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An analysis of medical images processing in MATLAB environment

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ABSTRACT
In recent technologies, advanced software for processing medical images has gained a great interest in modern medicine field. It provides valuable scientific information, and hence, can significantly improve diagnosis and provide advance treatment like tumor detection in various unknown parts of the body like. The main contribution of this study is about the various challenges of medical images datasets in MATLAB environment. Recently, various security measures and mechanisms have been suggested to overcome these challenges and accelerate the adoption of various recent services in the field of medical images. Image is the main source of human access and exchange of information. The application of digital image processing in medical engineering is very extensive, and the result is very effective. Medical digital image processing can reduce the effect of noise, enhance the image and improve its quality. Processed images can accurately reflect the focus of disease and visually communicate medical and pathological information of the image. This paper introduces the technology of digital image processing based on Matlab. Using Matlab can acquire and recognize and process the images. As powerful simulation software, Matlab is widely used in scientific research and solved specific problems. Matlab toolbox for medical image processing can be effectively process the medical images, also provides a powerful way for medical image analysis.
Keywords - MATLAB, medical digital images, MATLAB environment.

I. INTRODUCTION

The rapid growth in the use of Electronic Health Records (EHR) across the global increasing level of diagnostic medical imaging means increasing amounts of data storage [8] [9].In a such scenario, where a professional view and process medical images remotely for the purpose of constructing a diagnosis it may be necessary to move large data sets across the network for processing [10]. Moving such data sets has the potential to introduce undesirable latency and also causing service level agreement (SLA) violations and degrading network performance for other users of the same infrastructure. With the progressive imaging technologies such as synchrotron based X-Ray microscopy and micro-spectroscopy, and computed tomography, research scientists can directly acquire the images of sub-cellular structures and have a new dynamic view of life. Hence, reconstructing, pre-processing and measuring the large image datasets are in high demand. Medical image study often involves interleaving numerous tools from heterogeneous sources, which brings about the problems of data compatibility, file formats, and interface with multi-processing computing environments.

Image processing has moved into the mainstream wave, not only in the engineering world; but also to the public. Personal computers now are able to handle large amount of graphics and images with ease. The fast network system and modem transfer rate are able to transfer images just in a fraction of time. Image manipulation software becomes a general and common item on personal computers. For example, Image Processing Toolbox in MATLAB provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development. User can perform image enhancement, image DE blurring, feature detection, noise reduction, image segmentation, geometric transformations, and image registration without serious difficulties.

This paper reviews about medical image processing and its challenges in MATLAB environment and also states various benefits due to medical image processing. The rest of the paper is organized as follows: This paper is divided into six sections. The first section introduces the study. It

provides the overall view of the visualization tools in medical image processing. The second section includes the objective of the study, which describes the challenges in medical image processing. The third section describes about the various tools and study implementation. A list of the computer environment and thorough discussion on the developmental tool or processing and analysis on various medical images are explained in section 4. Finally, the last two sections contain the results, conclusions, future develop.

II.   RELATED WORK

Nowadays Medical imaging has become one of the most important methods and techniques for visualization and interpretation of diagnostic in medicine field [1], [3]. Due to the advent of high performance digital computer systems in the past decade, it has witnessed a tremendous development of various advanced modalities and instruments for detecting, storing, transmitting, analyzing, and displaying medical images [10]. Nowadays a large volume of medical image data is being generated in hospitals and health care institutions through different modalities, namely, Magnetic Resonance Imaging (MRI), Ultrasound Imaging (US), Single Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET), Nuclear Medicine (Scintigraphy), Computed Tomography (CT) images, Digital Subtraction Angiography (DSA), Digital Fluorography (DF) and X-ray imaging (Radiography) [10]-[14]. Wearable Internet of Things (IoT) devices, Ubiquitous Sensor Networks (USN) and Body Sensor Networks (BSN) also generate a massive collection of bio signals such as heart-rate, oxygen level, respiration, blood pressure required at low cost [1]-[3].

Biomedical images and bio signals play a major role in modern e-health services and have become an integral part of medical data communication systems [2]. The medical communication system is a technology that allows any type of medical data to be transmitted from the point of healthcare to the desired specialist(s). The data is transmitted securely and rapidly for delivery to mobile devices or computers so that physicians can review the data and provide opinions [2]-[3]. Domain makes the e-health services very successful, viable and inevitable for cost effective delivery to the common men [10]-[14]. E-health services have been trying to utilize these technologies such as teleradiology, teleconsultation, telemedicine, telediagonosis and telematics for better patient care and timely services [1], [2], [12]-[14].

2.1. Development of digital image processing technology

Multi-disciplinary comprehensive development not only can avoid some local defects, but also will be applied in practice to the fullest. In the field of modern medicine, image processing technology has become an important branch. Noise pollution, information hiding, organizing fuzzy edges and other issues have potential impact on the accuracy of pathological diagnosis and treatment [19].

With the progress of science and technology, the existing digital image processing can meet the demand of the medical examination, doctor can intuitively to inform the patient of illness. Early 60s in the 20th century, image processing was the initial stage, image processing cannot be used widely spread due to the backward technology and incomplete algorithm, also high price of image processing equipment and higher storage cost. In the late 80s, image processing technology has also gradually taken on the stage and popularized further, lower cost was the main reason.

The emergence of a large number of mathematical algorithm and theory made image processing theory quicker and better and integrated with other disciplines, and then get the application in more and deeper field [19]. At present, the digital image processing is mainly focused on the improvement of the image quality; the radiation needs to collect information of hard and soft tissue at the same time, influenced by the artifact, and all kinds of noise during the procedure of image processing. If the diseased tissue and normal tissue attenuation coefficient vary a little, it cannot be distinguished lesions. However, digital image processing can be gained through a combination of a variety of mathematical algorithms and high-tech equipment to obtain more clearly anatomic structure of information, at the same time reduce the intensity of radiation, and thus obtain better diagnostic information.

2.2. The Principle and Method of Digital Image Processing

Digital image processing is that getting the results through a series of algorithms of image representative numerical computations [11]. For the image, "processing" is to change its form, and make it more conform to the requirements or to achieve some predetermined goals. Digital image processing has the following advantages: (1) good reproducibility; (2) high precision; (3) flexibility, not only can accomplish linear operation, but also complete nonlinear and mathematical algorithm expression of image processing operations. (4) Widely application. These advantages of digital processing technology make it widely used in the medical field.

2.2.1. Medical Basic Method of Digital Image Processing

The basic methods of digital image processing are image restoration and image enhancement [18]. Image restoration is to restore the original image information improve fidelity as far as possible. A basic feature of digital is its inherent noise. Noise, considered as a value around the random fluctuations of the real value, is the main factor to reduce image quality. The fundamental problem in image restoration is to eliminate the noise. Image enhancement is to use the related digital image processing technology. Select or extract the important part of the appearance or a particular area effectively through processing the preprocessed image. And at the same time, filter or mitigate the unnecessary image information. Image enhancement contributes to the image detail or calibration area identification [17], and improves the interpretation accuracy of the image. At present, the most commonly used method is histogram correction as different space of the image enhancement processing.

2.3. Matlab-based Digital Image Processing Technology

2.3.1 Medical Digital Image Processing Technology Research Content

Digital image-processing is a strong commonality, information storage, transmission and reliable image processing technology, because it implements the nonlinear processing of digital image processing easily, and the processing procedures and processing parameters [8] are variable. In the image processing, the input is the low quality image, and the output is the improved quality images, hence, the commonly used image processing methods are such as image enhancement, restoration, coding and compression.

2.3.2. Matlab-based in Medical Image Processing

Now, computer networking and remote diagnosis of medical image has become an irreversible trend, and confronted with massive data processing and image post-processing, Matlab software will undoubtedly has a broad application prospect. At present, Matlab is highly accepted in medical field, due to its powerful functions and easy operation. What's more, it can be utilized among ultrasound, CT and X-ray perspective of image enhancement, segmentation, morphological analysis etc. processing, which its characteristic image information is consistent with the expected standards and clinical diagnosis requirements, having a better reference value [15-8].

2.3.3. Matlab-based Image Acquisition and Image Reconstruction

Image processing software toolkit of Matlab provides general image file format (e.g., PCX, BMP, GIF, HDF, Tiff,XWD, etc.) to read and write functions, such as bmpeard, bmpwrite, tiffread, tiffwrite etc. These functions can be used to read the medical image in Matlab, or convert the image file format. Also it can be read directly from the coordinate system using get lager function image data, which is generated by Matlab graphics. That can be turned into image data. Matlab software has the characteristics of that it can generate the image only with the data, and it take the convenience for image reconstruction. Matlab [16] is the matrix lab, which can directly obtain the CT or MRI image data matrix. In addition, Matlab also provides a large number of FIR (finite impulse response) filter function, nonlinear filtering function and the two-dimensional convolution, two-dimensional fast Fourier transform, Radon transform, such as transformation function, there is no doubt that it provide a great convenience for image reconstruction, Algorithm and filtering algorithm.

2.3.4. Image Post-processing Based on Matlab

General medical imaging post-processing includes edge enhancement [19], smooth the interested region, filtration, calibration, and wide window adjustment. Matlab provides the corresponding processing function, which can generate the corresponding software system. Using Matlab imresize () function will enlarge (narrow) and keep its length unchanged. Also it provides lots of clip image rotation and block processing functions and process individual areas separately, and convert the image format (true color images RGB model will convert to gray scale image by rgb2gray) and image statistics processing, etc.

2.3.5. Feature Recognition

Matlab software provides the some simple characteristics image recognition methods can solve the medical image recognition [10, 19, and 6] problems. Especially the new Matlab using wavelet [15] analysis software will improve the characteristics of medical image recognition work. Providing a powerful support to some symptoms of computer automatic recognition and remote diagnosis technology.

2.3.6. Programming processing

Everyone has right to get the interested image and processing image, different methods of image processing and character recognition algorithm[12,

28] will be needed. Matlab software provides a convenient and easy programmatic interface, especially for medical experts who can according to their own interest and specialty selected special algorithm. They can achieve their goals through using the Matlab programming function. The development of the remote diagnosis technology also need simple and powerful image programming software, including sending image, image acquisition and image reconstruction [9, 10, and 11], image post-processing, characteristic recognition aspects of programming, Matlab software programming platform also can do this. Through Matlab for medical image processing, so as to generate the image processing system, can improve the image quality of the image, due to its simple operation, it is accepted in medical field.

III.   MEDICAL IMAGE PROCESSING AND ITS CHALLENGES IN MATLAB ENVIRONMENT

Imaging has become an essential component in medical research and clinical practice. A wide variety of image processing techniques have been used in medical field for image analysis. This employs a large number of visual and physiological features, a fact which usually impedes the training process [1, 2, and 3]. This survey focused on identifying specific software packages; and its advantages and disadvantages of using it. On the other hand, this survey also tries to communicate with software vendors in discussing on how technological problems can be resolved. The survey is very important in order to develop the tools (in both hardware and software) to give new learners the ability to analyze biomedical data to support the discovery and advancement of biomedical knowledge. In this study, the practice item of image processing software package was focused on Matlab application. Several imperatives were identified to be addressed by the survey:

1) To discover the current visualization practice in biomedical image processing techniques.

2) To relay current general and subject specific technological limitations.

An effective medical image processing for image processing is presented through survey result. Several aspects like the speed of the processing and ease of use are considered while the processing is being done. This is to make sure the software package does not only process the raw image for further analysis, but it is also able to manage the image data effectively and provides accurate and reliable scientific information.

IV. MATLAB TOOLS FOR MEDICAL IMAGE PROCESSING

The rapid development of information technology has directly impacted on the techniques in image processing techniques and the implementation of survey processing systems. This main development has been shifted from mainframe system to PC platform. User now can easily perform all kind operations and processing techniques ranging from small scale to large scale statistical operations.

The research framework and methodology complies with ADDIE model [4, 5]. ADDIE model is the generic process traditionally used by instructional designers and training developers. The five phases including Analysis, Design, Development, Implementation, and Evaluation represent a dynamic, flexible guideline for building effective training and performance support tools. Our work starts with conducting a survey to the new learners/students about their understanding on Biomedical Image Processing course to identify any problems or issues of how difficult to them to understand the Biomedical Image Processing course. To make meaningful to these new learners, we are going to develop user friendly Biomedical Image Processing software package, which new learners can do some Biomedical Image Processing analysis through various methods that have been taught in Biomedical Image Processing course.

Our plan is to use the MATLAB programming software [6] as a tool for developing this Biomedical Image Processing software package [7, 8]. Such techniques (image enhancement, filtering, segmentation and morphological operation) in Biomedical Image Processing that have been taught in the class (or in the syllabus) will be included in the Biomedical Image Processing software package. This software package should capable to display input image, output image and various click button for various image processing techniques as well as description of the techniques so the students will learn effectively the application on how biomedical image is analyzed instead of learning the mathematical algorithm for such techniques. A number of software packages for the image processing and editing have increased over the years. The different steps of image processing make each of the software packages differ with different relative strengths. Having the right software and appropriate processing techniques is necessary to guarantee the reliability of the data processing. The famous well-developed software packages for image processing are as follow:

4.1. Adobe Photoshop

Adobe Photoshop is a graphics editing program and used in teaching and research. It was

generally found to be useful and easy to use. It comes with functionality for scanning and scanned image manipulation. It can produce simple integration with other Adobe products.

4.2. Adobe Illustrator

It is the industrial standard software and works well with other graphics software. Not easily compatible with WORD and Windows PC users cannot easily send images to a non- graphics PC user.

4.3. Image Tool

Image Tool is a free package with powerful image processing capabilities. The main function is an image analysis and it is quite easy to use. According to the developer, Image Tool has no guaranteed future development and has no direct support.

4.4. Lab View

Its main use is to convert from one image file format to another. A large number of image formats are supported. Images can be increased or reduced in size. Image resolution may be altered in the preparation of images for importation into word-processing or desktop publishing packages.

4.5. Paint Shop Pro

It is used both in teaching and research. It is regarded as easy to use and useful. It is robust, good documentation and capable in conversion between different image file formats.

4.6. ImageJ

ImageJ is a freeware. It is a free package with powerful image processing capabilities. The most used features of the software are image editing, processing, and enhancement.

4.7. Image Prep

Image Prep is a specialist graphics manipulation package which has proved to be very useful for converting and enhancing graphics images. Used for manipulation of scanned photographic images for research software generation.

4.8. ERDAS Imaging

It is a package designed to plan for surface change such as urban development, transport planning and landscape planning. It is very useful but fairly difficult to use. Very hard to start off with,

but once you have conquered the initial problems it becomes a lot easier.

4.9. MATLAB

MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numerical computational. It is easy on customization and able to handle large matrices. It also uses the language script to customize statistical tests and matrix manipulation.

V. BENEFITS OF MEDICAL IMAGE PROCESSING IN THE MATLAB

Digital image occupies an important position in the field of medical engineering. Through the analysis of medical microscopic image processing and ultrasonic image processing, and the enhancement of X-ray lung image and etc., it has been widely used in medical diagnosis [10, 11]. Gray scale enhancement, wavelet noise reduction and point feature matching can improve the CT, ultrasonic image and radioactive isotope (RI) image quality, so that people have a clearly understanding of the lesions environment surrounding. Combined with advanced networking technology can achieve remote consultation and treatment.

A good image processing tool package is determined through five core capabilities: image utilities, image filtering and transformation, image compression, image analysis and programming; and data analysis environment. User can easily rate any software package according to the five core capabilities discussed above. It is very important for a software package during the designing step. It should cover around four essential qualities: validity, reliability, impact and practicality. Validity is normally taken to the extent which a processing can be shown to produce scores that are an accurate reflection of the image taken. Reliability concerns the extent to which processing results are stable, consistent and accurate. Impact concerns the effects, beneficial or otherwise. Practically can be defined as the extent to which a processing is practicable in terms of the resources needed to produce and administer it [13, 14, and 15]. The advantage of the development of image processing package is to provide effective and easy handling tools for users. It is important to consider the processing in all aspects like the speed and the quality of the image. MATLAB is a general numerical analysis and visualization tool. The underlying data structure in MATLAB is the matrices, and this structure lends itself well for image processing. This processing tool need to be revised to make them more user-friendly, focusing on issues such as layout, illustrations, message, information, and cultural

appropriateness. It should provide full functionality for the entire processing cycle: authoring, scheduling, administering and rating. It is a premier and affordable personal computer-based image processing.

IV. CONCLUSION

In this paper, we study about the various related work in the area of image processing in MATLAB environment also discuss about the need of MATLAB environment in the field of image processing and also discuss about the various challenges in medical field using MATLAB tools. The future direction of the work will be to study on various algorithms and methods using to compressed medical images such as Genetic Algorithms (GAs) and Fuzzy Logics.

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