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Image and Audio Embedding Technique in Image Steganography Using Neural Networks

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Abstract: In this paper, we clarify what steganography is and what it can do. The Steganography is the prowess of hiding information in the ways that fend off the revealing of secret messages. This project work discusses about image and audio embedding technique based on Neural Network FFBP-NN. Feed forward back propagation technique enhances the surety of the data. The data is encrypted by using the DCT technique and then hidden using the medical image and audio by tapping the abilities of FFBP-NN with the use of linear embedding technique and considering the characteristics of Human Audio System (HAS), a NN restrainer(controller) is designed to ensure the strength of embedded data adapting to the host audio itself entirely. The simulation experiment results show that the technique is racy (robust) too common digital audio processing methods as well as the quality of the medical image and audio is guaranteed. This paper mainly focused on the problem of audio and the image using Artificial Neural Networks (ANNs) has been addressed. Neural Network is trained to recognize/classify elementary-actions such as epochs, time, gradient, performance and quality of the image. The applications being used in this project mainly concentrate on FFBP-NN. Steganography system using features derived from Discrete Cosine Transforms (DCT) coefficients along with FFBP-NN classifier is evaluated, using an image dataset of thirty images, containing four classes and each class having five images. The action being performed is classified and displayed on the user interface along with a spoken sound version with the help of "Levenberg-Marquardtm" method.

Keywords: DCT, IDCT, Linear Embedding, Encryption Technique, FFBP-NN, Blocks, Co-efficient, RGB image.

I.INTRODUCTION

Steganography is the prowess and science of hiding messages in such a way that they cannot be detected and fundamentally means "to hide in plain sight" [1]. The advent of digital media, there is a vast scope for new techniques. Steganography is basically a type of data hiding technique that can help hide information within a cover medium, while maintaining the integrity, confidentiality and the irremovability of the hidden secret information. The cover medium can be of various data formats such as text, image, audio, and video. The secret message that is to be hidden, which can be in different formats, is usually embedded inside the cover medium using various different steganographic algorithms. Digital watermarking is another type of data hiding techniques, also called a digital signature, which can assert the ownership of the document or cover medium, or can also be used to hide a secret message inside the cover medium[2].

It however usually cannot assure the confidentiality like steganography can, but does assure the integrity of a watermarked document. Encryption is the more commonly used data hiding technique, and it can ensure the confidentiality of the information. However anyone can just modify the information thus rendering it useless for any intended receiver and destroying the integrity of the original information. A new audio and medical image hiding based on neural network is discussed in this project. Embedding scheme accomplishes the perceptual foil by deciding the maximal acceptable strength of the embedded watermark using NN controller [3][4].

II.FUNDAMENTAL OF IMAGE PROCESSING AND NEURAL NETWORKS

Digital image processing (DIP) methodologies arise from two major areas of application: enhancement of visual information in terms of pixels for realizing by human and actioning of digital image for computer memory, transmission, and representation for perception [6]. Digital image processing appropriates the use of composite algorithms. Hence can offer advanced performance for tasks which are simpler, and the implementation of methods which would be impossible by analog means DIP provides pragmatic technology for feature extraction, pattern recognition, classification and projection. The techniques used to provide perception to digital computer are called image processing and analysis techniques [7]. An image is represented as a 2-D function f (x, y), where x and y are planar coordinates and the amplitude of f for any values of (x, y) is the saturation or gray layer of the image for those values of x, y and amplitude. When these values are finite, discrete and quantized quantities, then the image is said to be digital image. The fundamental steps in DIP involves, image acquisition, enhancement, restoration, compression, segmentation, representation and recognition. Compression plays a major role in image processing .There are two types of paradigm file compression algorithms Lossy and Lossless Compression. The former technique is based on Discrete Cosine Transform (DCT) algorithm that mainly provocates the images into parts of differing frequencies. One of the steps called quantization is performed, where a

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part of compression actually occurs and the less important frequencies are discarded [8]. The frequencies obtained in the image decompression work on called Inverse Discrete Cosine Transform (IDCT). There are many applications of DIP such as, human activity monitoring, action recognition, monitoring weather reports, enhancing images from underwater photography, enhancing architectural drawing, creating digital images for films etc.

III. PROPOSED METHOD

A. Data hiding Algorithm:

The Discrete Cosine Transform (DCT)

The discrete cosine transform (DCT) helps separate the image into parts of differing importance and it transforms a signal or image from the spatial domain to the frequency domain. The most popular use of DCT is for image compression as it forms the basis for international standard loss image compression algorithm known as JPEG [21]. In just a few coefficients, most of the visual information about the image is concentrated. Extracted DCT coefficients can be used for recognition tasks such as action recognition. DCT normally discards high-frequency coefficients and transforms the low frequency ones, which reduces the data volume without sacrificing too much image quality.

A 2D-DCT of an M x N matrix is defined as follows:

$$F(u) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} \Lambda(i).cos\left[\frac{\pi.u}{2.N}(2i+1)\right] f(i)$$

and the corresponding inverse 1D DCT transform is simple $F^{-1}(u)$, i.e.

where

$$\Lambda(i) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for} \xi = 0 \\ 1 & \text{otherwise} \end{cases}$$

The general equation for a 2D (N by M image) DCT is defined by the following equation:

$$F(u,v) = \left(\frac{2}{N}\right)^{\frac{1}{2}} \left(\frac{2}{M}\right)^{\frac{1}{2}} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} \Lambda(i).\Lambda(j).cos$$

and the corresponding ***inverse*** 2D DCT transform is simple $F^{-1}(u,v)$, i.e.:

where

$$\Lambda(\xi) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for} \xi = 0 \\ 1 & \text{otherwise} \end{cases}$$

The basic operation of the DCT is as follows:

- The input image is N by M.

f(i,j) is the intensity of the pixel in row i and column j;

- F(u,v) is the DCT coefficient in row k1 and column k2 of the DCT Matrix.
- For most images, much of the signal energy lies at low frequencies,these appear in the upper left corner of the DCT.
- Compression is achieved since the lower right values represent higher frequencies, and are often small - small enough to be neglected with little visible distortion.
- The DCT input is an 8 by 8 array of integers. 8 bit pixels have levels from 0 to 255.
- Therefore an 8 point DCT would be:

Where

$$\Lambda(\xi) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for} \xi = 0 \\ 1 & \text{otherwise} \end{cases}$$

Therefore basic fundamental of image steganography using neural network in this project suggested as follows.

- By taking color image (RGB) as cover image (like JPEG 256*256 aspect ratio) and convert into gray scale image i.e. monochromatic plane/color image. Hence resize of image is done.
- Secret medical image used in this project is tif image format (32*32 aspect ratio) apply DCT technique to the blocks of the cover image .Entire cover image divided into 8*8 blocks and collect the feature extractions.
- Encoded data using DCT technique will be embedded by using "Linear Embedding Technique" [13][14].
- Given input is already compressed format like WAV audio and Sun Extension formats, hence compressed audio and image will reduce the utilization of memory.
- FFBP-NN training and learning mainly focused on "gdmlm" method which gives the results like epoch, gradient, performance, time etc.
- Audio format which is used in this project will play entire music.

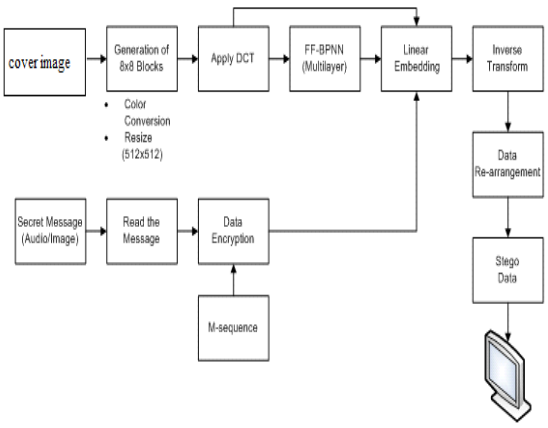

Figure: System Architecture for Image Steganography

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B.Data Extraction Algorithm

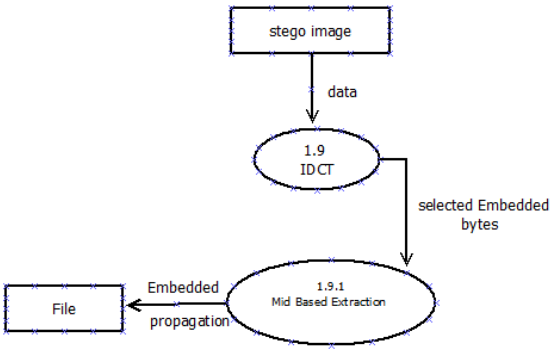

Figure:Flow Chart for Extraction

A) DCT Algorithm

The discrete cosine transform (DCT) assists distinguish the image into parts of disagreeing importance and it transforms a signal or image from the spatial domain to the frequency domain. The biggest use of DCT is for image compression as it forms the basis for international standard loss image compression algorithm known as JPEG [16][17]. In just a few coefficients, most of the visual information about the image is condensed. Extracted DCT coefficients can be used for recognition tasks such as action recognition. Action of images and audio has high correlation and redundant information which causes computational burden in terms of processing speed and memory utilization. DCT normally discards high-frequency coefficients and transforms the low frequency ones, which reduces the data volume without sacrificing too much image quality. This is a variation of the simple LSB technique. In this case, a discrete cosine transform (DCT) is used to transform 8 x 8 pixel blocks of the image into 64 DCT coefficients. This technique is used for files stored in the JPEG image format. The redundant bits selected to embed the hidden data are taken from the least–significant bits of the quantized DCT coefficients [13]. The modification on a single DCT coefficient affects all 64 image pixel blocks. Thus the smoothening of the pixel alteration is virtually impossible for human visual detection.

$$y(k) = w(k)\sum_{n=1}^{N} x(n)\cos\left(\frac{\pi}{2N}(2n-1)(k-1)\right), \quad k = 1, 2, \ldots N$$

where

$$w(k) = \begin{cases} \frac{1}{\sqrt{N}}, & k = 1, \\ \sqrt{\frac{2}{N}}, & 2 \le k \le N, \end{cases}$$

N is the length of x, and x and y are the same size. If x is a matrix, dct transforms its columns. The series is indexed from n = 1 and k = 1 instead of the usual n = 0 and k = 0 because MATLAB vectors run from 1 to N instead of from 0 to N – 1.y = dct(x,n) pads or truncates x to length n before transforming. The DCT is closely related to the discrete Fourier transform. To reconstruct a sequence very accurately from only a few DCT coefficients, a useful property for applications requiring data reduction.

B) Inverse DCT

The inverse discrete cosine transform reconstructs a sequence from its discrete cosine transform (DCT) coefficients. The idct function is the inverse of the dct function.

x = idct(y) returns the inverse discrete cosine transform of y

$$x(n) = \sum_{k=1}^{N} w(k)y(k)\cos\left(\frac{\pi(2n-1)(k-1)}{2N}\right) \quad n = 1, 2, \ldots N$$

Where

$$w(k) = \begin{cases} \frac{1}{\sqrt{N}} & k = 1 \\ \sqrt{\frac{2}{N}} & 2 \le k \le N \end{cases}$$

and N = length(x), which is the same as length(y). The series is indexed from n = 1 and k = 1 instead of the usual n = 0 and k = 0 because MATLAB® vectors run from 1 to N instead of from 0 to N-1.x = idct(y,n) appends zeros or truncates the vector y to length n before transforming. If y is a matrix, idct transforms its columns.

IV. IMPLEMENTATIONS AND MEASURES

MATLAB platform is chosen to develop the above steganographic algorithm. In a MATLAB framework there are extensive libraries and efficient functions of neural network and image processing which is very useful in steganography. Developers may use other programming language also.Security, embedding distortion and embedding rate can be used as schemes to evaluate the performance of the data hiding schemes.

A. Mean Squared Error & PSNR

The (weighted) mean squared error between the cover image and the stego-image (embedding distortion) can be used as one of the measures to assess the relative perceptibility of the embedded data. Imperceptibility takes advantage of human psycho visual redundancy, which is very difficult to quantify. Mean square error (MSE) and Peak Signal to Noise Ratio (PSNR) can also be used as metrics to measure the degree of imperceptibility.

B. Correlation

Correlation is one of the best known methods that evaluate the degree of closeness between two functions. This measure can be used to determine the extent to which the original image and the stego-image are close to each other, even after embedding data Localization, that is detection of the presence of the hidden data relies on the use of cross correlation function RXY of two images X and Y, defined as[8].

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V.Result Analysis

In this experiment we used JPEG and TIFF images of various resolutions as cover image. We train a set of 30 images which is randomly taken from internet. These images have various memory sizes. Image steganography uses the characteristics derived from 2D-DCT coefficients along with FFBP-NN tool. The system is evaluated in MATLAB using an image dataset of thirty images, containing four classes and each class having five images with dissimilar elementary objects.

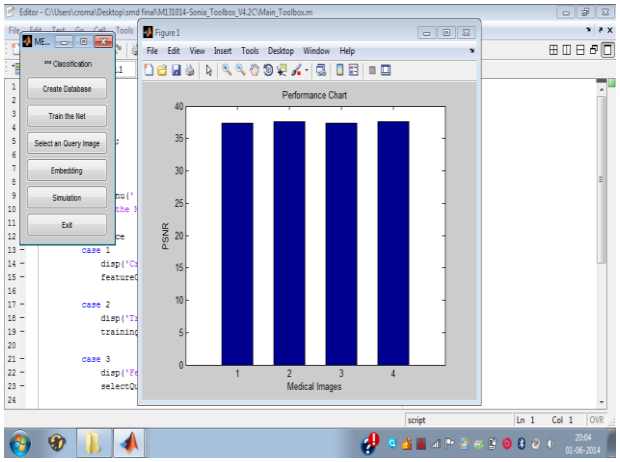

Figure: performance graph of PSNR ratio vs. Medical images

By performing the comparison of the cover image and the stego-image of existing system we come to conclude that the perceptibility ratio of the proposed method is better than the LSB steganography technique.

Table : Specifications of the MSE vs Epochs which relates the performance of images and audio format

Classes	MSE(mse)	Epochs	Performance
"01.jpg"	10 pow 0	2	0.1856
"02.jpg"	10 pow 2	3	0.2347
"03.jpg"	10 pow 4	5	0.2856
"04.jpg"	10 pow 5	8	0.3600

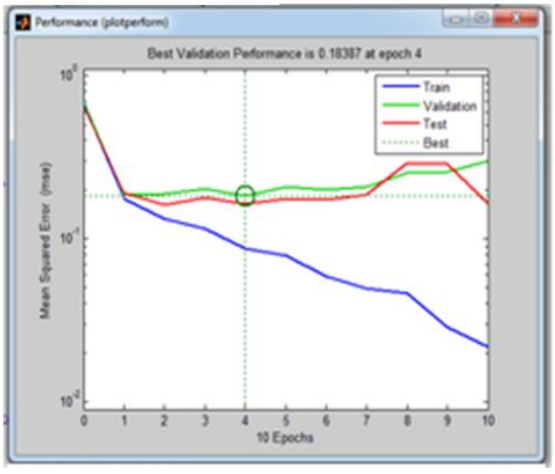

Figure: Performance graph MSE vs Epochs

Table: Specifications of the gradient, mu, val fail for the different images and audio formats.

Classes	Gradient	mu	Val fail
"01.jpg"	Gradient=0.123at epoch 2	Mu=0.001at epoch 2	Val=1 at epoch 2
"02.jpg"	Gradient=0.187at epoch 3	Mu=0.021at epoch 3	Val=2 at epoch 3
"03.jpg"	Gradient=0.123at epoch 3	Mu=0.031at epoch 3	Val=1 at epoch 4
"04.jpg"	Gradient=0.234 at epoch 5	Mu=0.801at epoch 5	Val=1 at epoch 2

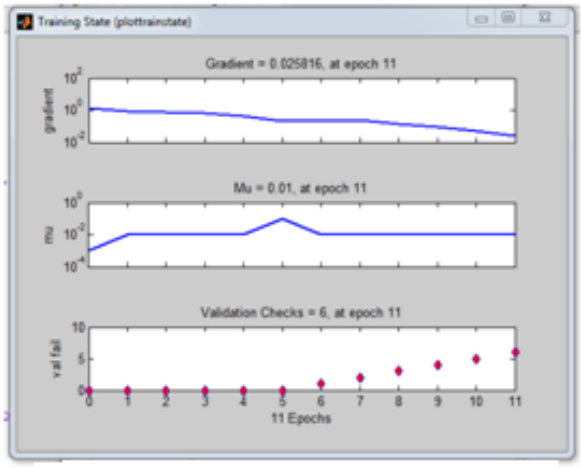

Figure: Training state graphs

VI. CONCLUSION AND FUTURE ENHANCEMENT

FFBP Neural Network is trained on images from one database for about 1000 epochs, and the system accomplished a recognition rate of 98.16% for fastest network training time. Among the algorithms and architectures suggested for Artificial Neural Networks, FFBP-NN is a supervised algorithm is used . The 2D-DCT and FFBP neural network are the heart for the design along with the implementation of encoding and decoding part of secret information. It can be implemented in server based system.Application can be enhanced to supports HDF, RAS, PPM image formats. Multilayered Feed Forward Neural Network can be used for embedding video frames, audio formats and images in image steganography.Comparison study with respect to neural network and fuzzy logic by using parameters like PSNR, MSE, Entropy, Training methodologies etc can be used to achieve better models or results in future.

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