible surgical planning, (2) simulation frameworks that integrate parametric shape models with patient-specific data to support visualization and shared decision-making during clinical consultation, and (3) image-driven intraoperative guidance systems for free-flap tissue shaping. Collectively, these approaches transform breast reconstruction from a largely subjective process into a data-driven, model-based workflow.

This work illustrates how biomedical imaging, computational modeling, and AI/ML can be integrated to address clinically relevant challenges in reconstructive surgery, with the potential to improve surgical precision, standardize outcome assessment, and enhance patient-centered care.

BIO

Fatima Merchant (Senior Member, IEEE) is a biomedical engineer whose research advances quantitative imaging and computational methods for clinical decision-making, surgical planning, and biological discovery. Trained in biomedical engineering at the University of Mumbai and The University of Texas at Austin (M.S., Ph.D.), she integrates multidimensional imaging, computational medicine, and tissue engineering to develop data-driven frameworks that bridge engineering innovation with translational impact.

She is a Professor in the Stephenson School of Biomedical Engineering and Director of Biomedical Data Science in the Gallogly College of Engineering at The University of Oklahoma, with adjunct appointments at the University of Houston and The University of Texas at Austin. Following postdoctoral training at Harvard Medical School, she spent a decade in the bioimaging industry as Lead Research Engineer at Iris International and its subsidiaries.

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