

Robust Watermarking for Anaglyph 3D images Using DWT Techniques

Ruchika Patel, Parth Bhatt

Abstract— In recent years the trend of 3D movies & projection took a very intensive attention. Anaglyph images are easily obtained by super impressive left and right eye images in different color planes of single image for subsequent viewing through colored glasses. Digital watermarking is a popular tool for copyright protection, content authentication, detection of illegal duplication and alteration, and secret communication. In this paper discrete wavelet transform (DWT) watermarking algorithm is used for embedding an image as digital watermark on one of the stereo pair images and then combine with the other image to form a 3D anaglyph watermarked image. In the reverse process, De-anaglyph is used to separate the two stereoscopic images from which watermark is extracted. Embedding watermark either in right image or left image yields more security compared to embedding watermark directly into an anaglyph image.

Index Terms—3D watermarking, Anaglyph image, Color image watermarking, Discrete wavelet transform (DWT).

I. INTRODUCTION

Increase in 3D demand is quite natural, as market is growing rapidly due to huge requirement of electronics media. Now a day's most of the movies are being produced in 3D format. At the same time copyright protection of 3D data can be implemented in 3D environment. Ultimately enhancement in 3D watermarking system is over whelming.

3D image is perceived by human as depth illusion from two different views. The first is left eye view whereas second is right eye view which offers high quality immersive viewing, which is known as stereo image method.

Anaglyph image is formed by combining stereo pair of images. Watermark can be embedded to anaglyph image but in this paper, watermark is embedded into right image of the stereo pair image and then combined with left image to form anaglyph image for more security. We can embed watermark in either right image or left image using DWT.

During the extraction, a reverse process is applied to the anaglyph image i.e., De-anaglyph, where we separate left image and right image and by using DWT and Inverse DWT, watermark Image is extracted from the watermarked-right image.

Rest of the paper is organized as follows.

Section II reviews brief study of anaglyph 3D images and its various methods. Section III comprises of DWT method in

3D images section IV deals with proposed method of watermarking, section V presents proposed method results. Finally a conclusion will be presented in section VI.

II. ANAGLYPH 3D IMAGE

Anaglyph 3D is the name given to the stereoscopic 3D outcome accomplished by means of converting each eye's image using filters of different colors, typically red and cyan. Anaglyph 3D images contain two differently filtered colored images, one for each eye.

To create an anaglyph image, it is essential to have two photos taken at the same time the photos should focus the same object, moving the camera laterally between 3 and 5 cm for the second picture [1].

Anaglyph can provide different view to each of two eyes. From the difference between the two views and other visual cues, the human visual wavelet called mother wavelet by increases and shifting [8]. The DWT has been introduced as a highly effective and flexible method for sub band decomposition of signals. The 2D DWT is now- a-days recognized as a key operation in image processing. It is multi-resolution analysis and it decomposes images into wavelet coefficients and scaling function. In Discrete Wavelet Transform, signal energy concentrates to specific wavelet coefficients.

Wavelets convert the image into a series of wavelets that can be stored more efficiently than pixel blocks. Wavelets have rough edges; they are able to render pictures better by eliminating the "blackness". In DWT, a time-scale illustration of the digital signal is achieved using digital filtering techniques. The signal to be analyzed is passed through filters with different cut-off frequencies at different scales. It is easy to implement and decreases the computation time and resources required [9]. A 2-D DWT can system can produce the stereoscopic be seen as a 1-D wavelet scheme which representation of spatial relationships in the scene.

An anaglyph image is designed by overlaying two views in different colors. When perceived through colored glasses, the two images will be separated from the composite one to feed each eye.

The separation is based on color filtering. A red- cyan. Color anaglyph image is generated by combining the red channel of the left image and the blue & green channels of the right image together. Anaglyph image being composed of red and cyan color layers. It is needed to have a glass (specks) which is made upon two different colors red and cyan as shown in Fig 1. In this way these glasses are used as filters and let each eye see only the stereo pair it deserves.

III. DISCRETE WAVELET TRANSFORM

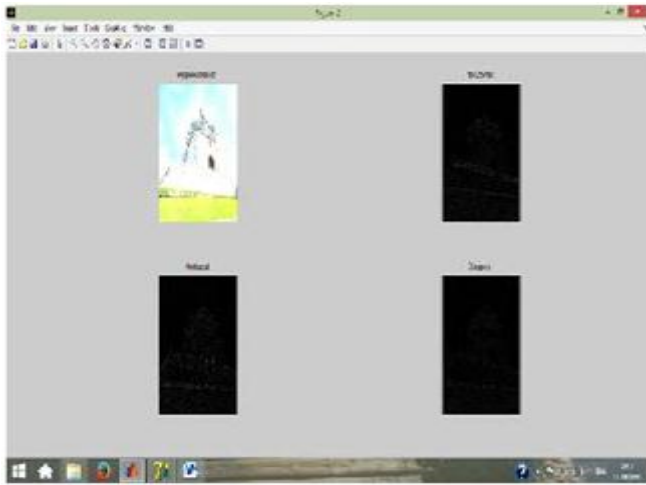
Discrete wavelet transform is a multi resolution

Ruchika Patel, Information Technology, Gujarat Technology University SVIT, Vasad, Gujarat 388306, India

Parth Bhatt, Asst. Professor, Department of IT, Gujarat Technology University SVIT, Vasad, Gujarat 388306, India

decomposition of a signal. Wavelet transform decomposes a signal into a set of basis functions. These basis functions are called wavelets. Wavelets are gained from a single example transform along the rows and then a 1-D wavelet transform along the columns. The 2-D DWT operates in a straight forward manner by introducing array transposition between the two 1-D DWT. The rows of the array are processed first with only one level of decomposition. This fundamentally divides the array into two vertical halves, with the first half storing the average coefficients, while the second vertical half stores the detail coefficients. This process is repeated again with the columns, resultant in four sub- bands within the array defined by filter output.

Consider an image; applying DWT corresponds to processing the image by 2-D filters in each dimension. The filter divides the image into four sub-bands: LL1, LH1, HL1 and HH1. The sub- bands LL1 represents lowest frequency components while LH1, HL1, HH1 represents highest frequency components.



2. 2D-DWT of Right Image

Fig. 2 shows, 2-D DWT decomposition of the image. Image consists of pixels that are arranged in two-dimensional matrix, each pixel represents the digital equivalent of image intensity.

IV. PROPOSED METHOD

We implemented the proposed method in MATLAB R2010b using a PC with Intel® Core™ 2Duo CPU and 3GByte RAM and 64 bit Window-7 operating system. The proposed method contains two steps. They are:

- 1) Watermark Embedding
- 2) Watermark Extraction.

DWT is applied to the sub-blocks of the watermark image to embed in the host image (Right image). In the watermarking extraction process, embedded watermark is extracted by the IDWT coefficient blocks.

4.1. Watermark embedding

The block diagram of proposed watermark embedding process is shown in Fig.3.

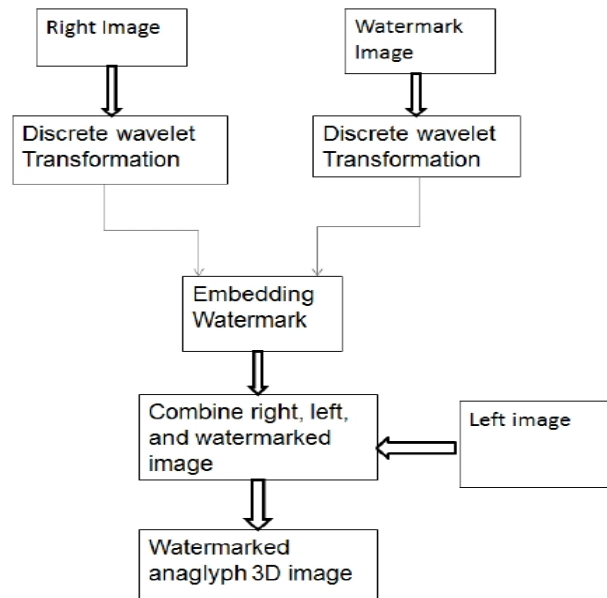


Fig.3. Watermark Embedding

The embedding process is divided into three steps.

Step 1: A 2-D wavelet transform is applied on watermark image and right image to obtain sub elements.

Step 2: Embed the sub-elements of watermark image into right image to obtain watermarked- right image.

Step 3: Combine watermarked-right image and left image to get the watermarked-anaglyph 3D image using DWT.

4.2. Watermark Extraction

In order to extract watermark from the anaglyph 3d image, we need to separate stereo pairs from watermarked-anaglyph 3D image by using De- anaglyph [2], which is a software to reconstruct the right view of a stereo image from the left view and a color anaglyph image. Block diagram of the proposed extraction process is shown in Fig.4.

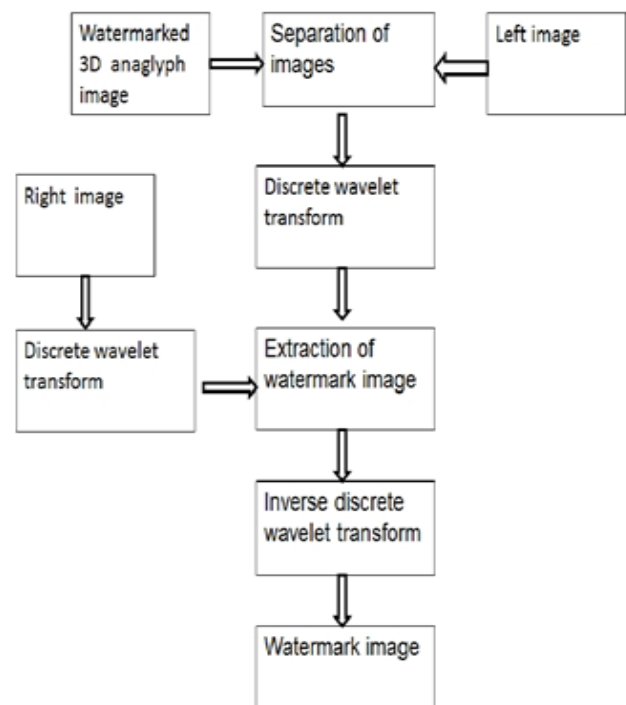


Fig.4. Watermark Extraction

Extraction process is done in three steps.

Step 1: Obtain Watermarked-right image from the watermarked 3D anaglyph image by using de-anaglyph.

Step 2: Apply two-dimensional wavelet transform to watermarked-right image and right image to get sub-elements.

Step 3: Extract watermark image by applying Inverse-Discrete Wavelet transform (IDWT).

V. EXPERIMENTAL RESULTS

In our proposed technique, watermark image is inserted in right image to form watermarked- right image.

The watermarked right image and left image is embedded and generated anaglyph 3D images. In the extraction process the watermark right image is separate using De-anaglyph software. The original watermark image is extracted using Inverse DWT.

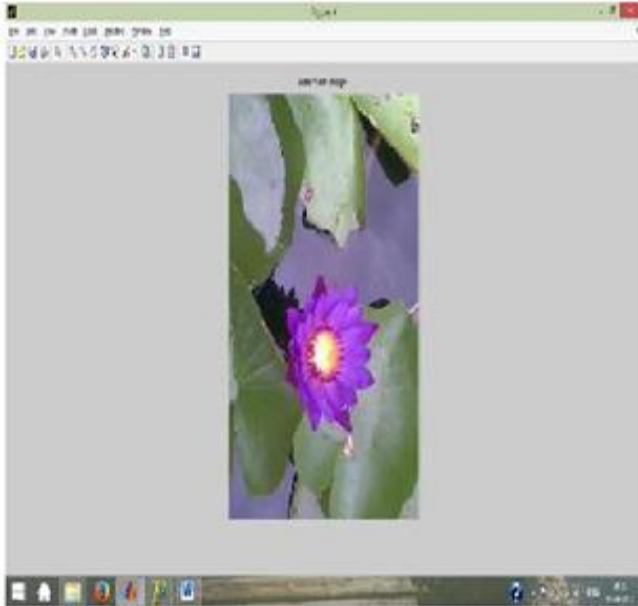


Fig. 5.1 Watermark Image



Fig 5.2 2D-DWT of watermark Image

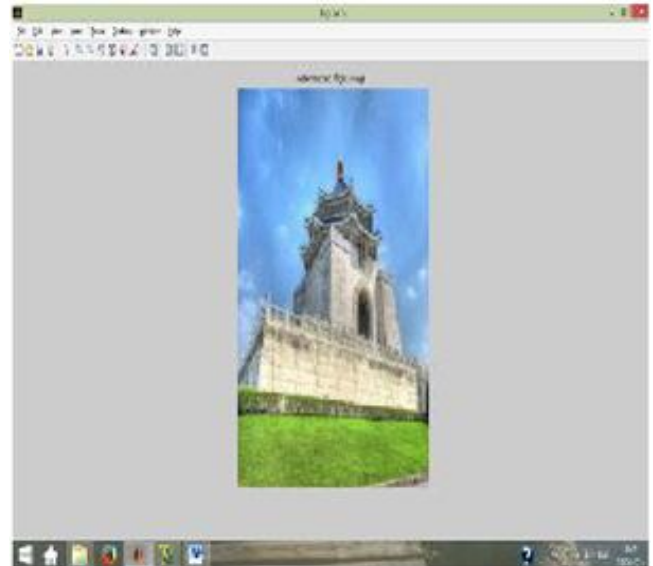


Fig 5.3 watermarked right image

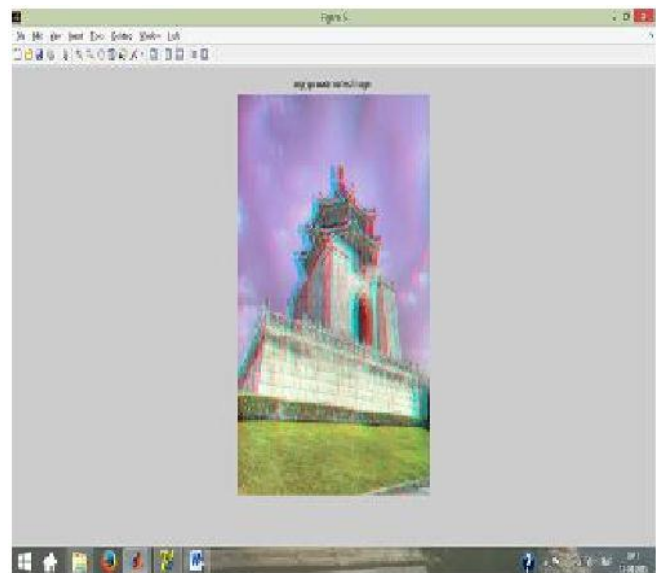


Fig 5.4 watermarked Anaglyph image

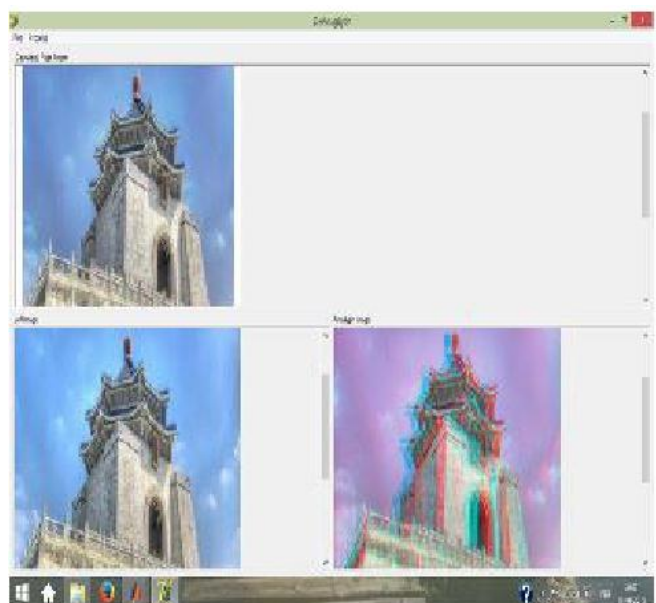
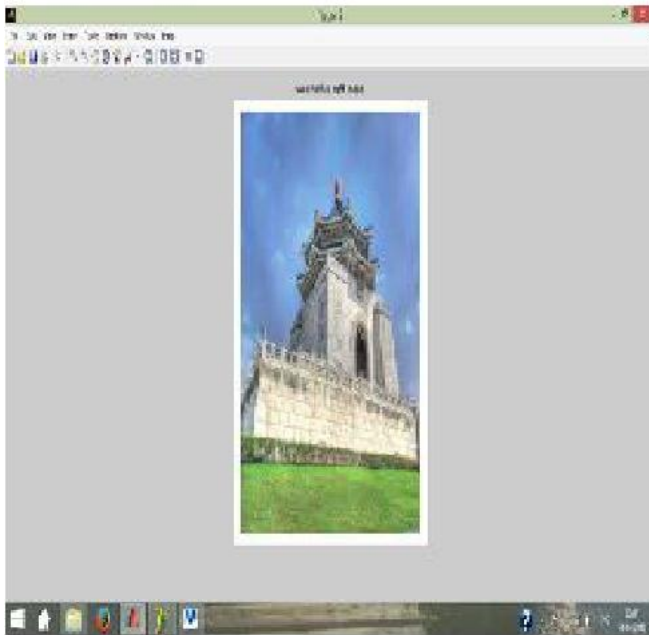


Fig 5.5 Extraction of Right Image



FFig 5.6 Extracted watermarked right image

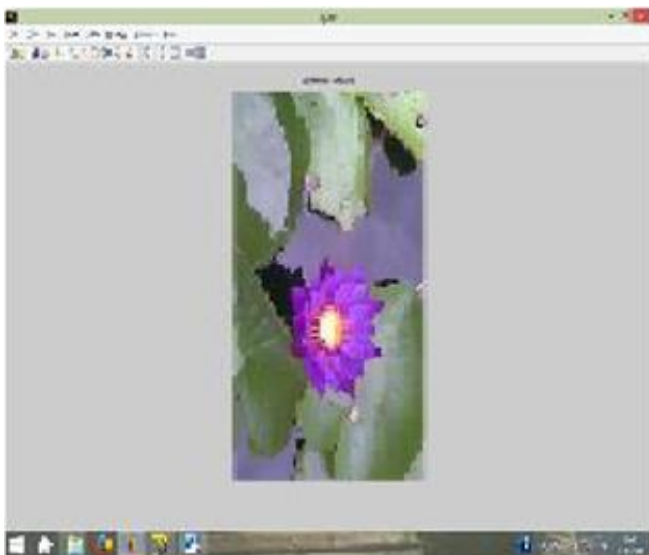


Fig 5.7 Extracted watermarked image

VI. CONCLUSION

In search for new approaches in protecting the 3D content produced by stereoscopic methods, we took a thorough look at the domain of stereoscopic images. Our main contribution is a systematic overview of issues and opportunities found in applying and extracting watermarked images from the 3D anaglyph image. These include intended design decisions and the tools used to produce such kind of watermarking. We propose to consider Matlab with Discrete Wavelet Transform to embed and extract the watermark image in the easiest way. De- anaglyph process has the disadvantage, the algorithm is not fast enough, it takes a few seconds to reconstruct right image which is cropped by few pixels too. The aforementioned assumptions are based on subjective assessment and have not been confirmed using formal evaluations with huge data sets.

VII. REFERENCES

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