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Implementation of several mathematical algorithms to breast tissue density classification

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HIGHLIGHTS

- Breast density classification can be obtained by suitable mathematical algorithms.
- Mathematical processing help radiologists to obtain the BI-RADS classification.
- The entropy and joint entropy show high performance for density classification.

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ABSTRACT

The accuracy of mammographic abnormality detection methods is strongly dependent on breast tissue characteristics, where a dense breast tissue can hide lesions causing cancer to be detected at later stages. In addition, breast tissue density is widely accepted to be an important risk indicator for the development of breast cancer. This paper presents the implementation and the performance of different mathematical algorithms designed to standardize the categorization of mammographic images, according to the American College of Radiology classifications. These mathematical techniques are based on intrinsic properties calculations and on comparison with an ideal homogeneous image (joint entropy, mutual information, normalized cross correlation and index Q) as categorization parameters. The algorithms evaluation was performed on 100 cases of the mammographic data sets provided by the *Ministerio de Salud de la Provincia de Córdoba, Argentina—Programa de Prevención del Cáncer de Mama* (Department of Public Health, Córdoba, Argentina, Breast Cancer Prevention Program). The obtained breast classifications were compared with the expert medical diagnostics, showing a good performance. The implemented algorithms revealed a high potentiality to classify breasts into tissue density categories.

1. Introduction

The breast tissue density is widely accepted to be an important risk indicator for the development of breast cancer. The BI-RADS (Breast Imaging Reporting Data System) density scale, developed by the American College of Radiology (ACR) (Reston, 1995), informs radiologists about the decline in sensitivity of mammography with increasing breast density. ACR defines four breast density categories according to the percentage of fat and fibroglandular tissue and radiologists evaluate and report it on the basis of visual analysis of mammography. The breast density categories are: density I, almost entirely fatty; density II, scattered fibroglandular tissue; density III, heterogeneously dense tissue and density IV as extremely dense tissue.

The various distribution of the parenchyma tissue makes automatic classification a difficult task, so in this scenario, as auxiliary tools, computer-aided diagnosis (CAD) and content-based image retrieval (CBIR) systems appear as real possibilities to help radiologists to reduce the variability of their analysis and also to improve the accuracy of mammography interpretation. CBIR systems (del Bimbo, 1999; Müller et al., 2004) use visual information extracted from images of database to retrieve similar images to a specific query. In CBIR systems, images are described as feature vectors and similarity is determined using measures of distance. The choice of a set of features that are able to capture pictorial content in a way closer to human perception is still a challenge. Some works have explored the use of CBIR and CAD systems to improve knowledge and provide facilities on these modalities. All the reported works agree with the importance of

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