Visualization of biomedical data health and social care essay

The term natural science refers to the search for " truth" about the natural world. Eventually, truth is defined by principles and laws that have evolved from explanations and measurements about the natural world. These two kinds can be reproduced through procedures that follow universal rules of scientific experimentation. The objective of science is to use explanations and measurements to distinguish the static and dynamic properties of objects, preferably in quantitative terms and to integrate these properties into principle and, finally, laws and theories that present a logical framework for understanding the world and our place in it. In this natural science, the mission of human medicine is the expedition for understanding one particular object, the human body, and its composition and role under all circumstances of health, illness and injury. This expedition has created models of human health and illness that are incredibly useful in preventing disease and disability, detecting and diagnosing illness and injury, and designing therapies to lessen pain and suffering and to recover the body to a state of wellness, or at least, structural and functional capacity. The achievement of these efforts depends on (a) our strength of understanding of the human body and (b) the ways to occur successfully in the progression of disease and the effect of injuries. The human body builds with an amazingly complex system. Getting data about its static and dynamic properties results in huge amounts of information. The question of hoe to acquire process and display vast quantities of information about the body is the major challenges to researchers and clinicians. Therefore, the presentation of information as images is the most efficient approach to addressing this challenge. Nowadays, Physicians increasingly rely as well on images to understand the human body and to cure the internal damage insight in the body. By using images to manage and interpret information about biological and medical processes is certain to continue its expansion, not only in clinical medicine but also in the biomedical research enterprise that supports it.

3. 2 Representation of Biomedical Data

From the time when the art began, Humans have been rendering the human body throughout art. In the region of 13, 000 BC early man sited one side of hand on the Lascaux cave's wall in the Dordogne region which is now France and dropped tincture around his hand to generate a siloutette. The other significant painted for the human body is that the human body being attacked by a bull carrying a wound with protruding human intestines. From 2613 to 332 BC, the Egyptians acquired internal anatomy knowledge while they setting up the mummification dead. They painted the human appearance with reliable proportions and even tools of classification to leave their history and to show their living style. About 500 BC, The Greeks germinated a true sense of surface anatomy and established it through their figure sculptures. Past 1517, Leonardo da Vinci had taken apart 30 all types of human of all ages, also used up numerous snakes, monkeys, birds and frogs to make and to give an unforgettable gathering of sketches and notes signifying the first successful achievement of medical illustrations for internal and external anatomy. The name of the book " On the Fabric of the Human Body," was published in 1543, and the most impressive 16th century volume on absolute anatomy. It included a collection of prints completed from woodblocks engrave under the trend of the Venetian master, Titian. These entire contents were based on sketches developed by Andreas Vesalius, who was an Italian surgeon at the University of Padua; he obtained a name for his pleasurable public dissections of the human body. Around 1800s, the realistic depictions of anatomy lessons in Philadephia were shaped by Thomas Eakins who used awareness, oil shade, and brushes from his human body dissections. In 1894, Max Brodel, who was the father of modern medical illustration began working for the surgeons at the Johns Hopkins Hospital. Brodel had been conventionally qualified in Liepzig Germany. He had suspiciously noted thousands of surgeries and autopsies. By using carbon dust on chalk-coated board, Brodel brought about breathtakingly realistic renderings of surgical procedures that served to train the surgeons of the hospital accurately what to look for during a procedure without all the blood, puss, and gore that exists on a photograph. In the early and mid-1900s, the first medical illustration program in the world was founded and consequently directed by Max Brodel at the Johns Hopkins Hospital. The Association of Medical Illustrators (AMI) was launched in 1945. In 1967, the AMI set up as a set of educational standards to be used toward the accreditation of graduate programs in medical illustration.

3. 3 Generation of Medical Imaging Techniques

Medical imaging refers to the process involving specialized instrumentation and techniques to create images or relevant information about the internal biological structures and functions of the body. Recent advances in medical imaging with significant contributions from electrical and electronic engineering, computer engineering, chemistry, medical physics and computer science have witnessed a revolutionary growth in diagnosis radiology. Fast improvements in engineering and computing technologies have made it possible to acquire high resolution multidimensional images of complex organs to analyze structural and functional information of human physiology for computer-assisted diagnosis, treatment evaluation and intervention. Through large databases of vast amount of information such as standardized atlases of images, demographics, genomics, etc. New knowledge about physiological processes and associated pathologies is continuously being derived to improve our understanding of critical diseases for better diagnosis and management. Medical imaging technique is an effective technique for clinical decision, which provides a trend towards evidence-based medicine that relies closely on objective findings for diagnostic tasks. As a result, the need for image visualization and analysis has extended beyond the traditional diagnosis arena in radiology departments and is becoming common practice in all medical subspecialty. Digital and 3D techniques for imaging diagnostic devices have made a dramatic progress, and computed tomography (CT) and Magnetic Resonance (MR) are common in this decade. The process of exploring, transforming, and view data in visualization can provide images to gain understand and insight into the data. CT and MR scanners can be used to create a volume by reconstructing a series of slicing images.

Digital Imaging Techniques

The marriage of powerful computer technology and medical imaging can save the lives of many patients and the quality of all their lives improved. Image processing pertains to the alternation and analysis of pictorial information. In generally, image processing is the correction of contrast and brightness on a television set by doing this can enhance the image until its subjective appearing to us is most interesting. The biological system (eye, brain and skin) receives, enhances, and dissects analyzes and stores images at enormous rates of speed. Fundamentally there are two-methods for processing pictographic information. They are: Optical processingElectronic processingOptical processing serves as an arrangement of optics or lenses to take out the process. A significant form of optical image processing is found in the photographic dark room. Electronic processing is further classified as (1) Analog processing and (2) Digital processing. Analog processing does the functions of control of brightness and contrast of television image. Varying the amplitude of the voltage level of the television signal is the representation of brightness throughout the image by electrically altering these signals. Digital images are composed of predetermined numbers of elements of which has an exacting location value. Image, picture, and pixel elements are used as elements for digital image processing. Digital image processing is related with processing of an image. In other words an image is a representation of an actual scene, either in black and white or in colour, and either in a digital form or print form. The acquisition of three-dimensional data from a subject can be done using different techniques. The selection of imaging technique is determined by the structure or anomaly that needs to be observed, convinced that some techniques are better suited than others for certain applications. If more complete information is necessary, different imaging techniques can be used to obtain images of the same object, complimenting each other. This is referred to as Multi-modal Imaging. The results from different imaging techniques can be merged into one representation by using the specialized software. For instance, we can take the Erasmus Medisch Centrum, which uses the Radionics software to combine the results of CT and MR scans. By using MR scans with a resolution of 256x256 pixels and CT scans with a resolution of 512x512 pixels, the software requires that the user specify three points which are in the same position and uses this information to fuse the scan sets. In order to differentiate the data sets, CT data are then presented in red and MR in green. Some of most generally used imaging techniques are presented in this section.

Computed Tomography (CT)

Computed tomography is an x-ray based technique developed in the early 1970s, and now in widespread medical use. It revolutionized medical imaging and is considered to be the greatest advancement in radiology since x-rays. By measuring the intensity of transmitted rays from different angles and rotating an x-ray emitter around the patient, we can get three dimensional imaging. The product is a collection of 2D sections of the body that provide anatomical information on the positions of soft tissues, air, and bone. CT scans are possibly the most common source of three-dimensional data.

Magnetic Resonance Imaging (MRI)

In Magnetic Resonance Imaging (MRI), also same as Nuclear Magnetic Resonance Imaging (NMR), the patient is placed inside a strong magnetic field typically generated by a large superconducting magnet. NMR is utilized to achieve images as a function of relaxation times and proton spin density. MRI is mostly used as a technique for producing anatomical images, but it can also give information on the physical-chemical state of tissues, flow diffusion and motion information.

Ultrasound

Ultrasound is a real-time tomographic imaging technique. It produces real-time tomograms of the position of reflecting surfaces (internal organs and structures) and can also be used to produce real-time images of tissue and blood motion. High-frequency pulses of acoustic energy are emitted into the patient's body where they are reflected at the boundaries between tissues of different impedance. By measuring the time delay and intensity of the reflected pulses, an image indicating tissue interfaces can be reconstructed. Ultrasound is usually used for blood vessels and imaging of the heart, as well as gall bladder stones and fetal development.

Positron Emission Tomography (PET)

PET imaging technique initiates with the insertion of a metabolically active tracer molecule that carries with it a positron-emitting isotope. Within a few minutes, the isotope accumulates in an area of the body for which the molecule has a kinship. The radioactive nuclei then crumble by positron emission. High-energy gamma rays are produced which can be detected by an array of detectors in the scanner, when the emitted positron collides with a free electron. PET scanners are mainly used for brain imaging, in particular, localization of brain tumors and strokes diagnosis, as well as monitoring blood flow changes associated with local brain function.

3. 4 Computed Tomography (CT) and file format

In 1972, Godfrey Hounsfield in England was invented CT imaging (also called CAT scanning for Computed Axial Tomography). Hounsfield used gamma rays, later named as X-ray, and a detector mounted on a special rotating frame together with a digital computer to form complete cross sectional images of objects. Hounsfield's original CT scan took hours to get a single slice of image data and above 24 hours to reform this data into a single image. Today's state-of-the-art CT systems can obtain a single image in no more than one second and recreate the image immediately. The digital computer invented the CT image. The fundamental algorithms involved in CT image renovation are based on theories proposed by the scientist Radon in about 1700's. To respect his remarkable discovery, Hounsfield was awarded the Nobel Prize and was granted Knighthood by the Royal Family of England. Radiology involves the usage of some form of radiation to image the body for medical purposes. Numerous different techniques and tools are available for looking at dissimilar parts of the body in diverse ways. For example: X-Ray, Ultrasound, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and Angiography and International procedures. Within these ways, Computed Tomography (CT) has several advantages for 3D medical imaging. Traditionally, Tomography is a technique of X-ray photography that uses penetrating radiation measurements from many angles about an object to reconstruct cross sectional images of the object interior. The images are two dimensional maps of the X-ray linear attenuation coefficient for small volume elements in the object defined by the effective X-ray beam size. The CT images offer quantitative measures of component feature density and dimensions as related to the linear X-ray attenuation of the material. X-ray computed Tomography (CT) is known today as the most operative single event in medical imaging from the time when the discovery of X-ray. The importance of CT is related to several of its features, including the following: Provision of cross-sectional images of anatomyAvability of contrast resolution superior to traditional radiologyCreation of images from X-ray communication data by a " black box" mathematical process requiring a computerCreation of clinical images that are no longer direct proof of a satisfactory imaging process so that intermediate control measures from physical and engineering are essentialMaking of images from digital data that are processed by computer and can be manipulated to yield widely changing appearancesThe quantitative dimensional capability available in CT image data is analogous to drawing cross sections. The CT data is digital, allowing processing for edge finding with dimensional accuracies to such pixel values in the original image. The CT data provides a highly cost effective approach for geometry acquisition which is generating digital format dimensional documentation. Multiple slice CT data at selected orientations may be used to define specific features. Computed tomography measures the attenuation of X-rays as they pass through the body. A CT image consists of levels of gray that vary from black (for air), to white (for bone), to gray (for soft tissues). In figure 3. 1, it will show a series of CT cross sections through a head. This slice is taken at a 90 degree angle to the spine roughly through the middle of the ears. The gray boundary around the head obviously shows the ear and bridge the nose. The bright areas are bone. The dark regions on the interior of the slices are the nasal passages and ear canals.

Fig 3. 1 CT slices through a human head

In my program, I used 93 slices of CT images, which are stored as a flat file format. Each slice has 256x256 pixels spaced 0. 8 mm apart with 12 bits of gray level. A flat file database store the data as a one record per line text file, a combination of both text and binary file (or a binary file) which separates columns by using " delimiters" which split the fields in a standard recognizable way. This way helps in finding all the way through records for information. Records can also be bordered by fixed length. Some form of field-padding can be used so that the record length is the equal as the next. The purpose of this project is to take this gray scale data (over 12 megabytes) and convert it into information that will give support to the surgeon. Providentially, the visualization toolkit is the right technique to complete this challenge. I will use isocontouring techniques to extract the bone and the skin surfaces and show orthogonal cross-sections to put the isosurface in situation. In VTK, the input medical imaging slice data is image data. Each image data slice is stored in a separate file with the file suffix being the slice number of the form prefix. 1, prefix. 2, prefix. 3 and so on. Before the image data starts, medical imaging files often have a header of a definite size. The header size varies from file format to file format. At last, other complication is that sometimes one or more bits in each 16-bit pixel are used to tag connectivity between voxels. VTK offers several image readers including above one, which is vtkVolume16Reader that can be able to read raw file formats of the type. Before use this function, I need to instantiate the class and set the require instance variables as follows.

v16reader→SetImageRange (1, 93);

v16reader→SetDataDimensions (64, 64);

v16reader→SetFilePrefix (argv [1]);

v16reader→SetDataByteOrderToLittleEndian ();

v16reader→SetDataSpacing (3. 2, 3. 2, 1. 5);

For the above reader, I was used to read a series of 2D slices (images) that compose the volume. These slices come with set series and each separate with pixels spacing. I need to use SetDataByteOrderToLittleEndian () function because of the byte ordering of the file when I am trying to read in. The reader will use SetFilePrefix () function for combination with the slice numbers to construct filenames by using formal FilePrefix. http://www. brighthub. com/science/medical/articles/2976. aspxhttp://medical-dictionary. thefreedictionary. com/Computed+tomography+scanshttp://www. scribd. com/doc/14101583/Scientific-Visualization2. 4 Visualization Techniques

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