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Review Article

Application of MATLAB and 3D SLICER in Medical Imaging - Preliminary Discussions Application of Medical Advance Mathematics

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Abstract

Medical advance mathematics is a compulsory course for all medical students when entered medical high education system. This paper represented studying experiences of this course, meanwhile, its applications MATLAB and 3D Slicer into medical imaging as well as preliminary discussions about functional dependences of correlations. This paper also demonstrates the discussion of the combinational features in open source software 3D Slicer and well-known scientific software MATLAB from engineer and radiologist point of view. Development of usage in 3D Slicer in medical research, as well as the MATLAB, demanding in different fields. Not only the medical applications, such as autism, multiple sclerosis, systemic lupus erythematosus, prostate cancer, schizophrenia, orthopedic biomechanics, COPD, cardiovascular disease and neurosurgery, but also 3D printing, artificial intelligence. This discussion represents the experience and review comments when using these two pieces of software simultaneously, from engineer and radiologist point of view. Finally, it concludes the future studies and the possibilities of transformations in other applications and version of software.

Keywords: Algorithms; Bidirectional Interface; Data Structure; Multi Organ; Multi - Modality Imaging

Introduction

Medical advanced mathematics is a course that all medical students in Chinese university are obliged to learn when entering the medical higher education [27].

This paper discusses how medical advanced mathematics is applied into medical imaging through the application of software MATLAB and 3D slicer.

MATLAB

Mathematical algorithms usually required the operator to implement the calculations based on operation rules and mathematical axioms or theorems [1]. These procedures not only complex and boring, but also occurred so many mistakes easily [1]. Accompanying development of computing technology rapidly, calculation of various mathematical problems can be solved with help of professional mathematical tool software, commonly used mathematical application software includes Mathematica, maple, MATLAB, etc. [1]. MATLAB is a scientific computing language and programming environment for algorithm development, data visualization, data analysis and numerical calculation [2]. MATLAB integrates numerical calculation, symbolic calculation and computational visualization, it is widely used in many application fields, including signal and image processing, communication, control system design, test and measurement, financial modelling and analysis, computational biology and so on [1].

3D slicer and MATLAB

3D slicer is an open resource platform for medical image informatics, image processing and 3D visualization. After more than 20 years, this software has been supported by various national health institutions and world development society. 3D slicer provides

physicians and researchers with free and powerful cross domain platform processing tools. In a variety of medical applications, including autism, multiple sclerosis, systemic lupus erythematosus, prostate cancer, schizophrenia, orthopedic biomechanics, COPD, cardiovascular diseases and neurosurgery [4,6,10,13,14,19,22,24, 25,28,32].

In 3D slicer software, there is MATLAB bridge function, which is used to connect the two software, and use MATLAB function to segment the images in 3D slicer software. For example, import CT images and use MATLAB to segment the images with functions, so that physicians or researchers can better master and analyze the disease [3,37].

Examples

For example, we can use first order statistics. Standard deviation, variance and root mean square are measures of histogram dispersion [3,37]. Let x represent the matrix of three-dimensional image and N discrete intensity I represent the series [3,37].

Standard deviation

$$SD = \left(\frac{1}{N-1}\sum_{i=1}^{N}(X(i)-\overline{X})^2\right)^{1/2}$$

Variance

$$\text{Variance} = \frac{1}{1-N}\sum_{i=1}^{N}(X(i)-\overline{X})^2$$

($\overline{X}$ *is the mean value of* X)

Root mean square

$$RMS = \sqrt{\frac{\sum_i^N X(i)^2}{N}}$$

Based on shape and size-based features, compactness, spherical nonuniformity, sphericity and surface to volume ratio can be measured, which describes that shape of tumor is spherical, round or extended [3,37]. The surface area of tumor is calculated by triangulation, that is, tumor surface if divided into connected triangles [3,37].

For example:

$$A = \sum_{i=1}^{N}\frac{1}{2}|a_i b_i \times a_i c_i|$$

N is the total number of triangles covering tumor surface, and a, b, c are edge vectors of triangles. Similarly, volume of tumor can also be calculated by using surface area.

Texture features can be analyzed by using mathematical knowledge of matrix [2,3,37].

Conclusion

Above special cases of CT images are common with hospital imaging professionals and researchers. From general and universal analysis, application of calculus function in MATLAB is particularly important and common in the micro and macro analysis of images [2,3,37].

We can more easily understand practicability of Medical Advanced Mathematics in medicine through MATLAB and 3D slicer. Medical advanced mathematics is widely used not only in medical imaging, but also in other medical fields such as traditional Chinese medicine [8,34], biomedicine [2,21]. Medical advanced mathematics has become an indispensable basic subject in the field of medical education in the world, and it is also a lifelong subject that every medical student needs to learn.

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