29 JUNE - 3 JULY
ACEX2026
RHODES · GREECE

19th International Conference on Advanced Computational Engineering and Experimenting
29 JUNE – 3 JULY 2026 | RHODES, GREECE

ABSTRACT:

From Anatomical Models to Surgical Prototypes: Clinical Applications of Medical 3D Printing

Juan Alfonso Beltrán-Fernández[1a]*, Mauricio González Rebattú y González[2b], Alejandro González-Rebattú[2c], Elias Humberto Hermida-Ochoa[3d], Alejandro Tonatiu Velázquez-Sánchez[1e], Pablo Moreno Garibaldi[1f]

*Corresponding author

[1]Instituto Politécnico Nacional - Escuela Superior de Ingeniería Mecánica y Eléctrica - Sección de Estudios de Posgrado e Investigación Edificio 5, 2do Piso, Unidad Profesional Adolfo López Mateos "Zacatenco" Col. Lindavista, C.P. 07738, Ciudad de México, México.

[2]ISSSTE Hospital Regional 1° de Octubre, Av. Instituto Politécnico Nacional 1669, Magdalena de las Salinas, Gustavo A. Madero, 07760 Ciudad de México, CDMX

[3]Hospital de Ortopedia Dr. Germán Díaz Lombardo, CILAB, Del Carmen 18, Chimalistac, Álvaro Obregón, 01070 Ciudad de México, CDMX

Email: a*jbeltran@ipn.mx , bmauriciorebattu@yahoo.com.mx, ctyo.rebattu@gmail.com ddrelias@hermidagroup.com, eatvelazquezs@ipn.mx, hpmg170588@gmail.com

Additive manufacturing (AM) has become a relevant tool for the development of patient-specific models and devices in biomedical engineering. In clinical practice, three-dimensional printing is commonly used to transform medical imaging data into physical anatomical models that assist in surgical planning, medical training, and patient communication. Most of these models are produced using fused deposition modeling (FDM) with thermoplastic materials such as polylactic acid (PLA) and acrylonitrile butadiene styrene (ABS). More recently, stereolithography (SLA) and related photopolymer-based technologies have enabled the fabrication of components with higher geometric accuracy and improved surface quality, which are required for surgical guides and precision medical prototypes.

This work presents a workflow for the implementation of additive manufacturing protocols in healthcare engineering. The proposed methodology integrates medical image segmentation, computer-aided design, and polymer-based additive manufacturing to generate anatomical models and surgical prototypes derived from clinical imaging data. Medical datasets, including computed tomography (CT) and magnetic resonance imaging (MRI), are segmented to obtain three-dimensional geometries that are converted into printable STL models. Different applications are shown and the resulting components are fabricated using either thermoplastic filaments or photopolymer resins.

Experimental evaluation includes dimensional accuracy measurements, mechanical characterization of printed structures, and geometric validation of anatomical replicas. Case studies are presented to illustrate the fabrication of resin-based models derived from oncological imaging datasets, allowing the reproduction of internal anatomical features and supporting visualization of tumor-related regions for surgical planning and medical training.

Additionally, the study explores the feasibility of reprocessing selected polymeric materials used in medical environments in order to reduce material waste and promote more sustainable manufacturing practices. The results demonstrate that additive manufacturing can effectively integrate medical imaging, engineering design, and rapid prototyping to produce functional anatomical models and surgical prototypes while contributing to more sustainable healthcare engineering solutions.

Keywords: Additive Manufacturing, Medical 3D Printing, Anatomical Models, Surgical Guides, Photopolymer Resins