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IMPROVING ROBUSTNESS FOR IMAGE WATERMARKING USING HISTOGRAM SHAPED METHOD AND LIFTING WAVELET TRANSFORM

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Abstract

Cropping and random bending are two common attacks in image watermarking. A novel image-watermarking method has been proposed to deal with these attacks, as well as other common attacks. In the embedding process, we first pre process the host image by a Gaussian low-pass filter. Then, a secret key is used to randomly select a number of gray levels and the histogram of the filtered image with respect to these selected gray levels is constructed. After that, a histogram-shape-related index is introduced to choose the pixel groups with the highest number of pixels and a safe band is built between the chosen and non chosen pixel groups. A watermark-embedding scheme is proposed to insert watermarks into the chosen pixel groups. The usage of the histogram-shape-related index and safe band results in good robustness. Moreover, a novel high-frequency component modification mechanism is also utilized in the embedding scheme to further improve robustness. At the decoding end, based on the available secret key, the watermarked pixel groups are identified and watermarks are extracted from them. The effectiveness of the proposed image-watermarking method is demonstrated by simulation examples.

Keywords: Watermarking, DCT, Gaussian, PSNR, DWT, BER, robustness, histogram

I.INTRODUCTION

A digital watermark is a kind of marker covertly embedded in a noise-tolerant signal such as an audio, video or image data. It is typically used to identify ownership of the copyright of such signal. "Watermarking" is the process of hiding digital information in a carrier signal; the hidden information should, but does not need to, contain a relation to the carrier signal. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners. It is prominently used for tracing copyright infringements and for banknote authentication. Like traditional watermarks, digital watermarks are only perceptible under certain conditions, i.e. after using some algorithm, and imperceptible otherwise. If a digital watermark distorts the carrier signal in a way that it becomes perceivable, it is of no use. Traditional Watermarks may be applied to visible media (like images or video), whereas in digital watermarking, the signal may be audio, pictures, video, texts or 3D models. A signal may carry several different watermarks

at the same time. Unlike metadata that is added to the carrier signal, a digital watermark does not change the size of the carrier signal.

One application of digital watermarking is source tracking. A watermark is embedded into a digital signal at each point of distribution. If a copy of the work is found later, then the watermark may be retrieved from the copy and the source of the distribution is known. This technique reportedly has been used to detect the source of illegally copied movies.

CROPPING

Cropping refers to the removal of the outer parts of an image to improve framing, accentuate subject matter or change aspect ratio. Depending on the application, this may be performed on a physical photograph, artwork or film footage, or achieved digitally using image editing software. The term is common to the film, broadcasting, photographic, graphic design and printing industries.

In the printing, graphic design and photography industries, cropping[1] refers to removing unwanted areas from a photographic or illustrated image. One of the most basic photo manipulation processes, it is performed in order to remove an unwanted subject or irrelevant detail from a photo, change its aspect ratio, or to improve the overall composition.[2] In telephoto photography, most commonly in bird photography, an image is cropped to magnify the primary subject and further reduce the angle of view when a lens of sufficient focal length to achieve the desired magnification directly is not available.

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GAUSSIAN FILTERING

In electronics and signal processing, a Gaussian filter is a filter whose impulse response is a Gaussian function (or an approximation to it). Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. Mathematically, a Gaussian filter modifies the input signal by convolution with a Gaussian function; this transformation is also known as the Weierstrass transform. The one-dimensional Gaussian filter has an impulse response given by

$$g(x) = \sqrt{\frac{a}{\pi}} \cdot e^{-a \cdot x^2}$$

and the frequency response is given by the Fourier transform

$$\hat{g}(f) = e^{-\frac{\pi^2 f^2}{a}}$$

with f the ordinary frequency.

HISTOGRAM CONSTRUCTION

A histogram is a graphical representation of the distribution of numerical data. It is an estimate of the probability distribution of a continuous variable (quantitative variable) and was first introduced by Karl Pearson. To construct a histogram, the first step is to "bin" the range of values that is, divide the entire range of values into a series of intervals and then count how many values fall into each interval. The bins are usually specified as consecutive, non-overlapping intervals of a variable. The bins (intervals) must be adjacent, and are usually equal size.

In a more general mathematical sense, a histogram is a function m_i that counts the number of observations that fall into each of the disjoint categories (known as bins), whereas the graph of a histogram is merely one way to represent a histogram. Thus, if we let n be the total number of observations and k be the total number of bins, the histogram m_i meets the following conditions:

$$n = \sum_{i=1}^{k} m_i.$$

CUMULATIVE HISTOGRAM

A cumulative histogram is a mapping that counts the cumulative number of

observations in all of the bins up to the specified bin. That is, the cumulative histogram M_i of a histogram m_j is defined as:

$$M_i = \sum_{j=1}^{i} m_j.$$

II EXISTING SYSTEM

ANALYSIS OF FOURIERTRANSFORM

The Fourier transform decomposes a function of time (a signal) into the frequencies that make it up, similarly to how a musical chord can be expressed as the amplitude (or loudness) of its constituent notes. For many functions of practical interest one can define an operation that reverses this: the inverse Fourier transformation, also called Fourier synthesis, of a frequency domain representation combines the contributions of all the different frequencies to recover the original function of time.

There are several common conventions for defining the Fourier transform $\hat{f}$ of an integrable function $f : \mathbb{R} \to \mathbb{C}$ (Kaiser 1994, p. 29), (Rahman 2011, p. 11). This article will use the following definition:

$$\hat{f}(\xi) = \int_{-\infty}^{\infty} f(x)\, e^{-2\pi i x \xi}\, dx,$$ for any real number ξ.

When the independent variable x represents time (with SI unit of seconds), the transform variable ξ represents frequency (in hertz). Under suitable conditions, f is determined by $\hat{f}$ via the inverse transform:

$$f(x) = \int_{-\infty}^{\infty} \hat{f}(\xi)\, e^{2\pi i \xi x}\, d\xi,$$ for any real number x.

The statement that f can be reconstructed from $\hat{f}$ is known as the Fourier inversion theorem, and was first introduced in Fourier's Analytical Theory of Heat, although what would be considered a proof by modern standards was not given until much later. The functions f and $\hat{f}$ often are referred to as a Fourier integral pair or Fourier transform pair.

Drawbacks:

- Fake Eyes tend to be more seriously distorted by the imaging system and thus yield a lower quality image under the same capturing condition.
- The Fourier transform has led to a very specific and limited view of frequency in the context of signal processing.
- The Fourier transform is essentially an integral over time. Thus, we lose all information that varies with time.

DIFFERENCE OG GAUSSIANS

In science, difference of Gaussians is a feature enhancement algorithm that involves the subtraction of one blurred version of an original image from another, less blurred version of the original. Thus, the difference of Gaussians is a band-pass filter that discards all but a handful of spatial frequencies that are present in the original grayscale image.

Given a m-channels, n-dimensional image

$$I : \{\mathbb{X} \subseteq \mathbb{R}^n\} \to \{\mathbb{Y} \subseteq \mathbb{R}^m\}$$

The difference of Gaussians (DoG) of the image I is the function

$$\Gamma_{\sigma_1,\sigma_2} : \{\mathbb{X} \subseteq \mathbb{R}^n\} \to \{\mathbb{Z} \subseteq \mathbb{R}\}$$

obtained by subtracting the image I convolved with the Gaussian of variance σ_2^2 from the image I convolved with a Gaussian of narrower variance σ_1^2, with $\sigma_2 > \sigma_1$. In one dimension, Γ is defined as:

$$\Gamma_{\sigma_1,\sigma_2}(x) = I * \frac{1}{\sigma_1\sqrt{2\pi}} e^{-(x^2)/(2\sigma_1^2)} - I * \frac{1}{\sigma_2\sqrt{2\pi}} e^{-(x^2)/(2\sigma_2^2)}.$$

and for the centred two-dimensional case :

$$\Gamma_{\sigma,K\sigma}(x,y) = I * \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/(2\sigma^2)} - I * \frac{1}{2\pi K^2\sigma^2} e^{-(x^2+y^2)/(2K^2\sigma^2)}$$

which is formally equivalent to:

$$\Gamma_{\sigma,K\sigma}(x,y) = I * \left(\frac{1}{2\pi\sigma^2}e^{-(x^2+y^2)/(2\sigma^2)} - \frac{1}{2\pi K^2\sigma^2}e^{-(x^2+y^2)/(2K^2\sigma^2)}\right)$$

which represents an image convoluted to the difference of two Gaussians, which approximates a Mexican Hat function.

Drawbacks

- DoG filters and a standard sparse logistic regression model, to bad illumination conditions.

LOCAL BINARY PATTERNS (LBP)

Local binary patterns (LBP) are a type of feature used for classification in computer vision. LBP is the particular case of the Texture Spectrum model proposed in 1990.LBP was first described in 1994.It has since been found to be a powerful feature for texture classification; it has further been determined that when LBP is combined with the Histogram of oriented gradients (HOG) descriptor, it improves the detection performance considerably on some datasets.

Drawbacks

- Although these methods are effective when a single image is used, they are vulnerable to high resolution-based spoofing attacks that use a large display.

DISCRETE COSINE TRANSFORM (DCT)

A discrete cosine transform (DCT) expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. DCTs are important to numerous applications in science and engineering, from lossy compression of audio (e.g. MP3) and images (e.g. JPEG) (where small high-frequency components can be discarded), to spectral methods for the numerical solution of partial differential equations. The use of cosine rather than sine functions is critical for compression, since it turns out (as described below) that fewer cosine functions are needed to approximate a typical signal, whereas for differential equations the cosines express a particular choice of boundary conditions.

In particular, a DCT is a Fourier-related transform similar to the discrete Fourier transform (DFT), but using only real numbers. DCTs are equivalent to DFTs of roughly twice the length, operating on real data with even symmetry (since the Fourier transform of a real and even function is real and even), where in some variants the input and/or output data are shifted by half a sample. There are eight standard DCT variants, of which four are common.

Formally, the discrete cosine transform is a linear, invertible function $f : \mathbb{R}^N \to \mathbb{R}^N$ (where $\mathbb{R}$ denotes the set of real numbers), or equivalently an invertible N ×N square matrix. There are several variants of the DCT with slightly modified definitions. The N real numbers x_0, x_{N-1} are transformed into the N real numbers X_0, ..., X_{N-1} according to one of the formulas:

DCT-I[edit]

$$X_k = \frac{1}{2}(x_0 + (-1)^k x_{N-1}) + \sum_{n=1}^{N-2} x_n \cos\left[\frac{\pi}{N-1}nk\right] \qquad k = 0,\ldots,N-1.$$

Drawbacks

- it is complex
- it has poor energy compaction

COMPARISON

Methods	PSNR(db)
Histogram shifting technique	72.41
Haar wavelet transform	78.62
Sorting technique	74.81
Optimal histogram pair shifting	78.00
Dynamic prediction error histogram shifting	79.06
Duality approach	39.10

DWT-DFT composite watermarking	41.10
DWT method	41.1
DCT	26.44
Non-Linear Regression	8.45

III PROPOSED SYSTEM

WATERMARK ENCODING PROCESS

A digital watermark is a kind of marker covertly embedded in a noise-tolerant signal such as an audio, video or image data. It is typically used to identify ownership of the copyright of such signal. "Watermarking" is the process of hiding digital information in a carrier signal; the hidden information should, but does not need to, contain a relation to the carrier signal. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners. It is prominently used for tracing copyright infringements and for banknote authentication. Both steganography and also the digital watermarking are employed to the steganographic techniques to embed data covertly in noisy signals. But whereas steganography aims for imperceptibility to human senses, digital watermarking tries to control the robustness as top priority.

Since a digital copy of data is the same as the original, digital watermarking is a passive protection tool. It just marks data, but does not degrade it or control access to the data.

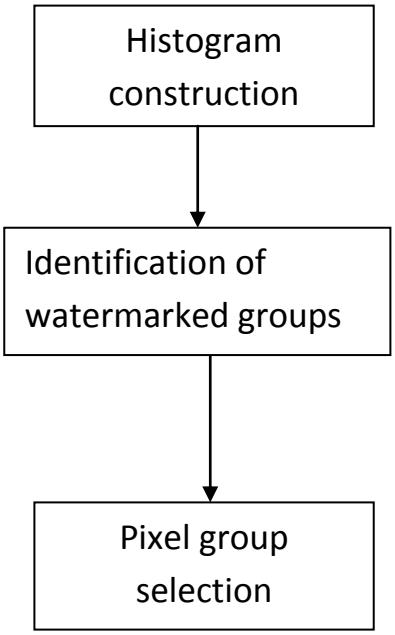
WATERMARK DECODING PROCESS

One application of digital watermarking is source tracking. A watermark is embedded into a digital signal at each point of distribution. If a copy of the work is found later, then the watermark may be retrieved from the copy and the source of the distribution is known. This technique reportedly has been used to detect the source of illegally copied movies.

Digital watermarking may be used for a wide range of applications, such as:

- Copyright protection
- Source tracking (different recipients get differently watermarked content)
- Broadcast monitoring (television news often contains watermarked video from international agencies)
- Video authentication
- One of the most important is the Software crippling on screen casting programs, to encourage users to purchase the full version to remove it.
- A digital watermark is called robust with respect to transformations if the embedded information may be detected reliably from the marked signal, even if degraded by any number of transformations.

PREPROCESSING
GAUSSIAN FILTERING



In electronics and signal processing, a Gaussian filter is a filter whose impulse response is a Gaussian function (or an approximation to it). Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. This behavior is closely connected to the fact that the Gaussian filter has the minimum possible group delay. It is considered the ideal time domain filter, just as the sinc is the ideal frequency domain filter. These properties are important in areas such as the oscilloscopes[2] and digital telecommunication systems.

Mathematically, a Gaussian filter modifies the input signal by convolution with a Gaussian function; this transformation is also known as the Weierstrass transform.

The one-dimensional Gaussian filter has an impulse response given by

$$g(x) = \sqrt{\frac{a}{\pi}} \cdot e^{-a \cdot x^2}$$

and the frequency response is given by the Fourier transform

$$\hat{g}(f) = e^{-\frac{\pi^2 f^2}{a}}$$

with f the ordinary frequency. These equations can also be expressed with the standard deviation as parameter

$$g(x) = \frac{1}{\sqrt{2\pi} \cdot \sigma} \cdot e^{-\frac{x^2}{2\sigma^2}}$$

and the frequency response is given by

$$\hat{g}(f) = e^{-\frac{f^2}{2\sigma_f^2}}$$

HISTOGRAM CONSTRUCTION

A histogram is a graphical representation of the distribution of numerical data. It is an estimate of the probability distribution of a continuous variable (quantitative variable) and was first introduced by Karl Pearson. To construct a histogram, the first step is to "bin" the range of values that is, divide the entire range of values into a series of intervals and then count how many values fall into each interval. The bins are usually specified as consecutive, non-overlapping intervals of a variable. The bins (intervals) must be adjacent, and are usually equal size.

If the bins are of equal size, a rectangle is erected over the bin with height proportional to the frequency, the number of cases in each bin. In general, however, bins need not be of equal width; in that case, the erected rectangle has area proportional to the frequency of cases in the bin The vertical axis is not frequency but density: the number of cases per unit of the variable on the horizontal axis. A histogram may also be normalized displaying relative frequencies. It then shows the proportion of cases that fall into each of several categories, with the sum of the heights equaling 1. Examples of variable bin width are displayed on Census bureau data below.

Thus, if we let n be the total number of observations and k be the total number of bins, the histogram m_i meets the following conditions:

$$n = \sum_{i=1}^{k} m_i.$$

CUMULATIVE HISTOGRAM

A cumulative histogram is a mapping that counts the cumulative number of observations in all of the bins up to the specified bin. That is, the cumulative histogram M_i of a histogram m_j is defined as:

$$M_i = \sum_{j=1}^{i} m_j.$$

EMBEDDING METHOD

A digital watermarking method is referred to as spread-spectrum if the marked signal is obtained by an additive modification. Spread-spectrum watermarks are known to be modestly robust, but also to have a low information capacity due to host interference.

A digital watermark is called robust with respect to transformations if the embedded information may be detected reliably from the marked signal, even if

degraded by any number of transformations. Typical image degradations are JPEG compression, rotation, cropping, additive noise, and quantization. For video content, temporal modifications and MPEG compression often are added to this list. A digital watermark is called imperceptible if the watermarked content is perceptually equivalent to the original, un watermarked content. In general, it is easy to create either robust watermarks or imperceptible watermarks, but the creation of both robust and imperceptible watermarks has proven to be quite challenging. Robust imperceptible watermarks have been proposed as a tool for the protection of digital content, for example as an embedded no-copy-allowed flag in professional video content.

ROBUSTNESS

A digital watermark is called "fragile" if it fails to be detectable after the slightest modification. Fragile watermarks are commonly used for tamper detection (integrity proof). Modifications to an original work that clearly are noticeable, commonly are not referred to as watermarks, but as generalized barcodes.

A digital watermark is called semi-fragile if it resists benign transformations, but fails detection after malignant transformations. Semi-fragile watermarks commonly are used to detect malignant transformations.

A digital watermark is called robust if it resists a designated class of transformations. Robust watermarks may be used in copy protection applications to carry copy and no access control information.

IV IMPLEMENTATION

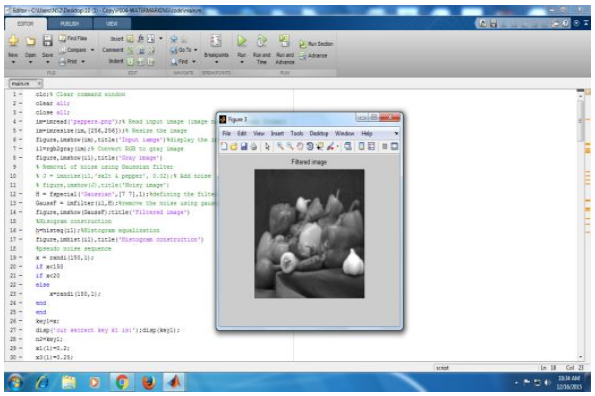


Fig 1 Input Image

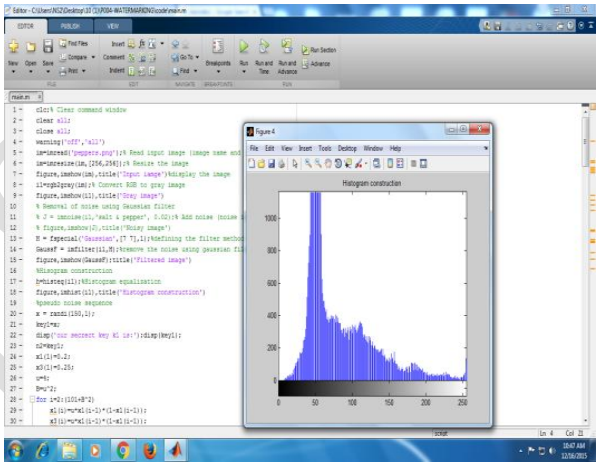


Fig 2 Filtered Image

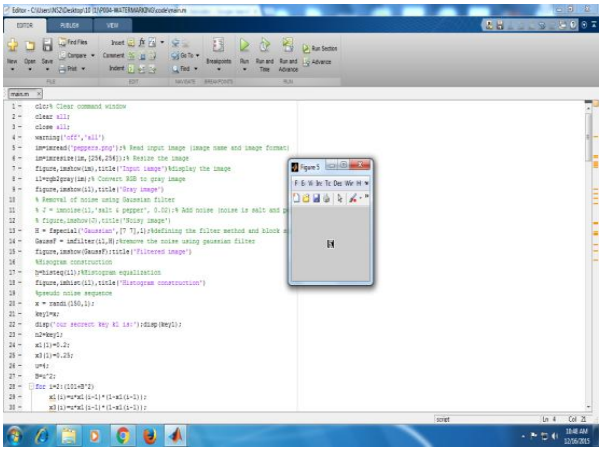


Fig. 3 Histogram Construction

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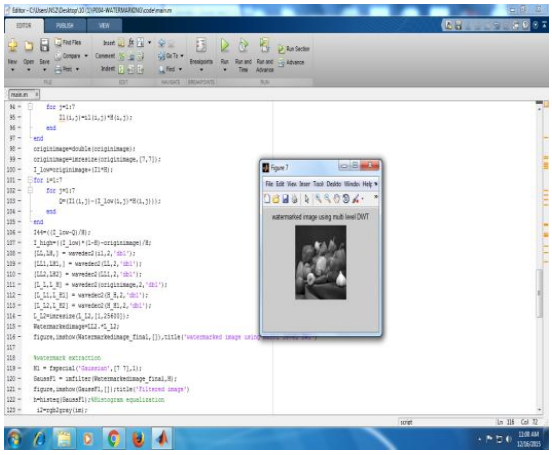

Fig 4 Secret Image

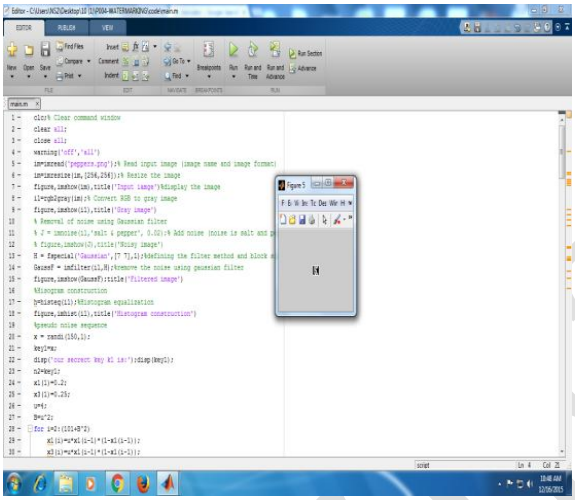

Fig 5 Watermarked Image

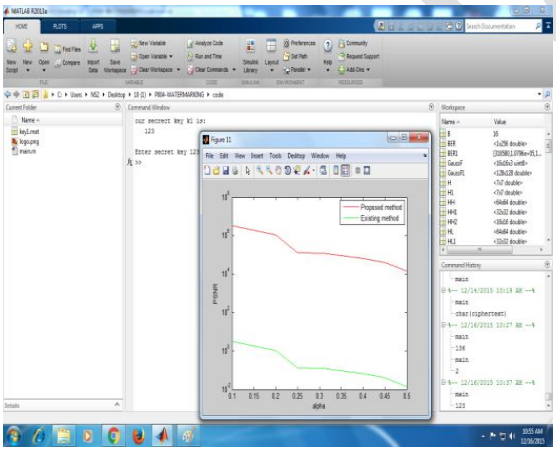

Fig 6 Retrieving Secret Image

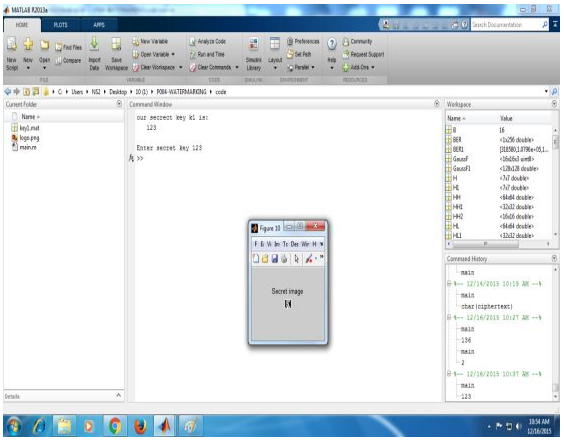

Fig 7 PSNR Comparison

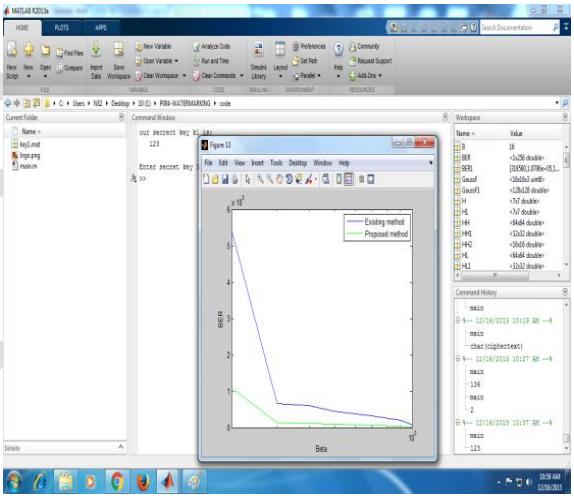

Fig 8 BER

V CONCLUSION

To deal with signal processing attacks, a Gaussian low-pass filter is employed to pre process the host image such that watermarks will only be embedded into the low-frequency component of the host image. tackle geometric attacks (including cropping attacks and RBAs), a histogram-shape-related index is utilized to form and select the most suitable pixel groups for watermark embedding. In addition, a safe band is introduced between the selected pixel groups and the non selected pixel groups to improve To robustness to geometric attacks. Furthermore, a novel HFCM scheme is

proposed to compensate the side effect of Gaussian filtering, which further enhances robustness. Due to the usage of secret key, the proposed watermarking method is also secure. The superior performance of the proposed method is demonstrated by simulation results. The LWT results in getting good reconstruction of watermark embedded image, increasing smoothness and decreasing aliasing effects since down sampling and up sampling is avoided in lifting scheme and also SVD helps to maintain the fidelity of the watermarked image and it reconstructs the watermark more efficiently.

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