Robust Digital Watermarking for Anaglyph 3D Images by Using DWT

Sanjay.T.Sanamdikar[1], Prof. Sanjay R. Zadokar[2]

[1]PDEA's College of Engi.Manjari, Pune (India)

[2]JSPM's BSP, Wagholi, Pune, (India)

ABSTRACT

In nowadays international, development in numerous fields is attracting human beings for reinforcing the technology. The exposure of 3-d era is now way booming and the humans display the massive interest on 3-D technology because it provides an immersive experience to the viewers [1]. The 3D images are extensively used in digital truth, medical imaging, video games and pc aided design. Therefore the effective watermarking technique is required for the protection of 3D content data. In this paper the watermarking i.e. content material safety is achieved with the help of discrete wavelet transform (DWT) on anaglyph 3-D photographs. To growth robustness of the proposed system, selection of row coefficient is important hence we pick certain coefficient sub blocks and group the coefficients from rows. The tool use for developing this proposed work is image processing and wavelet toolbox of MATLAB for "reading" the images and for performing the DWT operations. The simulation suggests that the strong extraction of embedded watermark is done from the synthesized anaglyph center 3D image. The embedded watermark may be effectively extracted no matter any noise attack on a front picture. The proposed scheme is relevant for any compression technique in addition to on any type of image.

Keywords- Anaglyph 3D Images, Discrete Wavelet Transform (DWT), Watermarking, 3D Watermarking.

I.INTRODUCTION

Nowadays, internet is an important part of our life. There are numerous types of digital data over the Internet, such as texts, photos, audio tracks, videos and 3D graphical objects etc. These are used more and more in industrial, medical and entertainment applications. Digital data is so widely used because it is easy to store, transfer and duplicate with high quality. However, the convenience also facilitates the get entry to of malicious customers to supply unauthenticated and pirate copies of the authentic work. There are two usual virtual information safety techniques: cryptography and watermarking. Cryptography absolutely modifications the appearance of the facts and as a end result nobody would be capable of decode the message without the secret key. Cryptography is often used in the transmission stage. Users have to decode the message before they can read or use the data. In contrast, watermarking preserve the observable quality of the data, for example the image fidelity, audio and video quality, in such a way that human beings can use the facts without being aware about the existence of the embedded message. Watermarking can be used each in transmission and for information utilization. In addition, cryptography aims to modify every single bit of the original data. In Digital

Watermarking the aim is to embed a code consisting of bits into a cover media, representing image, audio, video or graphics information. Digital watermarking is generally considered as a copyright protection technique. Digital Data is available in World Wide Web in the form of Images, Audio and video in large amount. It is very easy to replicate, distribute, modify, manipulate and spoil by means of the intruders, so there's a great need to protect the integrity of the digital records, the approach that is useful to avoid unauthorized copying or tempering of digital facts is Watermarking. Digital watermarking is used for safety of virtual images. The three-D watermarking structures can be categorized on the premise in their embedding area and detecting area as: 3D/3D, 3D/2D and 2D/2D [2]. The first type of watermarking device embeds the watermark in a 3D (geometry or texture) model and detects the watermark also in a 3D space. The second one extracts the watermark in a 2D representation (acquired by projection) of the 3D data. The last one deals with the content protection of image-based 3D data representation in which all the embedding and detection operations are applied to 2D images directly [8]. The advantages of anaglyph image have gathered the interest of many people's for research in the corresponding technique. In anaglyph 3D images not only pixels of watermarked image can be partially moved horizontally in a different distances but also modification is depth image can also be implemented.

The organization of the paper is in the following way where section II reviews brief study of 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 evaluates the performance and results of proposed system and section VI concludes this paper.

ANAGLYPH 3D IMAGES

Anaglyph 3D is probably the technology most people think about when they think about 3D images and movies. In fact if you have seen a 3D movie on DVD in the past, it most likely was using the anaglyph method. The anaglyph images are made up of two superimposed and offset color layers.

Fig.1. Anaglyph 3D Image

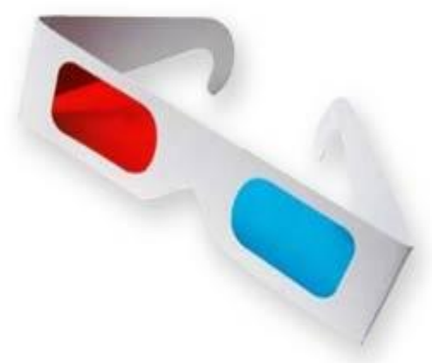

Fig.2. Paper anaglyph filters

When viewed with two color glasses (usually with one red lens and one cyan lens), the image appears to have some depth. The main advantage of anaglyph 3D is that it's inexpensive and accessible to most people. You don't need a new 3D ready projector or television as any equipment capable of showing a video will be able to show an anaglyph 3D video. Also because the technology is passive (no electronic components are needed in the glasses), the glasses are cheap to produce and usually are included with 3D movie DVDs. Having two colored lenses causes a loss of brightness. Because some of the light is blocked by the color filter, so the image may appear dimmer than the equivalent standard 2D movie. The colors can appear a bit off since one lens will give a red tint to the whole image while the other gives a blue tint.

Anaglyph images or anaglyphs are two-dimensional pictures that may motive a cause a three dimensional effect. Anaglyph images are composed of two shade layers, superimposed however but slightly moved relative to each other to produce the depth effect shown in fig.1. The main object is in the center, while the surrounding environment and background are moved laterally in opposite directions [4]. To produce an anaglyph is essential to have two photos taken at the same time (to keep the same lighting conditions and scenery), the photos should focus the same object, moving the camera laterally between 3 and 5 cm for the second picture. These pictures must be taken with filters so that only capture a portion of the light received on the basis that light is emitted in three colors, red, green and blue, if you do not have these filters, you can use photo editor Anaglyph glasses are formed by two lenses, each with one of the two colors in the image shown in fig.2. In this way are used as filters and let each eye see only the stereo pair it deserves. So, for example, if we had an image created from the displacement of a blue image (focused for the left eye) and red (focused for the right eye), we would need anaglyph glasses with the same color filters: the eye would have the right lens blue and red left lens, since the filter only lets you see the image that is not the same color.

II. DISCRETE WAVELET TRANSFORM

The essential concept of the DWT for a one dimensional signal is as follows. A signal is split into 2 elements, generally high frequencies and low frequencies. The edge components of the signal are in largely restricted within the high frequency element. The low frequency component is split once more into 2 parts of high and low frequency. This process is continued until the signal has been totally decomposed or application at hand. For compression and watermarking application, usually no extra than 5 decomposition steps are computed. Furthermore, from the DWT coefficients, the original signal may be reconstructed. The reconstruction process is called the inverse DWT (IDWT).

The two-dimensional wavelet transform that we describe can be seen as a one-dimensional wavelet transforms along the x and y axis. Mathematically the wavelet transform is convolution operation, that's equivalent to pass the pixel values of an photograph via a low bypass and high pass filters. DWT involves decomposition of photograph into frequency channel of steady bandwidth. This causes the similarity of available decomposition at each stage.

DWT is implemented as multistage transformation. Level wise decomposition is achieved in multistage transformation. At stage 1: Image is decomposed into four sub bands: LL, LH, HL, and HH in which LL denotes the coarse stage coefficient which is the low frequency a part of the photo. LH, HL, and HH denote the finest scale wavelet coefficient. The LL sub band may be decomposed further to attain higher stage of decomposition. This decomposition can continues till the desired level of decomposition is accomplished for the utility. The watermark can also be embedded in the remaining three sub bands to hold the nice of picture as the LL sub band is more sensitive to human eye. The DWT of a signal x is calculated by using passing it through a chain of filters. First the samples are handed through a low pass filter out with impulse response 'g' resulting in a convolution of the two:

$$y[n] = (x * g)[n] \sum_{k=-\infty}^{\infty} x[k]g[n-k] \quad \text{........................(1)}$$

A signal is decomposed and constructed by DWT, for this it uses different filter banks satisfying the perfect reconstruction (PR) condition. The decomposition of signals is given as below

$$y_{HIGH}[n] = \sum_{k=-\infty}^{\infty} x[k]h[2n+1-k] \quad \text{.....................(2)}$$

$$y_{LOW}[n] = \sum_{k=-\infty}^{\infty} x[k]g[2n-k] \quad \text{........................(3)}$$

The general discrete wavelet transform (DWT) of filter analysis tree for three levels of independent DWTs are shown in Fig.3.

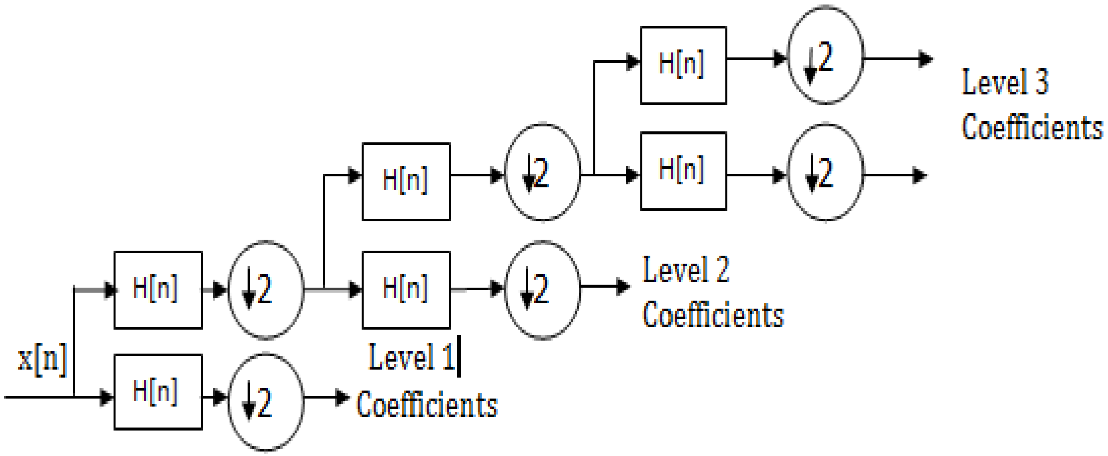

Fig.3. Filter analysis tree.

Fig4. Three Popular Wavelet Decomposition Structures on Image: a) Pyramid, (b) Spacl, (c) Wavelet.

Discrete wavelet transform is a multi-decision decomposition of a signal. 1 level DWT entails applying a low bypass and a high pass filters along the columns after which the rows, respectively. In two dimensional applications, for every level of decomposition DWT is implemented in vertical path, followed by applying the DWT within the horizontal direction.

III. DEVELOPMENT OF SYSTEM

Thissection describes the proposed watermarking scheme. Two-level DWT is applied to the sub-blocks of the watermark image to embed messages in center anaglyph image. In the watermarking extraction process, embedded watermarks are extracted by the IDWT coefficient blocks.

WatermarkImag
e

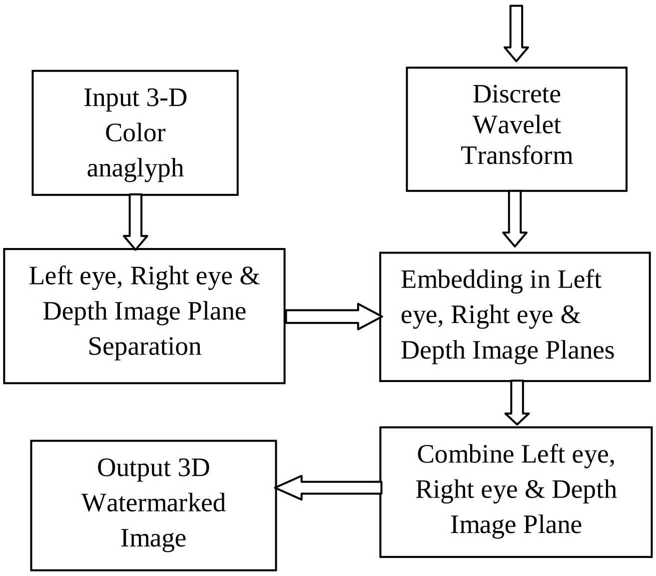

Fig.5. Block Diagram of Embedding watermark

Watermark Embedding

Figure 5 shows a block diagram of the proposed watermark embedding process for anaglyph 3D images.

Step 1(Dividing into Sub-images): The host anaglyph 3D image, is splits into left eye view image, right eye view image and depth image.

Step 2(2-level DWT): The watermark / secrete image whose length is M x N. A two dimensional wavelet transform is applied to watermark image and split it into A (Approximation), H (Horizontal), V (Vertical) and D (Diagonal) elements.

Step 3 (Message encoding): A (Approximation), H (Horizontal), V (Vertical) and D (Diagonal) elements of watermark / secrete image are embed into left eye view image, right eye view image and depth image.

Step 4 (Images encoding): Combine the left eye view image, right eye view image and depth image to get the 3d anaglyph watermarked 3D image.

Watermark Extraction

Figure 6 shows a block diagram of the proposed watermark extraction process. The extraction is the inverse process of watermark embedding. The watermark is faithfully extracted from the 3D image. The detail steps are given below.

Steps 1(Dividing into sub-images): The host 3D anaglyph watermarked 3D image, is splits into left eye view image, right eye view image and depth image.

Step 2: Extract the A (Approximation), H (Horizontal), V (Vertical) and D (Diagonal) elements from the left eye view image, right eye view image and depth image planes by applying Inverse Discrete Wavelet Transform (IDWT).

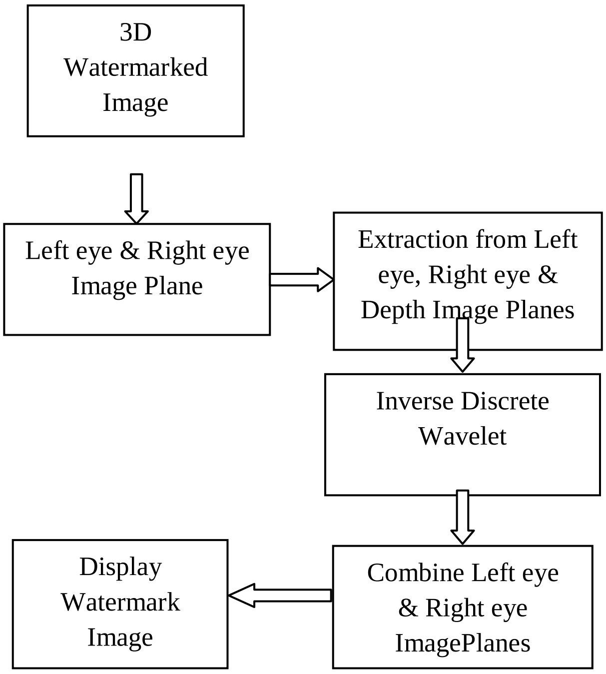

Fig.6. Block Diagram of Extraction Watermark.

Step 3: Combine an A (Approximation), H (Horizontal), V (Vertical) and D (Diagonal) elements to recover the watermark of each plane.

Step 4: Combine left eye view image, right eye view image and depth image to get the original 3D image.

IV. RESULT ANALYSIS

The detail steps of 3D image watermarking are given below.

1. Select a 24 bit true color 3D image of any dimensions and called this image as Original image plane.

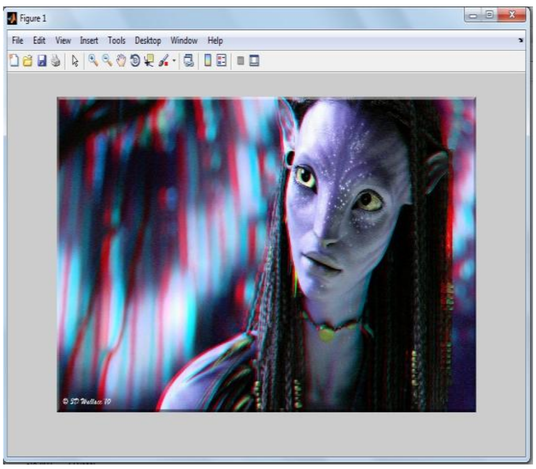

Fig.7. Original 3D anaglyph image

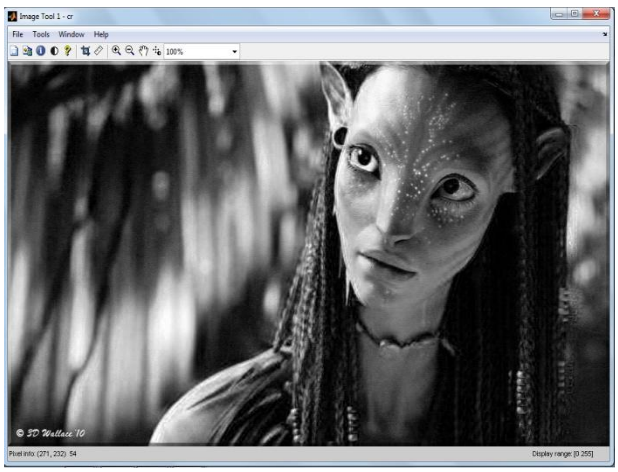

Fig.7. (a) Left eye

Fig.7. (b) Right eye

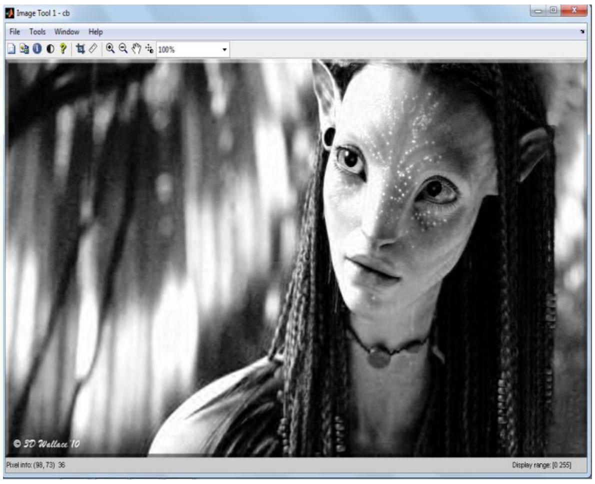

Fig.7.(c) Depth image

Fig.8. Watermark Image

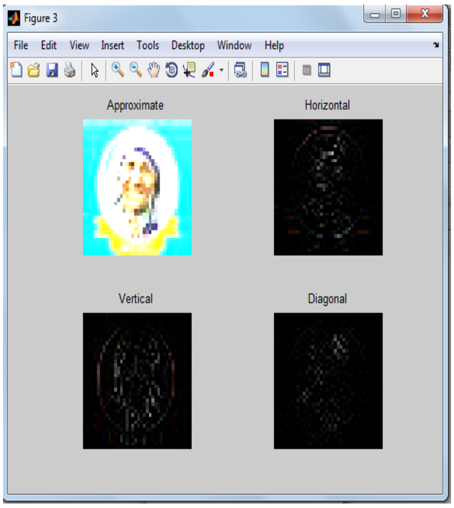

Fig.9. A, H, V, D components

2. Decompose the image into basic Left eye, Right eye and Depth image planes. Shown in figures 7.a), b) and c).
3. Select another 24 bit true color image and called this image as watermark image, which is shown in fig.8.
4. Apply the 2D DWT to each R, G, and B planes of the watermark image for getting the A, H, V and D components of the R, G, B planes of watermark image (fig.9).
5. Embed the values of A, H, V and D components of R, G, and B planes of watermark image. The 3D watermarked image wherein the watermark is embedded is shown in figure 10.

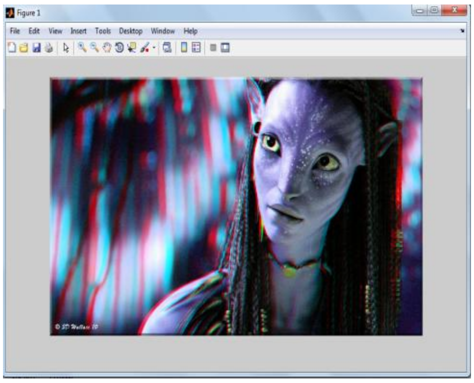

Fig.10. Watermarked 3D Image

Fig.11. Extracted Watermark

TABLE I. PSNR Values of Multiple Tested images

Sr. No.	Name		Size		PSNR			
					Using DCT		*Proposed DWT Method*	
	Test 3D images	*Watermark Image*	*Original image*	*Watermark image*	*extracted watermark*	*watermarked image*	*extracted watermark*	*watermarked image*
1	3D image j.jpg	Logo g.jpg	598x1038x3 uint8	74x74x3 uint8	18.4483	66.9801	23.2014	66.9801
2	3D image j.jpg	Logo a.jpg	598x1038x3 uint8	74x74x3 uint8	18.4483	61.7044	19.9236	66.9778
3	3D image q.jpg	Logo d.jpg	544x1274x3 uint8	74x104x3 uint8	18.4247	61.7036	21.3635	66.0001
4	3D image r.jpg	Logo m.jpg	579x1024x3 uint8	65x83x3 uint8	16.6786	62.6849	17.3897	67.9272
5	3D image k.jpg	Logo r.jpg	720x1280x3 uint8	82x66x3 uint8	16.4099	63.7308	19.7838	69.2180
6	3D image k.jpg	Logo s.jpg	720x1280x3 uint8	74x74x3 uint8	18.2735	63.6620	20.7128	69.2419

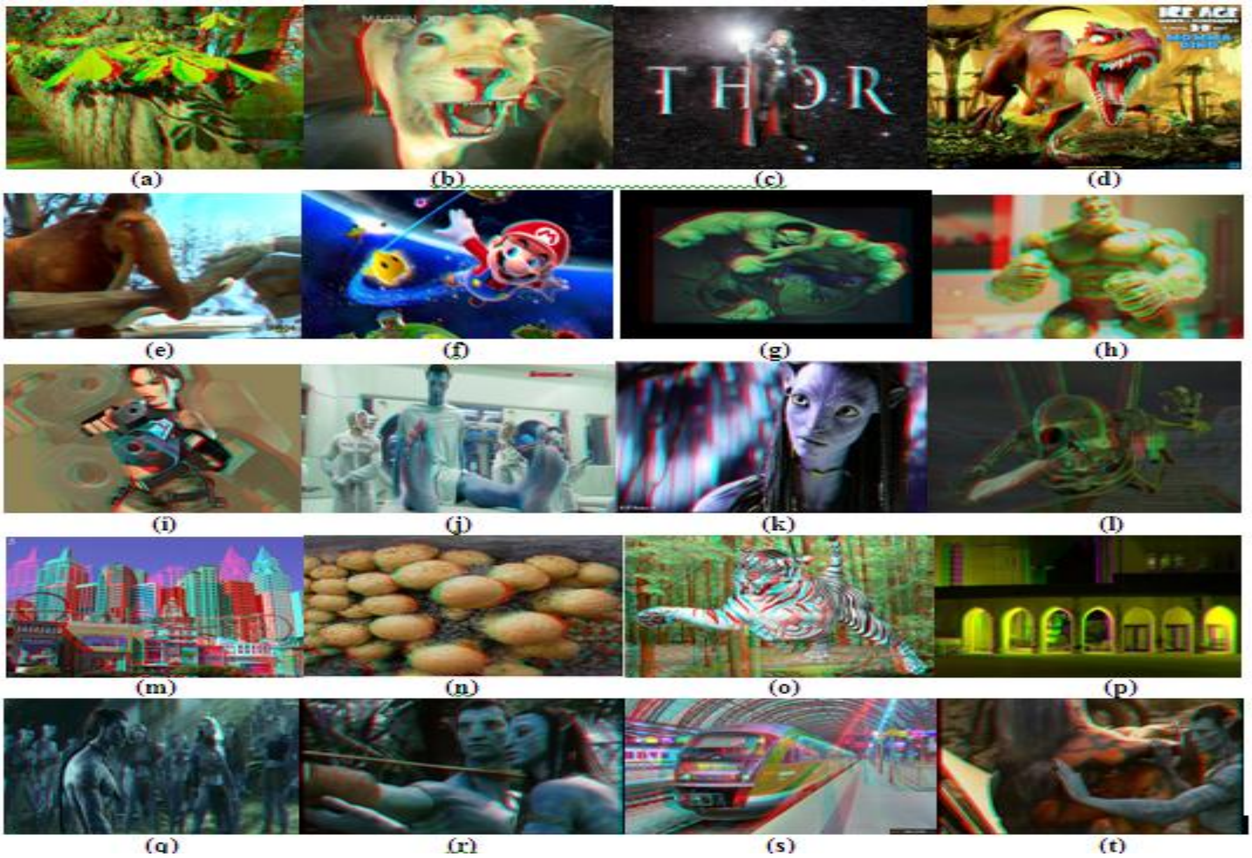

Fig. 12. (a-t) Test 3D images

By using IDWT the A, H, V and D components are combined to get the extracted watermark. Figure 11 shows the extracted watermark image.

The simulated experiments are carried out to demonstrate the effect of proposed schemes. In this dissertation work different size of original 3D Anaglyph images and watermark images are used as shown in figure 12 and figure 13. To compare the invisibility of the watermark we test the proposed algorithm on series of standard images. The various parameters of the images are also shown in tables. Lower the value of PSNR the quality of watermarked image is good and can be easily observed. PSNR calculated as:

$$PSNR = 10log_{10}\left(\frac{R^2}{MSE}\right) \qquad (4)$$

To measure the perceptual quality, we calculate the peak of signal-to-noise ratio (PSNR) that is used to estimate the quality of the watermarked frames in comparison with the original ones.

V. CONCLUSION AND FUTURE WORK

The proposed watermarking system can be used to protect the copyright contents present in the 3D images. The watermark has been in DWT domain. The proposed watermarking scheme is effective to reduce the noise because here watermark is embedded in all three layers of anaglyph 3D image. This study also shows different considerations for designing effective watermarking schemes for protecting Anaglyph 3D images, as compared with protecting traditional 2D images. In this paper 3D watermarking categorization is achieved based on the fundamental components of 3D representation techniques, namely 3D-3D, 3D-2D and 2D-2D watermarking. Experimental results show high PSNR for various Anaglyph 3D images.

The current system can survive compression without affecting the hidden watermark. Also the current system can supports to the JPEG, PNG and BMP compression formats of 3D images. The proposed method provides much better robustness and visual quality in the resulting watermark images.

The digital watermarking for image-based 3D data is still in its infancy stage, this work is just the first step toward exploiting this interesting and important topic and of course, there are lots of different issues worthy of further investigations. Also there are some problems with the anaglyph technique because we noted that, the resulting color of the images is appeared to be changed and also the color quality looks poor or degraded, in some cases it is homogeneous. Moreover, the use of anaglyph glasses is restricted for some people with some sort of medical condition, because prolonged use can lead to headaches and even nausea, vomiting and dizziness in the most serious cases.

The tool use for developing this proposed work is image processing and wavelet toolbox of MATLAB for "reading" the images and for performing the DWT operations.

The future scope of this system is copyright contents protection in the 3D images work very well under constrained conditions although systems work much better for anaglyph 3D images but the resulting color of the images is appeared to be changed and also the color quality looks poor or degraded, in some cases it is homogeneous.

Also in future a wavelet-based watermarking scheme for 3D videos should be used. In this watermark is embedded into motion scene frames of the 3D videos.

REFERENCES

[1] Hee-Dong Kim, Ji-Won Lee, Tae-Woo Oh, and Heung-Kyu Lee, “Robust DT-CWT Watermarking for DIBR 3D Images”, IEEE Transactions on Broadcasting 2012.

[2] Yu-Hsun Lin and Ja-Ling Wu, “A Digital Blind Watermarking for Depth-Image-Based Rendering 3D Images”, IEEE transactions on Broadcasting, Vol. 57, No. 2, June 2011.

[3] Majid Masoumi and Shervin Amiri, “A Blind Video Watermarking Scheme Based on3D Discrete Wavelet Transform”, International Journal of Innovation, Management and Technology Vol. 3, No. 4, August 2012.

[4] Ahmed A. Abdulfetach, Xingming Sun, Hengfu Yang and Nur Mohammad, “Robust Adaptive Image Watermarking using Visual Models in DWT and DCT Domain”, Information Technology Journal 9(3): 460-466,2010,ISSN 1812-5638.

[5] Mukesh C. Motwani “Third Generation 3D Watermarking: Applied Computational Intelligence Techniques”, University of Nevada, Reno, July, 2011.

[6] Badillo I. Elias, “3D Generation and Watermarking From 2D Images and Videos”, New Mexico Tech, EE Department, Digital Image Processing.

[7] Sadik. A.M .Al-Taweel and Putra Sumari, “Robust Video Watermarking Based On 3D-DWT Domain” , Universiti Sains Malaysia 11800, Penang, MALAYSIA, 978-1-4244-4547-9/09/$26.00 ©2009 IEEE.

[8] Alper Koz, “Watermarking for 3D Representations”, Thesis, August 2007.

[9] Ming Luo,"Robust and Blind 3D Watermarking" , Thesis, May 2010.

[10] C. Fehn, P. Kauff, M. Op de Beeck, F. Ernst, W. Ijsselsteijn, M. Pollefeys, L. Vangool, E. Ofek, and I. Sexton, "An evolutionary and optimised approach, on 3D-TV," IBC 2002, Int. Broadcast Convention, Amsterdam, Netherlands, Sept. 2002.

[11] C. Fehn, "Depth-image-based rendering (DIBR), compression and transmission for a new approach on 3D-TV," Proc. SPIE Conf. Stereoscopic Displays and Virtual Reality Systems XI, 2004, vol. 5291, pp. 93–104.

[12] Y. H. Lin and J. L.Wu, "A digital blind watermarking for depth-imagebased rendering 3D images," IEEE Trans. Broadcasting., vol. 57, no. 2, pp. 602–611, Jun. 2011.

E. Halici and A. Alatan, "Watermarking for depth-image-based rendering," in IEEE Int. Conf. Image Process. (ICIP).