A DWT Based Steganography Using Haar Transforms

Ms. Manisha Kude[1], Prof. Manjusha Borse[2], Prof. R.K Harshvardhan[3]
[1]PG Student E&TC Engineering Department, Late G.N. Sapkal COE, Nasik, Maharashtra, India
[2]Asst. Professor, E&TC Engineering Department, Late G.N. Sapkal COE, Nasik, Maharashtra, India
[3]Asst. Professor, Electrical Engineering Department, Sandip Foundation's SIEM, Nasik, Maharashtra, India

Keywords- DWT (Discrete Wavelet Transform), HSV (Hue Saturation Value), HVS (Human Visual System)

Abstract- In this paper, we are describing a unique method of embedding secret data within skin, as it is not that much sensitive to HVS (Human Visual System) .This takes advantage of Biometric features such as skin-tone. In this process, the data will be embedded in selected regions, instead of embedding data anywhere in image.

At first skin-tone detection is performed on input image using HSV (Hue, saturation, value) color space. Secondly, cover image is transformed in frequency domain. This is performed by applying Haar-Discrete Wavelet Transform (DWT), leading to four sub-bands. Sub-band LL (Low-Low band) is used for processing the data. Different levels of DWT are used with Haar transforms. Then the payload (number of bits which can be embedded) is calculated. Finally, secret data embedding is performed in one of the high frequency sub-band by tracing skin pixels in that band. Before performing all steps cropping on input image is performed and then in only cropped region embedding is done. Cropping results into more security than without cropping, as cropped region works as a key at decoding side.

1. INTRODUCTION

Steganography technique is used to hide information in some media, technically termed as cover media. The positive aspect of steganography over cryptography is messages that do not attract attention to attackers and even receivers. Steganography and cryptography are often used hand in hand to ensure security of the secret information. This approach can become more secure and can be potentially be useful to some security-demanding applications. [1]

Watermarking is well known technique to hide messages and its significance is seen while providing ownership on copyrighted material and for finding out creators of illegally made copies. Therefore, an effective data hiding method must be robust against all types of duplication attacks. In contrast to watermarking technique, steganography prefers to hide information as much as possible and requires cover media with very less distortion. Steganography is the method of writing hidden messages in such a way that no one, apart from the sender and intended recipient, suspects the existence of the message, a form of security through obscurity. Generally, messages will appear visually like images, articles, or some other cover text and, classically, the hidden message may be in invisible ink between the visible lines of a private letter.

2. STEGANOGRAPHY TECHNIQUES

Historical records related to Steganography, can be traced down to techniques based on chemicals and colours that was used by the Greek historian Herodotus and date back to around 440 BC. Also, Romans were known to use invisible inks, which were based on natural substances such as fruit juices and milk. Null ciphers, a technique in which the 3rd letter from each word is taken off, making it look like a harmless message was established in ancient times. [2] With scientific research with advanced techniques and imaging techniques coming into picture, the art of hiding information get a new face altogether. The following are some of the well known Steganographic techniques [2]:

2.1) *Wavelet Transform*

Wavelet transform is used to convert a spatial domain into frequency domain. The use of wavelet in image stenographic model lies in the fact that the wavelet transform clearly separates the high frequency and low frequency information on a pixel by pixel basis. Discrete Wavelet Transform (DWT) is preferred over Discrete Cosine Transforms (DCT) because image in low frequency at various levels can offer corresponding resolution needed. [2]

2.2) Haar Wavelet

It is a piecewise wavelet that provides orthogonal decomposition given as Wavelet Transform: It converts an image from time or spatial domain to frequency domain. It provides a time frequency representation. The Wavelet Transform is obtained by repeated filtering of the coefficients of the image row-by-row and column-by-column. The Haar Wavelet Transform is the simplest of all wavelet transform. In this the low frequency wavelet coefficient are generated by averaging the two pixel values and high frequency coefficients are generated by taking half of the difference of the same two pixels. The four bands obtained are approximate band (LL), Vertical Band (LH), Horizontal band (HL), and diagonal detail band (HH). The approximation band consists of low frequency wavelet coefficients, which contain significant part of the spatial domain image. The other bands also called as detail bands consists of high frequency coefficients, which contain the edge details of the spatial domain image.Three of the most popular ways to decompose an image are: pyramid, spacl, and wavelet packet. [3]

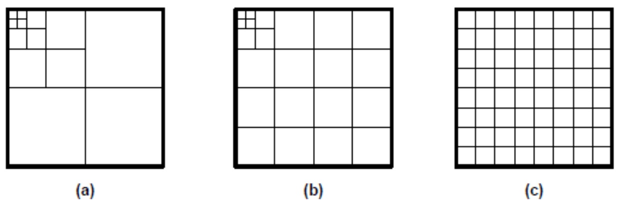


Fig 1: Ways to decompose an image are:
a) Pyramid b) spacl, c) Wavelet packet

2.3) Steganography in Spatial Domain

Simplest steganography technique is such that it embeds the bits of secret information directly into the least significant bit (LSB) plane of the cover image. If we are working on a gray-level image, 1 pixel consists of 8 bits. While performing the basic LSB substitution, it acts to embed the confidential data at the right-most bits i.e. the bits with the smallest weighting, so that the embedding procedure retains the original pixel value mostly. This process is straightforward, but it will generally has low ability to bear some signal processing or noises and secret data can be easily stolen by extracting whole LSB plane.

2.4) Steganography in Frequency Domain

Robustness of Steganography gets rectified if properties of the cover image are opted to be exploited. For example, it is generally a preferable option to hide message in noisy or error regions instead of smoother regions as degradation in smoother regions is more noticeable to human HVS (Human Visual System).Taking these aspects into consideration working in frequency domain becomes more attractive. Here, sender data transforms the cover image into frequency domain coefficients before embedding secret information into the image. Different sub-bands of frequency domain coefficients provide valuable information regarding vital and non-vital pixels of image resides. These methods are extremely complex and slower than spatial domain methods; however they are more secure and tolerant to noises. Frequency domain transformation can be applied either in DCT or DWT. [2]

2.5) Adaptive Steganography

Adaptive Steganography is a peculiar case of two former methods. It is also known as “Statistics aware embedding” and “Masking”. This method utilises statistical global features of the image, before attempting to embed secret data in DCT or DWT coefficients. The statistics will decide where to make informative changes.

2.6) Haar Discrete Wavelet Transform

Wavelet transforms inbuilt the capability to provide some information on frequency-time domain simultaneously. In this transform, time domain is transferred through low-pass and high-pass filters which will be used to extract low and high frequencies respectively. This process will be repeated for several times and each time a part of the signal is drawn out of it.

DWT analysis divides signal into two classes (i.e. Approximation class and Detailed Class) by signal decomposition for various frequency bands and scales. DWT utilizes two varied sets of functions: scaling function and wavelet function, which associate with low and high pass filters. These kind of decomposition in few manner bisects time reparability. Haar wavelet tranform keeps operating on data by calculating the sums and differences of adjacent elements. This wavelet operates first on adjacent horizontal elements and then on adjacent vertical elements. A distinguished feature of the Haar wavelet transform is that the transform is equal to its inverse. Each transform computes the data energy in relocated to the top left hand corner.[4]

3. PROPOSED USER CLASSIFICATION SCHEME

The proposed scheme consists of the following transformation processing:

3.1 DWT (Discrete wavelet transform)

The wavelet transform concentrates the energy of the image signals into a few numbers of wavelet coefficients. It has better time-frequency localization property the fundamental idea behind wavelets is to analyze signal according to scale. It was developed as an alternative to the short time Fourier to overcome problems related to its frequency and time resolution properties .Wavelet transform decomposes a signal into a set of basic functions. These basic functions are obtained from a mother wavelet by translation and dilation.

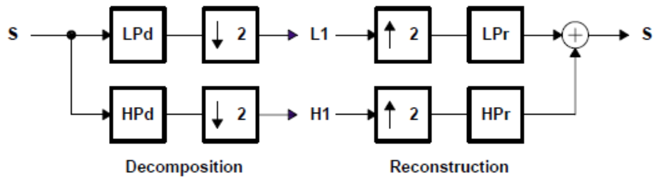


Fig 2: Image Transformation

Where

LPd: Low-Pass Decomposition Filter
HPd: High Pass Decomposition Filter
LPr: Low Pass Reconstruction Filter
HPr: High Pass Reconstruction Filter

1)

$$\mathrm{w}\varphi(\mathrm{a},\mathrm{b}) = \int_{-\infty}^{+\infty} \mathrm{f}(\mathrm{x}) * \varphi\mathrm{a},\mathrm{b}(\mathrm{t})\mathrm{dx}$$

$$\varphi\mathrm{a},\mathrm{b}(\mathrm{t}) = \frac{1}{\sqrt{\mathrm{a}}}\varphi\left(\frac{\mathrm{t}-\mathrm{b}}{\mathrm{a}}\right)$$

Where, a and b are both real numbers which quantify the scaling and translation operations respectively.

$$\mathrm{DWT}(\mathrm{x},\mathrm{y}) = \begin{cases} \mathrm{dj},\mathrm{k} = \sum(\mathrm{x}\,(\mathrm{n})\mathrm{h} * \mathrm{j}(\mathrm{n}-2\mathrm{jk}) \\ \mathrm{dj},\mathrm{k} = \sum(\mathrm{x}(\mathrm{n})\mathrm{g} * \mathrm{j}(\mathrm{n}-2\mathrm{jk}) \end{cases}$$

3) The coefficients dj, k refer to the detail components in signal x (n) and correspond to the wavelet function, whereas aj, k refer to the approximation components in the signal. The functions h(n) and g(n) in the equation represent the coefficients of the high-pass and low-pass filters respectively, whilst parameters j and k refer to wavelet scale and translation factors. For the case of images, the one-dimensional (1-D) [4]

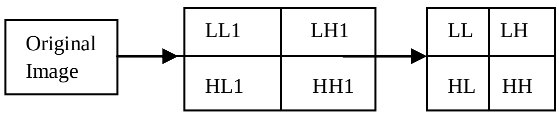


Fig.3: Process of decomposing using DWT of an image

The symbols L and H refer to low-pass and high-pass filter respectively. LL represents the approximation sub-band & LH, HL and HH are the detail sub-bands. LL is the low frequency sub-band gives global description of an image with directional features. Horizontal coefficients (LH) correspond to the low-frequency component in the horizontal direction and high-frequency component in the vertical direction

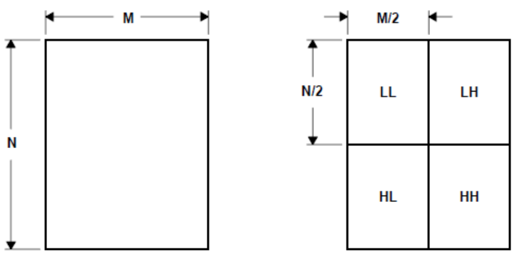


Fig 4: Image Decomposition sub-bands

3.2) Haar wavelet transforms

The initial DWT was invented by the Hungarian mathematician Alfred Haar. For an input represented by a list of numbers, the Haar wavelet transform may be considered to simply pair up input values, storing the difference and passing the sum. This process is repeated recursively, pairing up the sums to provide the next scale.

3.3) IDWT

Inverse discrte wavelet transform is applied on DWT sub-bands to reconstruct original image.Inverse discrete wavelet trasnform combines different coefficient from image and reconstruct that image. DWT gives sub-band coding using low pass and high pass filtering. DWT gives multiresolution analysis good compared to other transform like fourier transform which genrally use for staionary signal s which can be inversed to get all data which will be reduced by diffrent levels of discrete wavelet tarnsform all coefficients are collected which is required for reconstruction. [5]

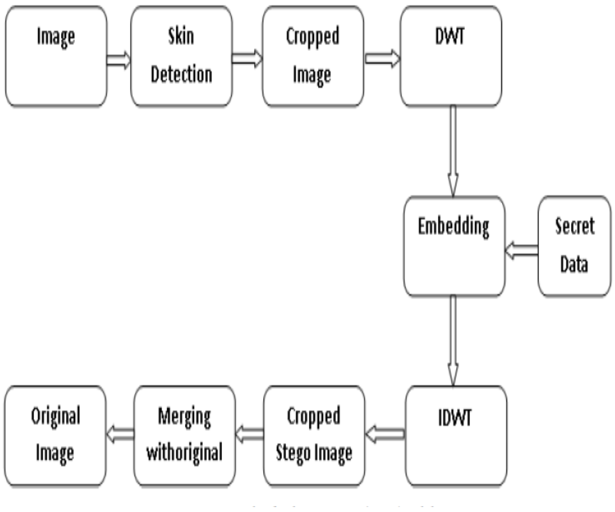


Fig.5: Block diagram of Embedding Image

Fig. 5 shows block diagram of the proposed user classification scheme. It is composed of six main blocks; input face image capture using webcam, face and face and lip detection from given image ,lip portion detection can also be one of the stage which is included in stage two in block diagram. Cropping of lip portion from total image & lip tracking i.e. determining coordinates of lip are showed in one stage in diagram. Forming the vector of coordinate array.[6] Training of lip vector i.e. coordinates array and classification. Our system will try to classify user depending upon different lip movements of user. Lip tracking is obtained by taking coordinates which will be saved as database and during real time the coordinates are calculated are matched with same .The classifier is used to give correct match or not.[7] The following is the algorithm for the image embedding:

1. Start process
2. Load Image of any format that is jpeg, png, bmp etc.
3. Resize the image into MXN =256x256
4. Apply Skin tone detection on resized image
5. Apply the DWT to only the cropped area, which yields 4 sub-bands denoted by LL, HL, LH, HH
6. Embed in B-plane
7. Perform embedding on secret data in one sub-band, i.e. LL
8. Obtain earlier image by tracking skin pixel in sub-bands
9. Perform IDWT to LL band
10. Crop stego-image of size Mc X Nc = 256x256
11. The image obtained after performing IDWT will be similar to original image by if visually inspected.

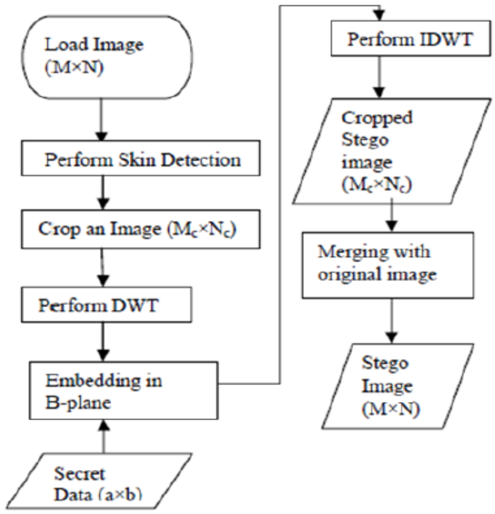


Fig.6: Flow chart for Embedding Image

4. Results

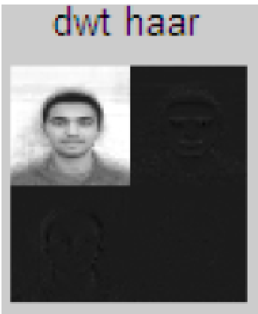
Four stages are completed in which first of all image is captured from webcam and then skin part of that image is obatined then it is passed for discrte wavelet transform which performs low pass and high pass filtering using haar transform and data is stored in one file which is going to embed into skin part.DWT with diffrent levels with haar and daubeshoan wavelet are used for processing.DWT with more levels gives reduced coefficients.

a)

b)

c)

d)



e)

Fig 7: Preprocessing of image

5. CONCLUSIONS

In this paper biometric steganography is presented that uses skin region of images in DWT domain for embedding secret data. By embedding data in only certain region (here skin region) and not in whole image security is enhanced. Also image cropping concept introduced, maintains security at respectable level since no one can extract message without having value of cropped region. Features obtained from DWT coefficients are utilized for secret data embedding. This also increases the quality of stego because secret messages are embedded in high frequency sub-bands which human eyes are less sensitive.

REFERENCES

1. P. Mohan Kumar , K. L. Shunmuganathan , “A Multilayered Architecture for Hiding Executable Files in 3D Images”, Indian Journal of Science & Technology, Vol. 3, April 2010
2. Swapnali Zagade, Smita Bhosale, “Skin based Data hiding in Images by Using 'Haar' and 'db2' DWT Technique’s”, International Journal of Science and Research (IJSR), Vol 3, June 2014
3. Prajakta Deshmane, Prof. S.R. Jagtap, “Skin Tone Steganography for Real Time Images”, International Journal of Engineering Research and Applications (IJERA) Vol. 3, Issue 2, March -April 2013
4. Elham Ghasemi, Jamshid Shanbehzadeh, Nima Fassihi , “High Capacity Image Steganography using Wavelet Transform and Genetic Algorithm”, Int. multiconf. Of Engineers & Computer Scientist, 2011
5. Ms. Sonam Malik and Mr. Vikram Verma, “Comparative analysis of DCT, Haar and Daubechies Wavelet for Image Compression”, International Journal of Applied Engineering Research, Vol.7 No.11 (2012)
6. Yogesh V.Jeughale, Ravindra G.Dabhade, Priya D.Rakibe, “Face identification based on lip movement features”, International Journal of Research in Engineering Technology and Management, Vol 2, Sept-2014
7. David Halupka,Parhan Aarabi,Duy Nguyen,” Real time face detection and lip feature extraction using field programmable gate array”,Pg No-42,43,Sep,12.2007
8. Rouigueb, S. Chitroub, and A. Bouridane, “Fuzzy Local ICA for Speaker Recognition Using Voice and Lip Motion “, IEEE Proceedings of the World Congress on Engineering 2012 Vol I WCE 2012, July 4 - 6, 2012
9. P. Viola and M. Jones. Rapid object detection using a boosted cascade of simple features. Computer Vision Vision and Pattern Recognition, IEEE Computer Society Conference on, April 2001.