International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869 (O) 2454-4698 (P), Volume-4, Issue-3, March 2016

Effective Image Quality Estimation Using Wavelet Based Watermarking Technique

Anjali Krishna, Shanavaz K T

Abstract— **Image and video quality measurement is a challenging problem in many of the image processing fields. The paper addresses the Image Quality Assessment (IQA) problem using the objective metrics of the watermarks. The proposed scheme helps to assess the quality of an image by using a tree structure based watermarking method without accessing the cover image.Process of the watermarking is done in the wavelet domain of the cover image .The watermarking coefficients are embedded in the selected trees of the decomposed image.Comparing the original watermark and the extracted watermark will indicate the quality degradation of the original cover image. Applications of image/video watermarking in copy control, broadcast monitoring, finger printing, video authentication, copyright protection etc is immensely rising Performance can be evaluated in terms of the PSNR,SSIM under different distortions.**

IndexTerms—**Imagewatermarking,Waveletdecomposition,Quadtreedecomposition,watermak,embedding,distortion,quality estimation.**

I. Introduction

In the recent years,the evaluation of image and video quality estimation plays an important role in the digital media such as image processing, broadcasting etc.Quality metrices are of three types:Full Reference,Reduced Reference and No Reference metrices. The Full Reference metric requires the original image to estimate the quality.therefore Reduced Reference metric and the No Reference metric are more useful and practical in many cases. Watermarking techinque is a better method to assess quality in terms of either a Reduced Reference or a No Reference metrics.

(i)Full Reference Methods (FR): FR metrics compute the quality difference by comparing the original video signal against the received video signal. Typically, every pixel from the source is compared against the corresponding pixel at the received video, with no knowledge about the encoding or transmission process in between. More elaborate algorithms may choose to combine the pixel-based estimation with other approaches such as described below. FR metrics are usually the most accurate at the expense of higher computational effort.

(ii)Reduced Reference Methods (RR): RR metrics extract some features of both videos and compare them to give a quality score. They are used when all the original video is not available, or when it would be practically impossible to do so, e.g. in a transmission with a limited bandwidth. This makes them more efficient than FR metrics.

(iii)No-Reference Methods (NR): NR metrics try to assess the quality of a distorted video without any reference to the original signal. Due to the absence of an original signal, they may be less accurate than FR or RR approaches, but are more efficient to compute.

In this proposed scheme watermark is embedded in the cover video and both will undergoing the same distortion such that by extracting the watermark can be used to determine the quality of the cover image.A tree structure based watermarking is provided so that the watermark should show the same degradation that happens to the cover image.Complexity of the image is analysed to find out the contents in the video by using a quadtree decomposition.

The attacker can only destroy or detect the secret information. Wavelet Transform is a recent technique frequently used in digital image processing, compression, watermarking etc. The transforms are based on small waves, called wavelet, of varying frequency and limited duration. The wavelet transform decomposes the image into three spatial directions, i.e. horizontal, vertical and diagonal.Image and video watermarking is moderately a latest technology that has been considered to solve the dilemma of fraudulent misuse and distribution of digital video. The main aim is that hiding the information into the video for protection.Image watermarking study predictable fewer attention than image watermarking due to is take over complexity, alternatively, lots of algorithms have already been proposed. Transform-domain watermarking techniques proved to be extra robust and imperceptile compared to spatial domain techniques because disband the watermark in the particular domain of video frame, making it extremely not easy to remove the embedded watermark.

II. Literature Review

The phenomenal growth of the Internet has highlighted the need for mechanisms to protect ownership of digital media.The extension of this concept in the digital world is the digital watermarking.Exactly identical copies of digital information, such as images, text or audio, can be produced and distributed easily. Digital watermarking is a technique that provides a solution to the longstanding problems faced with copyrighting digital dataDigital watermarking rapidly growing research area of digitised images, video and audio has urged the need of copyright protection, which can be used

Anjali Krishna, Department of ECE, College of Engineering kallooppara,Thiruvalla,India,Phone:0479-2427241.

Shanavaz K.T, Department of ECE, College of Engineering kallooppara,Thiruvalla,India,Phone:0469-2677890.

to produce verification against any illegal attempt to either reproduce or manipulate them in order to change their identity. Digital watermarking is technique providing embedded exclusive rights information in images. Watermarking is the method of hiding the secret information into the digital media using some strong and suitable algorithm. Algorithm plays an essential role in watermarking as, if the used watermarking technique is capable and strong then the watermark being embedded using that technique cannot be easily detected.

A.Quality Assessment Methods

1.Structural Similarity Measure

Structural similarity provides an alternative and complementary approach to the problem of image quality assessment [1]. It is based on a top-down assumption that the HVS is highly adapted for extracting structural information from the scene, and therefore a measure of structural similarity should be a good approximation of perceived image quality.: Define the structural information in an image as those attributes that represent the structure of objects in the scene, independent of the average luminance and contrast. Since luminance.and contrast can vary across a scene, we use the *local* luminance and contrast for our definition. The system separates the task of similarity measurement into three comparisons: luminance, contrast and structure: There are a number of issues that are worth investigation with regard to the specific SSIM index, the optimization of the SSIM index for various image processing algorithms needs to be studied and the application scope of the SSIM index may not be restricted to image processing.

2. RR metric method

In [2], introduce a practical quality-aware image encoding, decoding and quality analysis system. Here use a reduced-reference image quality assessment algorithm based on a statistical model of natural images and a previously developed quantization watermarking-based data hiding technique in the wavelet transform domain. An effective way for digital watermarking, copyright protection, a process which embeds (hides) a watermark signal in the host signal to be protected is suggest in [2]. A new method introduce for assessing perceptual image quality. Here proposed SSIM indexing approach, which are analyses on structural similarity of the images. It depends on the image formation point of view and also for quality estimation scheme in [7]. Here [8], explains challenges in the video watermarking. LSB replacement does not provide robustness therefore it is not applicable for digital watermarking. Using different techniques it is easy to extract LSB embedded watermarks. The DCT domain watermarking, is extremely challenging to JPEG compression and random noise. In case of wavelet domains, this is highly resistant to both compression and noise. There will be minimal amounts of visual degradation. Also suggest HVS masks are tremendously preferred to analyze video sequences of frames to embed watermark.

As in the RR metric we are providing the partial or side information about the reference image this information usually consists of relevant features extracted from the original media which are transmitted and compared with the analogous features extracted from the degraded media[3]. The side information consists of two distinct types of measurements: spatial measurement extracted from the frames edges, and temporal measurements extracted from frames differences. The following figure [5]shows the framework used for reduced reference image quality assessment metric. In which at the sender side first feature extraction is take place and then this partial or side information is send along the channel. At the receiver side distorted image and extracted features are compared by using RR quality analysis method. For the feature extraction from the original media first we have to decompose the image for this purpose we are using the Multiscale Geometric Analysis framework.

3.Watermarking method

A digital watermarking-based image quality evaluation method that can accurately estimate image quality in terms of the classical objective metrics, such as peak signal-to-noise ratio (PSNR), weighted PSNR (wPSNR), and Watson just noticeable difference (JND), without the need for the original image[4]. In this method, a watermark is embedded into the discrete wavelet transform (DWT) domain of the original image using a quantization method.Considering that different images have different frequency distributions, the vulnerability of the watermark for the image is adjusted using automatic control. After the auto-adjustment, the degradation of the extracted watermark can be used to estimate image quality in terms of the classical metrics with high accuracy. The watermark is embedded into the frequency domain of the image. Different images may have quite different frequency distributions. At the transmitter side, the vulnerabilities of the embedded watermark are adjusted automatically based on the frequency characteristics of the image and, critically, an empirically predetermined mapping function.

The watermark embedding process is implemented in the DWT domain, because the DWT can decompose an image into different frequency components (or different frequency subbands) [11]. Different frequency components have different sensitivities to image compression, which makes it much easier to control the watermark vulnerability. The vulnerability of a watermark is mainly affected by two factors: the amount of watermark bits embedded into each frequency component of the image and the corresponding watermark embedding strength which is controlled by the quantization parameter. At the receiver side, the image quality is estimated based on the degradation of the extracted watermark [10]. the watermark embedding and extraction are implemented in the 3-level DWT domain of the original image using the quantization method [6], [11], [10].. The larger the quantization parameter, the more robust the watermark.

III. Design and Analysis

The proposed method which performs watermark embedding into image content is based on Discrete Wavelet Transform (DWT). Reasons for the usage of this orthogonal transformation are its good results in applications which deal with image processing.

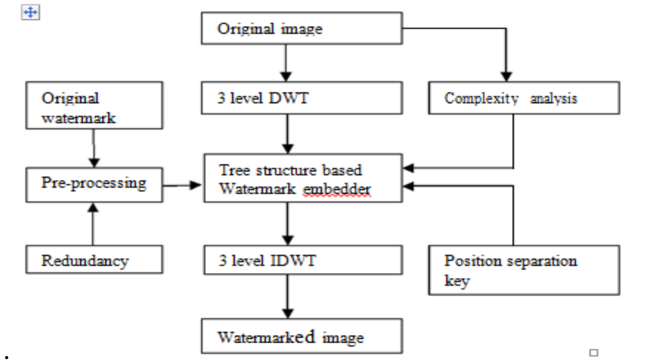


Fig 1. Block Diagram of the proposed System

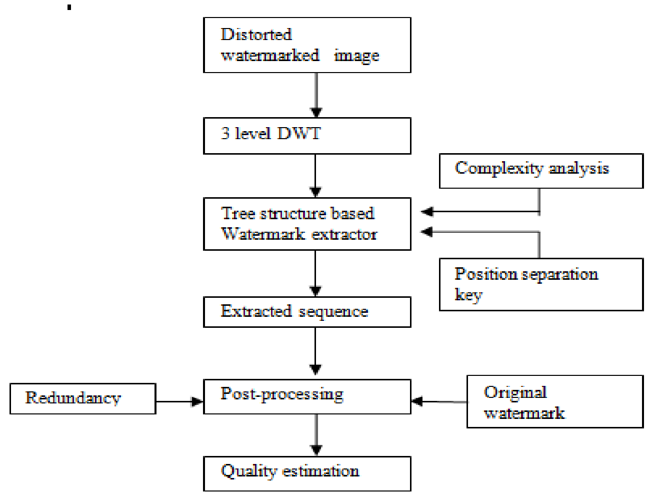


Fig 2 Watermark extraction and quality estimation

The watermark embedding mainly consists of three steps.

1) Initially to read the original image

2) Then to read the secret image

3) Then to apply the embedding tools that are mainly include

a)Then to add the redundancy (one or more) b)Apply wavelet decomposition c)Then to apply the complexity by using mathematically, Complexity= $\sum$(n*2^i) n:no:of quad tree decomposition nodes,i:level of the decomposition d) data embedding

4) Then to apply decryption tool

5) Analysis by using TDR

I Aquisition of cover image and 3level DWT

Quality of the image is estimated by using watermarking technique. Selecting image as the cover medium and also select watermark as an image.Then image will experience, decomposition, embedding and extraction. The watermark embedding strength is estimated by analyzing the quality degradation of the cover image.The correlated DWT coefficients are grouped together using the SPIHT tree structure.

The DWT decomposed image is further decomposed into a set of bitplane images. The binary watermark bits are embedded into the selected bitplanes After the watermark embedding, the inverse 3- level DWT is applied to obtain the watermarked image. In order to estimate the quality of the degraded image, extract watermark from the watermarked image. By comparing the original watermark with the extracted watermark consequences the quality degradation information. The TDR of the extracted watermark will be calculated to evaluate the degradation of the watermark.

A.Decomposition using Haar wavelet

The image is read in the form of matrix and the image is decomposed upto n levels that produce 2^n different sets of coefficients. For this experiment, the value of n is selected as 3. The Haar wavelet is also the simplest possible wavelet. It is also the only symmetric wavelet in the Daubechies family.The technical disadvantage of the Haar wavelet is that it is not continuous, and therefore not differentiable,which can be a problem for some applications, like compression and noise removal of audio signal processing.So,here we are using another wavelet that is biorthogonal(4.4)wavelet.

B.Decomposition using Bior4.4 wavelet

In the biorthogonal case, rather than having one scaling and wavelet function, there are two scaling functions that may generate different multiresolution analysis, and accordingly two different wavelet functions. The functions used in the calculations are easier to build numerically than those used in the Daubechies wavelets.

II.Acquisiton of watermark and preporocessing.

The cover image is selected first and then select a text image as watermark with a particular image size, which will be later converted into grayscale image. The length of the original watermark sequence denoted as *len*.Every bit in the real watermark is repeated a few times to get a redundant watermark sequence for watermark embedding for the accuracy of watermark bit extraction at the receiver side,. In this proposed scheme, set *Redundancy=3* and the real watermark sequence is repeated *Redundancy-1* times to get the redundant watermark sequence with *Redundancy * len* bits long.

III.Quadtree generation and Data Embedding

The tree structure based watermark embedder is designed to embed the binary watermark bits into the selected bitplanes of the selected DWT coefficients of the selected trees. The tree structure based watermark embedder has three functions,

(a)Forming the tree structure,

(b)Selecting the trees and the DWT coefficients for the watermark embedding and

(c) Embedding the binary watermark bits into the selected bitplanes of the selected coefficients.

(a)The Formation the Tree Structure:

The tree structure is formed by categorizing the DWT coefficients with inherent similarities across all the DWT subbands. The correlated coefficients build up the parent-descendants relationship and form a tree.

(b)The Selection of Trees and DWT Coefficients:

For the applications of the watermarking based quality estimation, it is desirable to embed watermark throughout the cover image so that, even the watermarked image is locally tampered, the extracted watermark can still reflect the quality degradation of the cover image. According to the length of the watermark sequence, the trees for watermark embedding are chosen using the position separation key.The watermark bits are not embedded into the *LL* subband of the DWT decomposed image in order to keep the embedded watermark invisible and limit the image quality degradation caused by the watermark embedding.The watermark bit assignment is denoted as $A_{\omega b} = [a_1, a_2, a_3]$, where a_1, a_2 and a_3 are the number of watermark bits to be embedded in the DWT level 1, 2 and 3 in every selected tree. For watermark embedding, the redundant watermark sequence is divided into ω_{segs}.

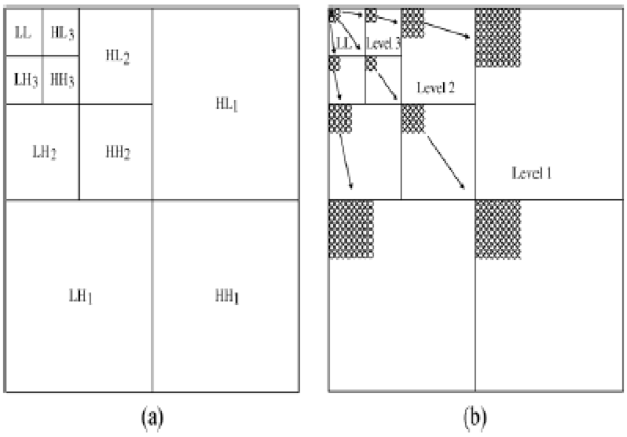


Fig 3. The tree selection from the three DWT orientations.

(c)The watermark embedding:

The binary watermark bits are embedded into the selected bitplanes of the selected DWT coefficients. Here, the DWT coefficient bit on the selected bitplane represent as *c*, the watermark bit denoted as ω and the watermarked DWT coefficient bit as ω_c .Then,the watermark bit will be embedded using the following equation,

$$c_{\omega} = \begin{cases} c, if\ c = \omega \\ \omega, if\ c \neq \omega \end{cases}$$

Here the scheme is based on watermarking and tree structure in the DWT domain. The Set Partitioning in Hierarchical Trees (SPIHT) is most efficient way to exploit the inherent similarities across the subbands in the wavelet decomposed image.The good summarization of local region characteristics of image was achieved by DWT and SPIHT All the correlated DWT coefficients across the subbands are grouped together using the SPIHT tree structure. The DWT decomposed image is further decomposed into a set of bitplane images. Then, each DWT coefficient is decomposed into a sequence of binary bits. The binary watermark bits are embedded into the selected bitplanes of the selected DWT coefficients of the selected trees.The higher frequency DWT subbands and less significant bitplanes are more sensitive to distortions, and vice versa. Therefore, the robustness of the watermark depends on the selection of bitplanes for watermark embedding and the percentages of the watermark bits embedded into the three DWT levels. Thus, for different selected trees, the watermark embedding strengths are different.

The content complexity of the cover image is assessed using the following equation

$$complexity = \sum_{i=1}^{n} \left(N_i \times 2^i \right)$$

Here the quad-tree decomposition of the cover image are achieved using the threshold =0.17, where the maximum intensity value of the cover image is not bigger than 1.

IV. EXTRACTION & QUALITY ESTIMATION

The image group index transmitted from the sender side isused to retrieve the watermark bit.In one tree, the bitplane indices for all the DWT coefficients on each DWT level are averaged. The position separation key is used to locate the watermarked DWT coefficients. This strategy effectively reduce the watermark extraction error caused by the bitplane selection in the watermark extraction scheme. Remember that *Redundancy=3*. Then, the three distorted watermarks are compared bit by bit and the watermark is extracted using equation.

$$\omega_e(i, j) = \begin{cases} 1, N_1 \geq N_0 \\ 0, N_1 < N_0 \end{cases}$$

$$TDR = \frac{number\ of\ correctly\ detected\ watermark\ bits}{total\ number\ of\ watermark\ bits}$$

MSE, PSNR, and SSIM are the most commonly used objective image/video quality measures. Mean Squared Error is the average squared difference between a reference image and a distorted image.. Peak Signal-to-Noise Ratio is the ratio between the reference signal and the distortion signal in an image, given in decibels. The higher the PSNR, the closer the distorted image is to the original. Structural Similarity is based on the idea that the human visual system is highly adapted to process structural information, and the algorithm attempts to measure the change in this information between and reference and distorted image.

V. RESULTS ANALYSIS

The proposed method has been applied on various images and successful results based on the quality of the watermark extracted have been received. Quality of the watermark is defined by the robustness, amount of noise in the watermark and so on. Also, it is resistant to different security breaches that may affect the authenticity of the information. Attacks like Subtractive attack, Distortive attack, Additive attack, Filtering, and others do not have significant effects on the original information embedded in the working image.The image used in the algorithm is an lena image(512×512). The watermark image(100×100) has been invisibly embedded in the image and it isembedded with the help of DWT. In this paper we concentrate on no reference objective quality metric. In our experiment we have both the original and the distorted watermark images to measure the quality of the image.

(a) (b)

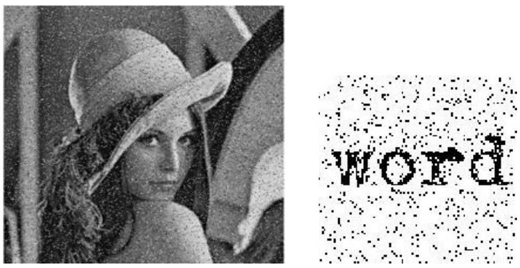
Fig 4.Input image(a)cover image (b)secret image

(a) (b)

Fig5.Imagedecomposition(a)using haar wavelet(b)Decomposed image(PSNR=48.01)

(a) (b)

Fig 6.Image decomposition(a)using bior4.4 wavelet(b)Decomposed image(PSNR=52.90)



(a) (b)

Fig 7 . (a)Distorted watermarked image(salt and pepper noise) (b)Extracted secret image

Performance evaluation when a salt and pepper noise is added.For noise level 1,is shown in the table below.

TableI. Performance Evaluation

Wavelet	PSNR(dB)	SSIM
Haar wavelet	48.01	0.9445
Bior4.4	52.30	0.9989

VI. Conclusion

The proposed scheme has good computational efficiency to estimate the image/video quality.Embed the watermark in the coefficients of a 3-level DWT decomposition to make the algorithm robust to geometric attacks and maintain the original quality of the watermarked image. Placing the watermark in the level coefficients of the DWT decomposition is robust to geometric attacks and lossy compression and distortion in chrominance is less noticeable than distortion in luminance.The watermark embedding strength is assigned to an image by pre-analyzing its content complexity in the spatial domain.The watermarkembedding using biorthogonal wavelet(bior4.4) is much better compared to the haar wavelet and watermark is not embedded in the approximation sub band during watermark embedding to reduce the loss image quality. In future work, the proposed scheme will be further developed to estimate the quality of an image/ video distorted by multiple distortions..

Acknowledgment

The authors would like to thank all the staffs of Department of ECE,college of engineering,kallooppara for their constant encouragement and support.

References

[1] Sha Wing ,Dong Zheng,Jiying Zhao, a member ,IEEE,Wa James Tam and Filippo Speranza,"Adaptive watermarking and tree structure based image quality estimation" IEEE transaction on multimedia, vol 16,no 2,feb 2014.

[2] Z. Wang, A. C. Bovik, H. R. Sheikh, and E. P. Simoncelli, "Image quality assessment: From error visibility to structural similarity," IEEE Trans. Image Process., vol. 13, no. 4, pp. 600–612, 2004.

[3] S.Wang, D. Zheng, J. Zhao, W. J. Tam, and F. Speranza, "An image quality evaluation method based on digital watermarking," IEEETrans. Circuits Syst. Video Technol., vol. 17, no. 1, pp. 98–105, 2007.

[4]M. Schneider and S.-F. Chang, "Digital Watermarking for Telltale TamperProofing and Authentication," in Proc. IEEE Int. Conf.Image Processing, 1996, vol. 3, pp. 227–230.

[5] D. Zheng, J. Zhao, W. Tam, and F. Speranza, "Image quality measurement by using digital watermarking," in Proc. IEEE Int. Workshop Haptic, Audio and Visual Environments and Their Applications, 2003,pp. 65–70.

[6] A. Mishra, A. Jain, M. Narwaria, and C. Agarwal, "An experimental study into objective quality assessment of watermarked images," Int.J. Image Process., vol. 5, no. 2, pp. 199–219, 2011.

[7] J. D. Koch, M. D. Smith, and R. Telang, Camcording and Film Piracy in Asia-Pacific Economic Cooperation Economies. Washington, DC, USA: International Intellectual Property Institute, Aug. 2011. [2] B. Stelter and B. Stone, Digital Pirates Winning Battle with Studios. Fair Harbor, NY, USA: The New York Times, Feb. 2009.

[8] G. C. Langelaar, I. Setyawan, and R. L. Lagendijk, "Watermarking digital image and video data. A state-of-the-art overview," IEEE Signal Process. Mag., vol. 17, no. 5, pp. 20–46, May 2000.

[9] G. Doërr and J.-L. Dugelay, "A guide tour of video watermarking," Signal Process., Image Commun., vol. 18, no. 4, pp. 263–282, 2003.

[10] K.-S. Kim, H.-Y. Lee, D.-H. Im, and H.-K. Lee, "Practical, real-time, and robust watermarking on the spatial domain for high-definition video contents," IEICE Trans. Inform. Syst., vol. E91-D, no. 5, pp. 1359–1368, May 2008.

[11] K.-S. Kim, D.-H. Im, Y.-H. Suh, and H.-K. Lee, “A practical real-time video watermarking scheme robust against downscaling attack,” in Proc. 6th Int. Workshop Digit. Watermarking, vol. 5041. 2008, pp. 323–334.
[12]M. Carnec, P. Callet, and D. Barba, “Full reference and reduced reference metrics for image quality assessment,” in Proc. 7th Int. Symp.Signal Processing and Its Applications, 2003, vol. 1, pp. 477–480.
[13]A. Said andW. Pearlman, “A new, fast and efficient image codec based on set partitioning in hierarchical trees,” IEEE Trans. Circuits Syst. Video Technol., vol. 6, no. 3, pp. 243–250, 1996.
[14] S. Altous, M. K. Samee, and J. Gotze, “Reduced reference image quality assessment for jpeg distortion,” in Proc. IEEE 7th Int. Symp.ELMAR, 2011, pp. 97–100.
[15] M. Jamzad and F. Yaghmaee, “Achieving higher stability in watermarking according to image complexity,” Scientia Iranica J., vol. 13, no. 4, pp. 404–412, 2006.
[16]M. Barni, “Improved wavelet-basedwatermarking through pixel-wise masking,” IEEE Trans. Image Process., vol. 10, no. 5, pp. 783–791,2001

Anjali Krishna is currently pursuing M-TECH in electronics with specialisation in signal processing, College of Engineering,kalloopppara.She received his B-Tech(ECE) from the Musaliar College of Engineering and Technology,Pathanamthitta in 2014.Her areas of interest are Digital communication, Digital image processing and embedded design

Shanavaz K Tis currently an H.O.D Assistant Professor with the Department of Electronics and Communication,College of Engineering,Kallooppara..He received PhD in Wavelet and received Masters Degree. His areas of interest are Wavelet ,Wireless Technology Digital communication, Digital image processing and embedded design.