Image And Video Quality Estimation based on Tree Structure Watermarking using KD-Tree Complexity Analysis

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Abstract

Quality estimation of image and video is very important. There are various quality estimation techniques including full reference, reduced reference and no reference quality metrics. In these quality metrics reduce reference and no reference quality metrics are more practical than full reference quality metrics. In this paper quality estimation based on tree structure watermarking using k-d tree complexity analysis is used. The proposed method uses embedded watermark to estimate the quality of cover video and image under distortions. The watermarking is done on the dwt domain of the cover image and video. The dwt coefficients are categorized in to hierarchical tree and the watermarking is done on the selected bit planes. Complexity analysis used to find out how much details an image and video contains for that kd-tree based complexity analysis is used. The quality is estimated under different distortion strength in terms of PSNR and QOI.

Keywords: watermarking based quality estimation, complexity analysis, DWT based watermarking, k-d tree

I. INTRODUCTION

The evaluation of image and video quality is very important because quality is key determinant of every process like video broad casting, image processing etc. The quality metrics are mainly of three types i) full reference quality metrics ii) reduced reference quality metrics and iii) no reference quality metrics. The full reference quality metrics evaluate the quality of image or video by comparing the difference between the original image and distorted image this is the direct comparison method and easy method but, if we not available with the original image then we cannot compare the distorted image with the original image .this method is less practical when the original image is not available. The reduced reference quality metrics are estimate the quality by comparing the partial information of image and the distorted image and the other hand the no reference quality metrics are estimate the quality of image and video without using the original one .This reduced and no reference quality metrics are really useful and practical than full reference quality metrics. Watermarking method is one of the most promising method for the quality estimation of image and video in the case of no reference and reduced reference quality metrics. In this scheme watermark is embedded in to cover image and both will go same distortion and at the receiver side the watermark will extract and it will compare with the original watermark and estimate the quality. The challenging task in watermark based quality estimation the watermark should show all the quality degradation happened to the cover image in order to provide this a tree structure based watermarking is used by this the embedded watermark can show all the degradation happens to cover image.

In this paper proposed a video and image quality estimation based on tree structure watermarking using kd-tree complexity analysis is used. Complexity analysis is used to find out the details containing in an image and video. In previous work they have used quad tree decomposition for analyze the complexity of an image. In this work the kd-tree complexity analysis is used for image and it also implemented in video.

II. RELATED WORKS

The Full-Reference quality metrics provide more accurate quality evaluation results comparing to the Reduced or No-Reference quality metrics. However, the Full-Reference quality metrics become less practical when the original image is not available. The Reduced-Reference quality metrics evaluate the quality of a distorted image using partial information of the original image. In literature, such partial information can be some features extracted from the original image [8]–[10]. The Reduced-Reference quality metrics do not require the presence of the original image for quality evaluation. This study largely inspired by [1]-[3] where the same tree structure based watermarking is used and quad tree decomposition is used to find out the complexity of an image. In this work the watermark embedding done on the dwt domain of the cover image, the dwt coefficients are arranged in a tree structure the watermark is embedded in to selected bit plane of selected tree, HVS masking guides the bit plane selection this HVS masking. Redundancy is another step used in the original watermark at the receiver side in order to prevent the loss of bits, the redundancy 3 is used there. The quad tree gives complexity value of image. Complexity indicates how much details an image contains. A higher complexity value indicates that the image is more complex and the image contains more detail information. Comparing to a less complex image, the quality of a more complex image degrades faster against the same distortion [4]. For this

case, to reflect the quality degradation of the cover image, we need to embed more watermark bits into the lower DWT levels of a more complex image. For a less complex image, we consider to embed more watermark bits into the higher DWT levels, finally we get an embedded watermarked image and it will go undergo the distortions. At the receiver side we extract the watermark and compare the distorted watermark with original watermark and find out the TDR values. TDR are indicates True Detection Rates it is the ratio of correctly detected watermark bits and the total number of watermark bits. This will gives the quality degradation happen to the image and corresponding PSNR also calculated for the estimation of quality

III. PROPOSED METHOD

The proposed scheme is using kd-tree based complexity analysis in quality estimation based on tree structure watermarking. The image and video quality estimation done using kd-tree based complexity analysis concept.

A. Kd-Tree Based Complexity Analysis

The Kd-tree based complexity analysis is used to find out the details contain in an image. Trees as a data structure has been widely been used in querying methods and extracting data from various sources. Apart from querying, trees have been used in space partitioning and clustering [2] algorithms. Kd-tree, introduced by Bentley in 1974 is a well-known space partitioning data structure for organizing points in k-dimensional space. Kd-trees are range trees the building of kd- tree gives the details of the image. Kd-tree is a binary tree. The values less than root node is go to the left portion and values greater than root node go to the right side like that the trees is building up and the complexity value is calculated. This value gives the complexity of an image. Kd-tree has been extensively used in computing surface area heuristic that sub divides geometry into regions of small surface areas. The proposed method includes number of steps discrete wavelet transform of the image, tree structure based watermarking, this step contains the sub steps like addition of redundancy, HVS masking and the complexity of an image. The next step is the distortion of application , extraction of watermark, the final step is the comparison of original and the extracted watermark and the quality estimation is the final step. This done by calculating the true detection rates .Finally, the PSNR and QOI is calculated for image and video and quality estimated.

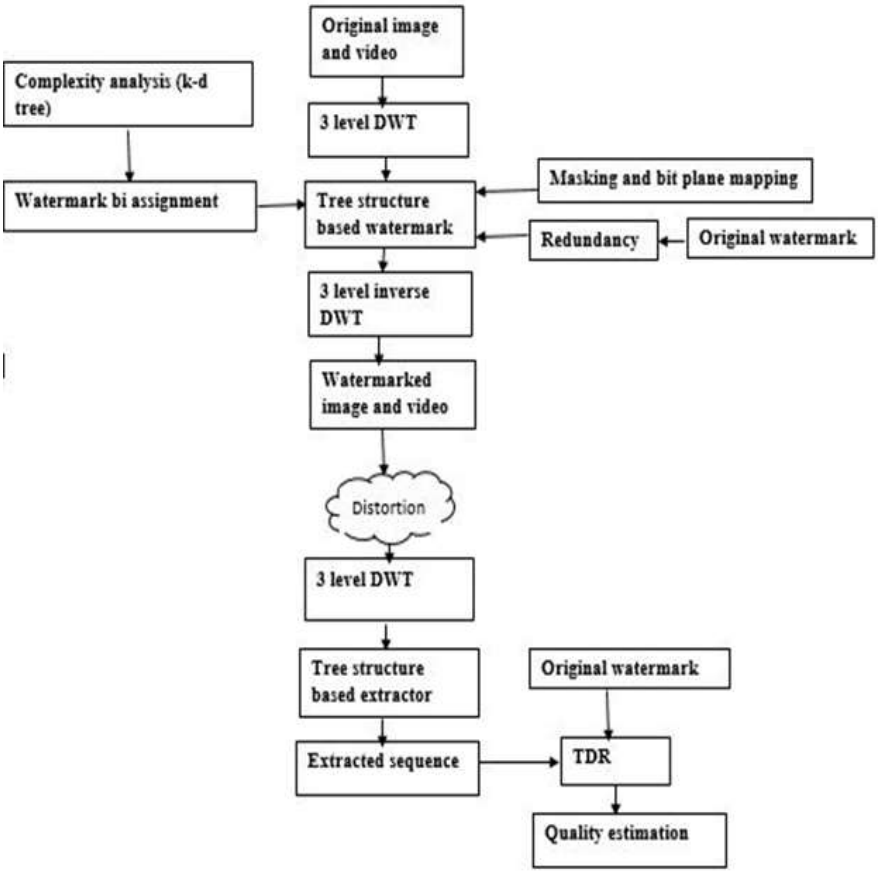


Fig. 1: Design of proposed system

B. Discrete Wavelet Transform of Image and Video

Discrete wavelet transform is used to decompose the image in to DWT sub bands.

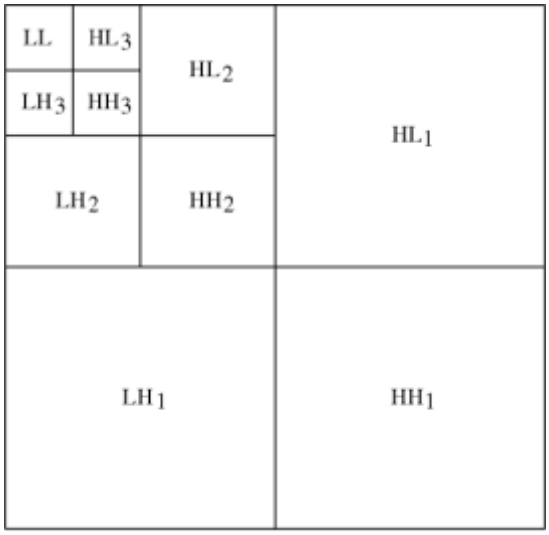


Fig. 2: DWT decomposed sub bands

C. Tree Structure Based Watermark Embedder

The tree structure based watermark embedder [1] is used to embed the watermark bits in to selected bit planes of selected watermark coefficients. Dwt coefficients with inherent similarities are arranged in to tree structure manner in that the LL sub band is exclude from embedding because it contains important information about the image. If we embed the LL sub band it will loss the quality of image. Redundancy is the one of the main step watermark embedding is the addition of redundancy [1]. Redundancy 3 is used in the watermark bits in order to overcome the loss of bits. The watermark is embedded in to the selected bits of selected discrete wavelet transform coefficients.

D. Masking and Bit Plane Mapping

The other factor that controls the watermark embedding strength is the bitplane selection for the watermark embedding. By decomposing the DWT image into a set of binary bitplanes, each DWT coefficient is decomposed into a binary bit sequence. The less significant bits are more sensitive to distortions than the more significant bits. If we embed the whole watermark in the least significant bitplane of the DWT image, we obtain the most fragile watermark and the least quality degradation to the cover image, and vice versa. In the proposed scheme, the bitplane selection is guided by the analysis of the HVS masking [1] effects on the DWT decomposed image. The analysis of the HVS masking effects helps to increase the capacity for watermarking without causing more quality degradation to the cover image.

The four factors affecting the behavior of HVS masking.

- Band sensitivity or frequency masking: Intensity variations are less in high resolution bands [1].
- Background luminance: Intensity variations are calculated here[1]
- Spatial masking or edge proximity: The human eyes are more sensitive to noise addition near edges or contours of images [1].
- Texture sensitivity: Intensity variations in highly textured areas are less visible than those in the flat-field areas of images.

HVS masking is calculated by using this factors for image and video.

E. The Analysis of Image Content Complexity

The image content complexity is evaluated by using Kd-tree based decomposition. Kd-tree is a binary tree in which the values less than root node is placed in left side and values greater than root node is placed in right side. The Kd-tree building process is used to find the complexity of an image. Complexity means the details containing in an image. This step includes in tree structure based watermarking process and it necessary to know how much details contains in an image for watermarking procedure. A higher complexity value indicates that the image is more complex and the image contains more detail information. By watermarking using tree structure based embedder the watermarked image is obtained.

F. Distortion Application

Distortion is added to the image and as a noise. When the image or video is transmitted there is a chance of noise so the noise like salt and pepper is used here in range of 0 to 1

G. Watermark Extraction

The next step is the watermark extraction. The same tree structure based watermark extractor is used to extract the distorted secret image. Three level DWT is applied on the embedded image and extraction is carried out.

H. Quality estimation

The image and video quality estimation is done by comparing the original watermark with the extracted watermark and detect the truly detected watermark bits and estimate the quality of image and video

IV. EXPERIMENT AND EVALUATION

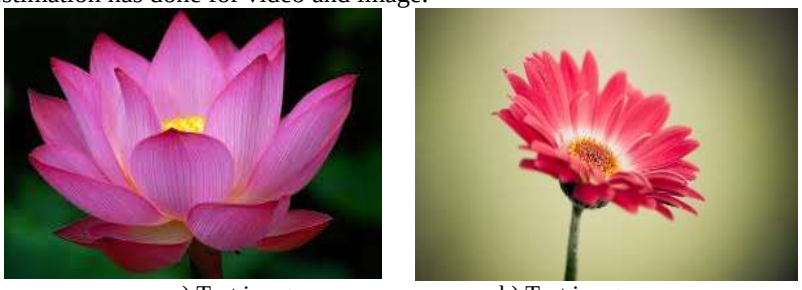
The data used for this experiment are image and video. The image format supporting this experiment are .jpeg and .png and the video format is .avi format. The proposed KD tree complexity analysis is compared with the previous work and this complexity analysis based video quality estimation is done.

A. Original Image and Original Watermark

The experiment used different format images like .jpg and .png. All of these images are 512 *512 in size and they contain different textures, such as portraits, plants, animals, sceneries, buildings, crowd, animation and computer generated patterns. Videos used .avi format. The binary image used as a watermark.

B. Experiment-Summary

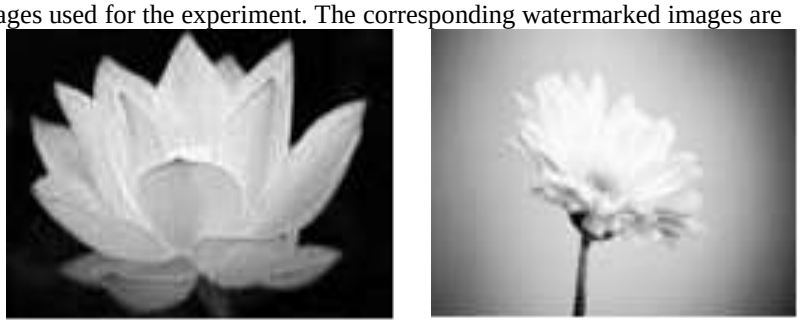
The scheme used complexity analysis based on kd- tree based complexity analysis. Complexity values estimated for image and video. For video the complexity values are estimated for each frame. The previous work used quad tree based complexity analysis. The complexity values is measured and compared for image also the quality estimation is done for both image and video. The proposed scheme is evaluated under different distortion strength for image and video and the quality is estimated in terms of TDR-PSNR and TDR-QOI. The experiment has done several times using different images and the complexity values calculated and the quality estimation has done for video and image.



a) Test image b) Test image

Fig. 3:

These are the some test images used for the experiment. The corresponding watermarked images are



a) Watermarked image b) Watermarked image

Fig. 4:

The above mentioned are some examples of test images and watermarked image. The complexity values are compared with the proposed scheme and previous work.

Table - 1

Complexity values calculated using kd-tree

Image	*Kd complexity*
Image 1	*0.14455*
Image 2	*0.14165*
Image 3	*0.12543*

Table 1 shows the complexity values using proposed scheme that is kd-tree complexity analysis and table II shows the comparison of complexity values of proposed scheme and the previous work.

Table -2
Comparison of proposed work and previous work

Image	*Kd complexity*	*Quad complexity*
Image 1	*0.14455*	*0.05178*
Image 2	*0.14165*	*0.01302*
Image 3	*0.12543*	*0.00770*

From Table 2 it is clear that proposed scheme shows much better complexity analysis of image than previous work.

a) Test video
Fig. 5:

The above figure shows the test video used for the experiment. The proposed scheme implemented in video also and the proposed complexity value also calculated for each frame of video.

Table - 3
Complexity value of each frame of video

Video frames	*Complexity value*
1	*0.15748*
2	*0.15912*
3	*0.1603*

The quality estimation of image and video also done in terms of PSNR, QOI versus TDR.

Table - 4
Quality estimation of image

Image Name	*Noise Level*	*QOI*	*TDR*	*PSNR*
Images.jpg	*0.4*	*0.76826*	*0.9857*	*18.4466*
Images.jpg	*0.5*	*0.74975*	*0.9766*	*16.3078*

This table details about the quality estimation. Under experiment images undergone different distortion strength. When the noise level increases the corresponding true detection rate decreases and the PSNR and Quality of image (QOI) value also decreases with respect to TDR value. The graph is plotted TDR-PSNR and TDR-QOI.

1) TDR-PSNR

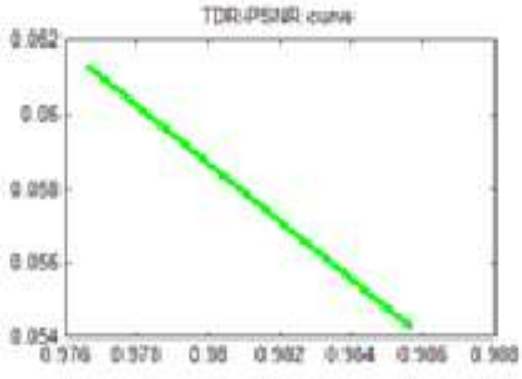


Fig. 6: TDR-PSNR

2) TDR-QOI

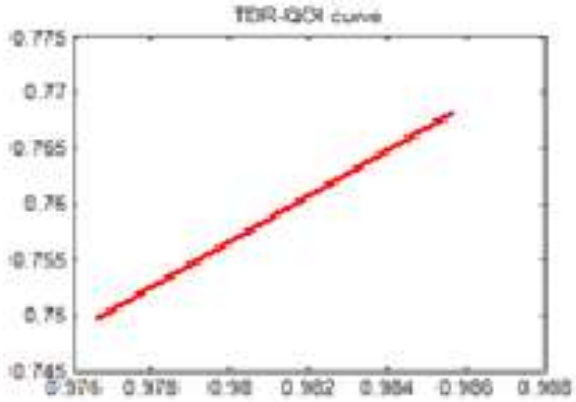


Fig. 7: TDR-QOI

The quality estimation of video also done in terms of PSNR and the graph is plotted same as image. Only 3 complexity values of 3 frames are listed foe video there is number of values are available.

Table - 5

Quality Estimation of video

Video name	*Noise level*	*QOI*	*TDR*	*PSNR*
Cart1.avi	*0.4*	*.69296*	*0.9858*	*18.4164*
Cart1.avi	*0.5*	*.61647*	*0.977*	*16.3827*

Table 5 shows the quality estimation video under different distortion strength. The quality variation is same as image. When the noise level increases the corresponding true detection rate decreases and the PSNR and Quality of image (QOI) value also decreases with respect to TDR value. The video complexity analysis and the quality estimation has done in test video and the corresponding value has estimated and the quality estimation graph has drawn. The graph is plotted TDR-PSNR and TDR-QOI (Quality of Image).

The TDR-PSNR graph is plotted as below curve

3) TDR-PSNR

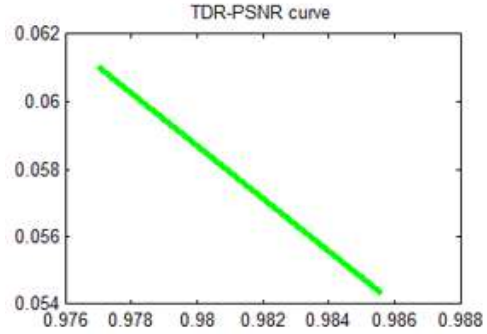


Fig. 8: TDR-PSNR

The TDR-QOI graph is plotted as below.

4) TDR-QOI

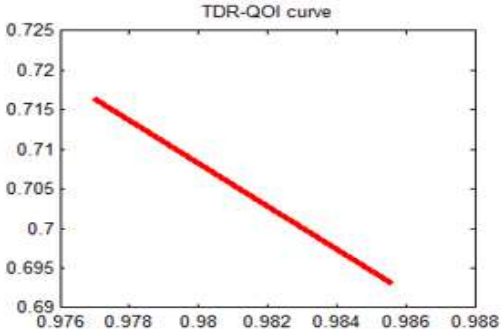


Fig. 9: TDR-QOI

V. CONCLUSION

In this work anew Kd-tree based complexity analysis for the content complexity analysis of image in tree structure based watermarking for the quality estimation. The work is explained about the quality estimation of image or video in terms of PSNR and QOI. The kd tree based work is proposed in both image and video Based on the tree structure, the binary watermark is embedded into the selected bit planes of the selected DWT coefficients The watermark embedding strength is assigned to an image by pre-analyzing its content complexity in the spatial domain and proposed kd tree analysis is used here. The perceptual masking effect of the DWT decomposed image in the DWT domain. Meanwhile, the watermark is not embedded in the approximation subband, which reduces loss in image quality caused by embedding the watermark. The proposed system shows 64% increase complexity value than previous work. The quality estimation based on proposed work has done for video and image. The experimental results show that the proposed scheme works effectively.

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