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PROCEEDINGS

In-Silico Automated 3D Reconstruction of the Biomechanical Trapeziometacarpal Joint from 4D Imaging

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ABSTRACT

Biomechanical research reveals that the geometric shapes and dynamic behaviors of organ tissues play a pivotal role in determining their mechanical properties. Recent advancements in time-correlated imaging technologies, such as Computed Tomography (4D-CT) and Magnetic Resonance Imaging (4D-MRI), have enabled the non-invasive capture of both geometric data and dynamic information over time. However, the manual segmentation of these extensive datasets proves to be laborious and expensive. This study introduces an automated workflow designed for image segmentation and classification within 4D-CT scans, with a specific focus on the bone structures surrounding the Trapeziometacarpal (TMC) joint in this study. By employing a multi-model ensemble approach, the method efficiently identifies regions of interest. Furthermore, to ensure model consistency and quantify variations in joint morphology, statistical shape analysis is utilized to standardize 3D models. This innovative approach significantly reduces the costs associated with manual segmentation efforts and presents a flexible alternative to traditional biomechanical analysis models. The potential applications of this method are vast, including biomechanical finite element analysis, the design of customized assistive devices, and the enhancement of rehabilitation therapies. These applications underscore the method's promise in advancing the field of biomechanics.

KEYWORDS

4D CT; trapeziometacarpal joint; medical image segmentation; stastical shape analysis; biomechanic

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