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Review on Digital Image Processing in Biomedical Applications

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***Abstract*—** Every day is greater the number of images obtained to characterize the anatomy and functions of the human body; because of this the automation of the medical image processing has become a practice to improve the diagnosis and treatment of certain diseases. In this study the main areas of application of computer vision to the digital processing of medical images are reviewed. This paper gives the details about the methods of biomedical image processing and after that it also describe about medical imaging modalities. Some of the medical imaging modalities are described in this paper like X-ray imaging, CT, MRI, and ultrasound. The optical modalities like endoscopy, photography and microscopy are also more important in this field. The following steps of image analysis are explained in this paper, feature extraction, segmentation, classification, quantitative measurements and interpretation. It mainly focuses on segmentation of biomedical images, because of its high relevance. Special segmentation methods and techniques have been developed in the medical field.

***Keywords*—** Medical imaging modalities, Bacterial image analysis, automated image analysis

I. INTRODUCTION

Image processing is a rapidly growing area of computer science. Its growth has been fueled by technological advances in digital imaging, computer processors and mass storage devices. Fields which traditionally used analog imaging are now switching to digital systems, for their exibility and affordability. Digital image processing is concerned primarily with extracting useful information from images, this is done by computers. Image analysis tasks can be as simple as reading bar coded tags or as sophisticated as identifying a person from their face. Computers are indispensable for the analysis of large amounts of data, for tasks that require complex computation, or for the extraction of useful information. Extracting higher-level information, and for many applications such as medicine, biomedical, bioinformatics and remote sensing, human analysts still cannot be released by computers. Image processing algorithms may be placed at three levels. At the lowest level are those techniques which deal directly with the raw, possibly noisy pixel values, with denoising and edge detection being good examples

II. PRIOR WORKS

The authors [5] introduce an improvement to the mining Apriori association rule generates approximate association rules. The apriori algorithm takes into consideration missing values and noisy data. The experiment indicates that apriori effectively generates rules that approximate positive correlations in the input database.

This section discusses some of the significant literatures towards Gram- staining characterization for Gram color images, bacterial cell identification and classification, and bacterial cell growth phase analysis and cell division time determination. Characterization of P HB storage in activated sludge extended filamentous bacteria by automated color image analysis has been examined (Pandolfi et al., 2007). A simple image analysis algorithm for evaluation of extended filaments length based on the enhanced digitized image using statistical analysis is presented in (Kima et al., 2008). Digital image analysis of actinomycetes colonies as a potential aid for rapid taxonomic identification has been investigated in (Velho and Kamat, 2010).These research efforts lead to an automated Gram-staining based cell classification and cell growth studies.

The statistical image analysis for automatic identification of bacterial types is proposed in (Trattner and Greenspan, 2004). The morphological classification of blood leukocytes by microscope images has been carried out in (Vincenzo and Scotti, 2004). The automated image analysis of atomic force microscopy images of rotavirus particles has been investigated by Venkataraman et al. (Venkataraman et al.,2006). Quantification of uncultured microorganisms by fluorescence microscopy and digital image analysis has been carried out in (Holger and Michael, 2007). Efficient automated method for image-based classification of microbial cells has been investigated in (Pekkaet al., 2008). New methods for automated image analysis and bacteria type classification are presented by employing several discriminative features for class determination. The cell image analysis ontology that relates different cell parts or whole cells, The mass spectrometry tools for the classification and identification of bacteria are dealt in (Sarcha Sauer and Magdalena Kliem, 2010) and these a re based on statistical data analysis. The heuristic Bayesian segmentation for discovery of co-expressed genes within genomic regions using geometric features is studied in (Petri et al., 2010). Timing the start of division in E. coli: a single-cell study has been carried out in (Reshes et al., 2008). Evidence for a bimodal distribution of Escherichia coli doubling times below a threshold initial cell concentration is determined in (Peter I., et al., 2010). A fast and robust hepatocyte quantification algorithm including vein processing has been developed in (Tetyana et al., 2010) using global thresholding and extracting data of different characteristics.

III. ISSUES IN BIOMEDICAL APPLICATIONS

A major challenge in microbial ecology is to develop reliable and facile methods of computer assisted microscopy that can analyze digital images of complex microbial communities at single cell resolution, and compute useful quantitative characteristics of their organization and structure without cultivation. Image analysis is now a well-established complement to optical microscopy, allowing routine quantification of microscopic observations. Recent method developments include location and enumeration of bacteria in solid foods, in situ microscopy and image analysis for on-line monitoring of yeast fermentations, and texture analysis of fungal colonies for subsequent transfer. Notable recent applications include studies on the pulsatile growth of hyphal apices, biochemical differentiation of fungal colonies, and simple structural differentiation of mycelia from submerged fungal cultures.

Presently, the technological need is to provide fully unsupervised analysis for flow chamber microscopy images of the cells. The analysis includes noise filtering, cell recognition and determination of cell (geometric) properties for cell classification. The cell size determination is a significant step in the cell division time determination. Image-based analysis can provide genetic as well as molecular information in fixed or living cell without losing tissue morphology or spatial organization in a cell culture. Digital image cytometry addresses many interesting problems such as cancer prognosis and drug screening, analysis of sub-cellular compartments, dot-splitting, and co-localization studies, which have a large number of applications in the field of cell and molecular biology as well as biotechnology. The developments in the field of microbiology and also the digital image processing.

a) The development of tools for supporting biologists and clinicians in their analysis processes and for implementing automated diagnostic systems.

b) The automatic detection and classification of various types of bacterial cells using digital image processing techniques, which will be very useful in national health care management and cost effective medical treatment.

c) Viruses usually are too small to be seen with the light microscope and thus be studied by using electronic microscope with digital image processing techniques which will help the microbiologists for the detection and classification of various bacterial cells .

IV. MODELS FOR DIGITAL IMAGE PROCESSING TECHNIQUES AND ALGORITHMS

The algorithm and techniques employed to perform digital image processing are most important. Digital image processing techniques are numerous. Many of these techniques may also be applied for biological imaging application. Within the supervised framework, five DIP methods have been used. The basic steps of digital image processing (DIP) essential for object recognition in a digital image are:

- Image acquisition
- Image preprocessing
- Image segmentation
- Feature extraction
- Image classification

a. Image acquisition

Until the early 1990s, most image acquisition in video microscopy applications was typically done with an analog video camera, often simply closed circuit TV cameras. Often digital cameras used for this application provide pixel intensity data to a resolution of 12-16 bits, much higher than that used in consumer imaging products. Ironically, in recent years, much effort has been put into acquiring data at video rates or higher (25-30 frames per second or higher). What was once easy with off-the-shelf video cameras now requires special, high speed electronics to handle the vast digital data bandwidth. Higher speed acquisition allows dynamic processes to be observed in real time, or stored for later playback and analysis. Combined with the high image resolution, this approach can generate vast quantities of raw data, which can be a challenge to deal with, even with a modern computer system. It should be observed that while current

CCD detectors allow very high image resolution, often this involves a trade-off because, for a given chip size, as the pixel count increases, the pixel size decreases. As the pixels get smaller, their well depth decreases, reducing the number of electrons that can be stored. In turn, this results in a poorer signal to noise ratio. For best results, one must select an appropriate sensor for a given application. Because microscope images have an intrinsic limiting resolution, it often makes little sense to use a noisy, high resolution detector for image acquisition. A more modest detector, with larger pixels, can often produce much higher quality images because of reduced noise. This is especially important in low-light applications such as fluorescence microscopy. In the following, we describe the light microscopy, the fluorescence microscopy and the transmission electron microscopy (TEM).

b. Image pre-processing

Preprocessing is very essential in a variety of situations since it helps to suppress information that is not relevant to the specific image processing or analysis task. Therefore, the aim of pre-processing is an improvement of the image data that suppresses undesired distortions or enhances some image features important for further processing, although geometric transformations of images (e.g. rotation, scaling, and translation) are also classified as pre-processing methods (Gerald, et al., 2007). In electrical engineering and computer science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or, a set of characteristics or parameters related to the image. Most image processing techniques involve treating the image as a two-dimensional signal and applying standard signal processing techniques to it. Image processing usually refers to digital image processing, but optical and analog image processing also are possible. The most commonly used image preprocessing techniques are; image enhancement, image convolution, morphological operations and noise filtering, etc.

c. Feature extraction

In cytology, automating the feature extraction process yields an objective, quantitative, detailed, and reproducible computation of cell morpho- functional characteristics and allows the analysis of a large quantity of images. In this thesis we are used color and geometric shape features.

- Color features

Color is an important dimension of human visual perception that allows discrimination and recognition of visual information (Smith, 2001). Color features are relatively easy to extract and match, and have been found to be effective for indexing and searching of color images in image databases. One of the main aspects of color feature extraction is the choice of a color space.

d. Image segmentation

In computer vision, segmentation refers to the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (edge detection). Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s). When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to rate 3D reconstructions with the help of interpolation algorithms like marching cubes. The most commonly used image segmentation techniques are thresholding, edge based image segmentation, watershed segmentation, active contour models and color image segmentation.

e. Image classification

Classification is a method of categorizing or assigning class labels to a pattern set under the supervision of a teacher. It is one of the familiar and popular techniques in pattern recognition and data mining. The decision boundaries are generated to discriminate between patterns belonging to different classes. The patterns are initially partitioned into training and test sets randomly and the classifier is trained on the former. The test set is used to evaluate the generalization capability of the classifier. There are different categories of the classification methods like decision trees, probabilistic methods, nearest neighbor classifier, regression, neural networks, fuzzy inference system etc. Among these, the 3σ, nearest neighbor (K-NN), neural network, fuzzy and neuro fuzzy classifiers are employed in this research work for performance evaluation. For identification and classification of the various bacterial cells and its subgroups, we have used different classifiers, namely 3σ, K-NN, Neural network, Fuzzy and Neuro Fuzzy classifiers, which are described.

V. CONCLUSION

A wide variety of researches have been made on biological imaging. Each work has its own technique, contribution and limitations. As a review paper, we might not include each and every aspect of individual works; however attempt has been made to deal with a detailed review of the most common traditional and modern Bacterial Cell Image Analysis. This paper addresses overview and use of biomedical image processing. And discuss on bacterial cell image analysis, process of application of bacterial cells followed by models for biological segmentation and classification and issues. At present, digital image processing tools work largely on relational images. However, in the future we can expect to see digital image processing tools.

REFERENCES

[1]. Suzuki K, Abe H, MacMahon H, Doi K, "Image-processing technique for suppressing ribs in chest radiographs by means of massive training artificial neural network (MTANN)". IEEE Transactions on Medical Imaging., 2006, vol. 25,no.4, pp. 406-416.

[2]. WeixingWang,Shuguang Wu **"**A Study on Lung Cancer Detection by Image Processing" international conference on Communications,Circuits and Systems Proceedings, 2006, pp. 371-374.

[3]. Md. FoisalHossain, Mohammad Reza Alsharif "Image Enhancement Based on Logarithmic Transform Coefficient and Adaptive Histogram Equalization"International Conference on Convergence Information Technology, 21-23 November, 2007, pp. 1439 – 1444.

[4]. P.S. Hiremath, Parashuram Bannigidad, International Journal on Biomedical Engineeri ng and Technology (IJBET), Inderscience Publishers Ltd., USA, 2011, Vol. 7, No.3, pp. 257-265.

[5]. Wenhong Li,Yonggang Li,KexueLuo, "Application of Image Processing Technology in Paper Currency Classification System", IEEE transactions 22-24 Oct. 2008, pp. 1- 5.

[6]. Li Minxia, ZhengMeng "A Study of Automatic Defects Extraction of X-ray Weld Image Based on Computed Radiography System" International Conference on Measuring Technology and Mechatronics Automation - ICMTMA, 2011.

[7]. P.S. Hiremath, Parashuram Bannigidad, "Automated Gram-staining characterization of bacterial cells using colour and cell wall properties Proceedings of the International Conference on Signal and Image processing (ICSIP-2009), Aug. 19-21, 2009, VVIT-Mysore, Karnataka, India, pp. 209-211.

[8]. Kanwal, N. , Girdhar, A. ; Gupta, S "Region Based Adaptive Contrast Enhancement of Medical X-Ray Images", Bioinformatics and Biomedical Engineering, (ICBBE) 2011 5th International Conference, pp. 1-5.

[9]. Noorhayati Mohamed Noor, Noor Elaiza Abdul Khalid. "Fish Bone Impaction Using Adaptive Histogram Equalization (AHE)" Proceedings of the Second International Conference on Computer Research and Development 2010, IEEE Computer society Washington, pp.163-167.

[10]. Lu Zhang, Dongyue Li, ShuqianLuo , **"**Information extraction of bone fracture images based on diffraction enhanced imaging" International Conference of Medical Image Analysis and Clinical Application (MIACA) 10-17 June 2010, pp.106 -108.

[11]. Md.FoisalHossain, Mohammad Reza Alsharif, and Katsumi Yamashita **"**Medical Image Enhancement Based on Nonlinear Technique and Logarithmic Transform Coefficient Histogram Matching**",** IEEE/ICME International Conference on Complex Medical Engineering July,2010, pp. 13-15.

[12]. P.S. Hiremath, Parashuram Bannigidad, International Journal on Biomedical Engineeri ng and Technology (IJBET), Inderscience Publishers Ltd., USA, 2011, Vol. 7, No.3, pp. 257-265.

[13]. P.S. Hiremath1, Parashuram Bannigidad2, Soumyashree S.Yelgond3**, "** An Improved Automated Method for Identification of Bacterial Cell Morphological Characteristics", International Journal of Advanced Trends in Computer Science and Engineering, Vol.2 , No.1, Pages : 11-16 (2013)

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