DCT and Simulink Based Realtime Robust Image Watermarking

Durgansh Sharma *durgansh@gmail.com*
Ph.D. Student, UPES, Dehradun India
Asst. Professor, Jaipuria Institute of Management, Noida, India

Manish Prateek *mprateek@ddn.upes.ac.in*
Professor, Centre For Information Technology,
College of Engineering Studies, UPES, Dehradun, India

Tanushyam Chattopadhyay *t.chattopadhyay@tcs.com*
Senior Scientist, R&D, Innovation Lab,
Tata Consultancy Services, Kolkata, India

Abstract

Ownership of digital content has become a serious matter, due to the exponential raise in the global repository of digital multimedia content, like images are to be considered in this paper. The validated proof as an imperceptible and robust watermark is needed to be embedded in the digital images. This paper proposes a simulation of DCT with Fuzzy Logic based HVS model for Realtime Robust Image Watermarking technique using Simulink.

Keywords: Realtime, Digital Image Watermarking, Fuzzy logic, HVS, Simulink.

1. INTRODUCTION

Digital image watermarking is a process used for embedding a set of information in an image for enhancing its authenticity. It has been used through various optimized techniques but mainly on gray scale images already available in the repository. In this paper, we propose a simulink based model for realtime robust image watermarking. The robustness of the process of image watermarking includes DCT and Fuzzy Inference System, which implements HVS (Human Visual System) for embedding the watermark in an image, captured using webcam in realtime. It transforms the captured image from spatial domain to frequency domain using DCT and applies fuzzy logic to implement the HVS logic for embedding the watermark in the host image.

Within a span of few years, we have observed the exponential raise in the usage of digital media for distribution of images. This model could be extended for the realtime image watermarking in camera enabled mobile devices to improve the authorization of the image distributed using digital media which seems to have no boundaries with the open ended environment called internet.

2. REVIEW

The model in this paper proposes the technique to incorporate the authorization watermark in the host image captured in real time. Motwani et al. [1] used MAMDANI type Fuzzy Inference System (FIS), its input parameters are derived from Human Visual System (HVS) using the sensitivity towards brightness, edge and contrast of the gray scale image which has been further improved to use blue frame of a colour image captured using webcam. Charu et al. [2] further used and extended the research work using the three layered Fuzzy-BPN having a layer configuration of (3-3-1) for learning mechanism through 50 iterations. Charu et al. [2] divided an image of size 256x256 into 1024 blocks of size 8x8 and compute its sensitivity, on the basis of the variance computed using Fuzzy-BP, the blocks were filtered and the random sequence of numbers are embedded as watermark. This procedure generated a good quality imperceptible watermarked image, but, in this paper we try to insert the system identification numbers using the suggested techniques of Zhao, Jian, and Eckhard Koch [5][6]. Saraju et al.[3] has suggested a simulink based realtime perceptual watermarking architecture for video broadcasting through FPGA. Saraju et al. [3] has suggested very useful methods of combining cryptography and watermarking for better results in hiding useful data in a video frame as a visible transparent watermark, and Diffie et al. [7] has suggested various new ways of cryptography which can give better results in data hiding. We try to use his suggestive method in an image captured in a single shot through webcam using simulink.

3. MODELLING AND ANALYSIS

We consider a 640x480 pixel image captured using webcam for this presented work. The characteristics are modeled using Eckhard et. al. [5, 6] presented that the multimedia data must contain a label or code, which could identify it uniquely as property of the copyright holder. The embedded watermark extracted from the signed image using proposed algorithm was compared for the similarity correlation using SIM(X, X^*) proposed by Cox et al. [4]. this parameter is determined for recovered watermark. Computed values show a good significance level of optimization in the process of embedding and extraction of watermark.

Sharma et al. [9] proposed Fuzzy inference system (FIS) is used to embed the watermark in the host image in the DCT domain. The FIS is based on a set of 27 inference rules using SIGMOID way of interpreting the logical inputs, based on the facts of HVS based sensitivity towards noise in the image with respect to brightness, texture or contrast, edges.

Rule No.	Luminance Sensitivity	Contrast Sensitivity	Edge Sensitivity	Weighting Factor
1	DARK	LOW	SMALL	LEAST
2	DARK	MEDIUM	SMALL	LEAST
3	DARK	HIGH	SMALL	LEAST
4	MEDIUM	LOW	SMALL	LEAST
5	MEDIUM	MEDIUM	SMALL	LEAST
6	MEDIUM	HIGH	SMALL	LEAST
7	BRIGHT	LOW	SMALL	LEAST
8	BRIGHT	MEDIUM	SMALL	LEAST
9	BRIGHT	HIGH	SMALL	LEAST
10	DARK	LOW	MEDIUM	LESS
11	DARK	MEDIUM	MEDIUM	HIGH
12	DARK	HIGH	MEDIUM	HIGHER
13	MEDIUM	LOW	MEDIUM	LESS
14	MEDIUM	MEDIUM	MEDIUM	AVERAGE
15	MEDIUM	HIGH	MEDIUM	AVERAGE
16	BRIGHT	LOW	MEDIUM	LESS
17	BRIGHT	MEDIUM	MEDIUM	AVERAGE
18	BRIGHT	HIGH	MEDIUM	HIGHER
19	DARK	LOW	LARGE	LESS
20	DARK	MEDIUM	LARGE	HIGHER
21	DARK	HIGH	LARGE	HIGHEST

22	MEDIUM	LOW	LARGE	LESS
23	MEDIUM	MEDIUM	LARGE	AVERAGE
24	MEDIUM	HIGH	LARGE	HIGHER
25	BRIGHT	LOW	LARGE	LESS
26	BRIGHT	MEDIUM	LARGE	HIGHER
27	BRIGHT	HIGH	LARGE	HIGHEST

TABLE 1: HVS based 27 Rules for Fuzzy Inference System.

In this paper, we propose a technique to embed imperceptible watermark in an image in realtime. The model constitutes of webcam needed to acquire an image in realtime, Matlab version 8.0 with Simulink running on a computer. The acquired image constitutes of RGB colour frames; we propose to extract the Blue frame for embedding the watermark in it and merge it with other two Red and Green colour frames to reconstitute the image. This process makes the image watermarking robust and optimized.

The host image captured in realtime in spatial domain having the size of 640x480 pixels is divided into the blocks of 8x8 pixels each. Discrete Cosine Transformation (DCT) is used for the transformation of these blocks in the frequency domain. All the three HVS characteristics mentioned formerly are computed over these blocks as follows:

The Luminance Sensitivity: It is derived from the DC coefficients from the DCT blocks of the host image according to following formula:

$$L_i = \frac{X_{DC,i}}{X_{DCM}} \qquad (1)$$

Where, $X_{DC,i}$ denotes the DC coefficient of the i^{th} block and X_{DCM} is the mean value of the DC coefficients of all the blocks put together.

The Contrast Sensitivity: The contrast sensitivity is derived from the texture content of a region of 8x8 blocks in an image. The value of variance computed of an image block is provided to the direct metric for the quantification of the texture as a parameter. A routine proposed by Gonzalez et. al. [9] is used through MATLAB. The execution of this routine is given by (2).

```
t = statxture(f)
```
(2)

where, f is the input image or the sub-image (block) and t is the 7 – element row vector, one of which is the variance of the block in question.

The Edge Sensitivity: The edge could be detected in an image using the threshold operation; edge sensitivity can be quantified as a natural effect to the calculation of the block threshold T. The Matlab image processing toolbox implements bluethresh(f) routine which computes the block threshold using histogram – based on Otsu's method of computing graythresh(f) [8]. The implementation of this routine is given by (3)

```
T = bluethresh(f)
```
(3)

Where, f is the host sub-image (block) in question and T is the computed threshold value. These three parameters are fed into the FIS shown in Figure 3.

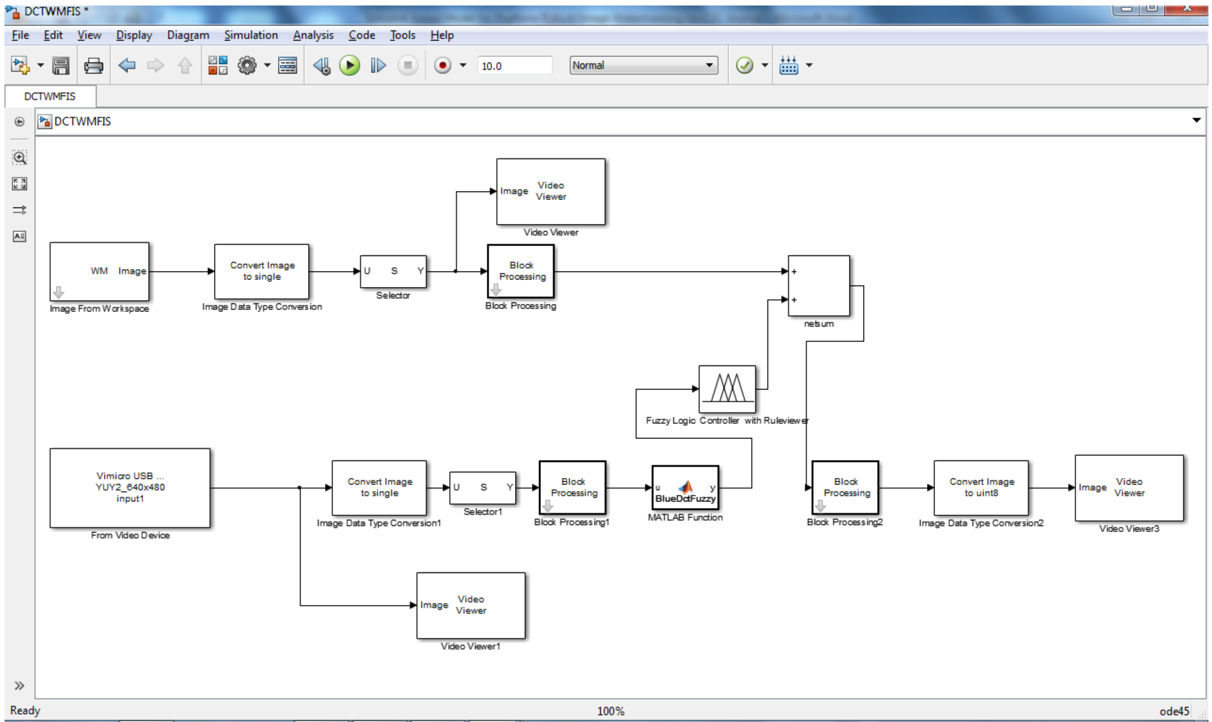


FIGURE 1: Simulink Model for DWM.

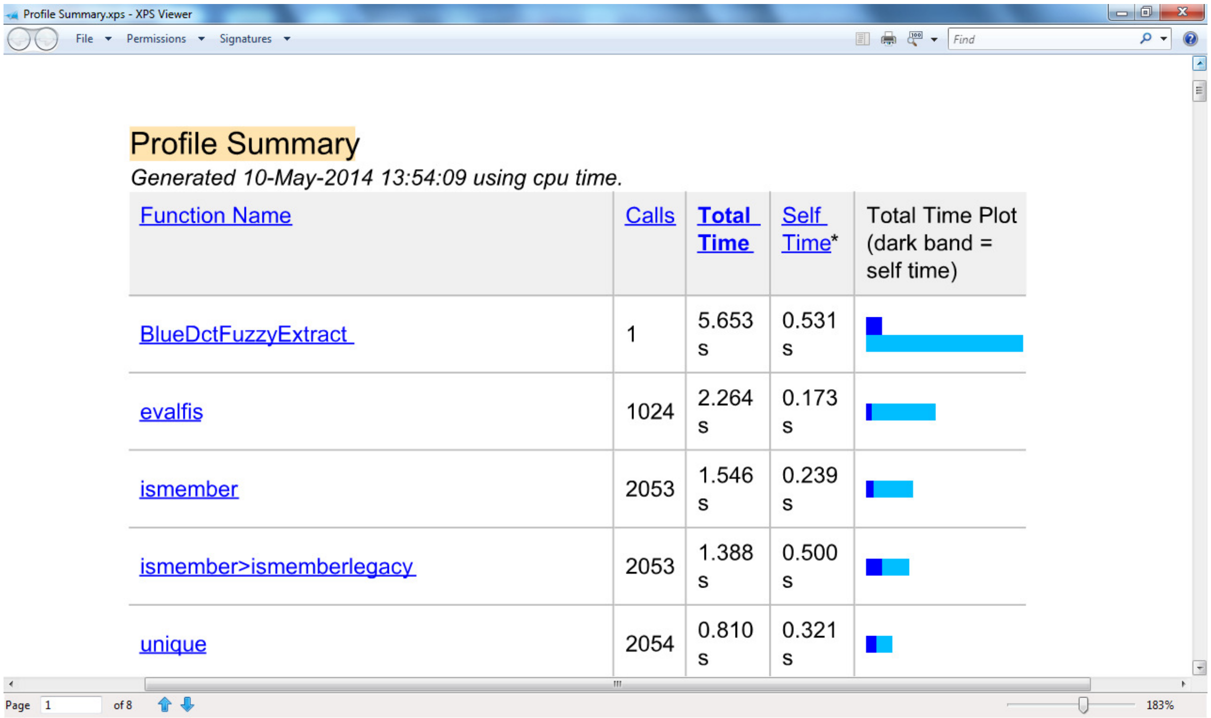
Once the watermark is embedded then Quality assessment of the signed image is done by computing Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR).

Extracting Watermark from Signed Image and Computing SIM(X, X^*) Parameter: Firstly, the DCT of both host and signed images are computed block wise. Thereafter, the computed coefficients are subtracted from each other and the watermark is recovered. Let the original and recovered watermarks be denoted as X and X^* respectively. A comparison check is performed between X and X^* using the similarity correlation parameter given by eq. (1).

$$SIM(X,X^*) = \frac{\sum_{i=1}^{n}(X,X^*)}{\sum_{i=1}^{n}\sqrt{(X,X^*)}} \qquad (1)$$

4. RESULTS

The profile summary shows the time consumed in the entire process of realtime image watermarking using the proposed method.



Profile Summary

Generated 10-May-2014 13:54:09 using cpu time.

Function Name	Calls	Total Time	Self Time*	Total Time Plot (dark band = self time)
BlueDctFuzzyExtract	1	5.653 s	0.531 s	
evalfis	1024	2.264 s	0.173 s	
ismember	2053	1.546 s	0.239 s	
ismember>ismemberlegacy	2053	1.388 s	0.500 s	
unique	2054	0.810 s	0.321 s	

FIGURE 2: Profile Summary of Time Consumed.

Following are the result of watermark embedding process adopted in this paper using SIMULINK

FIGURE 3: Original Image Captured in Realtime.

FIGURE 4: Watermarked Image in Blue Channel.

MSE: 4.2053dB; PSNR: 41.957dB

5. CONCLUSION

Computed value of SIM(X, X*) parameter for the image depicted in Figure 4 (Singed Image) is 18.5987 which indicates a good watermark recovery process. The time consumed in image watermarking is computed as approx. 12 seconds, this model could be extended for the realtime digital image watermarking in camera enabled mobile devices for improving the authenticity of images captured and shared using Smartphone.

6. REFERENCES

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