Chapter 75
Multimodal Indexing and Information Retrieval in Medical Image Mammographies:
Digital Learning Based on Gabor Filters Model

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ABSTRACT

In this chapter, we propose a new indexing approach on medical "image scanner" databases combining the analysis process of the texture characteristics with the information contents. The proposed model is based on the digital image components using the vector of characteristics. This vector represent the morphological processing result on image texture. It is linked to semantic attributes of the image using the annotations of medical professionals. Our context of study is based on "Mammographic Image Analysis" (MIAS) in databases. The first aspect concerning the morphology processing on images called the "numerical signature" vector. In our approach, the image analysis of the texture is based on the Gabor Wavelets (or Filters) Theory. In offline processing for each image in MIAS databases, the Gabor Wavelets determine all numerical signatures: vectors of image characteristics as multi-index. In online, the query by image is in real-time processing to define the query signature (or image-query vectors) and to determine similarities by matching of multi-index with all images in databases. The similarities are built between the image-query and images in MIAS databases using the same Gabors' algorithms implemented. In order to evaluate the robustness of our system (based on multi-index, semantic attributes, query and information retrieval by image), we experiment with a controlled database of 320 mammographies. The performance results show a set of successful criteria in image representations based on the Gabor's Wavelets, semantic attributes and combining with significant ratios in the system recall and precision.

INTRODUCTION

The development of the electronic devices of imagery in various forms has given trillions of stored images in the world using Internet and needs has been expressed on image analysis in professional contexts especially in medicine. In particular, the medical field generates significant billions of images for therapeutic interest. In this context, medical images come mainly from the x-rays (or scanner), the magnetic resonance (or IMR), the ultrasonic imagery, the microscopic or from the nuclear medicine imagery. This dynamic in information sources comes from the practical variability with extreme difficulty to analyse and to exploit images in quantitative, qualitative and objective ways.

In the pioneering works on image, the implemented systems were based on the text representation of image (Text-Based Image Retrieval: TBIR). In this kind of systems, the indexing process on images is based only on text descriptors (as significant words in text, term of index using specific thesaurus in domain, keywords in descriptions and annotations, user or professional semantic tags, etc.). Today, this way to process is the case of the major search engines in the Web. However, it was proved that these processes in image indexing are not sufficient and in particular when it concerns the indexing of significant images in sensitive areas like medicine, mechanical Engineering, biometrics, photo-satellites, etc. other than those found in social networks. Therefore, it will be a significant contribution to develop other kind of systems based of the digital components (and numerical characteristics) of images. Since the 90s, scientific communities started implementations in image indexing systems based on query by contents (Content-Based Image Retrieval System: CBIR system) (Akgül, Rubin, Napel, Beaulieu, Greenspan, & Acar, 2011; Singh & Mazumdar, 2010; Florea, Rogozan, Bensrhair, Dacher, & Darmoni, 2005; De Oliveiraa, Jachadob, & Chaveza, 2010).

Today, we find some kind of CBIR Systems which make possible the information retrieval on image using the web. As example, we can list *tineye[1], cydral[2], gazopa[3],* etc. These implemented systems using the web of images make possible to carry out the information image search by URL or direct remote loading of image query from the hard disk of the user. Several indexing techniques and information image search approaches were elaborate (Harbaoui, Ghenima, & Sidhom, 2009). But, observations in this type of image representation show limits to remain faithful to the analyzed image. Certainly in image file, this last contains instead of text representations a set of digital components characterized by sets of colors, textures and forms (Ravani, Mirali, & Maniasadi, 2010). In some of these reasons, the indexing systems and image query or query by image content engines are under the study since the 90s (Ravani, Mirali, & Baniasadi, 2010; Sidhom, 2002; Giro-i-Nieto, Ventura, Phot-Tuset, Cortes, & Marques, 2010).

Our objective in this research work is to represent and combine the two approaches, as the informational approach using semantic attributes to the numerical approach using the digital vector signature. For testing, we used the "Mammographic Image Analysis" (or MIAS) databases containing 320 mammography images. All mammographic images were diagnosed by medical specialists and all are completed by a set of notes describing the pathological case of the disease. In the first step of analysis and development, we carry out in offline the semantic indexing of all images in MIAS sources based on medical specialist notes. Next, we extend semantic representations by the aspect of numerical characteristics by calculating the Gabor Wavelets on image to determine all numerical signatures: vectors of image characteristics as multi-index. This last processing is based on the extraction of texture parameters of a mammography in

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