VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Sebastian Amador Sanchez**

The public defense will take place on **Thursday 2nd April 2026 at 4pm** in room **I.2.01** (Building I, VUB Main Campus)

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ADVANCING LANDMARK LOCALIZATION THROUGH DEEP SEGMENTATION FOR RELIABLE MALALIGNMENT ASSESSMENT IN LOWER LIMB RADIOGRAPHS

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Abstract of the PhD research

Knee osteoarthritis affects millions worldwide and is frequently associated with lower limb malalignment. Clinical assessment of malalignment relies on manual landmark identification in X-ray images, a time-consuming process prone to interobserver variability. While most automated approaches use regression-based deep learning, this thesis investigates image segmentation with circular masks centered on landmark locations as an alternative strategy.

First, we introduce a segmentation-guided coordinate regression framework that integrates a segmentation network with a coordinate regression branch, trained end-to-end. This hybrid approach improves localization accuracy over standard regression and increases robustness compared to standalone segmentation, thereby mitigating false positives and missed detections, and enabling the automatic quantification of malalignment.

Second, we optimize segmentation-based methods by evaluating architectures, post-processing strategies, and mask sizes. A fully convolutional model trained with radius-15 masks, combined with adaptive threshold-based centroid extraction, outperformed conventional landmark localization approaches, with improved performance in knee phenotype classification.

Third, we propose a Siamese network trained with a contrastive loss for quality control that detects inaccurate predictions by comparing image patches to reference embeddings. The method reliably identifies errors exceeding 2.0 mm and estimates their magnitude, outperforming baseline methods.

Overall, this thesis advances the field of landmark localization and demonstrates its clinical relevance for the automated assessment of lower limb malalignment. Beyond landmark localization accuracy, our contributions address robustness and failure identification, two aspects that are often overlooked yet vital for future clinical deployment.