Watermarking Using Artificial Intelligence Techniques

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INTRODUCTION

All Berne union member countries in Berne, Switzerland accepted an international agreement for governing copy right called, The Berne Convention, in 1886 and is modified at Paris in 1971 (Fitzgerald, Brian, Shi, Xiaoxiang, Foong, Cheryl, Pappalardo, & Kylie, 2011). The countries have realized the importance of Intellectual Property Rights (IPR) after the establishment of the World Trade Organization (WTO) in 1995. The term Digital Rights Management (DRM) is applied to refer the protection of copyrights of digital media files (Hannibal Travis, 2008).

Digital watermarking represents the authentication through inserting a watermark into the digital content. The quality measures used for digital image watermarking robustness are peak signal to noise ratio (PSNR), normalized correlation (NC), bit correct ratio (BCR) and mean absolute error (MAE) etc. (Shih & Wu, 2005). A number of digital watermarking applications were developed based on Fuzzy logic and Neural Networks applications.

The present review is conducted in two broad categories of artificial intelligent techniques. The intelligent techniques considered in the review are (i) Fuzzy logic techniques (ii) different neural network (NN) architectures including Multi-Layer Perception (MLP), Radial basis function neural network (RBFNN) and recurrent neural networks. The review is conducted based on the papers published in journals/international conferences/edited volumes in the areas of digital image watermarking and information hiding. The rest of the paper is organized as follows: Section 2 presents Overview of Fuzzy logic and Neural Networks areas and section 3 presents reviews of papers dealing with the application of fuzzy logic and NN. Section 4 gives insights and section 5 concludes the review with future directions.

BACKGROUND

Fuzzy set theory, given by Zadeh (1965), has found a number of applications. Fuzzy logic is a problem-solving control methodology that lends itself to implementation in systems ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems. It uses an imprecise but very descriptive language to deal with input data more like a human operator and it has a variety of applications (Zimmermann, 1996). Fuzzy logic can also be used to derive fuzzy 'if-then' rules from data to solve classification problems.

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An artificial neural network (ANN) (Lacher, Coats, Sharma, & Fantc, 1995) is an information-processing paradigm inspired by the way biological nervous system, such as the brain, processes information. A neural network is an interconnected group of artificial neurons that uses a mathematical model or computational model for information processing. Due to the advantages like adaptive learning, self-organization, real time operation and fault tolerance via redundant information coding, neural networks found extensive applications in digital image watermarking. The MLP (Rumelhart, Hinton, & Williams, 1986), RBFNN (Moody & Darken, 1989), Recurrent Neural Network (Hopfield, 1982) are some of the popular neural network architectures. They differ in aspects including the type of learning, node connection mechanism, the training algorithm etc. Back propagation neural network (BPNN) is a supervised learning technique used by MLP for training the network (Rosenblatt & Frank, 1961).

MAIN FOCUS

This section describes the literature review of digital watermarking of images by using fuzzy logic and neural network techniques.

Fuzzy Logic

Lou and Yin, (2001) used a fuzzy clustering technique to obtain a different strength watermark by local characteristics of a image in the novel adaptive digital watermarking technique. Fuzzy c-means clustering algorithm is used to extract the image characteristics in Human Visual System (HVS) model. Experimental results showed that the scheme was superior to the Cox, Kilian, Leighton, and Shamoon (1997) scheme and Huang, Shi, and Shi (2000) scheme in terms of imperceptibility and robustness against different attacks. Wu and Xie (2003) presented a digital watermarking scheme based on fuzzy c-means clustering and HVS in Discrete Cosine Transform (DCT) domain. Wu and Xie (2003) discussed a blind scheme in Discrete Wavelet Transform domain by fuzzy c-means clustering theory. Experimental results showed that the scheme is more robust against JPEG (Joint Photographic Experts Group) compression, Gaussian noise and small scale cropping attacks.

Hsieh and Tseng (2005) given a model that deals with a fuzzy inference filter to choose the larger entropy of wavelet coefficients to embed watermarks. Experimental results showed that the approach has transparency and robustness to resist the general image processing attacks such as smoothing, sharpening, and JPEG compression. Sakr, Zhao and Groza (2005); Sakr, Zhao and Groza (2005) used Dynamic Fuzzy Inference System (DFIS) to extract the human eye sensitivity knowledge using the HVS model. DFIS model exploits dynamic membership function engine to accurately approximate the relationship found between all properties of a HVS model. Experimental results showed that the scheme is superior to the Cox et al. (1997) scheme, Huang and Shi (1998) scheme in terms of embedded watermark length, imperceptibility and robustness against different attacks. The drawback of both the methods is that they are vulnerable to geometric attacks.

Sakr, Georganas, and Zhao (2006) discussed a digital watermarking scheme based on bi-orthogonal wavelets-based HVS and FIS (Fuzzy Interference system). The algorithm is not robust against low-pass filtering attacks and geometric attacks such as rotation, scaling and translation. The given FIS model has superior computational efficiency when compared to Mamdani FIS (Jang, Sun, & Mizutani, 1997).

Kirovski et al. (1998,2006) have discussed methods based on combinational logic synthesis watermarking by having quality limitation due to mapping of overlapped maximum cones. The method is complex in nature for watermark extraction. Fahmy (2009) has presented a quasi blind image watermarking technique based on Naturalness Preserving Transformation (NPT). Mortezaei and Moghaddam (2010) have discussed a method based on fuzzy logic. In this both the watermark and cover images are segmented to