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Colour Image Watermarking Using Modified HAAR Transform

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***Abstract*- Protecting innovative substance and licensed innovation in a computerized frame has turned out to be progressively troublesome as advances, for example, the web, broadband accessibility and versatile get to progress. It has become dynamically less demanding to duplicate, change and redistribute computerized media, bringing about incredible decreases in business benefits. Advanced watermarking is a method which has been proposed as a conceivable answer for address this issue. Computerized Watermarking is an innovation which is utilized to distinguish the maker, proprietor, merchant of a given video or picture by implanting copyright marks into the advanced substance. In this venture, a powerful watermarking method in light of Discrete Wavelet Transform (DWT) is utilized. In this method the inclusion and extraction of the watermark in the dim scale picture is observed to be powerful than other change procedures. The execution of the proposed calculation is investigated by two execution measures to be specific Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE). The proposed calculation is actualized utilizing MATLAB programming.**

I. INTRODUCTION

The web is a heavenly transport system for the propelled media by virtue of its unobtrusiveness and capability. The use of web and remote applications has made it straightforward and fast to transmit data and with the availability of serious processing, unapproved Operations, for example, computerized copying and adjusting of data can be performed for the most part effortlessly. Therefore, there is necessity for a couple of methodologies to secure propelled pictures. There are distinctive procedures to play out this procedure of securing the pictures.

1. Cryptography
2. Steganography
3. Watermarking

A. What is Digital Watermark?

Computerized Watermark is an example of bits embedded into an advanced picture, sound, video or content record that distinguishes the document's copyright data (creator, rights, and so on.). The name originates from the faintly obvious watermarks engraved on stationary that distinguish the maker of the stationary. The motivation behind advanced watermarks is to give copyright security to licensed innovation that is in computerized arrange.

II. WATERMARKING CLASSIFICATION

A portion of the vital sorts of watermarking in view of various watermarks are given underneath:

A. Noticeable watermarks

Noticeable watermarks are an augmentation of the idea of logos. Such watermarks are appropriate to pictures as it were. These logos are trimmed into the picture however they are straightforward. Such watermarks can't be evacuated by trimming the inside piece of the picture. Further, such watermarks are secured against, for example, factual investigation. The disadvantages of noticeable watermarks are corrupting the nature of picture and recognition by visual means as it were. Consequently, it is unrealistic to recognize them by committed projects or gadgets. Such watermarks have applications in maps, designs and programming UI.

B. Undetectable watermark

Undetectable watermark is covered up in the substance. It can be identified by an approved organization as it were. Such watermarks are utilized for content and/or creator validation and for recognizing unapproved copier.

C. Public watermark

Such a watermark can be read or retrieved by anyone using the specialized algorithm. In this sense, public watermarks are not secure. However, public watermarks are useful for carrying IPR information. They are good alternatives to labels.

D. Fragile watermark

Fragile watermark are also known as tamper-proof watermarks. Such watermark are destroyed by data manipulation or in other words it is a watermarks designed to

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be destroyed by any form of copying or encoding other than a bit-for-bit digital copy. Absence of the watermark indicates that a copy has been made.

E. Private watermarks

Private watermarks are also known as secure watermarks. To read or retrieve such a watermark, it is necessary to have the secret key.

F Perceptual Watermarks

A perceptual watermark exploits the aspects of human sensory system to provide invisible yet robust watermark. Such watermarks are also known a transparent watermarks.

III. IMAGE WATERMARKING TECHNIQUES

Digital Image watermarking schemes mainly fall into two broad categories: Spatial- domain and Frequency-domain techniques.

A. Spatial Domain Techniques

Some of the Spatial Techniques of watermarking are as follow.

B. Least-Significant Bit (LSB)

The earliest work of digital image watermarking schemes embeds watermarks in the LSB of the pixels. Given an image with pixels, and each pixel being represented by an 8-bit sequence, the watermarks are embedded in the last (i.e., least significant), bit, of selected pixels of the image. This method is easy to implement and does not generate serious distortion to the image; however, it is not very robust against attacks. For instance, an attacker could simply randomize all LSBs, which effectively destroys the hidden information.

C. SSM-Modulation-Based Technique

Spread-range procedures are techniques in which vitality produced at least one discrete frequencies is purposely spread or disseminated in time or recurrence spaces. This is accomplished for an assortment of reasons, including the foundation of secure correspondences, expanding imperviousness to regular obstruction and sticking, and to forestall location. At the point when connected to the setting of picture watermarking, SSM based watermarking calculations install data by straightly consolidating the host picture with a little pseudo commotion flag that is regulated by the implanted watermark.

D. Recurrence Domain Techniques

Contrasted with spatial-area strategies, recurrence space techniques are all the more broadly connected. The point is to install the watermarks in the phantom coefficients of the picture. The most normally utilized changes are the Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT), Discrete Leaguers Transform (DLT) and the Discrete Hadamard Transform (DHT). The explanation behind watermarking in the recurrence area is that the attributes of the human visual framework (HVS) are better caught by the otherworldly coefficients.

E. Discrete Cosine Transformation (DCT)

DCT like a Fourier Transform, it speaks to information as far as recurrence space instead of an abundancy space. This is valuable since that relates more to the way people see light, so that the part that are not seen can be distinguished and tossed away.DCT based watermarking strategies are powerful contrasted with spatial space procedures. Such calculations are strong against basic picture handling operations like low pass sifting, brilliance and complexity modification, obscuring and so forth. Be that as it may, they are hard to actualize and are computationally more costly. In the meantime they are frail against geometric assaults like pivot, scaling, editing and so forth. DCT space watermarking can be ordered into Global DCT watermarking and Block based DCT watermarking. Implanting in the perceptually noteworthy part of the picture has its own points of interest in light of the fact that most pressure plans expel the perceptually unimportant bit of the picture.

F. Discrete Wavelet Transformation (DWT)

The Discrete Wavelet Transform (DWT) is presently utilized as a part of a wide assortment of flag preparing applications, for example, in sound and video pressure, evacuation of commotion in sound, and the reenactment of remote radio wire appropriation. Wavelets have their vitality packed in time and are appropriate for the investigation of transient, time-differing signals. Since the majority of the genuine signs experienced are time fluctuating in nature, the Wavelet Transform suits numerous applications extremely well. We utilize the DWT to execute a straightforward watermarking plan. The 2-D discrete wavelet changes (DWT) disintegrates the picture into sub-pictures, 3 subtle elements and 1 guess. The guess looks simply like the first; just on 1/4 the scale. The 2-D DWT is a use of the 1-D DWT in both the level and the vertical bearings. The DWT isolates a picture into a lower determination estimate picture (LL) and in addition even (HL), vertical (LH) and corner to corner (HH) detail parts.

The low-pass and high pass channels of the wavelet change actually break a flag into comparative (low pass) and spasmodic/quickly evolving (high-pass) sub-signals. The moderate changing parts of a flag are safeguarded in the channel with the low pass channel and the rapidly changing parts are kept in the high-pass' channel. In this manner we can implant high vitality watermarks in the districts that human vision is less touchy to, for example, the high-determination detail groups (LH, HL, and HH). Inserting watermarks in these areas enable us to build the vigor of our watermark, at practically zero extra effect on picture quality. The way that the DWT is a multi-scale investigation can be utilized to the watermarking calculation's event.

The change of a flag is simply one more type of speaking to the flag. It doesn't change the data content present in the flag. Fourier Transmission (FT) portrayals do exclude neighborhood data about the first flags. Despite the fact that the WFTs can give confinement data, they don't give adaptable division of the time-recurrence plane that can track moderate changing marvels while giving more subtle elements to higher Frequencies. The wavelet portrayal was acquainted with revise the downside of the previous two techniques utilizing a multi-determination conspire.

The Wavelet Transform gives a period recurrence portrayal of the flag. A wavelet arrangement is portrayal of a square-basic (genuine or complex esteem) work by a specific orthonormal (two vectors in an internal item space are orthonormal in the event that they are orthogonal (when two things can autonomously or they are opposite) and all of unit length).

There are two groupings of wavelets:

(a) orthogonal (The low pass and high pass channels have same length)

(b)bi-orthogonal (The low pass and high pass channels don't have same length). In light of the application, both of them can be utilized.

The Wavelet changes add to the coveted testing by separating the flag with interpretations and enlargements of an essential capacity called "mother wavelet". The mother wavelet can be utilized to frame orthonormal bases of wavelets, which is especially valuable for information recreation.

A wavelet, in the feeling of the Discrete Wavelet Transform (or DWT), is an orthogonal capacity which can be connected to a limited gathering of information. Practically, it is especially similar to the Discrete Fourier Transform, in that the changing capacity is orthogonal, a flag went twice through the change is unaltered, and the information flag is thought to be an arrangement of discrete-time tests. Both changes are convolutions. The Discrete Wavelet Transform(DWT), which depends on sub-band coding is found to yield a quick calculation of Wavelet Transform. It is anything but difficult to execute and lessens the calculation time and assets required.

In DWT, the most unmistakable data in the flag shows up in high amplitudes and the less conspicuous data shows up in low amplitudes. Information pressure can be accomplished by disposing of these low amplitudes. The wavelet changes empowers high pressure proportions with great nature of remaking. As of late, the Wavelet Transforms have been decided for the JPEG 2000 pressure standard.

The discrete wavelet change utilizes low-pass and high-pass channels, h(n) and g(n), to grow an advanced flag. They are alluded to as investigation channels. The enlargement performed for each scale is presently accomplished by a decimator. The coefficients and are delivered by convolving the computerized motion, with each channel, and after that destroying the yield. The coefficients are created by the low-pass channel, h(n), and called coarse coefficients. The coefficients are created by the high-pass channel and called detail coefficients. Coarse coefficients give data about low frequencies, and detail coefficients give data about high frequencies. Coarse and detail coefficients are delivered at different scales by repeating the procedure on the coarse coefficients of each scale. The whole procedure is registered utilizing a tree-organized channel bank, as found in Fig.

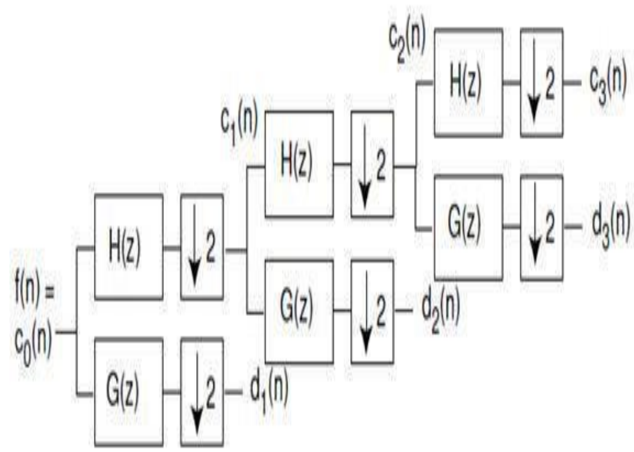


Fig 1. Analysis filter bank.

The high and low pass channels isolate the flag into a progression of coarse and detail coefficients. Subsequent to examining, or preparing, the flag in the wavelet space it is frequently important to restore the flag back to its unique area. This is accomplished utilizing union channels and expanders. The wavelet coefficients are connected to a combination channel bank to reestablish the first flag, as found in Fig.

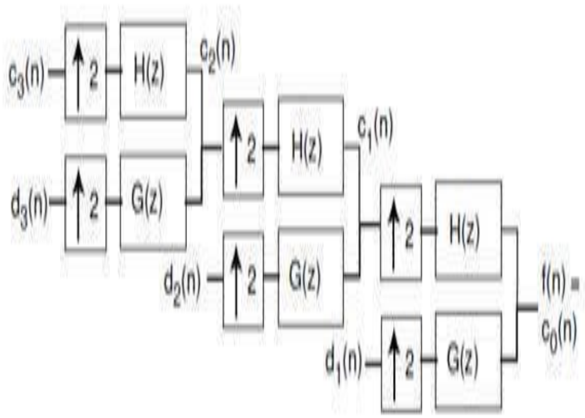


Fig 2. Synthesis Filter Bank.

The high and low pass channels consolidate the coefficients into the first flag. The discrete wavelet change has an immense number of utilizations in science, designing, and arithmetic and software engineering. The wavelet space portrayal of a picture, or any flag, is helpful for some applications, for example, pressure, clamor decrease, picture enrollment, watermarking, super-determination and so on.

IV. HAAR FUNCTION

For the most part, wavelets, with all speculations and adjustments, were expected to adjust this idea to some reasonable applications. The Discrete Wavelet Trans-frame utilizes the Haar capacities in picture coding, edge extraction and twofold rationale outline and is a standout amongst the most encouraging systems today. The non–sinusoidal Haar change is the total unitary change. It is neighborhood, in this manner can be utilized for information pressure of non–stationary "spiky" signs. The computerized pictures might be dealt with as such"spiky" signals. Lamentably, the Haar Transform has poor vitality compaction for picture, in this way by and by, essential Haar change is not utilized as a part of picture pressure. One ought to recall that investigates in this subject are still in advance and ordinary new arrangements and changes are found.

Fourier techniques are not generally great apparatuses to recover the flag, especially on the off chance that it is very non–smooth; an excessive amount of Fourier data is expected to remake the flag locally. In these cases the wavelet investigation is regularly exceptionally viable in light of the fact that it gives a basic way to deal with managing the neighborhood parts of a flag, consequently specific properties of the Haar or wavelet changes permit breaking down the first picture on unearthly area adequately. These techniques will be portrayed in this paper.

A. The Discrete HAAR Wavelet Transform

An extraordinary property of the Haar capacities is that aside from work haar(0, t), the i–th Haar capacity can be produced by the confinement of the (j − 1)–th capacity to be half of the interim where it is not quite the same as zero, by augmentation with 2 and scaling over the interim [0, 1]. These properties give extensive enthusiasm of the Haar work, since they nearly relate them to the wavelet hypothesis. In this setting, the initial two Haar capacities are known as the worldwide capacities, while all the others are signified as the neighborhood capacities. Subsequently, the Haar work, which is an odd rectangular heartbeat match, is the least difficult and most seasoned wavelet. The inspiration for utilizing the discrete wavelet change is to acquire data that is all the more separating by giving an alternate determination at various parts of the time–frequency plane. The wavelet changes permit the parceling of the time-recurrence space into non uniform tiles regarding the time–spectral substance of the flag. The wavelet techniques are firmly associated with traditional premise of the Haar capacities; scaling and expansion of a fundamental wavelet can produce the premise Haar capacities.

The operations performed for the process of digital image watermarking are clearly explained in the form of block diagram.

There are two stages involved in it.

1. Embedding
2. Extraction

Steps involved in embedding process**:**

Step1: Consider the host and watermark images as inputs

Step2: The RGB forms of the images are converted into their respective YCbCr forms. This is done in order to lower the intensity values.

Step3: Y-components of the YCbCr forms are selected for further process because they have the low intensity values when compared to the intensity values of chrominance blue and chrominance red components.

Step4: Sub banding the original images into LL(approximated image), LH (horizontal detail), HL(vertical detail) and HH(diagonal detail).

Step5: For both images DWT (discrete wavelet transform) is applied to the LL bands i.e. approximated image. This is done because any changes performed on the low frequencies are invisible.

Step6: The obtained DWT forms of host and watermark images are embedded by using the code (Wm_LL = H_LL+ α W_LL).Where "α" is multiplication coefficient

Step7: IDWT is applied on the output of embedding block.

Step8: now the YCbCr form of image is converted into its respective RGB form. Finally the colour watermarked image is obtained.

Steps involved in the extraction process:

Step1: The final output of embedding process is taken as the input for extraction process.

Step2: Convert the RGB form of watermarked image into its YCbCr form. . This is done in order to lower the intensity values.

Step3: Y-component of the YCbCr form is selected for further process because it has the low intensity values when compared to the intensity values of chrominance blue and chrominance red components.

Step4: Sub banding the original image into LL(approximated image), LH(horizontal detail), HL(vertical detail) and HH(diagonal detail).

Step5: DWT (discrete wavelet transform) is applied to the LL bands i.e. approximated image. This is done because any changes performed on the low frequencies are invisible.

Step6: The obtained output of an DWT block is given to the extraction where the watermark image is extracted from the watermarked image by using code(**Wnew_LL = (Wm_LL – H_LL) / α**)

Step7: IDWT is applied to the extracted watermark image.

Step8: The conversion of image which is in YCbCr form to RGB takes place in this step. This block gives us final extracted color watermark image.

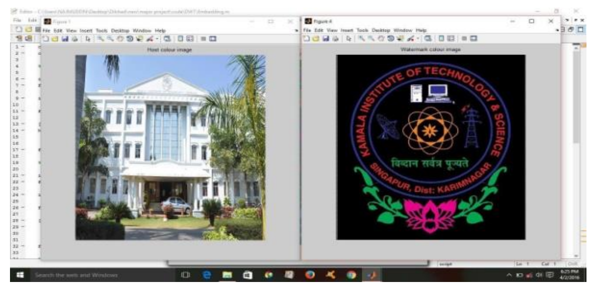
V. MATLAB SOFTWARE

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include

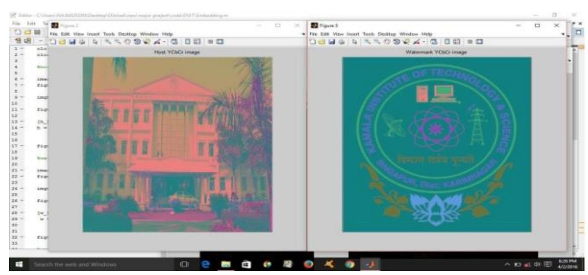
- Math and computation
- Algorithm development
- Data acquisition
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including graphical user interface building.

VI. RESULTS

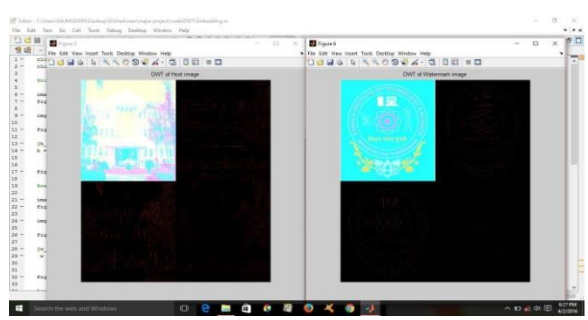
Considering the host image and watermark image in which it has more black pixels.



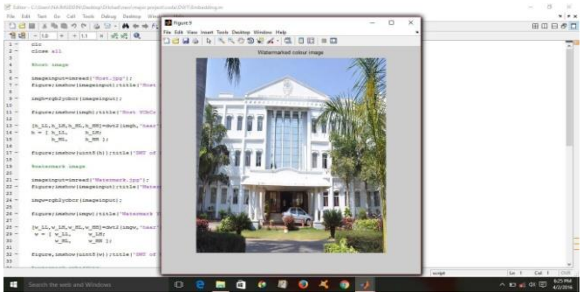
In this figure we are converting the host and watermark image to its corresponding YCbCr images , in the YCbCr we are selecting Y components as our requirement which has less intensity values when compared to chrominance blue and chrominance red , inorder to lower the effect to human eye.



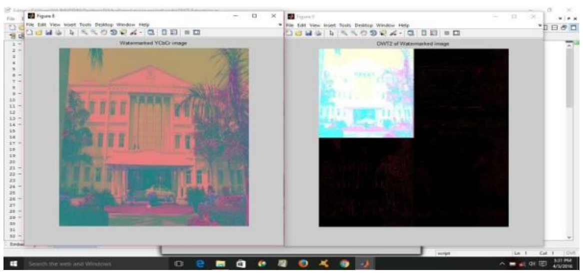
The obtained images are then sub banded into LL,LH,HL,HH signals.where LL gives us approximate image the remaining three we give us detail images,if any changes done in the detailed images that will be visible to our eye because of that reason we are selecting approximate image i,e; LL band.



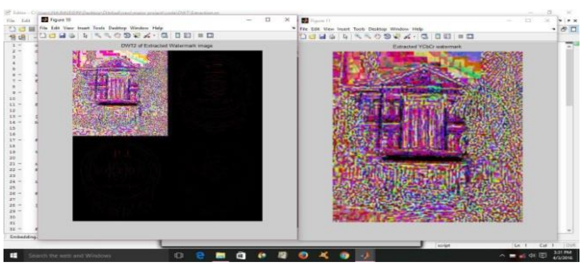
By using the embedding code($Wm\_LL = H\_LL + \alpha\ W\_LL$) ,we are embedding the watermark image into the host image. The finally obtained watermarked image is shown below figure.



The output of embedding process i.e, watermarked image will be the input for extraction process. Initially it is converted to its Ycbcr form then the discrete wavelet transform (dwt2) is applied to the Ycbcr image. This is shown in the figure below:

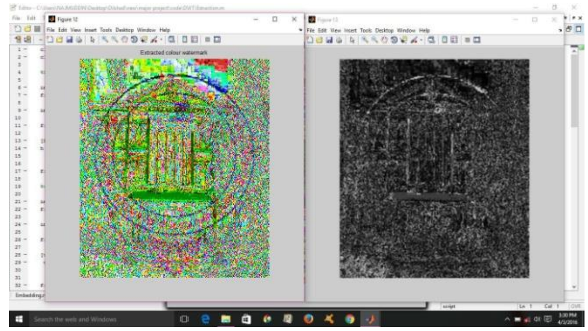


By using the extraction code $Wnew\_LL = (Wm\_LL – H\_LL) / \alpha$,we extract the watermark image from watermarked image. DWT2 is applied to this extracted watermark image, later the Ycbcr form of this extracted watermark is obtained.



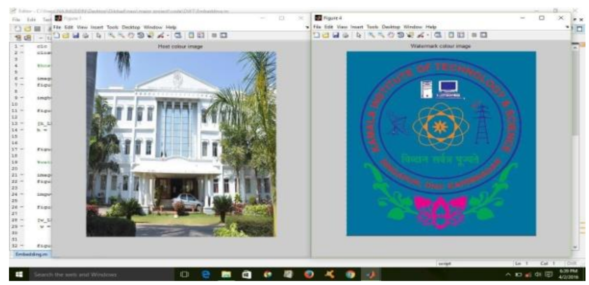
Finally the Ycbcr form of the image is converted to its RGB form i.e colored form. The extracted watermark will never be clear but it is disturbed.

The error image is useful for us in calculating the MSE and PSNR values of the image by which we can calculate their efficiencies.

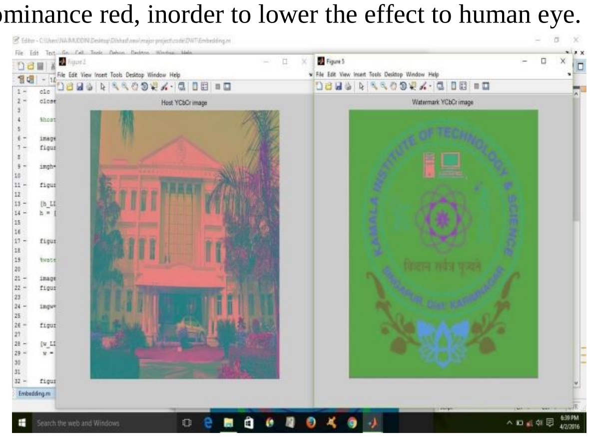


A. By Blue

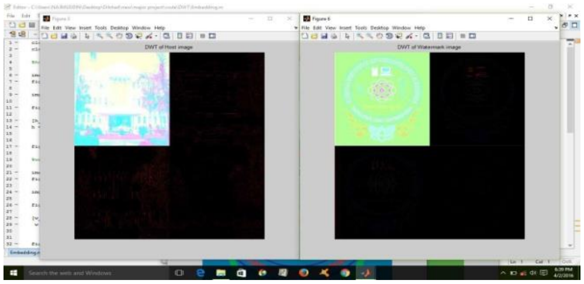
Considering the host image and watermark image in which it has more blue pixels.



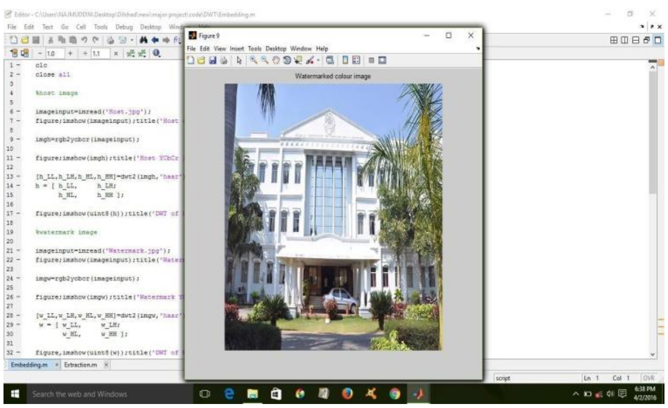
In this figure we are converting the host and watermark image to its corresponding YCbCr images, in the YCbCr we are selecting Y components as our requirement which has less intensity values when compared to chrominance blue and chrominance red, inorder to lower the effect to human eye.



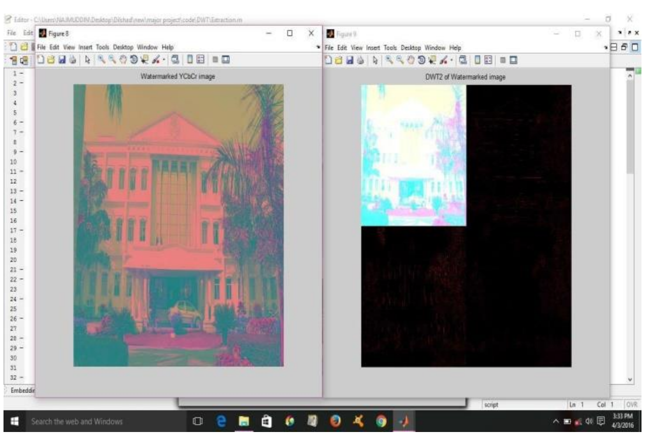
The obtained images are then sub banded into LL,LH,HL,HH signals. where LL gives us approximate image the remaining three we give us detail images, if any changes done in the detailed images that will be visible to our eye because of that reason we are selecting approximate image i.e. LL band.



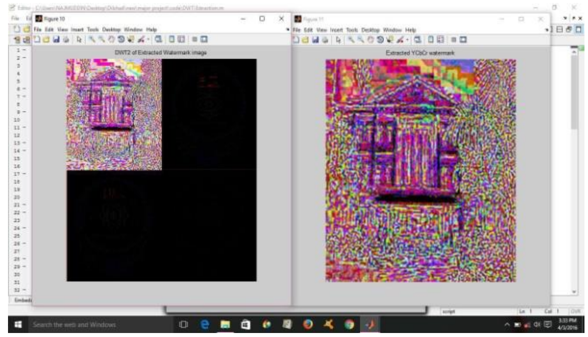
By using the embedding code (Wm_LL = H_LL + α W_LL) ,we are embedding the watermark image into the host image. The finally obtained watermarked image is shown below figure .



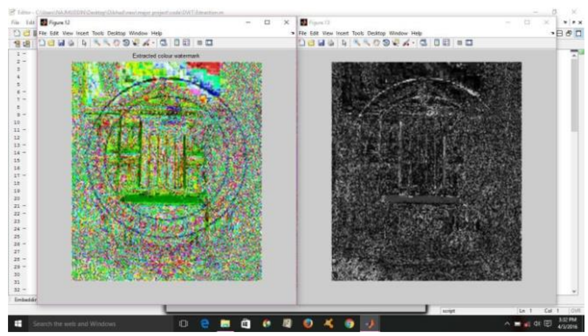
The output of embedding process i.e watermarked image will be the input for extraction process. Initially it is converted to its Ycbcr form then the discrete wavelet transform (dwt2) is applied to the Ycbcr image. This is shown in the figure below



By using the extraction code **Wnew_LL = (Wm_LL – H_LL) / α** ,we extract the watermark image from watermarked image. DWT2 is applied to this extracted watermark image, later the Ycbcr form of this extracted watermark is obtained



Finally the Ycbcr form of the image is converted to its RGB form i.e colored form. The extracted watermark will never be clear but it is disturbed. The error image is useful for us in calculating the MSE and PSNR values of the image by which we can calculate their efficiencies.



VII. DIGITAL WATERMARKING APPLICATIONS

There are two main applications of watermarking copyright protection and information hiding. For the area of copyright protection, the user can unambiguously identify themselves as the owner of the image (video, audio etc.) For information hiding, data can be hidden in a seemingly normal image and the image transmitted. The data can then be extracted at the other end, assuming that the user at the other end has the relevant information to do so.

In order to fully understand the main challenges involved in the development of watermarking related tools, some applications of invisible watermarks are listed here

VIII. Digital Watermarking Technology for Rights Management

One of the traditional applications of the watermark is copy-right protection. The primary reason for using watermarks is to identify the owner of the content by an invisible hidden "mark" that is imprinted into the image. In many cases, the watermark is used in addition to the content encryption, where the encryption provides the secure distribution method from the content owners to the receivers, and the watermark offers the content owners the opportunity to trace the contents and detect the unauthorized use or duplications. Without water-marking, there is no way to extend the control of the content owner once the content leaves the protected digital domain and is released to the user.

IX. CONCLUSION

The digital watermarking technique is very impressive for image authentication or protection for attacks. The frequency domain technique are good for applications where exact watermark need to be extracted and channel do not consists any noise. The robustness is the very important requirements of digital watermarking. So that improving the robustness in a watermarking is may be decreasing the imperceptibility, and vice versa. The performance measures like MSE and PSNR gives the idea of using perfect watermark which consists of less noise factors. This is done in this project by comparing the values in the form of table. The one with high PSNR value in the extraction process is considered to be the best suitable watermark.

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