Data acquisition and generative design for a smart spinal orthosis

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Abstract.
The design and development process of custom-made medical devices is very complex and often requires the use of additive manufacturing to obtain a customer compliant product. One of the key stages, but also very time consuming in the development of bespoke medical products, is the data acquisition of the patients' specific anatomy. The current research paper presents a detailed process of upper body data acquisition using 3D scanning protocols, with the goal of designing a custom smart spinal orthosis using generative design and additive manufacturing technologies. The initial captured cloud points were subjected successively to a series of surface manipulation and mesh optimization operations to generate the final working 3D model of the upper body. Each stage of the 3D model was obtained using a specific software application, as follows: *.DICOM images were generated using a 3D scanner software; *STL files were obtained by transforming initial files using MeshMixer software; *.STEP files were optimized using Fusion 360. Shape validation was done by 3D printing of a real scale upper body anatomical prototype using material extrusion. Authors also proposed a generative design process for the development of a personalized vertebral body from the construction of the smart spinal orthosis. The generative study was initialized with the following data: connection type, stress scenarios, material type (metals - Ti, Al, Steel; composites - ABS, PET, HIPS, PETG) and manufacturing technology (additive, subtractive, injection moulding). A set of 49 converged outcomes was generated after running the study and three were selected for further research.