Chapter 12
A Block-Based Arithmetic Entropy Encoding Scheme for Medical Images

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ABSTRACT

The digitization of human body, especially for treatment of diseases can generate a large volume of data. This generated medical data has a large resolution and bit depth. In the field of medical diagnosis, lossless compression techniques are widely adopted for the efficient archiving and transmission of medical images. This article presents an efficient coding solution based on a predictive coding technique. The proposed technique consists of Resolution Independent Gradient Edge Predictor16 (RIGED16) and Block Based Arithmetic Encoding (BAAE). The objective of this technique is to find universal threshold values for prediction and provide an optimum block size for encoding. The validity of the proposed technique is tested on some real images as well as standard images. The simulation results of the proposed technique are compared with some well-known and existing compression techniques. It is revealed that proposed technique gives a higher coding efficiency rate compared to other techniques.

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1. INTRODUCTION

In current health care practices, standard medical imaging systems are used for medical diagnosis. With the advancement in digital and scanning technologies, these medical imaging systems have become an important part of the diagnostic systems. These systems produce accurate images of high quality with high resolution and bit depths. Such improvement in imaging systems produces large amount of medical data to be processed, archived and transmitted. During past few decades, enormous amount of digital imaging data was generated, especially in biomedical field. The volumetric scanning technologies, such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) generate large number of image frames and require huge amount of space for storage. These image frames consume more bandwidth for transmission. It is a complex task to handle transmission, archiving and manage the data produced during radiological process (Ravishankar & Bresler, 2011; Bhardwaj, 2017). These facts motivate the research in the area of efficient compression techniques for high resolution and higher bit depth images. The aim of image compression is to remove redundant or irrelevant data from the image such that it could be stored, transmit and processed effectively (Williams, 1991; Bell et al., 1990). Further, the compression techniques are broadly divided into two categories i.e. lossless and lossy. But in the field of medical diagnosis, lossless techniques are widely adopted because the data is not lost during recovery process. On the other hand, lossy technique doesn't provide accurate recovery at the receiver side and may lead to wrong diagnosis (Al-Khafaji, 2013; Al-Khafaji & Ghanim, 2017; Kabir & Mondal, 2018).

In literature, different compression techniques have been reported for medical diagnosis such as dictionary encoding, transformation encoding and predictive encoding techniques. It is noted the transform-based standards cannot provide higher compression rate (Al-Khafaji & Ghanim, 2017). These standards contain Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) for compression. Other side, predictive based compression techniques perform well and provide higher compression rate with low complexity (Gupta et al., 2013). The joint photographic experts group- lossless (JPEG-LS) (DIS, 1991; Pennebaker & Mitchell, 1992; Weinberger et al., 2000) and context-based, adaptive, lossless image coding (CALIC) are standard predictive coding techniques for lossless compression of medical images (Wu & Memon, 1997). The JPEG-LS is based on low complexity lossless compression (LOCO-I) algorithm using standard median edge detector (MED) and golomb code (Weinberger et al., 2000; Matsuda et al., 2000). While, CALIC technique consists of two mechanisms, one is used for prediction and other is applied for image encoding. The prediction is done through gradient adjust predictor (GAP) and image encoding is performed by using arithmetic encoding. It is noticed that GAP predictor is more efficient than MED, but, is computationally extensive (Avramovic & Savic, 2011). So, the CALIC is more efficient than JPEG-LS in terms of Bits per Pixel (BPP). Many researchers have worked on predictive coding techniques and adopted lossless compression for medical images.

Many researchers have worked on predictive coding techniques and adopted lossless compression for medical images. Avramovic and Savic developed a predictive algorithm based on edge detection and local gradients (Avramovic and Savic, 2011). In this work, the strengths of 2D standard predictors are analyzed. The analysis showed that the GAP predictor performs well for medical images. Al-Mahmood & Al-Rubaye adopted a compression method that is based on a combination between predictive coding and bit plane slicing for compression of medical and natural image samples (Al-Mahmood & Al-Rubaye, 2014). This compression technique discards the lowest order bits and exploits only higher order bits in which most significant bit used predictive coding. Anitha proposed a hybrid technique that combines integer wavelet transforms (IWT) and predictive coding technique to improve the performance of lossless