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

Álvaro Bertelsen<sup>1</sup>, Amaia Iribar-Zabala<sup>1</sup>, Ekiñe Otegi-Alvaro<sup>1</sup>, Rafael Benito<sup>1</sup>, Karen López-Linares<sup>1</sup>, and Iván Macía<sup>1</sup>

<sup>1</sup>Vicomtech Foundation, Basque Research and Technology Alliance (BRTA)

November 1, 2023

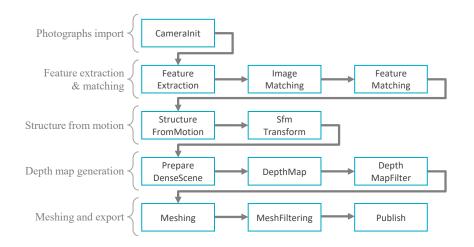
## Abstract

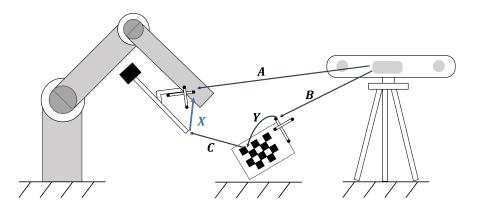
This work present a proof-of-concept of a robotic-driven intra-operative scanner designed for knee cartilage lesion repair, part of a system for direct in vivo bioprinting. The proposed system is based on a photogrammetric pipeline, which reconstructs the cartilage and lesion surfaces from sets of photographs 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  $\pm$  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  $-12.2 \pm 3.7$ ,  $-7.9 \pm 4.9$  and  $-15.2 \pm 3.4$  % 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.

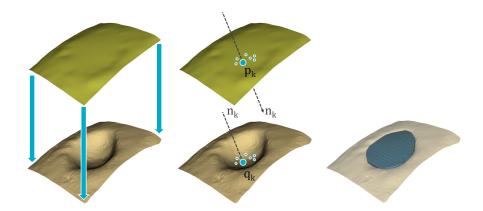
## Hosted file

AECAI2023\_id06\_paper\_v6.docx available at https://authorea.com/users/694706/articles/683665proof-of-concept-of-a-robotic-driven-photogrammetric-scanner-for-intra-operative-kneecartilage-repair









elii	
pr	
þe	
ay	
B	
ata	
Ĥ	
ed.	
-reviewed	
evi	
1-1	
-199	
en p	
bee	
4	
no	
has 1	
p.	
an	
rint	
pri	
prep	
ŝ	
12	
lhis.	
-	
1	
23	
34	
.157	
121	
8542	
38	
16	
au.	
541	
225	
0.0	
6	
/doi	
bs:/	
httj	
-	
ermission.	
permission.	
out permission.	
ithout permission.	
without permission.	
without permission.	
without permission.	
suse without permission.	
No reuse without permission.	
No reuse without permission.	
No reuse without permission.	
reserved. No reuse without permission.	
s reserved. No reuse without permission.	
ghts reserved. No reuse without permission.	
rights reserved. No reuse without permission.	
ghts reserved. No reuse without permission.	
: All rights reserved. No reuse without permission.	
rights reserved. No reuse without permission.	
: All rights reserved. No reuse without permission.	
nder. All rights reserved. No reuse without permission.	
thor/funder. All rights reserved. No reuse without permission.	
author/funder. All rights reserved. No reuse without permission.	
author/funder. All rights reserved. No reuse without permission.	
thor/funder. All rights reserved. No reuse without permission.	
the author/funder. All rights reserved. No reuse without permission.	
the author/funder. All rights reserved. No reuse without permission.	
the author/funder. All rights reserved. No reuse without permission.	
the author/funder. All rights reserved. No reuse without permission.	
ght holder is the author/funder. All rights reserved. No reuse without permission.	
the author/funder. All rights reserved. No reuse without permission.	
yright holder is the author/funder. All rights reserved. No reuse without permission.	
yright holder is the author/funder. All rights reserved. No reuse without permission.	
The copyright holder is the author/funder. All rights reserved. No reuse without permission.	
yright holder is the author/funder. All rights reserved. No reuse without permission.	
i — The copyright holder is the author/funder. All rights reserved. No reuse without permission.	
The copyright holder is the author/funder. All rights reserved. No reuse without permission.	
i — The copyright holder is the author/funder. All rights reserved. No reuse without permission.	
i — The copyright holder is the author/funder. All rights reserved. No reuse without permission.	
i — The copyright holder is the author/funder. All rights reserved. No reuse without permission.	
i — The copyright holder is the author/funder. All rights reserved. No reuse without permission.	
i — The copyright holder is the author/funder. All rights reserved. No reuse without permission.	
i — The copyright holder is the author/funder. All rights reserved. No reuse without permission.	

