

Chapter 18

Cancer Cell Image Analysis and Visualization

Tae-Yun Kim

Inje University, Korea

Hae-Gil Hwang

Inje University, Korea

Heung-Kook Choi

Inje University, Korea

ABSTRACT

We review computerized cancer cell image analysis and visualization research over the past 30 years. Image acquisition, feature extraction, classification, and visualization from two-dimensional to three-dimensional image algorithms are introduced with case studies of bladder, prostate, breast, and renal carcinomas.

INTRODUCTION

Microscopy has long been used as the standard for histological cancer cell image analysis, but the visual interpretation is subjective. Computer-based microscopy image acquisition, processing, and analysis started in the 1960s (Bergkvist, 1965), and at that time, personal computers lacked the capacity to process medical images; only workstations were powerful enough. Despite the controversy over whether decisions made by a machine could prevail over intelligent human visual cognition,

the biggest issues in computing were accurate classification and reproducibility.

First, Stenkvis (1978) and Bengtsson (1976) applied computing to examining cervix cancer cell tissue sections in Sweden. They developed a prescreening program for cervix cancer that simply classified normal and abnormal cells, i.e., benign and malignant cells.

Mathematical parameters can be used to extract two types of microscopic features: morphological and textural. In the Netherlands, Baak (1990) used morphological features to classify breast carcinomas. Pressman (1976) was the first to make use

DOI: 10.4018/978-1-4666-0909-9.ch018

of textural features, and Haralick (1973) subsequently developed more defining characteristics. Over time, the image resolution increased from 1 bit black-and-white to 8-bit gray scale to 16- and 42-bit red–green–blue (RGB) colors with high resolution. In addition, images have progressed from two-dimensional (2-D) to three- (3-D) and even four-dimensional (Choi, 2005).

Consequently, developments in both computer software and hardware have contributed greatly to the diagnosis and prognosis of patients with cancer.

MATERIALS AND METHODS

Image Acquisition

Early microscopic image acquisition involved attaching an analog charge-coupled device (CCD) camera to a microscope (Choi, 1994). Then, the analog signals were converted into digital signals using a frame grabber. Recently, digital CCD cameras have been attached directly to microscopes.

Histological Cell Feature Extraction

Once cells are stained with a biochemical reagent, the most important process is to identify the cell nucleus, which involves subtracting the region of interest (ROI) from the background. Then, we quantify the features of the cell nucleus, including the size, perimeter, major and minor axes, and cell numbers. Textural features include entropy, contrast, moment, and intensity variation. We can calculate more than 1,000 features. Then, we select significant features using statistical analyses (Cox, 1972).

Finally, we determine the cell densitometry of an area (Choi, 2007; Kayser, 1992). Generally, the most important objects in a ROI are the cell nuclei, for which we have calculated the cell features. Figure 1 shows the (a) morphology, (b) texture, (c) intensity, and (d) special staining for molecules in sample cells.

Data Classification

Normally, two methods are used for numerical data classification: statistical classification (i.e., the conventional method) and neural network methods. Statistical analyses include multivariate, factor, regression, principal components, and independent component analyses (John, 1992). Neural networks methods include back propagation networks, Hopfield networks, and adaptive resonance theory (Choi, 2007). Other classification methods are fuzzy theory and supported vector machines. The best method depends on the characteristics of a particular image.

Case Studies

Bladder Cancer Grading

In the early 1990s, we started to develop a computerized bladder cancer grading system. Tissue specimens were sliced to 4 μm thicknesses using a microtome and stained with Feulgen for DNA analysis. Figure 2 shows histological tissue images at 400 \times magnification of representative samples of grades 1 to 4 bladder cancer. In grade 1 (Figure 2a), the cells are orderly and little variation occurs in size or intensity. At intermediate grades (Figure 2b, c), the cells are more disordered, and they are completely disordered at grade 4 (Figure 2d). In addition, differences in size and intensity are observed.

Looking at detailed images, the staining intensity is also progressively darker. To classify these images, we can use morphological analysis based on cell size and texture analysis based on the intensity. We developed a classification software tool that classifies the cancer accurately (Knuechel, 1993), and obtained an 84.3% correlation between the computer grade and the subjective grading by a pathologist (Choi, 1994).

9 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/cancer-cell-image-analysis-visualization/65716

Related Content

A Systemic, Participative Design of Decision Support Services for Clinical Research

Alexandra Pomares Quimbaya, Rafael A. González, Wilson Ricardo Bohórquez, Oscar Muñoz, Olga Milena García and Dario Londoño (2016). *E-Health and Telemedicine: Concepts, Methodologies, Tools, and Applications* (pp. 371-390).

www.irma-international.org/chapter/a-systemic-participative-design-of-decision-support-services-for-clinical-research/138409

A Review on Negation Role in Twitter Sentiment Analysis

Itisha Gupta and Nisheeth Joshi (2021). *International Journal of Healthcare Information Systems and Informatics* (pp. 1-19).

www.irma-international.org/article/a-review-on-negation-role-in-twitter-sentiment-analysis/279236

Internet Use and Health Decision Making by Breast Cancer Patients in Malaysia

Gerald Goh Guan Gan and Khor Yoke Lim (2010). *Handbook of Research on Developments in E-Health and Telemedicine: Technological and Social Perspectives* (pp. 863-881).

www.irma-international.org/chapter/internet-use-health-decision-making/40680

Reforming Medical Curriculum While Ignoring Examinations: A Commentary on Sood and Ananthkrishnan's "Reforming Medical Curriculum in India in Recent Years: Conflicts of Political, Regulator, Educationist and Professional Natures and Strategies for their Resolution"

Sabyasachi Sircar (2012). *International Journal of User-Driven Healthcare* (pp. 76-78).

www.irma-international.org/article/reforming-medical-curriculum-while-ignoring/64333

The Design of a Cloud-based Clinical Decision Support System Prototype: Management of Drugs Intoxications in Childhood

Baya Naouel Barigou, Fatiha Barigou, Chawki Benchehida, Baghdad Atmani and Ghalem Belalem (2018). *International Journal of Healthcare Information Systems and Informatics* (pp. 28-48).

www.irma-international.org/article/the-design-of-a-cloud-based-clinical-decision-support-system-prototype/210577