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DIGITAL WATERMARKING FOR COLOR IMAGE BASED ON SEGMENTATION

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ABSTRACT

Digital watermarking is an efficient way to hide data. Digital watermarking techniques have been developed to protect security of media signals. It helps to protect intellectual property from illegal copying. It also provides a means of embedding a message in a piece of digital data without destroying its value. this paper introduces a comparative scheme of watermarking which uses watershed transform and Markov Random Field model for segmentation and discrete wavelet transform for watermark embedding. In this work, various types of wavelets are used for embedding watermark. Experimental results shows that MRF model give best results of segmentation than watershed transform and wavelet rbio3.1 gives large value of PSNR as compared to Haar and sym3.

KEYWORDS: Digital Watermarking, MRF Model, Watershed Transform

INTRODUCTION

A digital watermark is a signal permanently embedded into digital data (audio, images, video, and text) which can be detected or extracted using computing operations for making assertions about the data. The watermark is hidden in the host image or data such that it is unable to separate from the data and so that it is resistant to many operations without degrading the host document. In watermarking, for example, the important information is the “external” data (e.g., images, voices, etc.). The “internal” data (e.g., watermark) are additional data for protecting the external data and to prove ownership. A watermark is designed to permanently hide secure information in digital data like image, audio or video etc. Digital watermarking gives several advantages.

The robustness and the imperceptibility provide the most important characteristics. Digital watermarking technology is mainly applied for copyright protection, operation tracking or piracy tracking, image authentication and copy control, in which copyright protection is the most important application. Digital watermarking provides the owner of a data the means to mark the data invisibly.

The mark could be used to serialize a piece of data as it is used as a method to mark a valuable image. [1]. Watermarking is the process of embedding a special data into media such as image, audio and video. This embedded information, known as a watermark, can be extracted from the multimedia contents later and used for supporting the ownership. [2]There are various requirements of watermarking which can be fulfilled for good result. The watermarking requirements are application-dependent, but some of them are common to most practical applications. Most important thing is that these requirements compete with each other. Some of them are expressed in short as follows:

- **Security**

A watermark system is said to be secure, if the hacker cannot remove the watermark without having full knowledge of embedding algorithm, detector and composition of watermark. A watermark should only be accessible by authorized persons. This requirement is regarded as a security and the watermark is usually achieved by the use of cryptographic keys.

- **Invisibility**

Perceptual Invisibility: Researchers have tried to hide the watermark in such a way that the watermark is impossible to notice.

Statistical Invisibility: An unauthorized person (hacker) should not detect the watermark by means of statistical methods.

- **Robustness**

Digital images commonly are subject to many types of distortions, such as lossy compression, filtering, resizing, contrast enhancement, cropping, rotation and so on. The mark should be detectable even after such distortions have occurred.

- **Watermarking Extraction: False Negative/Positive Error Probability**

Even in the absence of attacks or signal distortions, false negative error probability (the probability of failing to detect the embedded watermark) and detecting a watermark when one does not exist (false positive error probability), must be very small.

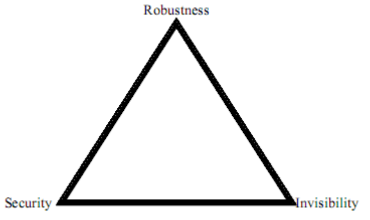


Figure 1.1: Digital Watermarking Requirements Triangle

- **Capacity Issue (Bit Rate)**

The watermarking algorithm should embed a predefined number of bits to be hidden in the input signal. This number will depend on the application. It has no general rule for this. However, in the image case, the possibility of embedding into the image at least 300-400 bits should be guaranteed. [1][7]

- **Imperceptibility**

Watermark cannot be seen by human eye or not be heard by human ear, only be detected through special processing or circuits. It can be detected by an authorized party only. [4]

PROPOSED WATERMARKING SCHEME

In the digital watermarking system, information carrying the watermark is embedded in an original image. The watermarked image is transmitted or stored, and then decoded to be resolved by receiver. In the proposed watermarking system we will first segment input image and then use discrete wavelet transform for embedding watermark in host image where we will process color image. First we give outline of the watershed transform and Markov Random

Field model which we are going to use for segmentation. Then we will describe watermark embedding algorithm. Lastly watermark detection algorithm will be outlined.

- **Watershed Transformation**

The Watershed transformation is powerful tool for image segmentation. It works better if one can identify or 'mark' foreground objects and background locations. Mostly watershed segmentation is applied to gradient of an image, rather than to the image itself. The goal of the watershed transform is to search for regions of high intensity gradients (watersheds) that divide neighbored local minima [6][7]. In proposed algorithm we will use Marker controlled watershed segmentation. The procedure for watershed transform is:

Step 1: Read color image and convert in to Grayscale.

Step 2: Compute gradient magnitude.

Step3: Mark foreground object

Step 4: Compute background markers

Step 5: Compute watershed transform of segmentation function.

- **Markov Random Field Model**

Markov Random field models can be useful in several areas of image processing. The success of Markov Random field (MRFs) can be attributed to the fact that they give good, flexible and stochastic model. Here we introduce MRF model shortly as follows;

A Markov Random Field (MRF) is a graph G = (V, E).

- V = {1, 2,...,N} is the set of nodes, each of which is associated with a random variable (RV), u_j, for j = 1...N.
- The neighborhood of node i, denoted N_i, is the set of nodes to which i is adjacent; i.e., $j \in N_i$ if and only if $(i, j) \in E$.
- The Markov Random field satisfies

$$p(u_i \mid \{u_j\}_{j\in\mathcal{V}\setminus i}) \;=\; p(u_i \mid \{u_j\}_{j\in\mathcal{N}_i}) \tag{1}$$

Ni is often called the Markov blanket of node i.

The distribution over an MRF (i.e., over RVs u = $(u_1,..., u_N)$) that satisfies (1) can be expressed as the product of (positive) potential functions defined on maximal cliques of G [Hammersley-Clifford Thm].

Such distributions are often expressed in terms of an energy function

E, and clique potentials Ψc:

$$p(u) \;=\; \frac{1}{Z}\exp(-E(u,\theta))\;, \quad \text{where } E(u,\theta) \;=\; \sum_{c\in\mathcal{C}} \Psi_c(\bar{u}_c,\theta_c) \tag{2}$$

Here,

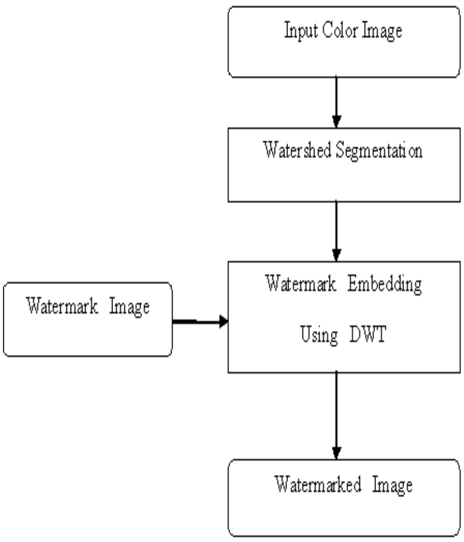
- C is the set of maximal cliques of the graph (i.e., maximal sub graphs of G that are fully connected),
- The clique potential Ψc, c ∈ C, is a non-negative function defined on the RVs in clique $\bar{u}_c$, parameterized by θc.
- Z, the partition function, ensures the distribution sums to 1:

$$Z = \sum_{u_1 \ldots u_N} \prod_{c \in \mathcal{C}} \exp(-\Psi_c(\bar{u}_c, \theta_c))$$

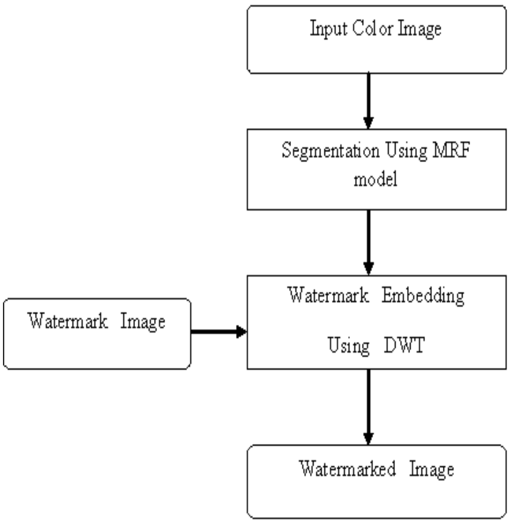
The partition function is important for learning as it's a function of the parameters θ = {θc}c∈C. But often it's not critical for inference. For our work we will use MRF model for segmentation of input color image and then watermark will be embedded in it.

- **Watermark Embedding Algorithm**

This paper introduces the watermarking based on segmentation of input image. We uses two methods for segmentation such as watershed transform and Markov random Field model. For watermark embedding, we will use DWT. The flow chart 2.1 and 2.2 gives outline of proposed algorithm.



Flow Chart 2.1



Flow Chart 2.2

Watermarking using watershed segmentation watermarking using MRF segmentation

Watermark embedding procedure is;

Step 1: Read input color image.

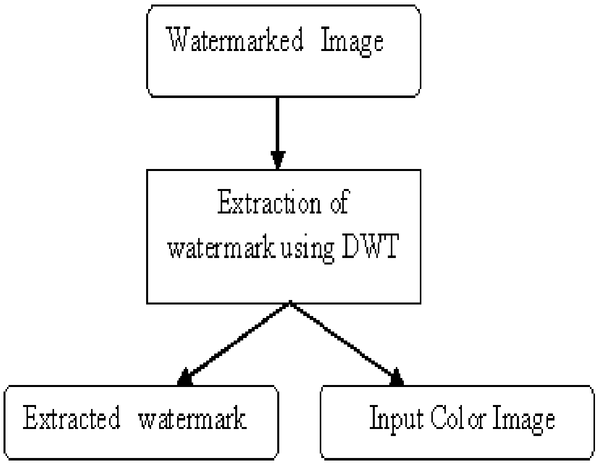
Step 2: Segment the input color image using watershed transform or MRF model

Step 3: Embed watermark image by using Discrete wavelet Transform.

Step 4: Resultant image is watermark embedded image.

WATERMARK EXTRACTION

Embedded watermark is extracted using discrete wavelet transform. After extraction of watermark we get two images one input image and another extracted watermark image. Flow chart 2.3 shows procedure for detecting watermark image from input image.



Flow Chart 2.3: Detection of Watermark

Detection procedure of watermark is:

Step 1: Take embedded watermark image as input.

Step 2: Apply discrete wavelet transform for extracting watermark.

Step 3: Result is input host image and watermark image.

RESULTS AND DISCUSSIONS

This proposed method is tested on two images using multiple wavelets. First we have used watershed transform for segmentation of input image, its Jaccard coeificient is calculated and then DWT is applied for watermark embedding. After that peak signal to noise ratio is computed. For watermarking we have used three wavelet like haar,sym3 and rbio3.1. Same process is repeated for MRF segmentation. In this we have tested results for first order and fifth order MRF. Table 1 and table 2 summaries results. Results are displayed in figure 4.1, figure 4.2, figure 4.3, figure 4.4, figure 4.5 and figure 4.6. Figure(a) input image, b) watermark image, c) segmented image, d) embedded image, e) recovered input image and f) recovered watermark.

- **Watermarking Using Watershed Transform**

Table 1: Watermarking Results for Watershed Transform

Sr. No	Image	Wavelet	Watershed		
			Jac. Coef.	PSNR	Time
I	Lena	haar	0.7604	66.71	2 sec.
		Sym3	0.7604	65.78	2 sec
		Rbio3.1	0.7604	67.55	2 sec
III	Dhanash ri	haar	0.8841	71.87	2 sec
		Sym3	0.8841	70.20	2 sec
		Rbio3.1	0.8841	73.50	2 sec

Lena Image

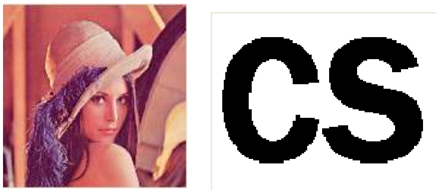


Figure 4.1 (a) **Figure 4.1 (b)**

Haar Wavelet

Sym3

Rbio3.1

Figure 4.1 (c) **Figure 4.1 (d)** **Figure 4.1 (e)** **Figure 4.1 (f)**

Dhanashri Image

Figure 4.2 (a) **Figure 4.2 (b)**

haar

Sym3

Rbio3.1

Figure 4.2(c) Figure 4.2(d) Figure 4.2(e) Figure 4.2(f)

- **Watermarking Using First Order MRF**

Table 2: Watermarking Results for MRF Model

Sr. No	Image	Wavelet	MRF First Order			MRF Fiftht Order		
			Jac. Coef.	PSNR	Time	Jac. Coef.	PSNR	Time
I	Lena	haar	0.2072	65.62	1m 35 sec	0.2078	65.43	4m 50sec
		Sym3	0.2072	64.92	1m 29 sec	0.2078	65.06	4m 20 sec
		Rbio3.1	0.2072	68.76	1m 33 sec	0.2078	69.10	4m 57sec
III	Dhanashri	haar	0.2855	65.29	1m 44 sec	0.2865	66.04	3m 50 sec
		Sym3	0.2855	64.89	1m 45 sec	0.2865	65.00	5m 5 sec
		Rbio3.1	0.2855	66.47	1m 34sec	0.2865	66.83	3m 35sec

Lena Image

Figure 4.3 (a)

Figure 4.3 (b)

Haar

Sym3

Rbio3.1



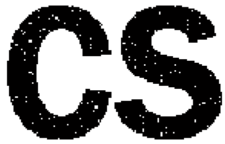



Figure 4.3 (c) Figure 4.3 (d) Figure 4.3 (e) Figure 4.3(f)

Dhanashri Image

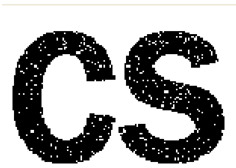

Figure 4.4 (a) Figure 4.4 (b)

Haar




Sym3



Rbio3.1




Figure 4.4 (c) Figure 4.4(d) Figure 4.4 (e) Figure 4.4 (f)

- **Watermarking Using Fifth Order MRF**

Lena Image


Figure 4.5 (a) Figure 4.5 (b)

Haar

Sym3

Rbio3.1

Figure 4.5(c) Figure 4.5 (d) Figure 4.5(e) Figure 4.5(f)

Dhanashri Image

Figure 4.6(a) Figure 4.6 (b)

Haar

Sym3

Rbio3.1

Figure 4.6(c)

Figure 4.6 (d)

Figure 4.6(e)

Figure 4.6(f)

CONCLUSIONS

Digital watermarking is an efficient way to hide data. Digital watermarking techniques have been developed to protect the security of media signals. A new comparative method is developed in this paper.

The proposed method gives segmentation for watershed transform and Markov Random Field model. MRF is used for first order and fifth order. Watermarking is done using discrete wavelet transform for Haar, sym3 and rbio3.1 type of wavelets. Experimental result shows that segmentation using MRF model gives Jaccord coefficient lowest that is segmentation efficiency is large. Result also shows that PSNR of watermarking is better for wavelet rbio3.1 as compared to haar and sym3.This means our work has obtained improvement in segmentation and watermarking.

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