An Efficient Digital Video Broadcasting-Terrestrial System using Orthogonal Frequency Division Multiplexing

[1]Lakshminarayana. M, [2]Basavaraj Hiremath, [3]Y S Sumathy,
[1, 2, 3]Assistant Professor
Department of Medical Electronics Engineering
M. S. Ramaiah Institute of Technology
Bangalore, Karnataka, India.
[1]lakshminarayana@msrit.edu, [2]bvhiremath@msrit.edu, [3]dr.sumathy@msrit.edu

***Abstract* —** The concept of Digital TV broad casting by satellite communication and terrestrial transmission has gained lots of attention from the researchers now a day; therefore, it has become an active research area of intensive development. There are various standardization activities are to increase the number of TV channels the allocated frequency bandwidth. In the field of digital terrestrial broadcasting OFDM, modulation technique is utilized to provide an end-to-end fast and robust communication. However, the applicability of OFDM modulation is to utilize the bandwidth, which has been allocated to the respective parallel channels (Carrier frequencies). This paper introduces a scalable and robust Digital Video Broadcasting – Terrestrial (DVB-T) which is employable for end to end video transmission using the Orthogonal Frequency Division Multiplexing (OFDM) to improve system performance concerning less number of BER computation. The DVM also integrated into the OFDM, which offers ease of faster transmission and reception of data. The projected technique also uses error correction and detection using forward error correction mechanism. The performance analysis of the proposed work considered the computation of SNR and BER calculation for different channels.

Keywords: Bit Error Rate, Carrier frequencies, Digital Video Broadcasting, Error correction, OFDM, Satellite communication, Signal to Noise Ratio.

I. INTRODUCTION

Frequency Division Multiplexing (FDM) has been conceptualized to combine numerous signals in order to transmit data packets through a single communication line or channel. Therefore, FDM is usually considered as an analog mechanism where each signal is allocated to different sub channels with different frequencies, which belongs a main channel. However, here it can be witnessed that transmission of FDM signals requires a very large amount of bandwidth. It has become a very critical drawback of this type of modulation. Most of the prior existing research adopted Orthogonal Frequency Division Multiplexing as an alternative of FDM, which successfully overcome the above stated issues. The following figure.1 shows different frequency spectrums (Power Spectral density) associated with FDM and OFDM communication technologies [1][2]. OFDM It can also be used to convert a frequency selective channel into a parallel collection of flat frequency channels in order to utilize the bandwidth [3]. At the collector side of digital video terrestrial broadcasting OFDM demodulation can be activated only by performing FFT [4].

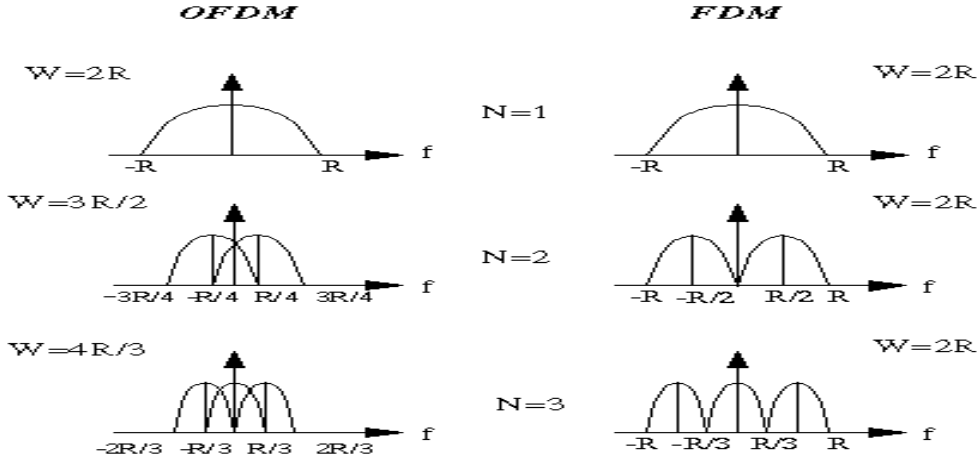

Fig 1. OFDM vs. FDM Power Spectrum Density

Since many years, the proposal given by Instrument Corporation (GI) for digital terrestrial broadcasting of High Definition Television (HDTV) over communication mediums has boosted up remarkable enthusiasm in the field of telecommunication and signal processing research domains. DVB takes highly adopted in many fields such as video recording and streaming over virtualized mediums [5][6][7]. There are various suggestions for efficiency video broadcasting and transmission have been defined and accepted in order to minimize various issues such as compression, transmission delay, minimization of BER at the receiver end etc. This work is highly motivated by the work of [8] where an efficient Video Broadcasting System-Terrestrial has been introduced; the study uses OFDM modulation to improve the excellence in terms of BER minimization and SNR computation. It also uses Interleaves and encoder for computation of error correction and detection using digital bits associated by an audiovisual signal.

This paper implements a design of an efficient Digital Video Broadcasting System (DVB-T) which utilizes OFDM concept to reduce BER receiving end (Receiver). Section II gives a brief introduction about the video broadcasting system with a general block diagram. Section III deals with the literature review describing it previous work done. Design methodology and the implementation of the proposed work has been described in section IV. Section V provides a detailed analysis of the experiment's results. Finally, the last section presents conclusion and future work.

II. FUNDAMENTAL ASPECTS OF DIGITAL VIDEO BROADCASTING TERRESTRIAL (DVB-T)

OFDM is considered as an extraordinary kind of multi-channel modulation technique, that divide into a single channel into many equal sub channels in this way numerous symbols associated with carrier frequencies can be referred in a similar way through channel. OFDM uses the concept of DFT during modulation period, it also uses acyclic prefix. There are lot of drawbacks have been discovered during the modulation of a signal such as OFDM spectral part connected with a particular signal into respective narrow sub carriers thus it results many sub carrier errors. The following fig.2 shows how bandwidth can be utilized considering the OFDM modulation [4].

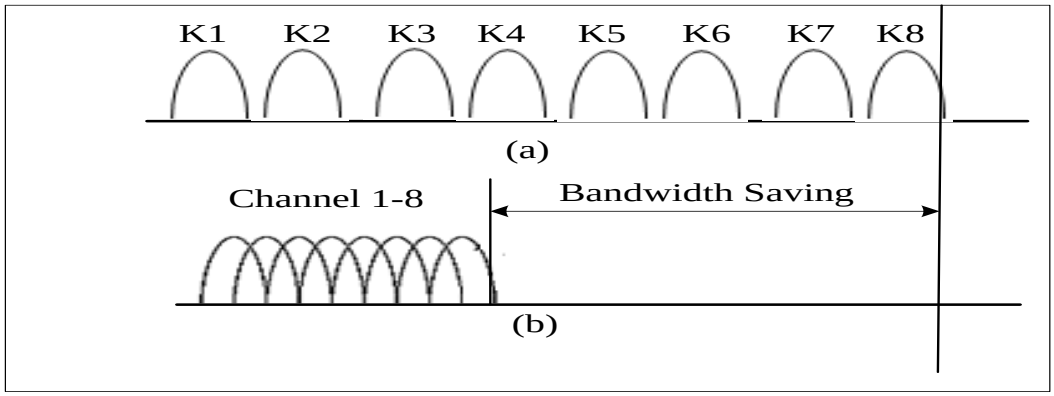

Fig. 2 (a). Normal Frequency Division Multiplexing, (b). Orthogonal Frequency Division Multiplexing

Digital Video Broadcasting-Terrestrial (DVB-T) is considered as widely adopted technique mostly used for digital terrestrial communication for video broadcasting for television channels worldwide with providing the services on air over thirty countries. DVB facilities has been enabled considering a standard prototype, which is named as DVB-T2 for higher spectral efficiency associated with OFDM signals. The existing review studies has been highlighted various features associated the implementation guidelines where structures and the main design-related technical innovations specification is specified the current research developments of the ultimate DVB-T2 will ease the deployment of OFDM systems integrated in commercial products [5][6]. Various coding, interleaving and modulation mechanisms have been activated widely in the area terrestrial video broadcasting and packet transmission environments where large scale deployment of network along with scalability and robustness also have been included in direction to deliver a healthy communication medium in between fixed, portable and mobile terminals.

The proposed scalable and novel Digital Video Broadcasting tool using OFDM modulation is designed in mandate to decrease the BER accompanying with a conveyed signal. The transmission and the receiver modules should be explained properly in terms of their Welch power spectral density estimation. To estimate the power spectral density of the input signal Welch method should be considered rather than Barlett method. To evaluate the simulation of DVB-T Signal in the occurrence of OFDM modulation. To calculate the BER by means of 2K mode then parameters should be specified for the same. The aim of the proposed work as follows. (i) To perform an in-depth investigation towards existing state of art techniques in order to find out the most efficient technique, (ii) To read the input video file/image file and perform a. first level of encoder, b. first level of inter-leaver, (iii) Second Level of encoder and Second level of inter-lever, (iv) To Evaluate Orthogonal Frequency Division Multiplexing, (v) To pass the transmitted data through a channel, (vi) To perform OFDM demodulation, (vii) To apply a. second level of de-interleaver, b. second level of decoder, c. first level of interlever,

d. first level of decoder, (viii) To compute the acquisition of the original image at receiver end, (ix) To compute the Bit Error Rate (BER) and plot the SNR Vs BER graph.

III. RELATED WORK

This section contains the in-depth review of many OFDM modulation techniques. Wood et. al [1] performed the analysis of different modes of Terrestrial Based Digital Video Broadcasting (DVB-T). Sigital Video Broadcasting (DVB) uses such modulation. Using Simulink simulation is performed. Through the modulation signal performance is improved. The Authors also investigated the presentation of OFDM and the effect of dissimilar multipath channels, viz, AWGN and Rayleigh. Nilson et.al [2] Deliberate IFFT and FFT blocks which make use of receiver as well as receiver of OFDM system. Authors utilized the 8-point IFFT/FFT (DIF) along with radix-2. Using VHDL execution performed in Field Programmable Gate Array FPGA. Using Xilinx ISE tools timing simulation as well as combined results are performed and analyzed. Engles et.al [3] Proposed design for efficient implementation of FFT and IFFT modules. The main objective of the work is implementation of core signal processing blocks of OFDM method on FPGA by using VHDL language. Using Frames OFDM transmission is performed. Every frame consists of 68 OFDM symbol and have duration of TF. One super frame will have four frames and every symbol is made up of 1705 carrier in 2K mode having duration of Ts symbol duration.

Xia et.al [4] provided signals of the Digital Video Broadcasting (DVB) standard for the European digital television service i.e. Digital Video Broadcast-Terrestrial (DVB-T). Saha et.al [5] presented OFDM for wireless communications. Authors have addressed the fundamental OFDM and associated modulation and mechanism to enhance the OFDM performance for wireless communication. Authors carried out different simulation to identify best BER performance of every Convolution and Reed-Solomon (R-S) codes and using the best outcome modeled the RS-CC concatenated codes. Through concatenating two kinds of codes the authors improved the effect of total BER by making use of the advantages of RS code correcting burst errors, whereas convolution codes re best fit for random error correction caused by noisy channel. Wong et.al [6] integrated a pure VHDL design with Intellectual property (IP) blocks employed for implementing OFDM transceiver. Writers have designed OFDM system by using IFFT and FFT blocks. Authors performed the simulation using XILINX ISE 14.2 software.

Kumar et.al [7] designed single chip (OFDM) transmitter as well as receiver using Verilog HDL. Variety of multi-carrier modulation techniques in different digital communication systems such as 3G GSM, LTE and WiMAX use OFDM. The benefit of such kind of transmission is the robustness it offers to channel fading in wireless communiqué field. From simulation, it is seen that every module of the proposed OFDM is working as intended. The yield from replication outcome of OFDM is verified with matlab output. Sinha et.al [8] BER enactment of two DTTB systems, such as CP-OFDM, which is based on DVB-T as healthy as Time Domain Synchronous (TDS-OFDM) which is based on DTMB, is determined in different channel conditions. Authors also discussed spectrum utilization as healthy as power efficiency to demonstrate transmission overhead of both systems. Through simulation, it is found that the presentation of mutually structures is identical. It is seen that by providing equivalents ration of Guard Interval (GI), DVB-T gives better performance compared to DTMB in term of SNR in Gaussian and Ricean Channels. Because of large code rates and large order of constellation, DTMB provides better performance in Rayleigh channel. Lakshminarasimman et.al [9] investigated DVB-T network plan that is constructed on design project, which is in corresponding to International telecommunication Union (ITU)'s Regional Radio Communication Conference (RRC-06) since June 2006 and Geneva (GE-06) frequency plan.

Uyar et.al.[10] analyzed creation of DVB-T scheme prototypical using Simulink with the intension of examining the BER presentation analysis of OFDM based DVB-T ,2k mode by make use of dissimilar inflection approaches in several program channels. Mandal et.al [11] performed MATLAB coding to establish a system level simulation environment and used this system performance hence deliver the outcome in assessing the presentation of DVB-T through 64QAM. Wang et.al [12] presented rTMO, which is based on cross-bilateral filtering which produces high quality HDR images as well as videos for broad range of exposure. Experiments carried out with an objective image quality metric showed that the proposed strategy is the only mechanism. Which can gracefully improve perceived details over large range of image exposures. Zhang et.al [13] [14] DVB-T which is a OFDM based and performed analysis in terms of different parameters across various communication channels. Performed comparison in term of BER performance of various modulation methods and for different value of SNR to find optimized parameters for 2k and 8k mode carriers Lam et.al [15] demonstrated that very a high spectral effective BER and PAPR could be accomplished by using DWT-DAPSK methods with DVTB-T2 system. Authors suggested that by the system it is possible to achieve further reduction in PAPR.

IV. PROPOSED SYSTEM AND IMPLEMENTATION

The purpose of the projected scheme is to obtain the modulated gesture by means of the OFDM technique. The signal is first passed through an encoder, which perform convolutional encoding, consequently the encoded signal is then sent to an interleaver that interleaved into N delays. The interleaved data is then applied a modulation technique which is preferably a quadrature amplitude multiplexing. The modulated signal is then passed through an OFDM bloc, which will further encode, modulate and will add cyclic prefix to the data. The construction of the projected scheme is displayed in fig.3. The pseudo code is a code like structure that consists of a programming structure but the implementation is written in simple English and flowchart of the proposed work also shown in fig.4.

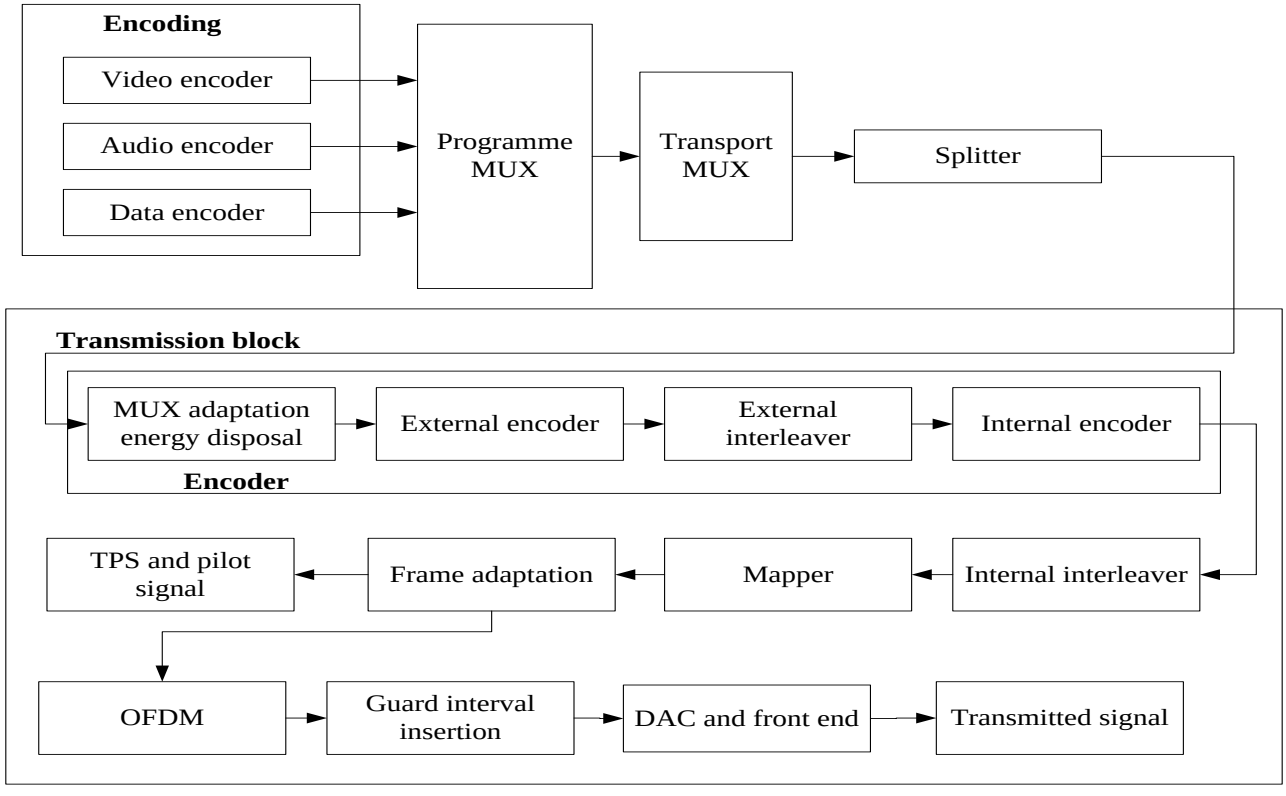

Fig.3: Proposed System Architecture

The function of this module is to implement the entire project concerning the encoding and modulation scheme ***Start*** *Load video, I* *Obtain number of frames* *For each frame* *Read first frame* *Resize image* *Add noise with respect to SNR* ***End of program***	***The function of this module is to apply the additive white Gaussian noise to the data*** ***Start*** *Load image* *Initialize noise factor, SNR value* *If input has noise factor* *Compute signal power/required SNR* *End* *If input has SNR value* *Compute signal power – required noise* *End* *If type of signal is real, then* *Add real type noise* *End* *If type of signal is complex* *Add complex type of noise* ***End of program***	***The function of this module is to apply a suitable encoding technique considering the structured encoded object and the data*** ***Start*** *Load image, I* *Initialize input data, type of encoding* *Convert message from parallel to serial format* *Convert data to binary format* *Perform cyclic encoding* *Convert encoded message from binary to decimal format* ***End of program***
The function of this module is to apply the interleaving technique for the encoded data ***Start*** *Load image, I* *Initialize input data, slope and number of rows* *Convert data from unsigned 32-bit data format to double* *Output ← output in each register* *Data ← data in each register* *Shift registers by number of delays* ***End of program***	***The function of this module is to apply convolution encoder with the data and the trellis structure*** ***Start*** *Load image, I* *Initialize trellis structure,* *M ← get message orientation* *Call function convcore.c* *Flip the message* *Out ← Set output data to logical* *State ← get the state of the encoder* ***End of program***	***The function of this module is to apply OFDM modulation technique for the encoded data*** ***Start*** *Load image, I* *Initialize data, m-ary value and modulation technique* *Divide the signal into n frames* *For i= 1: number of frames* *Extract data samples and add zero padding for IFFT* *Perform IFFT operation on data* *Arrange IFFT data samples* *G ← generate data stream* *C ← add cyclic prefix* ***End of program***

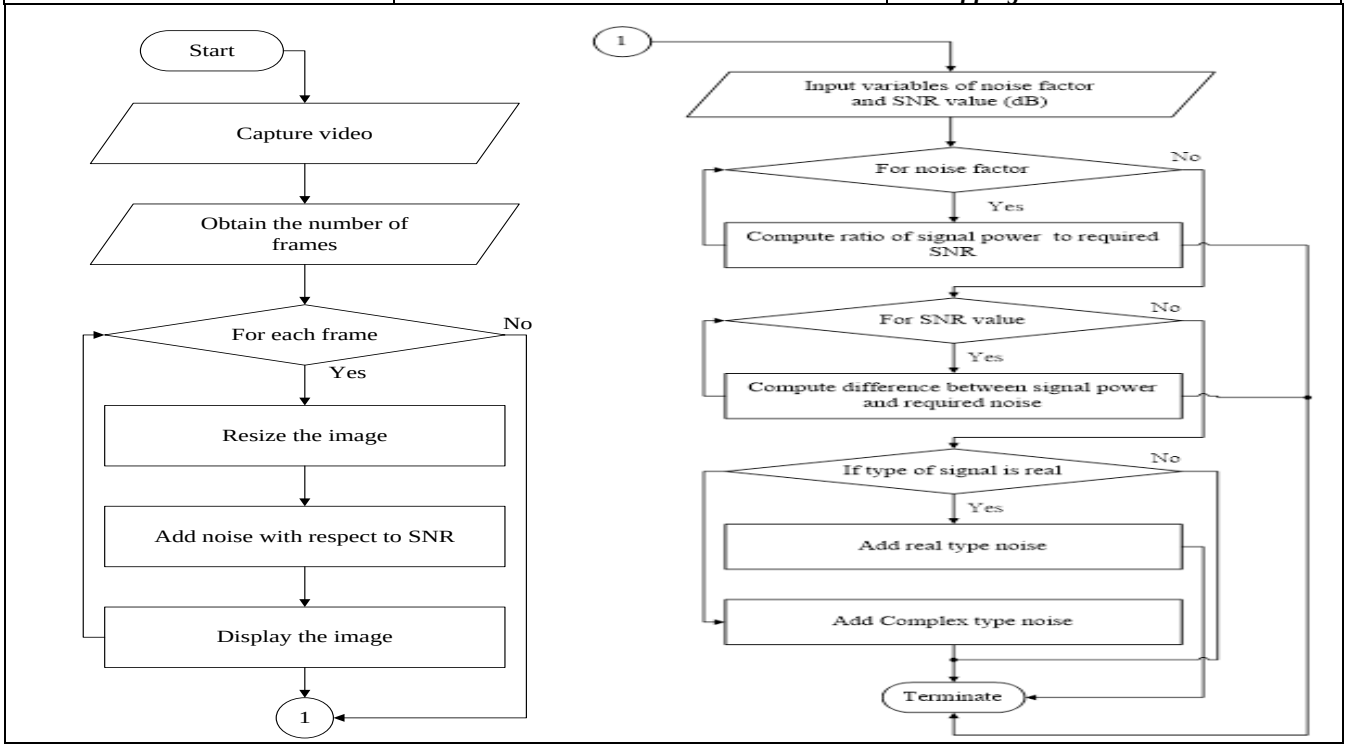

Fig.4. Pseudo code and flowchart of the proposed work

v. RESULTS AND DISCUSSION

The motive of the proposed design is to obtain the modulated signal using the OFDM technique. The signal is passed through an encoder, which perform convolutional encoding, consequently the encoded signal is then sent to an interleaver that interleaved into N-delays. The interleaved data is then applied a modulation technique which is preferably a Quadrature amplitude multiplexing. The modulated signal is then passed through an OFDM block, which will further encode, modulate and will add cyclic prefix to the data. The results of the proposed system are shown in figure 4(a) to 4(h).

Fig.4 (a). Input image, Noise image Received image for SNR= - 22

Fig.4 (b). Input image, Noise image Received image for SNR= - 29

Fig.4 (c). Input image, Noise image Received image for SNR= - 19

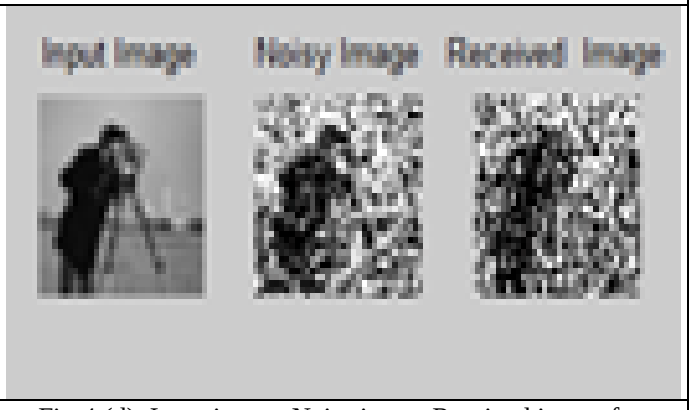

Fig.4 (d). Input image, Noise image Received image for SNR= 9

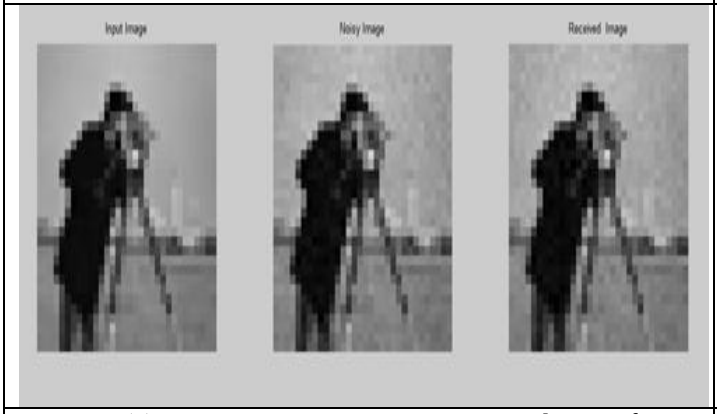

Fig.4 (e). Input image, Noise image Received image for SNR= - 0.2946.

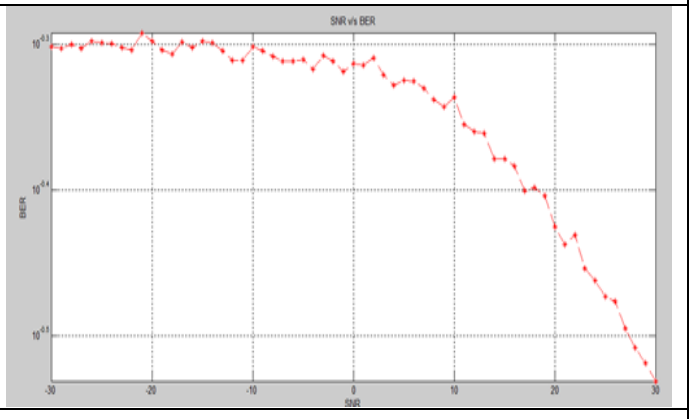

Fig.4 (f). SNR vs. BER

Fig.4 (g). Input image, RS Encoder, Received image.

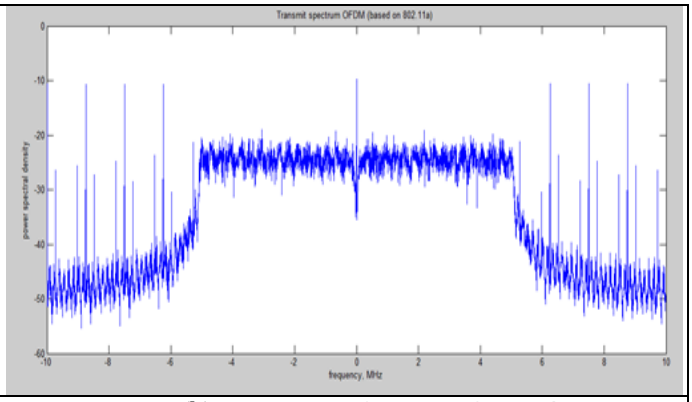

Fig.4 (h). Transmitter Spectrum OFDMA

From, fig. 4(a) to 4(e) describes that, the cameraman image is considered as input image. Here, the image is taken form a video. Then video is divided into number of frames, then theses frames are taken for the analysis purposes. In this, we have observed that the input image, the noisy image and the received image. In fig. 4(f), we can observe that as the signal to noise ratio vs. bit error rate. Here, signal to noise ratio increases as bits' error rate decreases. Typical value for signal to noise ratio between 5dB to 30 dB as well as bit error rate is in the range of 10-0.3 MHz Fig.4 (g) shows the input image, RS Encoded image and the received image. Finally, fig 4(h) shows the transmitted spectrum OFDMA signal. When image data is transmitted form transmitter to receiver, the image is going to undergone OFDMA techniques.

VI. CONCLUSION AND FUTURE WORK

The purpose of the proposed system is to obtain the modulated signal using the OFDM technique. The signal sent through an encoder, which perform convolutional encoding, consequently the encoded signal is then sent to an interleaver that interleaved into N delays. The interleaved data is then applied a modulation technique which is preferably a quadrature amplitude multiplexing. The modulated signal is then passed through an OFDM block that will further encode, modulate and will add cyclic prefix to the data. The time space signal furthermore their frequency area signal has been plotted. This entire project depends on the frequency results acquired from the reproduction of DVB-T signal utilizing the 2K mode and the parameters indicated for the same. Finally, it concludes that our proposed method yields better SNR value, an efficient Harness the high frequency spectrum to improve sound quality and picture and high quality of video. Further work is to improve the contract of the reconstructed result to achieve better PSNR value using image enhancement methods.

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