

Performance Evaluation of Block based Video Watermarking after Attacks

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Abstract--- In today's era use of digital media is most popular way of communication. Digital media covers images, videos and animations available online. The easy methods of accessing, copying and editing digital media have made them more popular. With several advantages these easy methods of copying and editing data have created some big issues like ownership identification. This increases the demand of protecting online digital media. Watermarking is solution of such problem. In this work, a block-based method has been proposed for video watermarking that uses a key at the time of embedding and extraction. Some frames are selected from the video according to a key. Watermark is embedded on the selected frames after dividing into parts called blocks. Each part of the watermark is embedded in one selected frame of the video. This method increases the security of the system as the complete watermark cannot be extracted without knowing the positions of watermarked frames and the position of the block in that frame. Watermarking is performed in the Discrete Wavelet Transform domain after scaling of watermark data. To show the authenticity of proposed scheme various attacks are applied on different watermarked video frames and extracted watermark results are shown under different tables.

Keywords--- Video Watermarking, DWT, SVD, Secret Key, Blocks of the Watermark, PSNR, NC, Attacks.

I. INTRODUCTION

Fast growing digital world is giving rise to safety issues also. Watermarking is helpful for the security of online digital content. Watermark is embedded in the digital content before uploading it online. The watermark embedded should be imperceptible to the users. Also, if an attacker wants to crack the watermark it should prove to be robust (Rao & Rao, 2016) (Tsai, Huang, & Kuo, 2011)

Piracy seems a major problem for the film industry (Koch, Smith, & Telang, 2011) (Stelter & Stone, Feb. 2009.) The main reason is the use of camcorder inside theatres. Australian economy lost more than \$1.37 billion in revenue in a duration of one year due to movie theft (Economic consequences of movie piracy – Australia, 2011). So, concern of protecting the copyright of digital video content is increasing. (Piva, Bartolini, & Barni, 2002) (Lu & Liao, Multipurpose watermarking for image authentication and protection, 2001) (Lu, Huang, Sze, & Lia, 2000).

There is large literature available on watermarking methods as this field is not new and already number of

methods have been given by researchers. (Asikuzzaman & Pickering, 2017) reviewed all the methods. Watermarking methods based on transform domain are more robust when compared with spatial domain. Then modified transform domain methods of watermarking shows an improvement over simple transform methods (Allali, Elabbadi, & Elhassa, 2012). SVD based watermarking shows improved results (Thind & Jindal, 2015) (Wenhai Kong, Wu, & Xiamu, 2006). Mostly all methods are concerned about the PSNR value of watermarked data when compared with the original one (Sharma & Mann, 2017). This method of watermarking takes the advantage of DWT- SVD and block based methods of watermarking. Authenticity of the watermarking method may be calculated with the attack bearing capabilities of that scheme. Proposed block based approach of watermarking is tested against seven attacks and some parameters like PSNR and NC are used for performance calculation after these attacks.

II. SVD DECOMPOSITION

SVD is an orthogonal matrix decomposition method. It is robust, reliable and attractive algebraic transform for image processing. Any digital Image of size $M \times N$, with $M \geq N$, can be represented by its SVD. $X = U \times S \times V^T$

$U (M \times M)$: U is orthogonal, $U^T U = I$; columns of U are the orthogonal eigenvectors of $X^T X$ and left singular vectors of X . $V (N \times N)$: V is orthogonal or $V^T V = I$; columns of V are the orthogonal eigenvectors of $X^T X$ and right singular vectors of X .

$S (M \times N)$: It is a diagonal matrix consisting of non-zero values in descending order called the singular values.

III. WATERMARK EMBEDDING DESIGN

The method used is based on DWT. Here input is a colored video and watermarking is performed as shown in Fig 1. Input video is converted into frames. Any frame is selected according to the secret key. Key is like a secret password known to the owner of the video, which is helpful to select the frames. Preprocess the frame and apply DWT on subbands LLh, LHh, HLh, HHh. Again apply DWT on the LHh and get 4 sub-bands again LL2, LH2, HL2, HH2. Convert LH2 into 9 blocks with the 3-row block and 3 column block. For the host, it is shown by gh.

gh{1,1}	gh{1,2}	gh{1,3}
gh{2,1}	gh{2,2}	gh{2,3}
gh{3,1}	gh{3,2}	gh{3,3}

Now take the watermark image and do pre-process operations on it.

Manuscript received September 16, 2019.

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Convert preprocessed watermark image to binary image. Convert the watermark image into 4 subbands LLw, LHw, HLw, HHw. Select LLw and divide it into the 9 blocks as done for LHh. For watermark, it is represented by gw.

$$\begin{bmatrix} gw\{1,1\} & gw\{1,2\} & gw\{1,3\} \\ gw\{2,1\} & gw\{2,2\} & gw\{2,3\} \\ gw\{3,1\} & gw\{3,2\} & gw\{3,3\} \end{bmatrix}$$

Select a block of the watermark and apply SVD on it to get U2, S2, V2. Here, all the 9 blocks have been selected one by one and watermarking is shown with each watermark block. Embedding is performed as $S=S1+c*S2$. Here c is a scaling factor. To get back the watermarked image, apply IDWT two times. Watermarked video is made again with the watermarked frames.

watermarked video is taken as input and locate the frames with the watermark. Select watermark frame and 2 times DWT is applied on the watermarked image to get extracted sub-bands -LLe3, LHe3, HLe3 and HHe3. Select LHe3, a watermark is embedded in this band and divide the watermarked band into 9 blocks. Find SVD of the located block and get [U3, S3, V3]. Locate that block where the watermark is present. All the nine block are selected one by one to extract the parts of watermark. From S3, extraction is performed with the following equation, $Sw = (S3 - S1) / c$. Here Sw is the extracted watermark. Extracted watermark parts are represented in Table 1. The extracted watermark is compared with the original watermark for performance calculation. Process of watermark extraction is shown in Fig.2.

IV. WATERMARK EXTRACTION

Extraction of watermark is the process to get back embedded watermark from watermarked video. For this

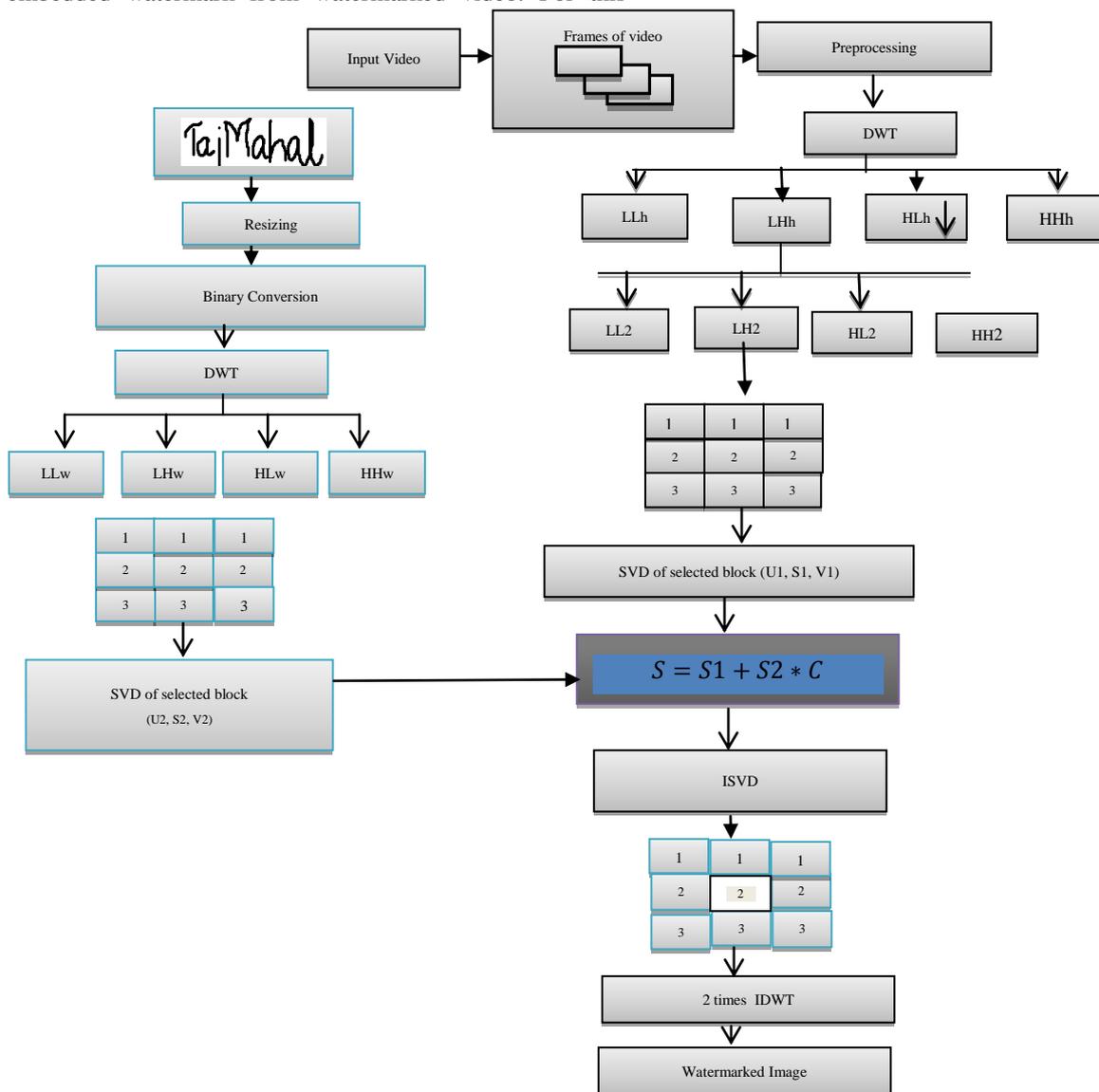


Fig. 1: Watermark Embedding Design

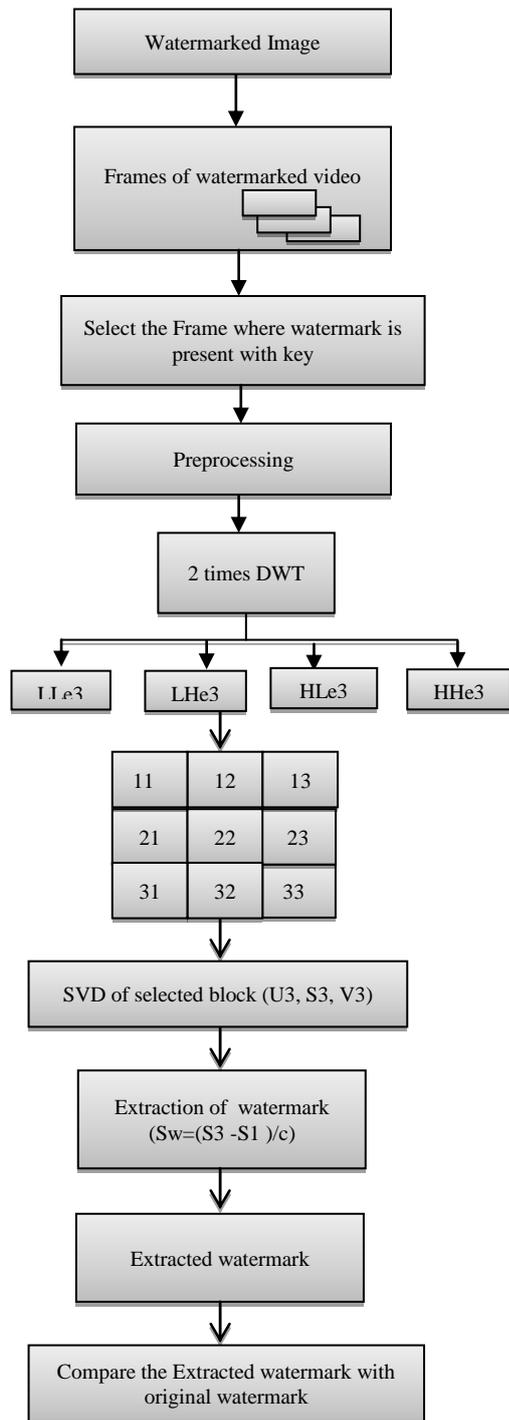


Fig. 2: Watermark Extraction Design

V. EFFECT OF ATTACKSAFTER BLOCKWATERMARKING

To check the authenticity of this scheme, a number of videos are taken. From these, results of 10 videos are shown in the tabular form. Videos that are taken are standard videos generally used in video processing. These are videos of Akiyo, Carphone, Claire, Coastguard, flower, foreman, mother-daughter, news, sports and wildlife. From these every entire 90th frame has been selected. Watermarking is applied on this frame using block based DWT-SVD method. Watermarked frames of these videos are undergone through various attacks. (Kutter, Voloshynovskiy , & Herrigel,

2000)given an overview about Watermark copy attack.(Kong, Yang, Wu, & Niu, 2006) have shown attacks on watermarked frames. (Hsiao, Chen , Chien, & Chen, 2007), (Khan, Tahir, Majid, & Choi, 2008)(Peng, Wang, & Wang, 2010) applied machine learning for extracting the watermark information after attacks in image watermarking. Attacks that are applied here are Gaussian attack, salt and pepper noise, speckle noise, Histogram equalization, cropping, 90 degree rotation, 180 degree rotation etc. After application of attacks watermark is extracted back from the attacked watermarked frames.

Gaussian Noise Attack

First attack applied is Gaussian noise attack. In this, the watermarked frame will change as if Gaussian noise is applied to it. Gaussian noise or normal noise is a random noise and effects both dark and light areas of an image. The Probability Density Function (PDF) of Gaussian noise is equal to that of the normal distribution, which is also known as the Gaussian distribution. The PDF of Gaussian random variable, x , is given by Eqn. (1).

$$p(z) = \frac{1}{\sqrt{2\pi}\sigma} e^{-(x-\bar{x})^2/2\sigma^2} \quad (1)$$

Where,

x represents intensity,

\bar{x} shows mean value of x .

σ is the standard deviation

σ^2 is the variance of x .

Salt and Pepper Noise

This noise is also known as shot noise and bipolar impulse noise. This type of noise is caused by sudden disturbances in the images mainly due to sensor and memory problems. Salt is white dot and pepper is black dot on the image. These black and white dots have pixel values different as compared to background of that dot. These dots are removed by using median filtering. PDF of this noise is given by-

$$p(x) = \begin{cases} P_a & \text{for } x = a \\ P_b & \text{for } x = b \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

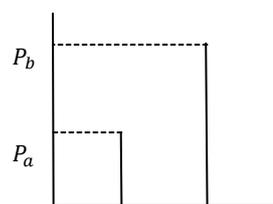


Figure 3: PDF of salt and Pepper noise

Speckle Noise

This noise is the inherent characteristic of ultrasound imaging. This noise is random and deterministic in an image. Table 4 shows the effect of Speckle noise. In this table extracted watermark after this attack, PSNR value and NC value is shown for all the 10 videos.

Histogram Equalization

Histogram method is used to uniformly distribute the intensity values. This enhances the quality of the image. This equalization is based on redistribution of the intensity values of images so that clarity of the image may be boosted. The effect of Histogram equalization is taken as an attack, as it changes the watermarked image. Effect on the extracted image after histogram equalization is shown in the Table 5.

Cropping

Cropping is to cut some part of image. This is generally done when one is interested in a particular area of the image. In cropping if the part of watermarked image where embedding is done, has been removed completely, then it is not possible to extract the watermark otherwise watermark can be extracted. Table 6 shows the effect of Cropping.

Rotation (90° and 180°)

In rotation also there is possibility that part of embedded watermark is moved at some other position, so some times it is somewhat difficult to extract watermark. Table 7 and Table 8 shows the effect of Rotation.

VI. VISUAL RESULTS

An experiment has been performed on Akiyo video containing more than 300 frames. In this experiment, PSNR value has been found for watermarked when compared with the host image. Again Normalized correlation has been found in between the extracted watermark and original watermark as well as between watermarked image after the attack and the original host image. The experiment is

performed on Matlab R2013a. Some frames have been selected according to the key. Table 1 shows the PSNR value, watermarked frame, extracted watermark and block with which extraction has been done. Here the value of scaling factor is 0.3. Frame number in which watermark is embedded is known to the owner and will work as the key. As it can be seen that a part of the watermark has been extracted from each frame and to completely extract the watermark all frames need to be located that is only known to the owner. Here is video contains more than 300 frames. The watermark is divided into 9 parts.

Table 2, Table 3, Table 4, Table 5, Table 6, Table 7 and Table 8 shows the effect of Gaussian noise, salt and pepper noise, Speckle noise, Histogram equalization, Cropping, Rotation 90°, Rotation 180° on the watermarked frame respectively. Videos taken are the standard videos like akiyo, carphone, Claire, Coastguard, Flower, Motherdaughter, News, Foreman, Sports and wildlife. A frame is selected randomly from each video and watermarking is applied on this selected frame. Mentioned attacks are applied on the selected frames and watermark is extracted back. Peak Signal to Noise Ratio Value (between watermarked frame and original frame) and Normalized Correlation (between watermarked frame and original frame) is also represented along with attacked frame. From all the tables (Table 2 to Table 8) it is clear that with block based method of watermarking, PSNR and NC values are in the acceptable range even after attacks.

Table 9 shows the NC values between watermark image and extracted watermark image. Table 10 shows the extracted watermark after attacks.

Table 1: Watermarked Images And Extracted Watermarks from each Block with PSNR

S. No.	Frame Number	PSNR	Watermarked frame	Extracted Watermark	Block for extracted watermark
1.	33	96.314			Ge{1,1}
2.	66	96.393			Ge{1,2}
3.	99	95.992			Ge{1,3}
4.	132	96.503			Ge{2,1}
5.	165	96.502			Ge{2,2}
6.	198	96.374			Ge{2,3}
7.	231	96.515			Ge{3,1}
8.	264	96.464			Ge{3,2}
9.	297	96.350			Ge{3,3}



Table 2: Gaussian attack

Akiyo	Carphone	Claire	Coastguard	Flower
				
PSNR - 56.75	PSNR - 56.87	PSNR - 56.78	PSNR - 56.98	PSNR - 60.86
NC- 0.918	NC- 0.924	NC- 0.926	NC- 0.933	NC- 0.974
Motherdaughter	News	Foreman	Sports	Wildlife
				
PSNR-56.65	PSNR - 56.49	PSNR - 58.91	PSNR - 56.83	PSNR - 57.35
NC- 0.931	NC- 0.906	NC- 0.963	NC- 0.939	NC- 0.951

Table 3: Salt and Pepper noise

Akiyo	Carphone	Claire	Coastguard	Flower
				
PSNR - 57.40	PSNR - 57.84	PSNR - 57.50	PSNR - 57.63	PSNR - 57.02
NC- 0.876	NC- 0.885	NC- 0.881	NC- 0.887	NC- 0.913
Motherdaughter	News	Foreman	Sports	Wildlife
				
PSNR- 57.78	PSNR - 57.30	PSNR - 55.26	PSNR - 57.87	PSNR - 57.85
NC- 0.887	NC- 0.866	NC- 0.843	NC- 0.893	NC- 0.900

Table 4: Speckle noise

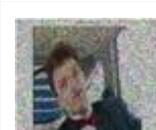
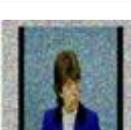
Akiyo	Carphone	Claire	Coastguard	Flower
				
PSNR - 57.31	PSNR - 57.31	PSNR - 56.94	PSNR - 56.92	PSNR - 55.38
NC- 0.863	NC- 0.861	NC- 0.855	NC- 0.857	NC- 0.871
Motherdaughter	News	Foreman	Sports	Wildlife
				
PSNR-56.86	PSNR - 57.62	PSNR - 55.94	PSNR - 56.61	PSNR - 56.32
NC- 0.852	NC- 0.864	NC- 0.863	NC- 0.851	NC- 0.851

Table 5: Histogram equalization

Akiyo	Carphone	Claire	Coastguard	Flower
PSNR - 61.41	PSNR - 60.66	PSNR - 58.35	PSNR - 59.71	PSNR - 55.33
NC- 0.952	NC- 0.944	NC- 0.904	NC- 0.929	NC- 0.870
Motherdaughter	News	Foreman	Sports	Wildlife
PSNR- 58.20	PSNR - 62.14	PSNR - 55.97	PSNR - 57.89	PSNR - 57.34
NC- 0.900	NC- 0.959	NC- 0.864	NC- 0.896	NC- 0.885

Table 6: Cropping

Akiyo	Carphone	Claire	Coastguard	Flower
PSNR - 55.91	PSNR - 56.45	PSNR - 55.05	PSNR - 57.12	PSNR - 58.13
NC- 0.824	NC- 0.848	NC- 0.779	NC- 0.875	NC- 0.932
Motherdaughter	News	Foreman	Sports	Wildlife
PSNR- 58.16	PSNR – 55.30	PSNR - 58.36	PSNR – 58.94	PSNR – 59.16
NC- 0.890	NC- 0.783	NC- 0.924	NC- 0.910	NC- 0.924

Table 7: Rotation 90°

Akiyo	Carphone	Claire	Coastguard	Flower
PSNR - 55.78	PSNR - 56.19	PSNR – 57.00	PSNR – 57.15	PSNR – 58.58
NC- 0.819	NC- 0.845	NC- 0.865	NC- 0.874	NC- 0.940
Motherdaughter	News	Foreman	Sports	Wildlife
PSNR- 58.98	PSNR - 56.39	PSNR - 59.96	PSNR – 60.21	PSNR - 60.09
NC- 0.914	NC- 0.832	NC- 0.949	NC- 0.935	NC- 0.941

Table 8: Rotation 180⁰

Akiyo	Carphone	Claire	Coastguard	Flower
				
PSNR - 56.62	PSNR - 57.51	PSNR - 59.18	PSNR - 56.94	PSNR - 57.11
NC- 0.851	NC- 0.886	NC- 0.918	NC- 0.867	NC- 0.916
Motherdaughter	News	Foreman	Sports	Wildlife
				
PSNR- 61.05	PSNR - 57.48	PSNR - 60.03	PSNR - 62.65	PSNR - 60.70
NC- 0.947	NC- 0.869	NC- 0.950	NC- 0.963	NC- 0.949

Table 9: NC (Between Watermark Image And Extracted Watermark Image)

Video Frame name	Gaussian noise	Salt pepper noise	Speckle noise	Histogram	Rotation 90	Rotation 180	cropping
Akiyo	0.851	0.886	0.888	0.856	0.854	0.852	0.851
Carphone	0.853	0.891	0.885	0.857	0.854	0.852	0.851
Claire	0.852	0.886	0.885	0.857	0.855	0.852	0.851
Coastguard	0.851	0.886	0.893	0.918	0.852	0.852	0.851
Flower	0.853	0.887	0.890	0.856	0.854	0.851	0.851
Foreman	0.853	0.902	0.892	0.857	0.856	0.852	0.851
Mother daughter	0.851	0.885	0.890	0.856	0.854	0.852	0.851
News	0.852	0.887	0.889	0.855	0.862	0.852	0.851
Sports	0.852	0.884	0.889	0.856	0.856	0.851	0.851
Wildlife	0.852	0.882	0.889	0.857	0.852	0.852	0.851

Table 10: Extracted Watermark after Attacks

Video	Gaussian	Salt & Pepper	speckle	Histogram Equalization	Rotation 90 ⁰	Rotation 180 ⁰	cropping
Akiyo							
Carphone							
Claire							
Coastguard							
Flower							
Foreman							
Motherdaughter							
News							
Sports							
Wildlife							

VII. COMPARISON OF PROPOSED SCHEME WITH EXISTING SCHEMES

The novelty of this paper can be represented and discussed. DWT and SVD methods are used here to gain the advantages of both transforms. To obtain better performance in terms of imperceptibility, block based method is used and the watermark is embedded in only one block of every selected frame.

This enhances the security of the watermarking scheme as complete watermark can not be extracted from the same frame of the video. So, any attacker needs to know all the frames and the block in each frame used for embedding watermark. A comparison of proposed method with previously existing methods is shown in Table 11. The calculated PSNR of proposed method is much better than (Adul & Mwangi, 2017) and (Panyavaraporn & Paramate, 2018). It is also shown here through bar graph.

Table 11: Comparison of Proposed Method with Existing Methods

S.No.	Methods	videos	Frames	Extracted Watermark	PSNR
1.	Proposed Method	Akiyo			96.393
2.	Ref [19]	Foreman			36.6
3.	Ref [20]	Basketball			37.9538

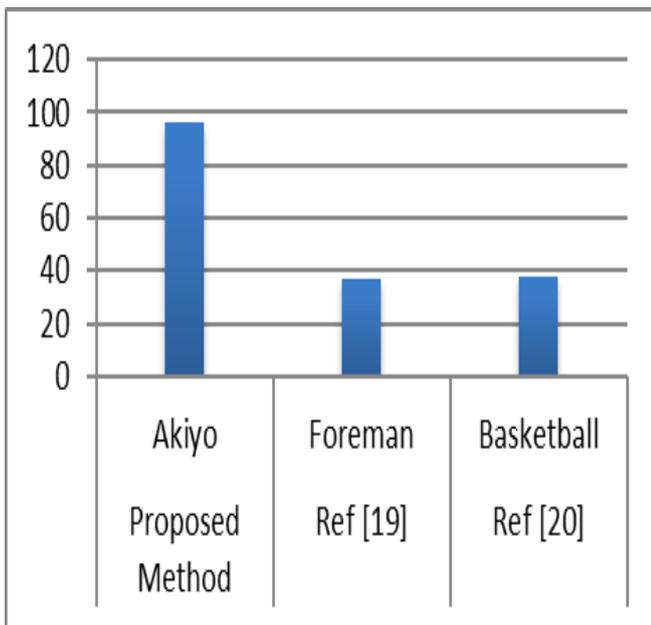


Fig. 4: Comparison graph of Three video frames- Proposed- Akiyo, Ref. [19]- Foreman, Ref. [20]- Basketball

VIII. CONCLUSION

In this paper effect of attacks after block based watermarking is shown. In this method, different part of watermark are embedded in different frames of video hence, to completely extract the watermark one should know the exact frames in which watermark is embedded and again the part of that frames in which watermark has been embedded. This scheme gives improved PSNR and improved security. Also unlike many other schemes watermark is not embedded in every frame of the video, so the time required for watermarking is less.

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