DYNAMIC PATTERN BASED MODEL FOR EFFECTIVE IMAGE-SEQUENCE WATERMARKING

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Abstract—In this paper, a dynamic patternbased watermarking model is presented to improve the secrecy of invisible watermarking. The feature adaptive pattern generation is defined in this research to hide data in image sequence. The image sequence is processed by DWT to identify the most effective container eligible images. Once the effective images are identified, the block segmentation is applied on each effective image. The feature adaptive evaluation is performed on each block of effective images. The parameters considered in this research for effective pattern generation are energy, entropy and frequency. The rules are applied on the feature blocks to generate the pattern where the secret image is store. In the final stage of this research, the histogram shift is applied on the pixel bits of generated patterns to perform the image-sequence watermarking. The secret image is equally distributed over each effective image. The evaluation results are taken in terms of MSE, PSNR, BCR and Similarity ratio. The results identified that the proposed model has provided the effective results for image sequence watermarking.

IndexTerms—Image Watermarking, Pattern Based, Histogram Shift

I. *INTRODUCTION*

The digital content is required to distribute in public domain to share them with authenticated individuals. But, the digital piracy and thefts are the challenges that can affect an organization in terms of financially and credibility. The digital contents are shared through the internet. This communicating information always suffers from the information theft. Various internal and external attacks are also accomplished by the users to disturb the secret image and to reveal the watermark. The invisible watermarking is applied to sign the digital content in secure way. The basic process model of image/digital-content watermarking is shown in figure 1

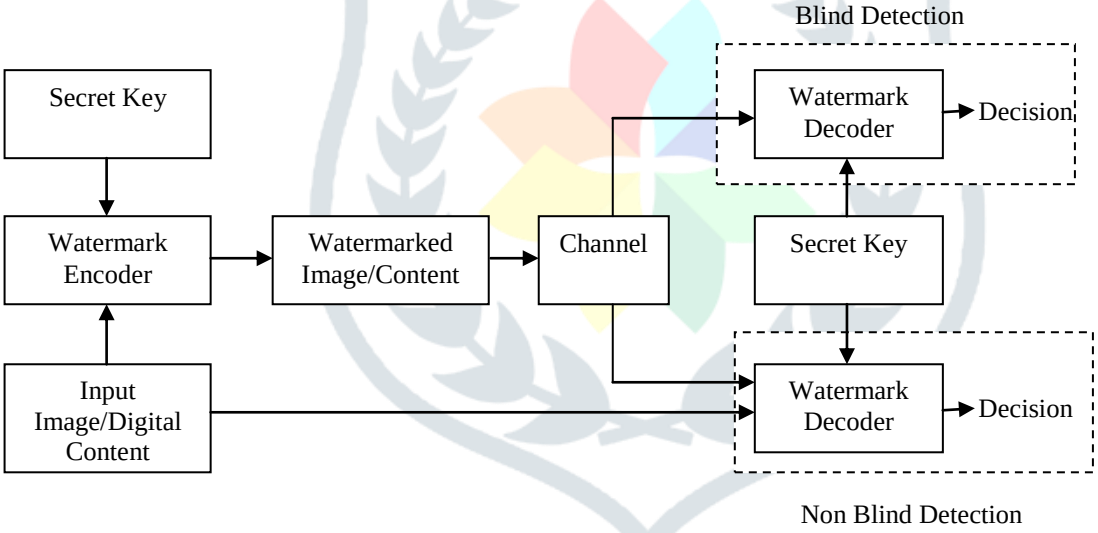

Figure 1: Secure Distribution of Digital Content

Figure 1 has provided the basic model of distribution of image and digital data in public domain. The original media file is taken by this model as input and the secret image. The watermark encoder is defined with encoding algorithm to hide the secret key within the digital media. This watermarked media file is then communicated through the channel in public domain. As the media file is received by some certification authority or the authenticated user, the watermark decoding is done on watermarked image/media file. The watermark algorithm is applied on the receiver side to extract the watermark from the distributed file. The decision specific mapping is applied to decode the digital media/image to retrieve back the secret image from watermarked file. Various methods are available to improve the watermarking to secure the digital content without affecting them. The authorization of the data can be assigned to secure the access of the digital content. The visible and invisible watermarking methods can be used to verify the authenticity of the digital files. The effective applications and behaviour of watermarking are listed below:

A) Fingerprinting

The fingerprinting is the method to identify that the media file can be used as the measure to recognize an individual. The fingerprinting is done by evaluating the medial file, color analysis and the motion evaluation over the image sequence. The watermarking is used as effective method to improve the finger printing. The individual image content evaluation is done to improve the fingerprinting for image-sequence.

B) Copy Control

The copy control is the integrated behaviour of watermarking to sign the authorization of a media file. It is used to avoid the illegal copy of the digital file or media. The copy protection can be done through visible or invisible watermarking methods. This kind of watermarking visualizes to inform the unauthorized person that the content is property of an individual or organization.

C) Digital Authentication

The watermarking can be implied within captured or authorized media or image file to achieve the integrity and reliability of particular application or the digital data. The fragile, semi-fragile and robust watermarking was defined by the researcher under some policy specification. The content preserve methods are applied to improve the authentication. The medical based video file, video scripts can be authenticated using watermarking methods.

In this paper, an effective and dynamic watermarking method is provided to secure the image-sequence. The proposed method first performed the image specific analysis and then generates the feature adaptive pattern on each image. The histogram shift method is applied on generated pattern to hide the part of secret image within the generated pattern. In this section, the basic concept of watermarking is described along with scope. In section II, the work provided by earlier researchers is discussed. In section III, the proposed research model for image-sequence watermarking is discussed. In section IV, the results obtained for proposed watermarking approach are provided in terms of PSNR and MSE parameters. In section V, the contribution of the work is provided.

II. RELATED WORK

Watermarking is widely used to secure the distribution of digital content in public domain. The organization authentication mark is to hide within the digital content to reserve their right on its access. Various watermarking algorithms are provided by the researchers to hide the data secretly and effectively. Li et al.[1] has provided the video watermarking on compressed video to improve the reliability of transport stream. The I-frames of video were used by the author to hide the data. Author modified the DC coefficient to hide the data within videos. The capacity and robustness of video watermarking were improved by the author. Amirjan et al.[2] analyzed the P-frames of video to improve the capability of video watermarking. The syntactic element of compressed video was analyzed to hide the data without affecting the quality of video. The motion information of video was analyzed to identify the quantized residual and to improve the video watermarking. Sathya et al.[3] combined the DWT and SVM transformation methods to retain the perceptual quality of video and to identify the key frames. Author applied the two level DWT on video sequence to identify the effective region to hide secret image. Panda et al.[4] has provided the dual watermarking model to the secret image in different FFT samples. Author combined the multiple bit plane method with spread spectrum technique to improve the robustness and effectiveness of video watermarking. Kaur et al.[5] has defined the DWT, LSB, DCT and Mojette based watermarking technique to improve the safety of digital content. Author defined the 3-level DWT with hierarchical decomposition to hide the secret image within the videos. The block DCT based method was also defined by the author to improve the data safety in video files. Kulkarni et al.[6] has proposed the hybrid wavelet transformation based approach to improve the video watermarking. The Haar-Kekre based hybrid wavelet was provided to watermark the secret image within video frames.

Ghalejughi et al.[7] has performed the video frame analysis based on chrominance channel to identify the effective frames. The dual tree complex wavelet transform (DT-CWT) was applied to hide the secret image. The binary sequence processed hyperbolic function was used to hide the secret content within video. Mishra et al.[8] has provided a strong watermarking algorithm by selecting the video frames randomly. The convolution filter and binary mask based approach was applied to select the frame and the region to hide the secret image. The selective frame based approach improves the quality and reliability of video watermarking. Maharjan et al.[9] has proposed the feature selective method to improve the watermarking. The hybrid method was provided to resolve the issues of Non sub-sampled Contourlet Transform, Discrete Wavelet Transformation and Singular Value Decomposition. The effective features of video frames(images) to hide the secret image were identified using Log Polar Transformation and Inverse Log Polar Transformation. The modified Arnolkd transformation was also introduced by the author to improve the reliability and acceptability of watermarking. Kadu et al.[10] analyzed the spatial data of video using DWT. The low frequency region is identified within each frame and considered as key area for data hiding. The blind watermarking was applied to hide the secret image within video. Kadu et al.[11] has provided the DWT based frame selection and frequency domain based data hiding algorithm. The pass component region is extracted from the video to improve the data hiding. The energy adaptive perceptual information was processed by the author to improve the watermarking performance.

Sridevi et al.[12] has defined a spread frequency analysis method to identify the effective frames. The I-frame evaluation was conducted by the author using DCT to identify the effective region within video frames. The frequency mask and level reduction method were applied in combined form to improve the performance of video watermarking. Coria et al.[13] has used the subset of various codeword with informed encoding method to improve the watermarking in video files. The DCT based region evaluation method was provided to analyze the likelihood pixels for improving the performance of digital watermarking. The content dependent scheme was provided by the author to improve the capacity to store the watermark within video image files. Mukhopadhyayi et al.[14] has improved the watermarking by integrated the encryption as the prior stage to the watermarking. The data secrecy and strength of watermarking algorithm was improved by the author by generating the dynamic key. The uncompressed videos and attack preserved method was provided by the author to improve the video watermarking. Chan et al.[15] has proposed a novel hybrid watermarking scheme to improve the scramble watermarks. The scene change analysis with error correction code was evaluated by the author to improve the reliability and strength of video watermarking. Schaber et al.[16] has defined the affine geometric transformation based watermarking scheme. The model was specifically defined to improve the robustness against geometric attacks. The contrast and frequency based evaluation was provided to improve the video watermarking. The spatio temporal synchronization method was provided to improve the watermarking.

III. PROPOSED MODEL FOR WATERMARKING

In this paper, an effective and reliable watermarking model is provided to improve the data secrecy. The proposed invisible watermarking based model has performed the dual evaluation on effective region selection on each effective image taken from the available image-sequence. This proposed watermarking model is divided in three main stages. The model with integrated work stages is provided in figure 2.

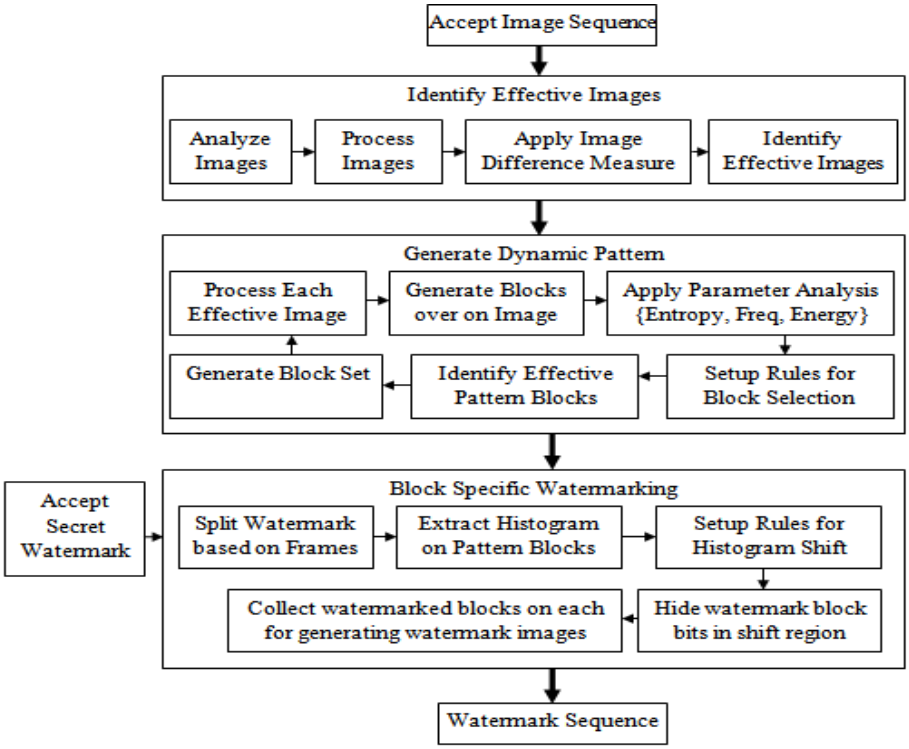

Figure 2 : Proposed Watermarking Model

The proposed watermarking model is applied to hide the secret image within high resolution images. The feature selection based pattern is generated for each effective image as shown in figure 2. In first stage, the image specific evaluation is performed to identify the effective images from available image-sequence. The proposed model has extracted the images and analyzes them based on low frequency features. The DWT (Discrete Wavelet Transformation) is applied in this stage to analyze the similarity between the available images. The effective images are identified based on the prior evaluation. The two level decompositionmethods applied over the image-pair. The extracted low frequency features are compared for consecutive extracted images and the effective images are extracted that are capable to hold the secret image. The maximum similarity basedimages are removed and the effective cover images are identified. Once the cover images are identified, the individual image analysis is performed to generate the effective pattern.

To generate the dynamic pattern over the effective images, the parameter adaptive evaluation is performed. For this evaluation, the images are divided in smaller block and the effective feature adaptive region extraction is done. The parameter adaptive evaluation is done using entropy, energy and frequency parameters. Once the parameters on each block are evaluated, the rules are applied on these parameters to generate the effective pattern. The block level selection is done over the effective images based on these rules. The parameters considered for the pattern evaluation are provided below:

$$\text{Energy} = \sum_{i=1}^{h}\sum_{j=1}^{w}[I(i,j)^2] \quad (1)$$

$$\text{Entropy} = \sum_{i=1}^{h}\sum_{j=1}^{w} I(i,j)log_2[I(i,j)] \quad (2)$$

$$\text{Frequency} = \sum_{i=1}^{h}\sum_{j=1}^{w} i * j * [I(i,j)] \quad (3)$$

The watermarking in this research is performed on the pattern identified based on the parametric evaluation applied of the feature blocks of each effective image. Now each of the pixels of pattern region selected for watermarking is analyzed at pixel level. In this stage, the bit adaptive histogram shift operator is applied to perform the information hiding. To hide the data, the secret image is converted to a one-dimensional array of bits. The block analysis is performed under histogram map and the two intensity pixels identified. The bit shift is performed on these pixels based on the bits extracted from the secret image. This process is repeated on each pattern block generated dynamically over the image-sequence. The analytical results are generated in terms of MSE and PSNR values. The evaluation results obtained for different real time image-sequences are provided in the next section.

IV. RESULTS AND DISCUSSION

The proposed research work is defined to watermark the secret image within the effective images selected from image-sequence. The effective image selection and dynamic pattern based approach is defined in this research for effective watermarking. The proposed model has distributed the secret image over the effective sequence images and the histogram shift method is applied to hide the bits of secret image. In this section, the watermarking results are provided. The results are collected on MSE, PSNR, BCR and Similarity ratio parameters for 9 differentimage-sequences. The features of the dataset are provided in table 1.

Table 1: Features of Image-Sequence Dataset

Input Sequences	Resolution	Number of Images
Sequence1	240x180	37
Sequence2	640x480	19
Sequence3	174x170	12

Sequence4	320x240	14
Sequence5	320x240	21
Sequence6	480x320	56
Sequence7	428x448	218
Sequence8	320x240	69
Sequence9	720x576	57

Table 1 has provided the description of the dataset in terms of resolution and the number of images within the image-sequences. The analysis of the watermarking is done under MSE and PSNR parameters. The MSE (Mean Square Error) is defined as the error rate identified as the difference between the original and recovered watermark. The watermarking method is considered effective, if the MSE rate is lower. The MSE based evaluation for nine image-sequences is provided in figure3.

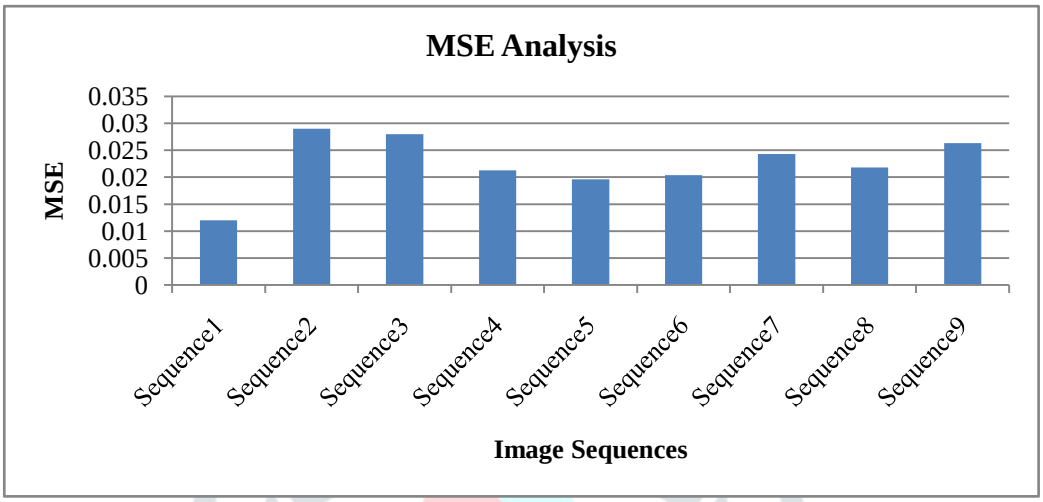

Figure 3 : MSE Analysis Results

The evaluation of the proposed watermarking model is provided in figure 3. The MSE based evaluation is provided in this figure. The results shows that the proposed model has provided the MSE value lesser than .03. It shows that the MSE value obtained for this model is extremely low. The evaluation results identified that the proposed model has provided the effective and reliable result for proposed watermarking model. Another evaluation considered in this paper is in terms of PSNR (Peak Signal to Noise Ratio). This parameter analyzes the effectiveness of watermarking method against noise existence. The PSNR based evaluation results are provided in figure 4.

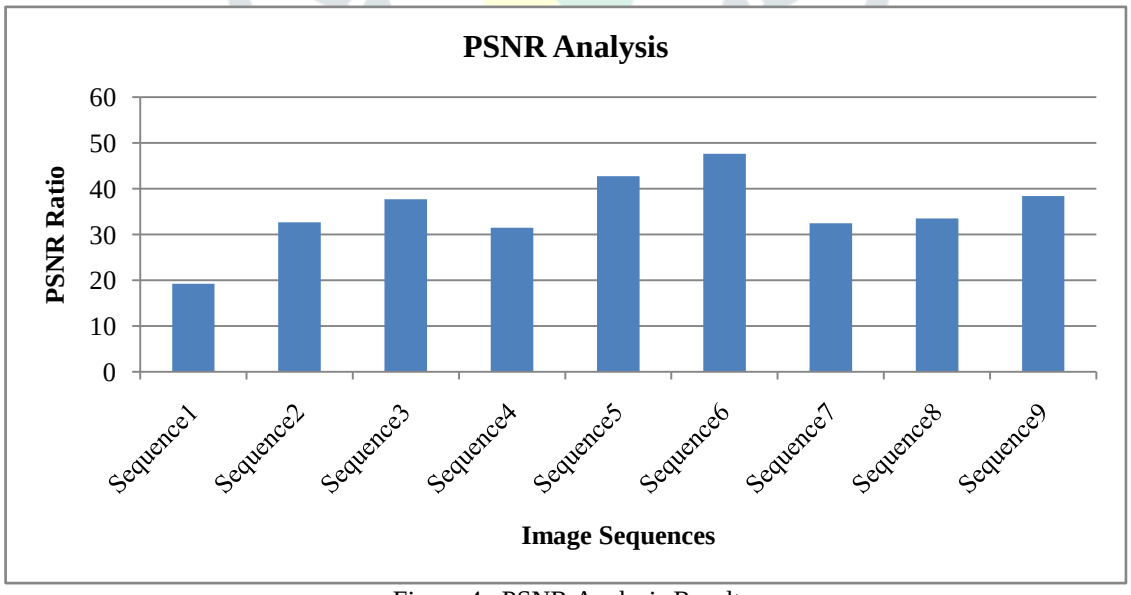

Figure 4 : PSNR Analysis Results

Figure 4 has provided the PSNR based analysis by comparing the original watermark and recovered watermark. The figure is providing the evaluation results for all nine image-sequences. The results shows that the most of the images-sequences have achieved the PSNR ratio higher than 30. It shows that the model is more significant against the PSNR parameter. The BCR (Bit Correct Ratio) is another parameter considered in this work for evaluation of the effectiveness of proposed watermarking model. The BCR based evaluation results for all nine image sequences is provided in figure 5.

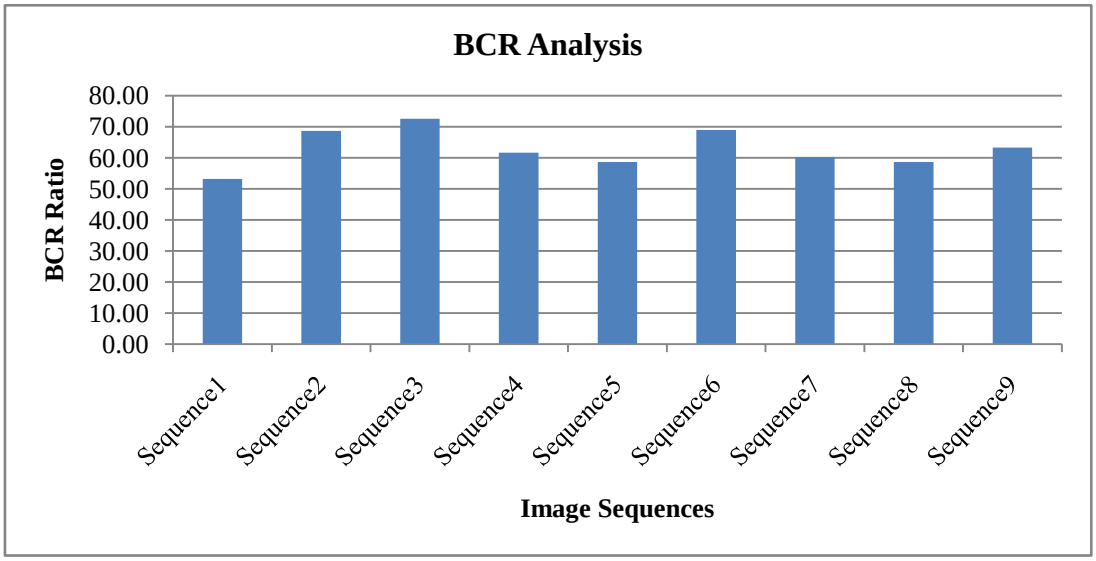

Figure 5 : BCR Analysis Results

Figure 5 has provided the evaluation of proposed model based on BCR parameter. The figure has provided the evaluation result for all nine image sequences. X axis in this figure shows the image-sequences and y axis represents the BCR ratio. The evaluation results identified that the most of the image-sequences achieved the BCR ratio higher than 50%. It shows that the effective watermark recovery is done for proposed model.

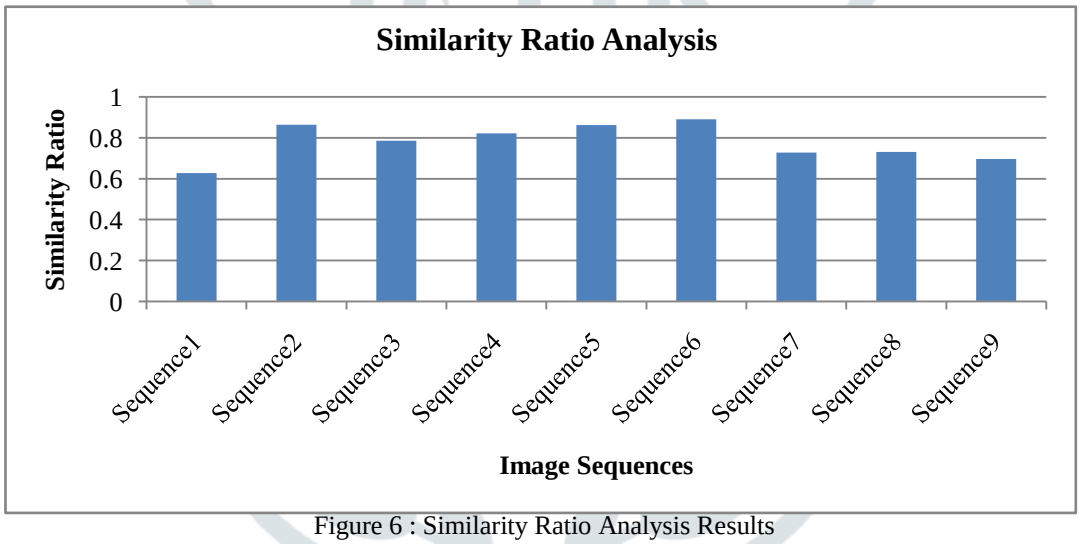

Figure 6 : Similarity Ratio Analysis Results

Figure 6 has provided the analysis of the proposed watermarking model in terms of similarity ratio. The similarity between the original and recovered watermark is obtained in this research. The similarity ratio obtained for all nine image sequences are provided in figure 9. The analysis results identified that the proposed model achieved the similarity ratio over 70% for eight image sequences. The results show that the proposed model has achieved the effective and accurate watermarking results.

V. CONCLUSION

Watermarking is able to improve the authorization and control the access of digital media and images while distributing the contents in public domain. In this paper, a dynamic pattern based method is defined to improve the image sequence watermarking. The work of this proposed model is divided in three work stages. In the first stage, the DWT based similarity analysis on image-pair is done to identify the effective container images. These effective images are divided in smaller blocks and the content adaptive features are extracted for each block. In this second stage, the rules are defined to generate the pattern for storing secret image. In the final stage, the histogram shift method is applied to store bits of the secret image. The proposed model is implemented on nine real time image sequences. The results show that the proposed model has provided the effective watermarking with lesser MSE value and higher BCR ratio, PSNR ratio and similarity ratio. The results identified that the model has improved the reliability and effectiveness of image sequence watermarking.

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