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Biography

Sushma Jaiswal, is an Assistant Professor in the Department of Computer Science & IT at Guru Ghasidas Vishwavidyalaya, Bilaspur. She holds a Ph.D. from RGPV and a D.Sc. in Computer Science & Engineering (2024). With over 21 years of experience, her expertise includes AI, Machine Learning, and Digital Image Processing. A prolific inventor, she holds a world record for the highest number of patents and copyrights filed by an individual, grants across the UK, Australia, Germany, and South Africa. She has published 150+ research papers, authored 40 books, and mentored multiple Ph.D. scholars. Recognized as a “Best Women Scientist,” she also serves as an International Educational Ambassador and reviewer for IEEE and Springer journals. Her leadership includes roles as NSS Program Officer and Alumni Coordinator. She was notably offered a Research Engineer role for Google’s R&D projects in 2017.

AI-Optimized Topology for Reducing Periprosthetic Bone Loss in Total Joint Replacements

Abstract:

Objective: To design a femoral stem that mimics the mechanical properties of natural cortical bone using AI-driven topology optimization, thereby mitigating periprosthetic bone loss caused by stress shielding.

Methods: We utilized a Generative Adversarial Network (GAN) integrated with a Physics-Informed Neural Network (PINN) to evolve the internal lattice structure of a Titanium-alloy (Ti6Al4V) hip stem. The AI was tasked with maximizing the “Strain Energy Density” (SED) in the surrounding periprosthetic bone while maintaining a safety factor of 2.0 against fatigue failure. Over 10,000 “In Silico” loading cycles (simulating walking, climbing stairs, and stumbling) were processed to refine the topology.

Results: The AI-optimized “biomimetic” stem featured a functionally graded porous architecture, with higher porosity in the proximal region and a dense core. Compared to traditional solid stems, the optimized design increased load transfer to the proximal femur by 64%.

Conclusion: AI-optimized topology allows for a “mechanical match” between implant and bone, significantly reducing the risk of long-term aseptic loosening and the need for revision surgery.