Mini Review

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Three-dimensional reconstruction for use in medicine and biomechanics

Abstract

Nowadays, the use of 3D reconstruction methods through three-dimensional imaging is becoming a widely used tool in both medical and engineering areas. This is because its application allows the realization of specialized diagnostics, pre-surgical evaluations, numerical analysis by means of the Finite Element Method (MEF), the generation of personalized prostheses, among others. This, in turn, has allowed a better understanding of the human body. There are several three-dimensional reconstruction techniques by means of medical images, which allow us to make an adequate model or biomodel depending on the circumstance. Therefore, it is very important to know each of them to select the appropriate one for each specific case study.

Keywords: finite element method, human body, circumstance, medical, engineering areas

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Abbreviations: MEF, finite element method; MPR, multiplanar reconstruction; HU, hounsfield units; MIP, maximum intensity projection; VR, volume reconstruction

Introduction

3D reconstruction by means of medical images is the process of analysis, assimilation and compression of a set of two-dimensional data (2D data) and its modelling in three dimensions, all this by using various techniques and algorithms that transform two-dimensional data in volume data.

Imaging allows the visualization of parts of the human body that would not be possible to see in a conventional way. This has transformed into a very important tool in the medical field since it allows to reveal, diagnose and examine diseases. In various areas of Engineering such as Biomechanics, it facilitates the study of anatomical structures by means of numerical analysis using the MEF, allowing the study of geometry and its conditions under the action of external loads and/or agents, among others.

Three-dimensional reconstruction techniques

There are severalthree-dimensional reconstructiontechniques, among the main ones are the following. Multiplanar Reconstruction (MPR), which allows to visualize the different planes (sagittal, coronal and transverse),[1] so when used in parallel it allows an overlap between them being a three-dimensional semi-visualization that emulates the location of the planes in each of the sections of the Tomography or Magnetic Resonance Imaging (Figure 1).

The Reconstruction of shaded surface (SDD) is based on the use of "thresholds" that allows to classify different tissues and bones, that is, by means of the use of Hounsfield units (HU) a threshold range is defined where the voxels that exceed this threshold allow to visualize those tissues and bones above this range (Figure 2).[2]

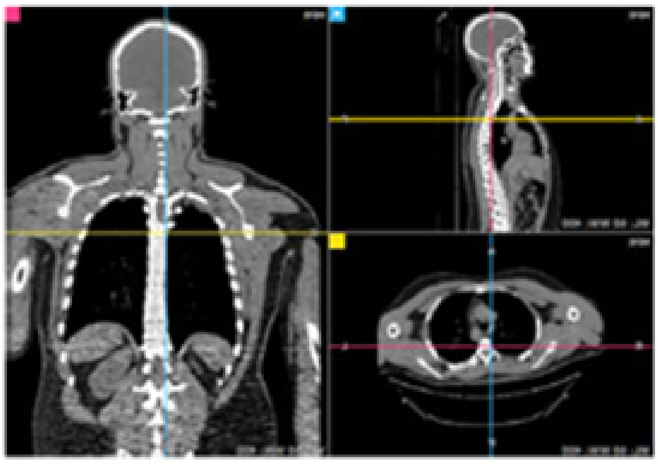

Figure 1 Visualization of sagittal, coronal and transversal planes.

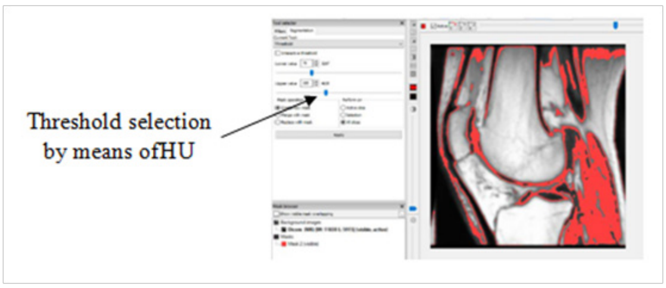

Figure 2 Tissue selection by HU.

Maximum intensity projection (MIP) is a mathematical technique by means of which only the range of two-dimensional slices superimposed in the higher intensity voxel range[3] (with the highest number in HU) is selected, obtaining an image Two-dimensional section of a thicker cut (Figure 3).

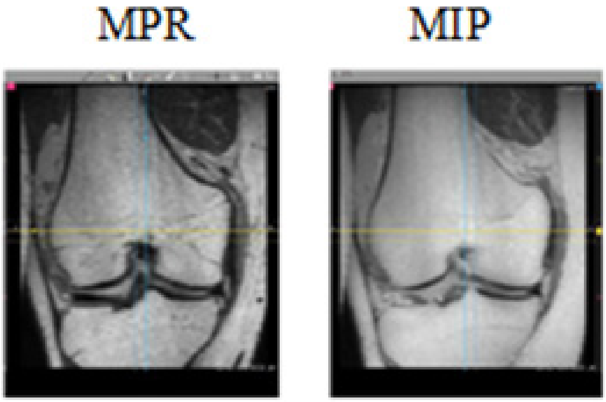

Figure 3 Comparison of two reconstruction techniques.

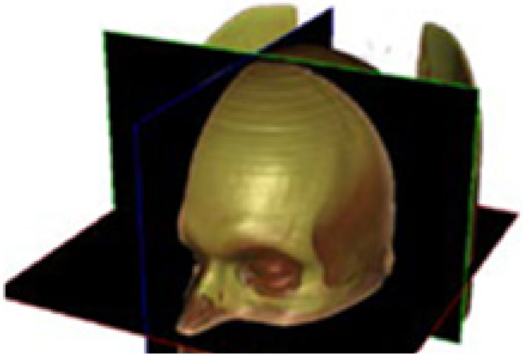

Figure 4 VR reconstruction of the skull.

Volume Reconstruction (VR) allows the most faithful three-dimensional visualization since it occupies all 3D data at the same time, making it far superior to the SDD and MIP techniques. The VR part of images of transversal coretes, where each of these cuts is composed of a two-dimensional arrangement in X and X, and by superimposing images the alienated pixels allow labeling each arrange in three-dimensional coordinates, i.e. the coordinate pair X, Y values are added to the Z axis (Figure 4).[4–8]

Conclusion

At present there are various reconstruction techniques, which can be used in medicine for diagnoses (observe fractures, pathologies, among others) as well as in areas such as biomechanics, among which there is a deep synergy. This has allowed strengthening their strengths and capacity, allowing the development of methodologies for more extensive and specific studies. With the images obtained from three-dimensional imaging studies and through the metrodologies described, it is possible to generate biomodels that allow a better exploration of the anatomical structures to be treated, observing them with greater precision. They allow, in turn, the simulation of various agents that can intervene from the diagnosis to the choice of treatment and materials that will be used in a personalized way for each patient. This will allow having a greater number of options to provide a better patient care, in a personalized and more precise way.

However, its management is not in the general domain of the medical or deontological community. Therefore, it is necessary to disseminate this knowledge through multidisciplinary work groups, which will allow a better treatment to patients from the dental office. This being the objective of the present work, in which it is not possible to present results, since it is not an experimental study. What is lent is a good proposal of methodologies to be used both in the care and diagnosis for patients, and to be used as a method of medical research.

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Conflict of interest

The authors declare there is no conflict of interests.

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