A STUDY ON STEGO IMAGE TRANSMISSION THROUGH OFDM CHANNEL: A LITERATURE REVIEW

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Abstract— **Wireless communication plays important role in today's information exchange with higher data rates. Whether it is mobile communication, satellite communication and Wi-Fi communication. Therefore need of information security with data hiding is basic hygiene today. In this paper we propose the implementation of data hiding with more secure algorithm over ofdm channel. Simulink model is used for describing the function of OFDM in detail.**

Index Terms— **OFDM, Simulink model, Data hiding, Digital Modulation schemes**

I. INTRODUCTION

Wireless communication technology is currently one of the world's fastest growing technologies and enhancement the network connection built a strong connection between the users of it. Communication means sharing of information. Information may be image, audio, video, data. Basically all information is data, whether it is an image audio or video. The data is consists 0 and 1 bit stream. Data transmission or digital transmission or digital communication is the physical transfer of data (a digital bit stream) point-to-point or point-to-multipoint communication channel. Examples of such channels are copper wires, optical fibers, wireless communication channels, storage media and computer buses. The data are represented as an electromagnetic signal, such as an electrical voltage, radio wave , microwave, or infrared signal. While analog transmission is the transfer of a continuously varying analog signal, digital communications is the transfer of discrete messages. The messages are either represented by a sequence of pulses by means of a line code (baseband transmission), or by a limited set of continuously varying wave forms (pass band transmission), using a digital modulation method. The pass band modulation and corresponding demodulation (also known as detection) is carried out by modem equipment. According to the most common definition of digital signal, both baseband and pass band signals representing bit-streams are considered as digital transmission, while an alternative definition only considers the baseband signal as digital, and pass band transmission of digital data as a form of digital-to-analog conversion. Data transmitted may be digital messages originating from a data source, for example a computer or a keyboard. It may also be an analog signal such as a phone call or a video signal, digitized into a bit-stream for example using pulse-code modulation (PCM) or more advanced source coding (analog-to-digital conversion and data compression) schemes. This source coding and decoding is carried out by codec equipment. Modern communication systems use digital modulation techniques. Advancements in very large-scale and digital signal processing (DSP) technology have made digital modulation more effective than analog transmission systems. Digital modulation offers many advantages over analog modulation. Some advantages include greater noise immunity and robustness to channel impairment, easier multiplexing of various forms of information (eg. voice, data and video) and greater security.

Furthermore digital transmission accommodate digital error control codes which detect and correct transmission errors and support complex signal conditioning such as source coding ,encryption and equalization to improve the performance overall communication link. New multipurpose programmable digital signal processors have made it possible to implement digital modulators and demodulators completely in software. Instead of having a particular modem design permanently frozen as hardware embedded software implementation now allow alterations and improvements helping to redesign or replace modem. In digital wireless communication systems, the modulating (e .g the message) may be represented as a time sequence of symbols or pulses, where each symbol has m finite states .Each symbol represents n bits of information, where n = $\log_2 m$ bits/symbol. Many digital modulation schemes are used in modern wireless communication systems and many more are sure to be introduced. Some of these techniques have suitable differences between one another and each technique belongs to a family of related modulation methods. For example, phase shift keying (PSK) may be either coherently or differentially detected and may have two, four , eight or more possible levels (e g. n = 1,2,3 or more bits) per symbol, depending on the manner in which information is transmitted within single symbol.

II. FACTORS THAT INFLUENCE CHOICE OF A DIGITAL MODULATION

A desirable modulation scheme provides low bit rates at low received signal to noise ratios, performs well in multipath fading conditions, occupies a minimum bandwidth and is easy and cost effective to implement. Existing modulation schemes are better in terms of bandwidth efficiency. Depending on the demand s of the, particular application, tradeoffs are made when selecting a digital modulation. The performance of a modulation scheme is often measured in terms of its power efficiency and bandwidth efficiency. Power efficiency describes the ability of a modulation technique to preserve the fidelity of a digital message at low power levels. In a digital communication system, in order to increase noise immunity, it is necessary to increase the signal power. However the amount which the signal power should to be increase d to obtain a certain level of fidelity (i-e an acceptable bit error probability) depends on particular type modulation employed. The power efficiency n (sometimes called energy efficiency) of a digital modulation scheme is a measure of how favorably this tradeoff between fidelity and

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signal power is made and often it is expressed as the ratio of the signal energy per bit to noise power spectral density (E_b/N_o) required at the receiver input for a certain probability of error (say 10^{-5})

Bandwidth efficiency describes the ability of a modulation scheme to accommodate data within a limited bandwidth. In general, increasing the data rate implies decreasing the pulse width of a digital symbol, which increases bandwidth of the signal. Thus there is an unavoidable relationship between data rate and bandwidth occupancy .However some modulation schemes perform better than others in making this tradeoff. Bandwidth eted bandwidth is efficiency reflects how efficiently the allocated bandwidth is utilized and is defined as the ratio of the throughput data rate per hertz in a given bandwidth. If R is the data rate in bits per second and B is the bandwidth occupied by the modulated RF signal, then bandwidth efficiency n is expressed as

$$n=R/B \text{ bps/hz}$$

The system capacity of a digital mobile communication system is directly related to the bandwidth efficiency of the modulation scheme, since a modulation with a greater value of n will transmit more data in a given spectrum allocation. There is a fundamental upper bound on achievable bandwidth efficiency. Shannon's channel coding theorem states that for an arbitrarily small probability error ,the maximum possible bandwidth efficiency is limited by noise in the channel and it is given channel capacity formula .Note that Shannon's bound applies for AWGN non fading channels.

$$N_{b\,max} = C/B = \log_2(1+S/N)$$

Where C = Channel capacity (in bps)
B = RF bandwidth
S/N= Signal to noise ratio

In the design of a digital communication system, very often there is tradeoff between bandwidth efficiency and power efficiency. For example adding control coding to a message increases the bandwidth occupancy(and this in turn reduces the bandwidth efficiency) but at the same time reduces the required received power for particular bit error rate and hence trades bandwidth efficiency for power efficiency. On the other hand higher level modulation schemes (M- ary keying) decrease bandwidth occupancy bandwidth increase the required received power and hence trade power efficiency for bandwidth efficiency.

III. Orthogonal frequency-division multiplexing (OFDM)

It is a method of encoding digital data on multiple carrier frequencies. OFDM has developed into a popular scheme for wideband digital communication wireless or over copper wires, used in applications such as digital television and audio broadcasting, DSL Internet access, wireless networks, power line networks, and 4G mobile communications .OFDM is essentially identical to coded OFDM (COFDM) and discrete multi-tone modulation(DMT),and is a frequency-division multiplexing (FDM) scheme used as a digital multi-carrier modulation method. The word "coded" comes from the use of forward error correction (FEC). A large number of closely spaced orthogonal sub-carrier signals are used to carry data[1] on several parallel data streams or channels. Each sub-carrier is modulated with a conventional modulation scheme (such as quadrature amplitude modulation or phase-shift keying) at a low symbol rate, maintaining total data rates similar to conventional single-carrier modulation schemes in the same bandwidth. The primary advantage of OFDM over single-carrier schemes is its ability to cope with severe channel conditions (for example, attenuation of high frequencies in a long copper wire, narrowband interference andfrequency-selective fading dueto mult ipath)without complex equalization filters. Channel equalization is simplified because OFDM may be viewed as using many slowly modulated narrowband signals rather than one rapidly modulated wideband signal. The low symbol rate makes the use of a guard interval between symbols affordable, making it possible to eliminate intersymbol interference (ISI) and utilize echoes and time-spreading (on analogue TV these are visible as ghosting and blurring, respectively) to achieve a diversity gain, i.e. a signal-to-noise ratio improvement. This mechanism also facilitates the design of single frequency networks (SFNs), where several adjacent transmitters send the same signal simultaneously at the same frequency, as the signals from multiple distant transmitters may be combined constructively, rather than interfering as would typically occur in a traditional single-carrier system.

IV. DATA HIDING

Internet acts as an efficient, cost effective and popular information sharing channel through which the globe has been shrunk to a digital city. At the same time, this technology explosion has also added a new penal code into our law book for cyber crime. There are wide ranges of threats waiting for the data to be communicated through this modern post master. The data may be copied, destroyed or changed by an adversary who wants to use it illegally. These digital crimes throw light on an important issue namely information security, which would not be achieved only through encryption .The information security, has generated a flurry of recent research activities in the area of digital watermarking and data hiding. Watermarking is a data hiding technique in which the author's copyright for information is protected by some hidden watermarks while steganography utilizes the technique in which cover images are used for encapsulating confidential information. It could be further classified into two domains namely *time domain* and *frequency domain* where the data is embedded or watermarked .The stability of watermarking designs could be endorsed with the following features.

(1) *Imperceptibility:* Distinction between the watermarked and original version of the image is highly impossible to naked eye which there by retains the high image quality.

(2) *Privacy*: Copying, modifying or erasing the watermarked image by any hostile user is highly restricted.

(3) *Robustness:* The quality of the watermarked image is still acceptable even though it has undergone some signal processing or noises.

(4) *Statistically undetectable*: Statistical or mathematical means for detecting the image will be extremely hard or in vain.

(5) *Blind Detection*: The native image is not needed for the extracting procedures. It could be further classified as frequency domain watermarking and spatial domain watermarking. In spatial domain the pixel values of the cover images are directly modified and hence the watermark is embedded. The vital assets of this method are easy computation and simple implementation. But its feeble ability to bear some signal processing or noises restrains its assets. In *frequency domain* method, mathematical tools like FFT, DCT or DWT are used in converting the image data into frequency domain coefficients. When the embedding procedure has been completed the watermarked images are retrieved back to spatial domain. The assets and limitations of the frequency domain are simply opposite to those of the spatial domain. Frequency domain method can bear appreciably some signal processing or noises but it is computationally slow and complex. The second technique of data hiding is called *Steganography* which is similar to the earlier method except that the confidential data to be transmitted are

embedded in cover media such as texts, images, audios and videos. This data hiding technique further is classified into *spatial* and *frequency* domains. The advantages and disadvantages of the watermarking techniques are equally applicable to steganography. Clearly, the aim of steganography is to prevent an illegitimate user to access the private data. There are two considerations in the design of a steganography system:
(1) *Invisibility*: this is in the difference between the cover and the Stego.
(2) *Capacity:* The data capacity or the payload of the cover is directly proportional to its performance. The problem is large payload can debase the image quality to an appreciable level because capacity and invisibility are contradicting each other. Hence, how to increase the capacity without disturbing the statistics of the cover is the key issue. There have been many embedding schemes namely LSB embedding, pixel value differencing, transform domain technique, spread spectrum technique etc., in the existing steganographic methods of secret communication. In these schemes, majority of the time, authors have adopted raster scan for data embedding and extracting processes. From the literature it is obvious that, if random scan is employed instead of raster scan in secret data embedding, the security can be improved significantly.

V. PROPOSED METHODOLOGY

In our paper we propose the implantation of data hiding with more secure algorithm over ofdm channel. Broadly the method can be divided in following main parts:

1. Message hiding in the image to be transmitted with improved 1 bit or 2 bit data hiding method,
2. This encoded image to be transmitted over OFDM channel with Gaussian white noise.
3. Reception of OFDM signal and decoding.
4. Decoding the message from the received signal.
5. Calculating the rmse and psnr of the method.

VI. METHODOLOGY IMPLEMENTATION

- Here we take input cover image of 320x240x3 consume 230400 bytes of uint8 data.
- Reshape it into 2D array and then in 1D vector Pass this vector to integer to bit block where each integer has equivalent 8 bit 'Map a vector of integer-values inputs to a vector of bits. Block inputs must be integer values in the range [-2^(M-1), 2^(M-1)-1] when they are treated as signed and [0, 2^M-1] when they are treated as unsigned. Fox fixed-point inputs, the stored integer value is used'.
- Reshape the output of above block into 8 rows 230400 col.
- The matrix is indexed any of the rows or column the output of sub matrix is 1x1x51 logical data.
- The input data is concatenated to above data. This gives output 1x4x51 logical this data is transposed and then resize in 2 rows and 5 col.This logical data is converted to **int** the output is 2x1x51 int8 The Bit to Integer Converter block maps groups of bits in the input vector to integers in the output vector. *M* defines how many bits are mapped for each output integer. For unsigned integers, if *M* is the Number of bits per integer, then the block maps each group of *M* bits to an integer between 0 and 2^M-1. As a result, the output vector length is 1/*M* times the input vector length. For signed integers, if *M* is the Number of bits per integer , then the block maps each group of *M* bits to an integer between -2^(M-1) and 2^(M+1)-1.
- The input of the OFDM system is binary matrix. The subsystem contains BPSK/OPSK/QAM modulator, IFFT block AWGN channel FFT block and BPSK/QPSK/QAM demodulator.
- The BPSK Modulator Baseband block modulates using the binary phase shift keying method. The output is a baseband representation of the modulated signal. The BPSK Modulator Baseband block provides the capability to visualize a signal constellation from the block mask. This Constellation Visualization feature allows you to visualize a signal constellation for specific block parameters
- The IFFT block computes the inverse fast Fourier transform (IFFT) of each row of a sample-based 1-by-*P* input vector, *u*, or across the first dimension (*P*) of an N-D input array, *u*. When you select the Inherit FFT length from input dimensions check box, *P* must be an integer power of two and the FFT length, *M*, gets set equal to *P*. When the input length, *P*, is greater than the FFT length, *M*, you may see magnitude increases in your IFFT output. These magnitude increases occur because the IFFT block uses modulo-*M* data wrapping to preserve all available input samples.
- AWGN block uses the Signal Processing block set. Random Source block to generate the noise. Random numbers are generated using the Ziggurat method. The Initial seed parameter in this block initializes the noise generator. Initial seed can be either a scalar or a vector whose length matches the number of channels in the input signal. For details on Initial seed, see the Random Source block reference page in the Signal Processing block set documentation set.
- The FFT block computes the fast Fourier transform (FFT) of each row of a sample-based 1-by-*P* input vector, *u*, or across the first dimension (*P*) of an N-D input array, *u*. When you select the Inherit FFT length from input dimensions check box, *P* must be an integer power of two, and the **FFT** length, *M*, is set equal to *P*. If you do not select the check box, *P* can be any length, and the value of the **FFT** length parameter must be a positive integer power of two.

VII. ERROR METRICS

The effectiveness of the stego process proposed has been studied by estimating the following three metrics.

A. Bit Error Rate (BER) and Bit Error

BER evaluates the actual number of bit positions which are replaced in the stego image in comparison with cover image. It has to be computed to estimate exactly how many bits of the original cover image (Ic) are being affected by stego process. The BER for the Stego image (Is) is the percentage of bits that have errors relative to the total number of bits considered in Ic.Let Icbin and Isbin are the binary representations of the cover image and stego cover then,

The total number of bit errors, $T_e = \sum_{i=1}^{n} |I_{cbin} - I_{sbin}|$

And the bit error rate BER = Te / T_n

B. Peak Signal to Noise Ratio (PSNR)

The PSNR is calculated using the equation,

$$\text{PSNR} = 10 \log_{10}\left(\frac{I_{max}^2}{MSE}\right) \text{dB}$$

where Imax is the intensity value of each pixel. Higher the values of PSNR better the image quality.

C. Mean Square Error (MSE)

The MSE is calculated by using the equation,

$$\text{MSE} = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\left(X_{i,j} - Y_{i,j}\right)$$

where *M* and *N* denote the total number of pixels in the horizontal and the vertical dimensions of the image *Xi,j r*epresents the pixels in the original image and *Yi*, *j*, represents the pixels of the stego-image.

The error metrics or measures of quality of image are BER, PSNR, and MSE .This is calculated by the given formula. Comparing this value with the existing method to the new proposed method. The image is passed through AWGN OFDM channel. After that its quality gets measured.

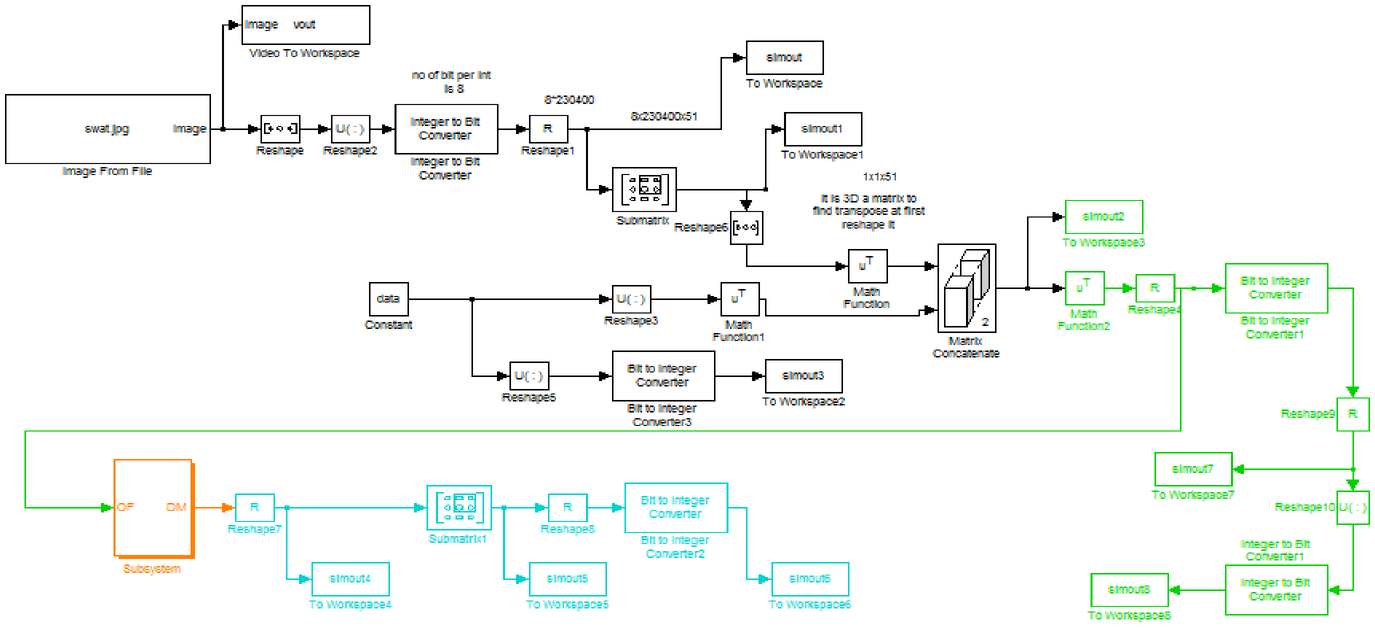

Fig1- Simulink Model of OFDM with data hiding, Trasnmission

and reception

VIII. CONCLUSION AND FUTURE WORK

In this paper the transmission of stego image through OFDM channel is given. The stego image contents a secret data which is to be-transmitted.In this study transmission of embedded bits is carried out by OFDM channel. The measure of quality of image or error metrics is calculated.The future work in this is to proposed a new method of data hiding and compare the result with the exisiting method.

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