Study of a bone segmentation and 3D modeling workflow for diagnosis and planning

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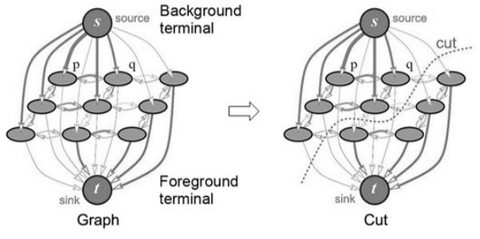
Introduction

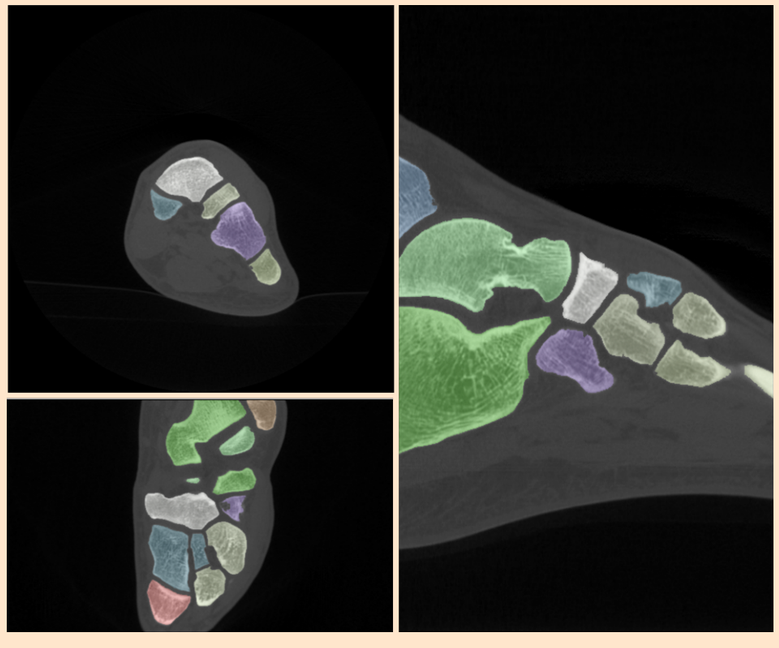
In orthopedics, preoperative planning is a fundamental step for successful surgery, This has been shown to facilitate surgical planning and communication with the patient, reduce the duration of surgery and intraoperative blood loss, resulting in better surgical outcomes. Cone beam CT and 3D anatomical modeling are performed prior intervention. Segmentation is the basis of 3D anatomical reconstructions, separating the region of interest (ROI) from surrounding tissues, this is a time consuming process affecting model accuracy. Our goal is to develop an efficient, fast, intuitive and usable segmentation tool for uncalibrated cone beam CT images. The tool will be integrated into a medical imaging platform all in one being developed at EidoLab, a joint laboratory between UNIFI and the company Imaginalis.

Methods

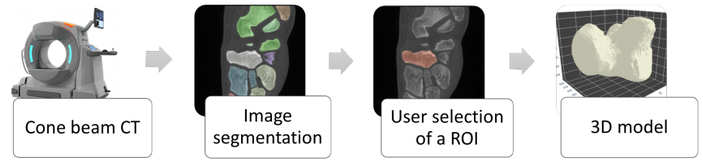
The first step of the research consisted in finding the best segmentation approach. A fully automated 3D segmentation algorithm has been developed, based on graph-cut. In our method, the algorithm is initialized with a threshold pattern to define the statistic of background and foreground terminals.
The segmented volume resulting from this algorithm is post processed with morphological operations. Bones making up extremities are separated via connected components labeling. A graphical user interface (GUI) allows the user to isolate single or multiple bones of interest. Finally, the segmented bones are rendered in 3D.



A fully automatic and usable bone segmentation workflow for **Multimodal Biomedical Imaging Platform All In-One.**



Results & Conclusions



The benchmark for testing the performance of our approach are classical graph cut implementation, where the statistic of background and foreground terminals are based directly on user scribbles on the image. In terms of usability, our approach requires less user interaction and provides more flexibility in segmenting adjacent bones, saving operator time. Quantitatively, the dice score coefficient (DSC) metric is used to compare our segmentation approach with classical graph cut: results show promising increasing in DSC.
In conclusion, a fully automated and usable bone segmentation workflow has been developed to be integrated into a multimodal biomedical imaging platform. The bone segmentation workflow involves automatic segmentation of bones. The user can then select a single or multiple bones to be displayed in 3D.
The next step will be the implementation of automatic anatomical structure instance segmentation for complex districts and a usable tool for segmentation and fixation of complex fractures.

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