Proof-of-concept of a robotic-driven photogrammetric scanner for intra-operative knee cartilage repair

Álvaro Bertelsen[1], Amaia Iribar-Zabala[1], Ekiñe Otegi-Alvaro[1], Rafael Benito[1], Karen López-Linares[1], and Iván Macía[1]

[1]Vicomtech Foundation, Basque Research and Technology Alliance (BRTA)

November 1, 2023

Abstract

This work present a proof-of-concept of a robotic-driven intra-operative scanner designed for knee cartilage lesion repair, part of a system for direct in vivo bioprinting. The proposed system is based on a photogrammetric pipeline, which reconstructs the cartilage and lesion surfaces from sets of photographs acquired by a robotic-handled endoscope, and produces 3D grafts for further printing path planning. A validation on a synthetic phantom is presented, showing that —despite the cartilage smooth and featureless surface— the current prototype can accurately reconstruct osteochondral lesions and their surroundings with mean error values of 0.199 ± 0.096 mm but with noticeable concentration on areas with poor lighting or low photographic coverage. The system can also accurately generate grafts for bioprinting, although with a slight tendency to underestimate the actual lesion sizes, producing grafts with coverage errors of -12.2 ± 3.7, -7.9 ± 4.9 and -15.2 ± 3.4 % for the medio-lateral, antero-posterior and craneo-caudal directions respectively. Improvements in lighting and acquisition for enhancing reconstruction accuracy are planned as future work, as well as integration into a complete bioprinting pipeline and validation with ex vivo phantoms.

Hosted file

`AECAI2023_id06_paper_v6.docx` available at https://authorea.com/users/694706/articles/683665-proof-of-concept-of-a-robotic-driven-photogrammetric-scanner-for-intra-operative-knee-cartilage-repair