# A SECURITIZED HAAR WAVELET AND CANNY EDGE AUDIO AND VIDEO WATERMARKING

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**ABSTRACT**

With the advancement in computer network, communication makes transmission of information relatively simple and quick. Many research works on Reversible and moment-based watermarking addressed security and reduced bit error rate but by focusing on either audio or video, compromising multimedia aspect that includes both audio and video. In the proposed framework, an integrated Haar Wavelet and Canny Edge-based Audio and Video (HWCE-AV) watermarking framework is introduced to reduce the bit error rate during embedding and reduce the computational cost while embedding watermarked image. First, Haar Wavelet-based Audio Watermarking is applied to the host audio signal where additive function is performed aiming at improving the security. Effective embedding using Haar Wavelet Transform is performed by splitting the host audio signal into fragments reducing the bit error rate involved during embedding.

Second Canny Edge–based Video Watermarking aims at reducing the channel bit error rate by introducing first derivative Gaussian in Canny Edge Detector. The modified mean sub-bands results in the improvement of throughput producing higher frame rate and therefore reduces the computational cost while embedding watermarked image. The proposed framework are analyzed in terms of audio security and bit error rate, embedding computational cost and channel bit error rate during extraction. Comparisons with state-of-the-art methods reveal that the proposed framework is superior in terms of audio security by 32.40% and video embedding computational cost by 31.24% compared to state-of-art-works.

***Keywords:*** Reversible watermarking, Moment-based watermarking, Haar Wavelet, First derivative Gaussian function, Canny Edge Detector

## I. INTRODUCTION

With the increasing expansion of digital networks all over the world, problems related to un-authorized taping, manipulation or updating data, results in heavy financial loss to the creators. Therefore, graphic designers, publishers of multimedia material required technical solutions to the problems related to copyright protection of multimedia data. Reversible Watermarking using Differential Evolution Data (RW-DEW) [1] provided measures medical images using reversible watermarking. Adaptive Watermarking using Quaternion Image Moments (AD-QIM) [2] used quaternion image moments to enhance robustness and reduce channel bit error rate. For efficient authentication of gray scale images, semi

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fragile watermarking approach [3] was applied resulting in increasing the accuracy of attack rate. However, measures were not taken for RGB color images. In [4], quantized-based semi fragile watermarking approach was applied that localized the tampered areas. Another method used spatial and frequency domain [5] techniques to prevent the attacks on watermarked images. However, security issues were not handled. In [6], a Quantization Index Modulation was introduced that used wavelet and principal component analysis to medical video. Though security was provided, there was a tradeoff between security and privacy.

To ensure privacy, reverse watermarking approach was applied in [7] addressing imperceptibility. In [8], a hybrid method using Discrete Wavelet Transform (DWT) and Singular Vector Decomposition (SVD) was applied to reduce the noise ratio. However, security was compromised. Code Division Multiple Access (CDMA) [9] improved the security in video data based on digital watermarking by adding four keys during embedding process. With the objective of improving the authentication level of video data [10], LSB was applied in video ensuring minimum MSE and PSNR values.

One of the important branches of data hiding is digital watermarking which has paid greater attention to experts and scholars and therefore become research hotspot with respect to security. Dual transform domain [11] based on DCT and Arnold Transform improved security and improve recovery system. Another method using real-time watermarking scheme [12] improved robustness against attacks. Robust digital audio watermarking algorithm [13] improved robustness of audio using DWT-SVD algorithm. In [14], bit error rate was reduced using random private key and Arnold transformations. However, the above methods lack embedding capacity. A robust audio water marking algorithm [15] to improve embedding capacity was presented using DWT and SVD.

One of the most important issues related to digital content is the protection of digital content in a wide manner. In [16], two dimensional bar codes were used for efficient data hiding improving the imperceptibility and robustness against attacks. Watermarking based on image discrete wavelet transform. However, with increase in communication bandwidth error rate also increased. To address this issue, Histogram Shifting and Predicted Error Expansion [18] were applied to audio files that resulted in improving the embedding capacity. However, robustness remained unsolved. Robustness against different attacks was provided in [19] using fractal color image watermarking algorithm. Wavelet transform method was applied in [20] to improve robustness.

Based on the afore mentioned techniques, in this paper we present an integrated Haar Wavelet and Canny Edge-based Audio and Video (HWCE-AV) watermarking framework that provide solution against channel bit error rate, security and computational cost. The organization of this paper is as follows. Section 2 discusses the proposed framework in detail. The experimental settings and discussion for validating the performance of our proposed framework are provided in Section 3 and Section 4 respectively. Finally, we conclude our paper in Section 5.

**2. Design of Haar Wavelet and Canny Edge- based Audio and Video (HWCE-AV) watermarking framework**

In this section, the design of Haar Wavelet and Canny Edge-based Audio and Video (HWCE-AV) watermarking framework with the objective of improving the security and reduce channel bit error rate is presented. In order to perform audio watermarking Haar Wavelet transform is applied to the audio signal. On the other end, video water-marking is performed in an efficient manner using Canny Edge Detector. Figure 1 shows the block diagram of Block diagram of Haar Wavelet and Canny Edge-based Audio and Video (HWCE-AV) watermarking framework.

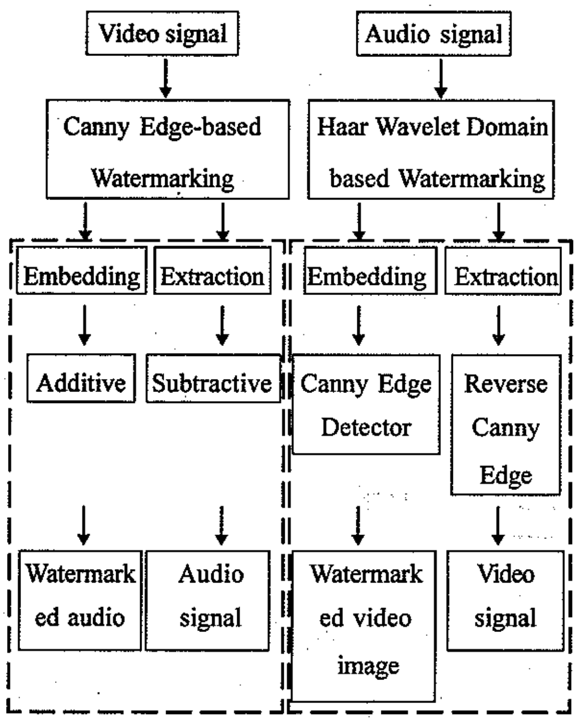


**Figure 1: Block diagram of Haar Wavelet and Canny Edge-based Audio and Video (HWCE-AV) watermarking framework.**

As shown in the figure, the HWCE-AV framework is divided into two parts namely, Haar Wavelet Domain based Watermarking and Canny Edge-based Watermarking. Audio watermarking is performed using Haar Wavelet Domain based Watermarking whereas video watermarking is performed by applying Canny Edge Detector. The brief description of the framework is presented in detail in the forthcoming sections.

**2.1 Haar Wavelet Domain based Audio Watermarking (improves security)**

In this section, a Wavelet Domain based Audio Watermarking (HWD-AW) model is presented with the objective of reducing the Peak Signal-to-Noise Ratio (PSNR) ratio. The HWD-AW model embeds the cover signal or watermark image into the host audio signal. Figure 1.a shows the block diagram of Haar Wavelet Domain based Audio Watermarking.

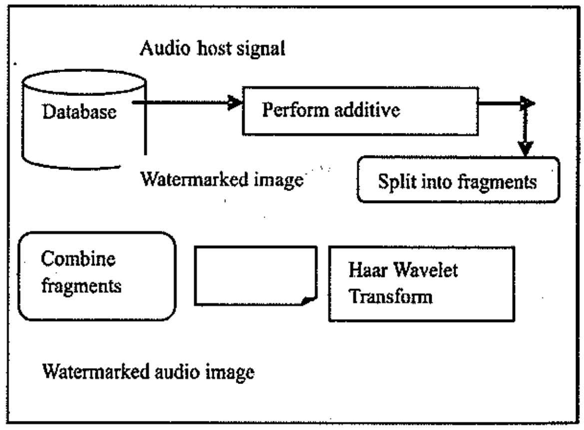


**Figure 1.a Block diagram of Haar Wavelet Domain based Audio Watermarking.**

As shown in the figure, an audio host signal is given as input from the database. With the host audio signal given as input, an additive function is performed. The additive function adds the scaling factor '$\delta$ ' to the host audio signal in addition to the cover signal. In order to perform effective embedding, the host audio signal is split into fragments and Haar Wavelet Domain is applied to the resultant fragmented binary data. Each bit of binary data of host audio signal is then selected for embedding the watermark portions with low frequency of highest energy of audio signal.

Let us consider the audio signal as '$AS_i$' and during the embedding process, the host audio signal is added with an additive function that consists of addition of original host audio signal and cover signal or watermarked image. The mathematical evaluation of additive function is as given below

$$WS(n) = AS(n) + \delta * CS(n) \qquad (1)$$

From (1), '$WS(n)$' the watermarked signal is the additive function of original host audio signal '$AS(n)$' and cover signal '$CS(n)$' respectively. Finally, 'δ' represents the scaling factor, a random number generated whenever an audio signal has to be sent and is assumed to be known to the sender and receiver at an interval of time.

The original host audio signal is split into smaller fragments 'f' of size 'N' units in order to perform effective embedding using Haar Wavelet Transform. In Haar Wavelet Transform, each bit of binary data is added to one fragment of host audio signal and is mathematically formulated as given below

$$BD_f(i) = AS(i) + \delta(f) * CS(f) \qquad (2)$$

From (2), '$BD_f$(i)' is the watermarked binary data. 'δ(f)' is the scaling factor to scale watermark binary data 'CS(f)' so that the additive function is highly imperceptible. With the application of additive function, the scaling factor is highly imperceptible and hence the proposed framework is said to be secured. Therefore the Peak Signal-to-Noise Ratio between the original host audio signal 'AS(i)' and embedded binary data '$BD_f$(i)' is given as follows

$$PSNR = \frac{AS(i)^2}{AS(i) - BD_f(i)^2} \qquad (3)$$

From (3), the peak signal-to-noise ratio 'PSNR' of the proposed framework is evaluated. By applying embedding binary data using Haar Wavelet Transform, the PSNR value is said to be improved. On the other hand, the extraction of original host signal is performed using reverse Haar Wavelet Domain.

During the extraction process, Reversible Haar Wavelet Domain based Audio Watermarking is performed on the receiver side where the input consists of Watermarked Audio image. Applying the Haar Wavelet Transform, which is in the form of fragments are combined to perform subtractive function to extract the host audio signal which is as given below

$$AS(n) = WS(n) - \delta * CS(n) \qquad (4)$$

From (3), the host audio signal is obtained at the receiver end with minimum noise. The algorithmic description of Haar Audio Watermark Embedding and Extraction (HAW-EE) is shown in figure 2.

**Input:** Audio Signal '$AS_i = AS_1, AS_2, \ldots, AS_n$', **cover Signal** '$CS_i = CS_1, CS_2, \ldots, CS_n$', Scaling factor '$\delta$',

**Output:** Extracted audio signal
**//Haar Audio Watermark Embedding**
Step 1: **Begin**
Step 2: **For** each audio signal $AS_i$
Step 3: Perform additive function using (1)
Step 4: Split audio signal into fragments '$f$' of size '$N$'
Step 5: Perform embedding using (2)
Step 6: **End for**
**//Haar Audio Watermark Extraction**
Step 7: **Begin**
Step 8: **For** each watermarked audio image
Step 9: Perform subtractive function using (4)
Step 10: Extract audio signal $AS_i$
Step 11: **End for**
Step 11: **End**

**Figure 2 Haar Audio Watermark Embedding and Extraction (HAW-EE) Algorithm**

Figure 2 shows the Haar Audio Watermark Embedding and Extraction (HAW-EE) Algorithm. The algorithm is divided into two parts where Haar Audio watermarking embedding is done first and extraction of audio signal is performed using Haar Audio watermarking extraction. To start with, a host audio signal is given as input. For each audio signal an additive function is performed where a scaling factor and watermarked signal is added to the input host audio signal with the objective of improving the security. Then the audio signal is split into fragments and the resultant watermarked audio image is obtained as the output. For efficient extraction, the reversible Haar Audio watermarking is applied to the resultant watermarked audio image. A subtractive function is performed on the extraction part by the receiver in order to obtain the original host audio signal with minimum error rate.

## 2.2 Canny Edge–based Video Watermarking (CE-VW) (reduces channel bit error rate)

In this section a Canny Edge–based Video Watermarking (CE-VW) model is presented. Visible video binary data is used as the watermarked image. To start with, a cover-video file is given as input where sequential frames are obtained from the video clip. Then, on each frame edge characteristics of image are selected based on Canny Edge Detector. The detected edge is then selected and based on group edge intensity value called as mean sub-band watermark image is then embedded to the mean sub-band aiming at improving the robustness.

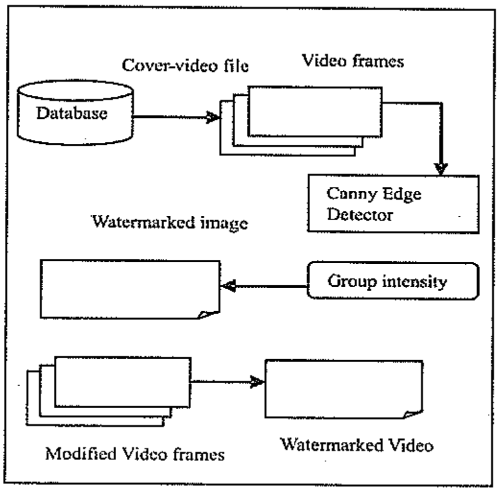


**Figure 3 Block diagram of Canny Edge–based Video Watermarking.**

Figure 3 shows the block diagram of Canny Edge–based Video Watermarking. Let us consider original host video '$V_i$' with the size of host video be $P * Q$' and '$W_i$' represents the watermarked binary image with a size of '$P_w * Q_w$'. The first step in the CE-VW model is to split the host video '$V_i$' into video frames '$F_i$', where '$i$' represents the number of frames and is mathematically formulated as given below.

$$V_i = \sum_{i=1}^{n} F_i \qquad (5)$$

The Canny Edge Detector in the proposed framework simplifies the analysis of cover-video frames by not only minimizing the amount of data to be processed, but also to preserve the information. This in turn minimizes the channel bit error rate that measures the presence of errors in the communication channel of the cover-video frame.

The Canny edge detector in the proposed framework uses First Derivate Gaussian Filter, as the raw cover-video frames are highly susceptible to noise. So First Derivate Gaussian Filter is applied to the raw cover-video frames. The resultant First Derivative Gaussian Filter point in different directions, so the Canny edge detector uses three filters to extract three edges pointing in horizontal, vertical and diagonal edges. The Canny edge detector returns a value for the First Derivative in the horizontal direction 'Hp' and vertical direction '$V_Q$'. From this the edge inclination and edge orientation is as given below.

$$EI = \sqrt{H_P^2 + H_Q^2} \qquad (6)$$

$$EO = \arctan\left(\frac{H_P}{H_Q}\right) \qquad (7)$$

From (6) and (7), the Edge Inclination '*EI*' and Edge Orientation '*EO*' is obtained which is used as the basis for determining the group average value. The group average value is then formulated as given below

$$GA = \frac{1}{p * 1} \sum_{i=1}^{p} \sum_{j=1}^{q} V(i,j) \qquad (8)$$

From (8), the group average value '*GA*' is obtained using the magnitude of coefficient '*V(i,j)*' with '' representing the total coefficients. From each edge orientation, the mean sub-band whose group average value is higher is selected. Watermarked image is now embedded in the mean sub-band as given below when coefficient is '$V(a,b)$'

$$GI(a,b) = V(i,j) - V(a,b) \qquad (9)$$

Now the coefficient value is modified as given below.

$$V(a,b) > GI(a,b) = 0, then\ V'(a,b) = V(a,b) + \delta\,(V(a,b) - GI(a,b)) \qquad (10)$$

$$V(a,b) > GI(a,b) = 1, then\ V'(a,b) = V(a,b) - \delta\,(GI(a,b) - V(a,b)) \qquad (11)$$

$$V(a,b) = GI(a,b) = 1, then\ V'(a,b) = V(a,b) + \delta\,(V(a,b) - GI(a,b)) \qquad (12)$$

$$V(a,b) = GI(a,b) = 0, then\ V'(a,b) = V(a,b) - \delta\,(GI(a,b) - V(a,b)) \qquad (13)$$

From the above (10), (11), (12) and (13), the modified mean sub-bands to their original positions are obtained to form the watermarked video frames. All watermarked video frames are then combined to obtain the watermark video. This construction of mean sub-bands in Canny Edge–based Video Watermarking helps in reducing the channel bit error rate.

Using the above results, the following form of extraction process is used where the receiver uses watermarked video to obtain the cover-video frames. After embedding the watermarked image by the sender, the extraction process is performed at the receiving end. During extraction process, the edge detected using Reverse Canny Edge Detector is decomposed into three directions to offer enhanced security while receiving cover-video frame in the destined end. As the mean sub-bands were used in the embedding process, also during the extraction process, the mean sub-bands of Canny Edge Detector are considered.

The receiver at the destination end uses the extraction process to retrieve the original cover-video file which is described below. As images are highly susceptible to noise, using Gaussian filter noise are removed thus obtaining new intensity values. Then by applying the Canny Edge–based Video Watermarking on each three directions, a wavelet coefficient is obtained. The obtained coefficients are quantized to produce numeral set of values that identifies the bits containing watermarked images. Thus the embedded bits are extracted in an efficient manner.

**Input:** Host Video '$V_i = V_1, V_2, \ldots\ldots V_n$', Frames '$F_i = F_1, F_2, \ldots\ldots F_n$', Horizontal direction '$H_p$' and Vertical direction '$V_Q$', Watermarked image '$I_i = I_1, I_2, \ldots\ldots IV_n$','

**Output:** Extracted video signal

**// Canny Edge–based Embedding**

Step 1: Begin

Step 2: For each Host Video '$V_i$'

Step 3: Split the host video into video frames '$F_i$',

Step 4: Detect edges using canny edge detector

Step 5: Obtain edge inclination and edge orientation using (6) and (7)

Step 6: Evaluate group average value using (8)

Step 7: Embed watermarked image using (9)

Step 8: End for

Step 9: End

**// Canny Edge–based Extraction**

Step 10: Begin

Step 11: For each watermarked video

Step 12: Obtain the edge using reverse Canny Edge Detector

Step 13: Obtain the mean sub-bands

Step 14: Extract host video

Step 15: End for

Step 16: End

Figure 4 given above shows the algorithm for Canny Edge–based Video Embedding and Extraction (CEV-EE). The algorithm includes two main parts where embedding is done one part and extraction is performed in another part. During embedding the sender sends a video host signal as input by splitting the host video into frames. With the frames, edges are detected using canny edge detector with the objective of reducing the channel bit error rate. Next, group average is performed for efficient embedding. On the other hand, the receiver with the help of watermarked video frames, extracting edges and using mean sub-band, the original host video signals are extracted.

**3. Experimental setup**

The Haar Wavelet and Canny Edge-based Audio and Video (HWCE-AV) watermarking framework is implemented using MATLAB code. The HWCE-AV framework uses the Hyperspectral images of natural scenes database taken from CVonline: Image Database to measure the parametric factors. Hyperspectral images of natural scenes consists of 15 rural and urban scenes each containing, rocks, trees, leaves, grass, and earth, obtained under daylight between mid-morning and mid-afternoon. Scenes were illuminated by direct sunlight in clear or almost clear sky when clouds were present. Hyperspectral images are acquired with a progressive-scanning monochrome to perform data compression operation. The wavelength of peak data compression varied from the range of 400–720 nm, with a full width at half maximum transmission of 10 nm at 550 nm, decreasing to 6 nm at 400 nm and increasing to 16 nm at 720 nm.

In order to perform video watermarking, Audio video interleaved (AVI) video files were used and simulated using MATLAB. The data set was obtained from Internet Archive 501(c) (3), a non-profit organization that consists of text, audio, moving images, and videos as well as archived web pages. The performance of the proposed framework is compared with two existing methods namely: Reversible Watermarking using Differential Evolution Data (RW-DEW) [1] and Adaptive Watermarking using Quaternion Image Moments (AD-QIM) [2]. The tests on the Hyperspectral images and AVI files were conducted to evaluate four parameters: audio security and bit error rate, embedding computational cost and channel bit error rate during video extraction.

Security with respect to audio being sent by the sender is measured on the basis of audio signals received by the receiver. Therefore, security is the difference between the total audio signals sent to the audio signals not received by the receiver.

$$S\,(AS) = AS_s - AS_{nr} \qquad (14)$$

From (14), '$AS_s$' refers to the audio signals sent and '$AS_{nr}$' refers to the audio signals not received by the receiver. It is measured in terms of audio signals per second (asps). As the name implies, a bit error rate is defined as the rate at which errors occur in a transmission system. The bit error rate while sending audio file is the ratio of number of errors to the total number of bits sent. The definition of bit error rate is translated into a simple formula as given below

$$BER = \frac{Number\ of\ errors}{Total\ number\ of\ bits\ sent} * 100 \qquad (15)$$

The embedding computational cost is the time taken to perform the modified mean sub-band and is measured in terms of milliseconds (ms). The Embedding Computational Cost is measured as given below

$$ECC = Time\ (V'(a,b)) \qquad (16)$$

The channel bit error rate (CBER) is defined as the rate at which errors occur in a transmission system. The CBER while sending video file is the ratio of number of errors while sending video to the video size. The definition of CBER is translated into a simple formula as given below

$$CBER = \frac{Number\ of\ errors\ in\ video}{Video\ size} * 100 \qquad (17)$$

**4. Discussion**

The result analysis of Haar Wavelet and Canny Edge-based Audio and Video (HWCE-AV) watermarking framework is compared with existing Reversible Watermarking using Differential Evolution Data (RW-DEW) [1] and Adaptive Watermarking using Quaternion Image Moments (AD-QIM) [2] respectively. Table 1 represents the audio security ate with different audio signals using MATLAB simulator and comparison is made with two other methods, namely RW-DEW [1] and AD-QIM [2].

**Table 1 Tabulation for audio security**

| Audio | Audio Security (ASPS) | | |
|---|---|---|---|
| Signals | HWCE-AV | RW-DEW | AD-QIM |
| 5 | 4 | 3 | 3 |
| 10 | 6 | 4 | 3 |
| 15 | 12 | 8 | 6 |
| 20 | 11 | 7 | 6 |
| 25 | 20 | 16 | 14 |
| 30 | 22 | 18 | 16 |
| 35 | 25 | 21 | 18 |

To ascertain the performance of the audio security rate, comparison is made with two other existing works Reversible Watermarking using Differential Evolution Data (RW-DEW) [1] and Adaptive Watermarking using Quaternion Image Moments (AD-QIM) [2] respectively. In figure 5, the number of audio signals sent by the sender to the receiver is varied between 5 and 35 at different time intervals using Hyperspectral images of natural scenes database taken from CVonline.

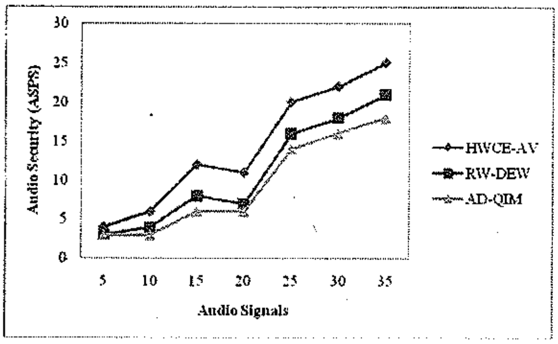


**Figure 5 Measure of audio security**

From the figure it is illustrative that the audio security rate is higher or increased using the proposed HWCE-AV framework when compared to the two other existing works. This is because with the application of the additive function that consists of original host audio signal and cover signal in an efficient manner resulting in the improvement of audio security rate by 26.18% compared to RW-DEW. Furthermore, the arrangement of scaling factor in a random manner known only to the sender and receiver with the objective increasing the audio signals improves the security rate by 38.62% compared to AD-QIM respectively.

The comparison of audio bit error rate at receiving end is presented in table 2 with respect to the number of bits sent ranging from 150 to 1050 taken up for experimental purpose. With difference noted in the bits sent, though the increase in bit error rate is not linear, but HWCE-AV proved to be better than the two state-of-the-art works.

**Table 2 Tabulation for bit error rate at receiving end**

| Bits | Bit Error Rate (%) | | |
|---|---|---|---|
| sent | HWCE-AV | RW-DEW | AD-QIM |
| 150 | 65.23 | 74.18 | 87.35 |
| 300 | 69.19 | 79.21 | 84.25 |
| 450 | 71.45 | 81.47 | 86.52 |
| 600 | 68.22 | 78.24 | 83.29 |
| 750 | 72.35 | 82.37 | 87.42 |
| 900 | 69.43 | 79.45 | 84.47 |
| 1050 | 74.17 | 84.19 | 89.24 |

In figure 6, we depict the bit error rate while sending audio signals with bit size in the range of 150 to 1050 for experimental purposes. From the figure, the value of bit error rate at the receiving end using the proposed HWCE-AV framework is lower when compared to two other existing works Reversible Watermarking using Differential Evolution Data (RW-DEW) [1] and Adaptive Watermarking using Quaternion Image Moments (AD-QIM) [2] respectively.

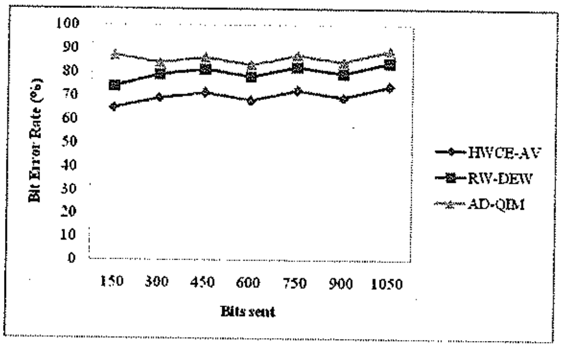


**Figure 6 Measure of bit error rate at receiving end**

From figure 6 it is illustrative that the bit error rate at the receiving end using HWCE-AV framework is reduced because the framework follows a Haar Wavelet Transform where each bit of binary data is added to one fragment of host audio signal. Therefore, the bit error rate at the receiving execution time is reduced by 13.99% compared to RW-DEW. With this binary data, the HWCE-AV uses a random scaling factor with the additive function, with the aim of reducing the bit error rate at the receiving end by 27.1% compared to AD-QIM. The video embedding computational cost of HWCE-AV framework is elaborated in table 3. The framework was considered with 10 different video signals for experimental purpose using MATLAB simulator.

**Table 3 Tabulation for video embedding computational cost**

| Video signal | Embedding Computational Cost (ms) | | |
|---|---|---|---|
| | HWCE-AV | RW-DEW | AD-QIM |
| 10 | 114.5 | 151.3 | 198.7 |
| 20 | 125.3 | 134.4 | 142.7 |
| 30 | 133.4 | 142.5 | 150.8 |
| 40 | 122.1 | 131.2 | 139.5 |
| 50 | 140.7 | 150.8 | 158.8 |
| 60 | 128.9 | 137.9 | 145.6 |
| 70 | 137.2 | 146.3 | 154.6 |

Figure 7 shows the measure computation cost incurred during embedding of video signal with respect to different video signals in the range of 200 MB to 1400 MB. With the increase in the number of video signals send, the computational cost during embedding is also increased, though efficiency proved to be higher in a comparative manner using the HWCE-AV framework.

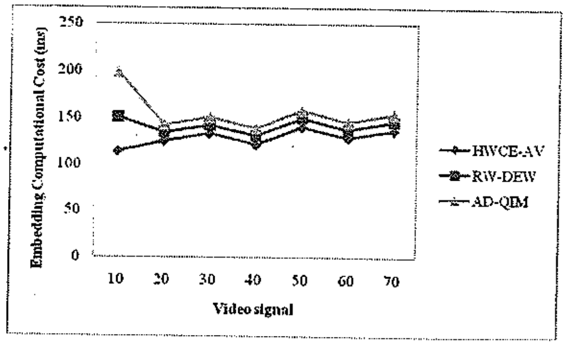


**Figure 7 Measure of embedding computational cost**

As illustrative in the figure, the embedding computational cost of video is observed to be less using HWCE-AV framework. This is because of the application of Modified Mean Sub-bands, where the Modified Mean Sub-bands is embedded to the watermarked image with the host video signal. Instead of applied to watermark image to the host video signal directly, the application of Modified Mean Sub-bands results in reducing the embedding computational cost of video in HWCE-AV framework by 19.38% compared to RW-DEW. In addition, the HWCE-AV framework uses modified coefficient value to the original positions of the video signals. As a result, the embedding computational cost for video signals is reduced by 43.1% compared to AD-QIM.

**Table 4 Tabulation for channel bit error rate**

| Video size (MB) | Channel Bit Error Rate (ms) | | |
|---|---|---|---|
| | HWCE-AV | RW-DEW | AD-QIM |
| 200 | 23.5 | 33.8 | 43.6 |
| 400 | 29.8 | 34.9 | 41.6 |
| 600 | 32.3 | 37.4 | 44.1 |
| 800 | 25.1 | 30.2 | 33.0 |
| 1000 | 34.6 | 39.7 | 46.4 |
| 1200 | 28.1 | 33.2 | 40.1 |
| 1400 | 36.6 | 41.7 | 48.2 |

Table 4 and figure 8 shows the channel bit error rate while sending 70 video files with varying sizes in the range of 150 MB to 1400 MB.

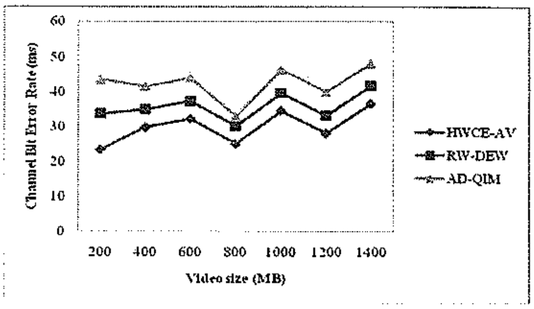


**Figure 8 Measure of channel bit error rate**

From figure 8 it is illustrative that the channel bit error rate at the receiving end is reduced using the HWCE-AV framework. This is because of applying first derivative Gaussian in Canny Edge Detector. With the application of first derivative Gaussian in Canny Edge Detector, the analysis of cover-video frames are not only simplified by reducing the size of data to be processed, but also information preserving is done at a greater extent. This in turn minimizes the presence of errors and therefore the channel bit error rate using HWCE-AV framework by 28.87 compared to RW-DEW and 58.5% compared to AD-QIM.

**5. Conclusion**

In this paper, we considered the design of a Haar Wavelet and Canny Edge-based Audio and Video (HWCE-AV) watermarking framework to improve audio security and computational cost while reducing the channel bit error rate at the receiving end during audio and video watermarking. An integrated framework is considered, and considered the problem of efficient audio and video watermarking in that framework. We showed that we can improve the rate of security as an optimization problem, the solution of which results in splitting the host audio signals into fragments centered on efficient audio watermarking using Haar Wavelet Domain based Audio Watermarking. The HWCE-AV framework offers less bit error rate with lesser execution time using additive function and random scaling factor. Finally, the application of Canny Edge–based Video Watermarking demonstrates that HWCE-AV framework provides lesser embedded computational cost with reduced channel bit err rate with the aid of CEV-EE algorithm. The performance of HWCE-AV framework was compared to other audio and video watermarking model, RW-DEW and AD-QIM respectively. We compared the performance with many different system parameters, and evaluated the performance in terms of different metrics, such as audio security, audio bit error rate, embedding computational cost for video and channel bit error rate at the receiving end during video watermarking. The results show that HWCE-AV framework offers better performance with significantly reducing the audio bit error rate by 20.54% and the video channel bit error rate at the receiving end by 43.68% compared to RW-DEW and AD-QIM respectively.

## References


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