

Title: Minimally Invasive *in-situ* 3D Bioprinting for Programmable Osteochondral Defect Regeneration

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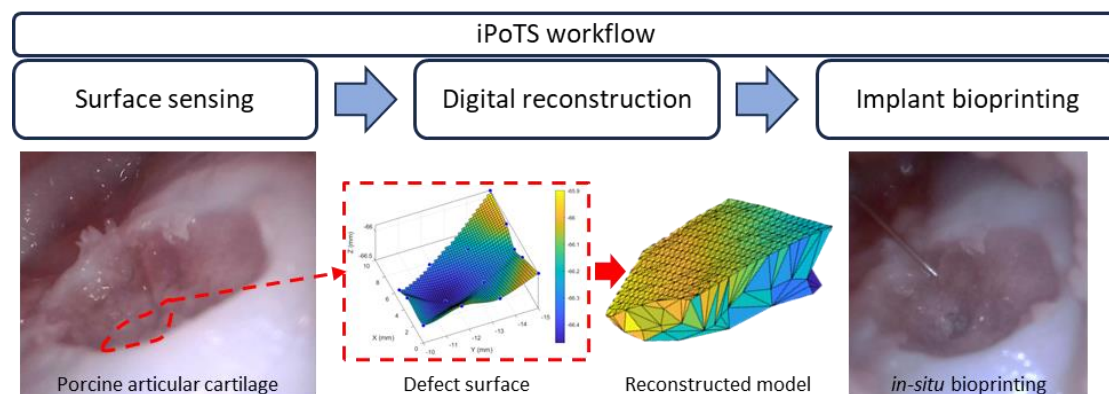
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Category: Enabling Technologies

Introduction: Osteochondral regeneration is currently an unmet need with few commercial implants in the market. The emerging technology of 3D bioprinting is already an attractive platform to pattern cells and to deliver biomolecules programmatically. However, the current bioprinting platform requests the working field as big as the diseased area. A minimally invasive bioprinting platform incorporated with navigation-free sensing is proposed to minimize the collateral damage to the surrounding tissues.

Methods: To enable a fully programmable therapeutic delivery, an Integrative Printing on Tissue System (iPoTS) has been built to incorporate surface sensing, geometrical reconstruction, and bioprinting on non-planar tissue surface. The robot mimics an arthroscopic surgery procedure to access cartilage in a keyhole surgery manner. We applied this technique successfully in Sinbone knee models as well as porcine knee *explants*.

Results: Inside the highly confined knee cavity, iPoTS can sense the defective region to digitally reconstruct the printing substrate. Upon mapping the substrate, it calculates the regenerative model to fill the defect and optimizes the printing trajectory to comply with the non-planar substrate. The printing can then be started to deliver therapeutic polymers, which offer programmable control of implant structure and composition.



Discussion and Conclusion: The development of iPoTS is a clinically-oriented project to achieve programmable delivery of therapeutic biomaterials, and is compatible with current clinical practices. The controllable implant patterning and composition can promote the scaffold integration by improving mass transportation efficiency and cell migration, which has the potential to shorten the post-surgical recovery time and promote long-term therapeutic efficacy.

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