BIOMEDICAL IMAGE PROCESSING USING MATLAB

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Abstract-*Biomedical imaging concentrates on the capture of images for both diagnostic and therapeutic purposes.The conventional methods used for imaging provides the image of low resolution which presents difficulties in producing accurate results .The use of advanced sensors and computer based technology has improvised the image processing which utilizes X-ray, CT (computed tomography), MRI (Magnetic resonance imaging), PET (positron Emission tomography) etc. A precise analysis of Biomedical imaging is an important stage in the contouring phase throughout radiotherapy preparation .Medical image processing tool are also similarly as important. This paper aims at using MATLAB software which provides better ways for image processing with enhanced resolution, contrast details for more accurate and reliable diagnosis***.***

Index Terms-Biomedical, CT scan, Image processing, MATLAB

I. INTRODUCTION:

An image refers to a 2D light intensity function f(x,y), where (x,y) denote spatial coordinates and the value of f at any point (x,y) is proportional to the brightness or gray levels of the image at that point. A digital image is an image f(x, y) that has been discretized both in spatial coordinates and brightness. The elements of such a digital array are called image elements or pixels.

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a sort of flag agreement in which input is picture, similar to video edge or photo and yield might be picture or attributes related with that picture.It is among quickly developing advances today, with its applications in different parts of a business. Picture Processing shapes center research region inside designing and software engineering disciplines as well.

Image processing essentially incorporates the accompanying three stages

- Importing the image with optical scanner or by digital photography.

- Analyzing and manipulating the image which includes data compression and image enhancement and spotting patterns
- Output is the last stage in which result can be altered image or report that is based on image analysis

DIP technique can be applied in variety of different fields such as Diagnostic image analysis, Surgical planning, Object detection and Matching, Background subtraction in video, Localization of tumours, Measuring tissue volumes, Locate objects in satellite images (roads, forests, etc.) ,Traffic control systems, Locating objects in face recognition, iris recognition, agricultural imaging, and medical imaging.DIP addresses challenges and issues like loss of image quality, enhance degraded image issues .

II. BIOMEDICAL IMAGE PROCESSING

In medical fields these days, medicinal imaging and handling devices are assuming significant jobs in numerous applications. According to Lee and Liew (2015), applications usually take place throughout the clinical track of events, not only within diagnostic settings, but prominently in the area of preparation, carrying out and evaluation before surgical operations [1]. Thus, the upsides and downsides of the medical picture will specifically impact the consequence of the analysis from a specialist to the patient.

Biomedical imaging concentrates on the capture of images for both diagnostic and therapeutic purposes. Biomedical imaging techniques encompass the fields of radiology, nuclear medicine and optical imaging. Previews of in vivo physiology and physiological procedures can be earned through cutting edge sensors and PC innovation. Biomedical imaging technologies utilize either x-rays (CT scans), sound (ultrasound), magnetism (MRI), radioactive pharmaceuticals (nuclear medicine: SPECT, PET) or light (endoscopy, OCT) to assess the current condition of an organ or tissue and can monitor a patient over time over time for diagnostic and treatment evaluation [2]. Molecular imaging is utilized in nuclear medicine and utilizes an assortment of strategies to imagine natural procedures occurring in the cell of life forms. Little measures of radioactive markers, called radiopharmaceuticals, are utilized for molecular imaging.Other types of medical imaging are magnetic resonance imaging (MRI) and ultrasound imaging. Unlike conventional X-ray, CT and Molecular Imaging, MRI and ultrasound operate without ionizing radiation.

Depending on the imaging technique and what diagnosis is being considered, image processing and analysis can be used to determine the diameter, volume and vasculature of a tumor or organ; flow parameters of blood or other fluids and microscopic changes that have yet to raise any otherwise discernible flags.

The science and engineering behind the sensors, instrumentation and software used to obtain biomedical imaging has been evolving continuously since the x-ray was first invented in 1895. Modern x-rays using solid-state electronics require just milliseconds of exposure time, drastically reducing the x-ray dose originally needed for recording to film cassettes. The image quality has also improved, with enhanced resolution and contrast detail providing more reliable and accurate diagnoses. Therapeutic pictures are generally utilized as radiographic procedures in conclusion, clinical investigations and treatment arranging.

A.COMPUTED TOMOGRAPHY:

Computed Tomography (CT), also commonly referred to as a CAT scan.A computerized tomography (CT) scan combines a series of 2D X-ray images taken from different angles around your body and uses computer processing to create cross-sectional images (slices) of the bones, blood vessels and soft tissues inside your body[3]. CT scan images provide more-detailed information than plain X-rays do . CT is often used to evaluate the presence, size and location of tumors. In addition, CT also uses to evaluate organs in the pelvis, chest and abdomen.

B.MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging (MRI) makes use of the magnetic properties of certain atomic nuclei. A model is the hydrogen atom (a proton) present in water atoms, and accordingly in all body tissues. The hydrogen nuclei behave like compass needles that are partially aligned by a strong magnetic field in the scanner. The neuclei can be turned utilizing radio waves, and they along these lines sway in the magnetic field while coming back to balance. All the while they emit a radio signal. This is detected using antennas (coils) and can be used for making detailed images of body tissues

C.POSITRON EMISSION TOMOGRAPHY

Alexander (2014) stated that positron Emission Tomography (PET) is a nuclear imaging technique that provides physicians with information about how tissues and organs are functioning. PET, often used in combination with CT imaging, uses a scanner and a small amount of radiopharmaceuticals which is injected into a patient's vein which binds with the protiens inside the body and emits a radiation which assist in making detailed, computerized pictures of areas inside the body.

D.ULTRASOUND SCAN

Diagnostic ultrasound, also known as medical sonography or ultrasonography, uses high frequency sound waves to create images of the inside of the body. The ultrasound machine sends sound waves into the body and is able to convert the returning sound echoes into a picture. According to Awad et al (2012), Ultrasound technology can also produce audible sounds of blood flow, allowing medical professionals to use both sounds and visuals to assess a patient's health [4].

III.MATLAB IMAGE PROCESSING

MATLAB is a high-level technical language and interactive environment for data analysis and mathematical computing functions such as: signal processing, optimization, partial differential equation solving, etc. It provides interactive tools including: threshold, correlation, Fourier analysis, filtering,basic statistics, curve fitting, matrix analysis, 2D and 3D plotting functions [5]. MATLAB and the Image Processing Toolbox provide a wide range of advanced image processing functions and interactive tools for enhancing and analyzing digital images. This platform is flexible and customizable, enabling you to include your own unique workflows and analytics, and allowing you to integrate with other tools. It scales to deal with large data or to combine different modalities and types of data. The interactive tools allowed us to perform spatial image transformations, morphological operations such as edge detection and noise removal, region-of-interest processing, image segmentation, image classification and Radon Transform.

MATLAB image processing technique is an effective method that can be used for problem solving in image processing. It uses Algorithms and mathematical process operations. By default, MATLAB stores most data in arrays of class double. The data in these arrays is stored as double precision (64-bit) floating-point numbers. All of MATLAB's functions and capabilities work with these arrays [6]. The MATLAB image processing use algorithms process number to represent the tissues information and the radiological density of the MRI and CT scan images. This new creation will be customize visual representations by applying the mathematical algorithms by using the MATLAB. The MATLAB will construct the data by extract the simplest single parametric and produce 2D reconstructions.

III.(a) TECHNIQUES OF IMAGE PROCESSING IN MATLAB

A digital image is an array of real numbers represented by a finite number of bits. The principle advantage of Digital Image Processing methods is its versatility, repeatability and the preservation of original data precision. The various Image Processing techniques are:

IMAGE PREPROCESSING AND ENHANCEMENT

In image preprocessing, image data recorded by sensors on a satellite restrain errors related to geometry and brightness values of the pixels. Pre-processing of images commonly involves removing low-frequency background noise, normalizing the intensity of the individual particles images, removing or enhancing data images prior to computational processing[7]. These errors are corrected using appropriate mathematical models which are either definite or statistical models. Image enhancement is the modification of image by changing the pixel brightness values to improve its visual impact. Image enhancement involves a collection of techniques that are used to improve the visual appearance of an image, or to convert the image to a form which is better suited for human or machine interpretation.

IMAGE SEGMENTATION

Segmentation is one of the key problems in image processing. Image segmentation is the process that subdivides an image into its constituent parts or objects. The level to which this subdivision is carried out depends on the problem being solved, i.e., the segmentation should stop when the objects of interest in an application have been isolated.

After thresholding a binary image is formed where all object pixels have one gray level and all background pixels have another - generally the object pixels are 'black' and the background is 'white'.Thresholding can be defined as mapping of the gray scale into the binary set {0, 1} :

$$S(x, y) = \begin{cases} 0, & if \quad g(x, y) < T(x, y) \\ 1, & if \quad g(x, y) \geq T(x, y) \end{cases}$$

where S(x, y) is the value of the segmented image, g(x, y) is the gray level of the pixel (x, y) and T(x, y) is the threshold value at the coordinates (x, y).

Segmentation of images involves sometimes not only the discrimination between objects and the background, but also separation between different regions. One method for such separation is known as watershed segmentation.

IMAGE CLASSIFICATION

Image classification is the labeling of a pixel or a group of pixels based on its grey value. Classification is one of the most often used methods of information extraction. In

Classification, usually multiple features are used for a set of pixels i.e., many images of a particular object are needed.

FEATURE EXTRACTION

This technique extracts high-level features needed in order to perform classification of targets. Features are those items which uniquely describe a target, such as size, shape, composition, location etc. When the pre-processing and the desired level of segmentation has been achieved, some feature extraction technique is applied to the segments to obtain features, which is followed by application of classification and post processing techniques. It is essential to focus on the feature extraction phase as it has an observable impact on the efficiency of the recognition system.

III. (B) IMAGE TOOLKIT

An X-ray Computed Tomography (CT) image is composed of pixels, whose brightness corresponds to the absorption of X-rays in a thin rectangular slab of the cross-section, which is called a "voxel'' [1,3]. The Pixel Region tool provided by MATLAB 7.0.1 superimposes the pixel region rectangle over the image displayed in the Image Tool, defining the group of pixels that are displayed, in extreme close-up view, in the Pixel Region tool window. The Pixel Region tool shows the pixels at high magnification, overlaying each pixel with its numeric value [2,5]. For RGB images, we find three numeric values, one for each band of the image. We can also determine the current position of the pixel region in the target image by using the pixel information given at the bottom of the tool. In this way we found the x- and y-coordinates of pixels in the target image coordinate system. The Adjust Contrast tool displays a histogram which represents the dynamic range of the X-ray CT image (figure 1) [8].

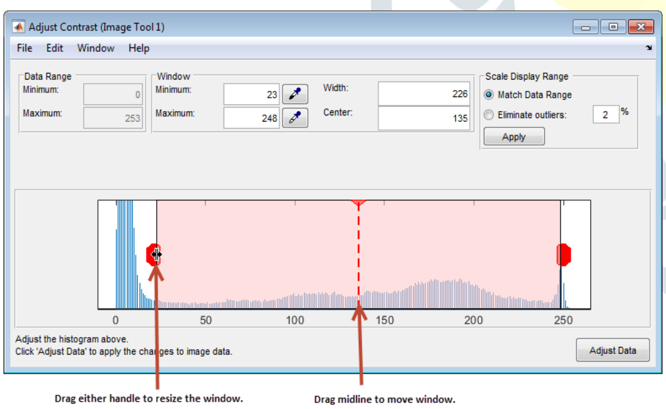
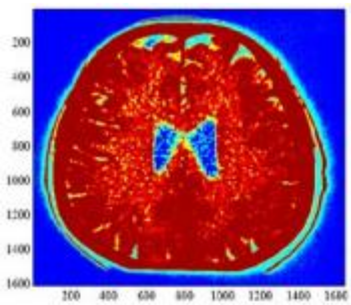


Fig 1- MATLAB image toolkit to adjust contrast

III. (c) PLOT TOOLS MATLAB

MATLAB provides a collection of plotting tools to generate various types of graphs, displaying the image histogram or plotting the profile of intensity values.

The ''Image'' creates an X-ray CT image graphical object by interpreting each element in a matrix as an index into the figure's colormap or directly as RGB values, depending on the data specified (Figure 2a.). The ''Image'' with Colormap Scaling (''imagesc'' function) displays an X-ray CT image and scale to use full colormap. MATLAB supports a number of colormaps. A colormap is an m-by-3 matrix of real numbers between 0.0 and 1.0. Each row is an RGB vector that defines one color Jet ranges from blue to red, and passes through the colors cyan, yellow, and orange. It is a variation of the hsv (hue, saturation, value) colormap(figure 2b)[9].



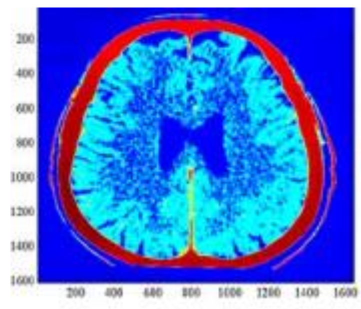


Fig 2a- Image based on direct RGB values   Fig 2b- colormap after variation in HSV

Contour Plot is useful for delineating organ boundaries in images. It displays isolines of a surface represented by a matrix.The contour3 function creates a three-dimensional contour plot of a surface defined on a rectangular grid as shown in figure (3)

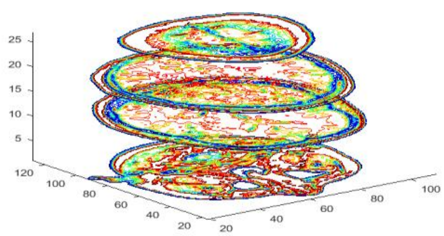


Fig 3- Contour3 on X-ray CT brain scan

The 3-D Surface Plot generates a matrix as a surface as shown in figure (4). We can also make the faces of a surface transparent to a varying degree. Transparency (referred to as the alpha value) can be specified for the whole 3D-object or can be based on an alphamap, which behaves in a way analogous to colormaps

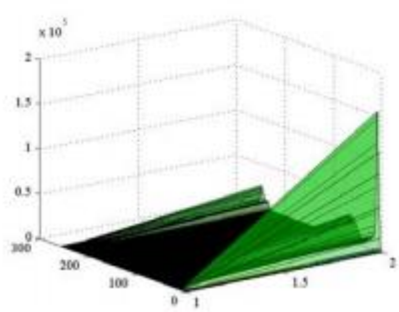


Fig 4- 3D Surface Plot of x-ray CT brain scan generated with histogram values

IV. CONCLUSION

Thus, there are many softwares which are being used for image processing but MATLAB is the most systematic approach towards this field and it is one of the software that offers simple instructions that helps to read images from variety of file formats.With this medical image processing tool, it is possible to speed up and enhance the operation of the analysis of the medical image. In medical imaging field, there are many visualization tools that can be used but most of them are not easy to handle. Hence, a creation of simple computer graphics such as histograms, bar charts and scatter plots by MATLAB package to manipulate and visualize matrices data will help. **REFERENCES**

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