BIOMEDICAL IMAGE PROCESSING

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ABSTRACT: Biomedical Image Processing is a broad field for image formation. It receive biomedical signal by medical equipment and then transform those signal into image view, picture processing , and image display to medical diagnosis based on features extracted from images. It captured images via x-ray, ultrasound, MRI, nuclear medicine and optical imaging technologies. This article reviews this topic in both direction fundamental and application, In fundamental view it include , some basic image processing techniques including outlining, deblurring, noise cleaning, filtering, search, classical analysis and texture analysis have been describe with example. The Art of Image processing have been design in two category: general purpose image processing systems and image analyzers. In order for these systems to be effective for biomedical applications, special biomedical image processing languages have to be developed. Then combination of hardware and software leads to clinical imaging devices. Two different type of clinical imaging devices have been discussed. There are radiological imaging which include radiography, Thermography, ultrasound, nuclear medicine and CT. Thermography is limited in application due to the low energy of its source. It is particularly useful to the military and other users of surveillance cameras. X-ray CT is excellent for static anatomical images and is moving toward the measurement of dynamic function, whereas nuclear imaging is moving toward organ metabolism and ultrasound is toward tissue physical characteristics. Heart imaging is one of the most interesting and challenging research topics in biomedical image processing: currently heart imaging includes the cineangiography, and noninvasive ultrasound, nuclear medicine, transmission, and emission CT methodologies have been reviewed. The heart images are taken at 15–30 frames per second, not using a subtraction technique. Our project in heart imaging, the dynamic spatial reconstructor and the dynamic cardiac three-dimensional densitometer, should bring some fruitful results in the near future. Microscopic imaging technique is very different from the radiological imaging technique in the sense that interaction between the operator and the imaging device is very essential. Because the white blood cell analyzer has been developed to the point that it becomes a daily clinical imaging device. An interactive chromosome karyotyper is being clinical evaluated and its preliminary indication is very encouraging. Tremendous efforts have been devoted to automation of cancer cytology; it is hoped that some prototypes will be available for clinical trials very soon. Automation of histology is still in process; much work still needs to be done in this area. The 1970s have been very fruitful in utilizing the imaging technique in biomedical application; the computerized topographic scanner and the white blood cell analyzer being the most successful imaging devices.

KEYWORDS: Extraction, Segmentation, classification, Quantitative measurements, and interpretation are presented in separate sections.

I. INTRODUCTION

The use of direct digital imaging systems for medical diagnostics, digital image processing becomes more and more important in health care. In addition to originally digital methods, such as Computed Tomography (CT) or Magnetic Resonance Imaging (MRI), initially analogue imaging modalities such as endoscopy or radiography are nowadays equipped with digital sensors. Digital images are composed of individual pixels (this acronym is formed from the words “picture” and “element”), to which discrete brightness or color values are assigned. They can be efficiently processed, objectively evaluated, and made available at many places at the same time by means of appropriate communication networks and protocols, such as Picture Archiving and Communication Systems (PACS) and the Digital Imaging and Communications in Medicine (DICOM) protocol, respectively. Based on digital imaging techniques, the entire spectrum of digital image processing is now applicable in medicine.

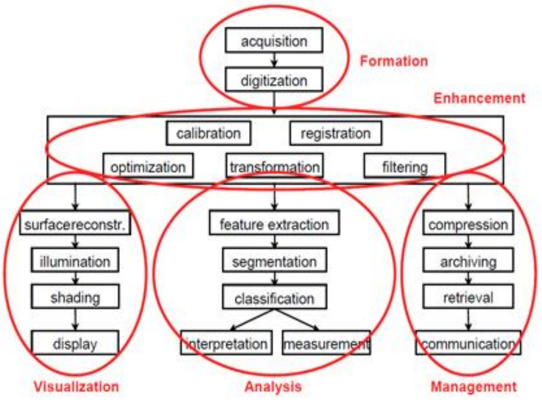


fig. 1.

1.1.1 *Steps of Image Processing*

The commonly used term “biomedical image processing” means the provision of digital image processing for biomedical sciences. In general, digital image processing covers four major areas

1. Image formation includes all the steps from capturing the image to forming a digital image matrix.
2. Image visualization refers to all types of manipulation of this matrix, resulting in an optimized output of the image.
3. Image analysis includes all the steps of processing, which

are used for quantitative measurements as well as abstract interpretations of biomedical images. These steps require a priori knowledge on the nature and content of the images, which must be integrated into the algorithms on a high level of abstraction. Thus, the process of image analysis is very specific, and developed algorithms can be transferred rarely directly into other application domains.

4. Image management sums up all techniques that provide the efficient storage, communication, transmission, archiving, and access (retrieval) of image data. Thus, the methods of telemedicine are also a part of the image management. In contrast to image analysis, which is often also referred to as high-level image processing, low-level processing denotes manual or automatic techniques, which can be realized without a priori knowledge on the specific content of images. This type of algorithms has similar effects regardless of the content of the images. For example, histogram stretching of a radiograph improves the contrast as it does on any holiday photograph. Therefore, low-level processing methods are usually available with programs for image enhancement.

1.1.2 Remarks on Terminology

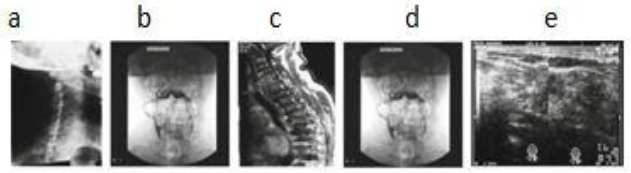
The complexity of an algorithm, the difficulty of its implementation, or the computation time required for image processing plays a secondary role for the distinction between low-level and high-level processing methods. Rather, the degree of abstraction of the a priori knowledge is important for this meaning. • The raw data level records an image as a whole. Therefore, the totality of all raw data pixels is regarded on this level. • The pixel level refers to discrete individual pixels. • The edge level represents the One-dimensional (1D) structures, which are composed of at least two neighbored pixels. • The texture level refers to Two-Dimensional (2D) or Three-Dimensional (3D) structures. On this level however, the delineation of the area's contour (in three dimensions: the surface of the volume) may be unknown. • The region level describes 2D or 3D structures with a well-defined boundary or surface. • The object level associates textures or regions with a certain meaning or name, i.e., semantics is introduces on this level. • The scene level considers the ensemble of image objects in spatial and/or temporal terms. If 3D structures are imaged over the time, also Four Dimensional (4D) data is acquired. From an iconic (concrete) to a symbolic (abstract) description of images, information is gradually reduced. Methods of low-level image processing operate on the raw data as well as on pixel, edge, or texture levels, and thus at a minimally level of abstraction. Methods of high-level image processing include the texture, region, object, and scene levels. The required abstraction can be achieved by increased modeling of a priori knowledge.

1.1.3 Biomedical Image Processing

A particular problem in high-level processing of biomedical images is inherently apparent: resulting from its complex nature, it is difficult to formulate medical a priori knowledge such that it can be integrated directly and easily into automatic algorithms of image processing. This is referred to as the semantic gap, which means the discrepancy between the cognitive interpretation of a diagnostic image by the physician (high level) and the simple structure of discrete pixels, which is used in computer programs to represent an image (low level). In the medical domain, there are three main aspects hindering bridging this gap: 1. Heterogeneity of images: Medical images display living tissue, organs, or body parts. Even if captured with the same modality and following a standardized acquisition protocol, shape, size, and internal structures of these objects may vary remarkably not only from patient to patient (inter-subject variation) but also among different views of a patient and similar views of the same patients at different times (intra-subject variation).Biological structures are subject to both inter- and intra-individual alterability. Thus, universal formulation of a priori knowledge is impossible. 2. Unknown delineation of objects: Frequently, biological structures cannot be separated from the background because the diagnostically or therapeutically relevant object is represented by the entire image. Even if definable objects are observed in biomedical images, their segmentation is problematic because the shape or borderline itself is represented fuzzily or only partly. Hence, medically related items often can be abstracted at most on the texture level. 3. Robustness of algorithms: In addition to these inherent properties of medical images, which complicate their high-level processing, special requirements of reliability and robustness of medical procedures and, when applied in routine, image processing algorithms are also demanded in the medical area. As a rule, automatic analysis of images in medicine should not provide wrong measurements. all images that have not been rejected must be evaluated correctly. Furthermore, the number of rejected images is not allowed to become large, since most medical imaging procedures are harmful and cannot be repeated just because of image processing errors.

1.2 Medical Image Formation

Medical images have become a major component of diagnostics, treatment planning and procedures, and follow-up studies. Furthermore, medical images are used for education, documentation, and research describing morphology as well as physical and biological functions in 1D, 2D, 3D, and even 4D image data (e.g., cardiac MRI, where up to eight volumes are acquired during a single heart cycle). Today, a large variety of imaging modalities have been established, which are based on transmission, reflection or refraction of light, radiation, temperature, sound, or spin. Figure. emphasizes the differences in image characteristic with respect to the imaging modality. Obviously, an algorithm for delineation of an individual vertebra shape that works with one imaging modality will not be applicable directly to another modality.



x-ray axial CT fluoroscopy MRI ultrasound

1.3 Image Enhancement

Low-level methods of imaging processing, i.e., procedures and algorithms that are performed without a priori knowledge about the specific content of an image, are mostly applied to pre- or post-processing of medical images .Therefore, the basic methods of histogram transforms, convolution and (morphological) filtering are mostly disregarded. As a special preprocessing method for medical images, techniques for calibration and registration are briefly introduced.

1.4 Image Data Visualization

Under the concept of image visualization, we had summarized all the transforms which serve the optimized output of the image. In medicine, this includes particularly the realistic visualization of 3D data. Such techniques have found broad applications in medical research, diagnostics, treatment planning and therapy. In contrast to problems from the general area of computer graphics, the displayed objects in medical applications are not given implicitly by formal, mathematical expressions, but as an explicit set of voxel. Consequently, specific methods have been established for medical visualization. visualization, and lighting and shading are also regarded .

1.4.2 Surface Rendering

To generate photo-realistic presentations of the volume surface, the lighting is simulated analog to natural scenes. According to the lighting model by Phong, ambient light is created through overlapping of multiple reflections, diffuse scattering on non-shiny surfaces, and direct mirroring on shiny surfaces. While the intensity of the ambient light remains constant in the scene for all surface segments, the intensities of diffuse and speckle reflections depend on the orientation and characteristics of surfaces as well as their distances and directions to the light source and the observing point of viewing

1.4.3 Volume Rendering

Direct volume visualization is abstained from preliminary calculation of the object surface. The visualization is based directly on the voxel data and, therefore, possible without any segmentation. This strategy allows visualization of medical 3D and 4D data by radiologists for interactive localization of pathological areas. The volume is processed either along the data layers (back-to-front or front-to-back) or along an imaginary light ray.

II. CONCLUSION AND OUTLOOK

The past, present, and future paradigms of Biomedical image processing are composed . Initially (until approx. 1985), the pragmatic issues of image generation, processing, presentation, and archiving stood in the focus of research in biomedical image processing, because available computers at that time had by far not the necessary capacity to hold and modify large image data in memory. The former computation speed of image processing allowed only offline calculations. Until today, the automatic interpretation of biomedical images still is a major goal. Segmentation, classification, and measurements of biomedical images is continuously improved and validated more accurately, since validation is based on larger studies with high volumes of data. Hence, we focused this chapter on image analysis and the processing steps associated with it. The future development is seen in the increasing integration of algorithms and applications in the medical routine. Procedures in support of diagnosis, treatment planning, and therapy must be easily usable for physicians. Therefore, further standardized in order to ensure the necessary interoperability for a clinical use.

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