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BER Analysis of HIPERLAN System with Different Interleaving Schemes

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Abstract: In wireless communication, higher data rates can be achieved by increased or more efficient use of bandwidth and transmitting power. A key technique for spectral optimization is Orthogonal Frequency Division Multiplexing (OFDM). OFDM is a technique proposed for high-speed wireless LAN by the European Telecommunication Standards Institute and IEEE which is being considered for 4G mobile. OFDM technology is described for physical layer of ETSI's proposed HIPERLAN standard whose data rate ranges from 6 to 54 Mbit/s depending on Quality of Service (QoS). It is designed to provide Wireless Local Loop (WLL) to core networks, e.g. Asynchronous Transfer Mode, GSM/UMTS or any IP-based multimedia network. Data rate, coding rate and modulation type are determined by the link adoption scheme automatically depending on the channel conditions. There are several ways to utilize the frequency band in a flexible way so that the available bandwidth is utilized to maximal efficiency. These access techniques uses a small portion of available energy with low power spectral density, high data transmission rates, less intercarrier interference and efficient use of bandwidth. The main cause of interference in OFDM system is channel fading, and all the errors are in transmission occurred due to effects of channel. One method that can be implemented to overcome this problem is by introducing channel coding. Channel encoding is applied by adding redundant bits to the transmitted data. The redundant bits increase raw data used in the link and therefore, increase the bandwidth requirement. So, if noise or fading occurred in the channel, some data may still be recovered at the receiver. While at the receiver, channel decoding is used to detect or correct errors that are introduced to the channel. To design an HIPERLAN system with Rectangular 16 – QAM Baseband Modulator and OFDM as a multiple access technique. Then, analyze this system with different interleaving schemes to reduce the interference and improve the performance of system.

Keywords: HIPERLAN, BER, OFDM, Interleaving.

I. INTRODUCTION OF HIPERLAN

Massive growth in wireless and mobile communications, the emergence of multimedia applications as well as high-speed Internet access and the deregulation of the telecommunications industry are the key drivers towards a new demand for radio-based broadband access networks. The ETSI Project BRAN (Broadband Radio Access Networks) focuses on standards for different types of wireless broadband access networks[5].

One of these systems called High Performance Radio Local Area Network shall provide high-speed communications (with a bit rate of at least 20 Mbps) between mobile terminals and various broadband infrastructure networks. In the U.S., a high-speed physical layer is being developed to extend IEEE802.11 which will reuse the MAC layer already defined. The respective system in Japan will have three different upper layer protocols for three different services, but it will be based on a common physical layer. A High-performance local area network (HIPERLAN) is an alternative wireless LAN standard to the IEEE 802.11. It is one of four standards specified by the European telecommunications standards institute (ETSI) to provide a concatenated service of interoperable technologies from different locations. HIPERLAN uses cellular-based data networks to connect to an ATM backbone[6].

The main idea behind HIPERLAN is to provide an infrastructure or ad-hoc wireless with low mobility and a small radius. HIPERLAN supports isochronous traffic with low latency. HIPERLAN emerged in 1991 with the goal of achieving higher data rates than the 802.11 standard. It was approved in 1996. A second version was introduced in 2000. This version is designed as a fast wireless connection and can be used with various networks, such as UMTS backbone, ATM, and IP networks[9]. HIPERLAN can also be used as a home network and supports a data rate of up to 54 Mbps. The HIPERLAN/2 protocol stack consists of the following layers:

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(a). Physical layer: An OFDM-based Physical Layer capable in providing up to 54 Mbps transfer rate for both the uplink and downlink.
(b). DLC layer: Its main function is to transfer the data to the physical layer in an efficient manner. This can be achieved by prioritizing the use of the shared medium. This layer uses retransmission mechanisms, priorities for different flows of data, error control mechanisms, maintenance of the wireless link (status of each separate connection, accept/reject new calls for resources) etc[10].
(c). Convergence layer (CL): In this layer a conversion of the IP, UMTS or ATM data into DLC packets has to be performed. CL is divided into sublayers: the Service Specific Convergence Sublayer (which is attached to the higher layers) and the Common Part (which is attached to the DLC layer). The SSCS performs the mapping for each particular technology (e.g. IP, Ethernet, ATM) while the CP takes care of segmentation and reassembly among other functionalities.
(d). The higher layers can be IP, ATM, UMTS or Ethernet. For each particular case a certain SSCS has to be developed.

II. SYSTEM MODEL OF HIPERLAN

HIPERLAN is intended to provide local wireless access to IP, ATM and UMTS infrastructure networks by both stationary and moving terminals that interact with access points which, in turn, usually are connected to an IP, UMTS or ATM backbone network. A number of these access points will be required to service all but the smallest networks of this kind and therefore the wireless network as a whole will support hand-overs of connections between the access points. Further more, such a wireless access network will be able to provide the Quality of Service (QoS), including required data transfer rates, that users expect from a wired ATM network[14].

The desired hardware features for HIPERLAN as any other wireless applications are size, power consumption, processing speed and computational accuracy. And these factors are not independent i.e. accuracy depends on the size and processing speed, in order to get accurate results the corresponding hardware size will be bigger and its processing speed will be slower and vice versa.

The orthogonal frequency division multiplexing (OFDM) function of HIPERLAN physical layer is to find the optimum fixed point word length. OFDM in HIPERLAN/2 is realized by a complex 64 point fast Fourier transform (FFT). FFT is a complex function whose implementation parameters i.e. its hardware size, computational accuracy and speed depends on the type of arithmetic format used.

HIPERLAN/2 is a WLAN standard operating in the 5 GHz band. Utilizing a bandwidth of 20 MHz, nominal user data rates ranged between 6 and 54 M bits^{-1} can be supported. The physical layer of HIPERLAN/2 is based on a link OFDM modulation scheme. The Data Link Control (DLC) layer of HIPERLAN/2 is based on a centrally controlled network topology with dynamically assigned medium access based on Time Division Duplex (TDD) and Time Division Multiple Access (TDMA) within a 'MAC frame' with duration of 2 ms. The HIPERLAN/2 standard also defines a number of Convergence Layers (CLs) to interface the DLC to higher level network structures such as TCP/IP, ATM and UMTS[15].

These Convergence Layers ensure that HIPERLAN/2 is suitable for a wide array of WLAN applications from office LANs to wireless home networks to cellular network 'hotspot' coverage. The HIPERLAN/2 physical layer is based on the use of OFDM. OFDM is used to combat frequency selective fading and to randomise the burst errors caused by a wideband-fading channel. A link adaptive modulation scheme is specified, with a number of transmission 'modes' defined. These physical layer modes employ different coding and modulation schemes to achieve a flexible trade off between SNR requirements and error performance.

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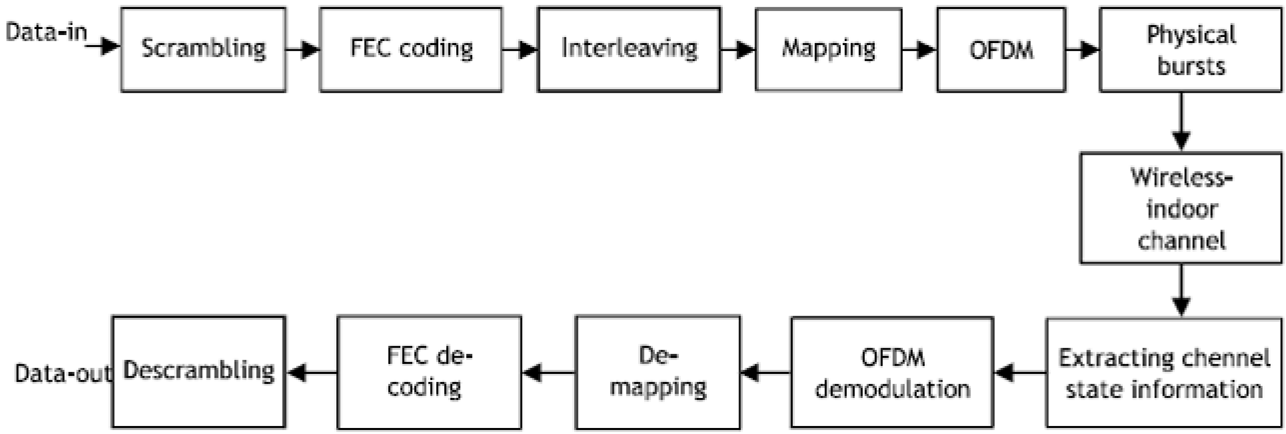

Figure 1. Block Diagram of HIPERLAN.

Figure shows the reference configuration of the HIPERLAN transmitter. Data for transmission is supplied to the physical layer in the form of an input train. This input train is supplied to the physical layer by the DLC. The input train is passed to a scrambler that prevents long runs of 1s and 0s in the data being input to the remainder of the modulation process. The scrambled data is input to a convolutional encoder. The encoder consists of a 1/2 rate mother code and subsequent puncturing. The puncturing schemes facilitate the use of the code rates: 1/2, 3/4 and 9/16. Additional puncturing is also used in order to keep an integer number of OFDM symbols with 54 byte PDUs.

The coded data is interleaved in order to prevent error bursts from being input to the convolutional decode process in the receiver. The interleaved data is subsequently mapped to data symbols according to either a BPSK, QPSK, 16-QAM or 64-QAM scheme. The OFDM modulation is implemented by means of an inverse FFT[7]. 48 data symbols and 4 pilots are transmitted in parallel in the form of one OFDM symbol. In order to prevent Inter-Symbol Interference (ISI), a guard interval is implemented by means of a cyclic extension. Thus, each OFDM symbol is preceded by a periodic extension of the symbol itself. The total OFDM symbol duration is given by ETSI.

The OFDM receiver essentially performs the reverse operations of the transmitter. However, the receiver is also required to undertake Automatic Gain Control (AGC), time and frequency synchronisation and channel estimation. Training sequences are provided in the preamble for the specific purpose of supporting these functions. Two OFDM symbols are provided in the preamble in order to support the channel estimation process. A prior knowledge of the transmitted preamble signal facilitates the generation of a vector defining the channel estimate, commonly referred to as the Channel State Information (CSI). Decoding of the convolutional code is implemented by means of a Viterbi decoder[8].

III. HIPERLAN PERFORMANCE ANALYSIS

Simulation of High Performance Radio Local Area Network (HIPERLAN) system is done in Simulink tool of MATLAB. The simulation results are plotted in term of the performance of HIPERLAN system that is Bit Error Rate (BER). First the HIPERLAN system is analyzed with different Interleaving schemes.

The five interleaving Schemes namely Matrix, Helical, Random, Block and Convolutional are analyzed and the Bit Error Rate (BER) of HIPERLAN system with these interleaving schemes is calculated to check the system performance. Analysis was done by observing the simulation result and tabulating the analysis results to make it more convenient to be read.In the performance analysis of HIPERLAN system the transmitted signal, received signal, scatter plots and bit error rate of the systems are analyzed.

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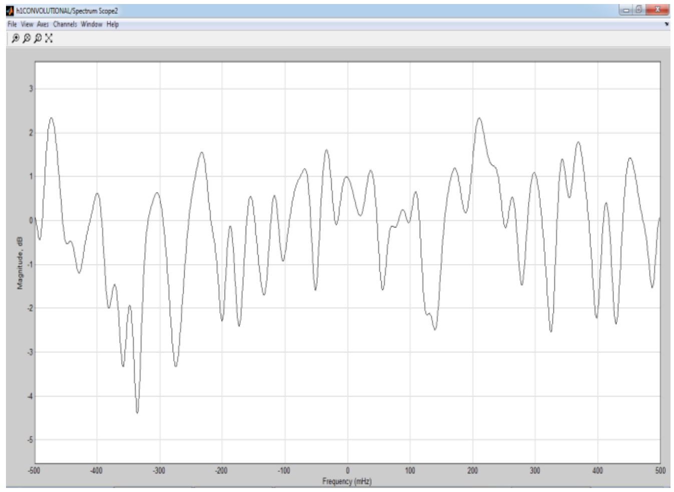

Figure 2. Transmitted Signal of HIPERLAN Before OFDM Modulator.

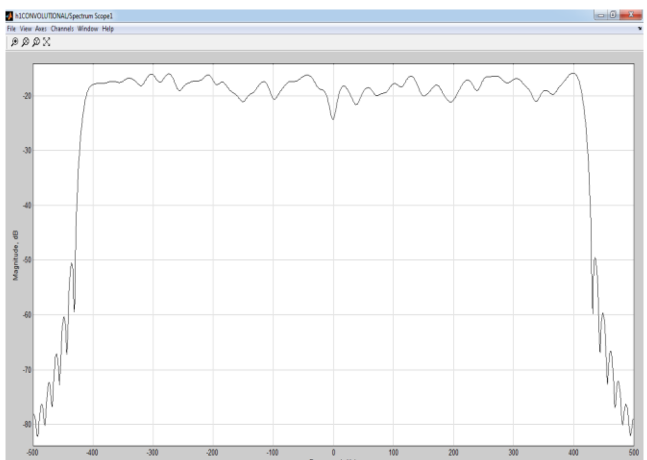

Figure 3. Transmitted Signal of HIPERLAN.

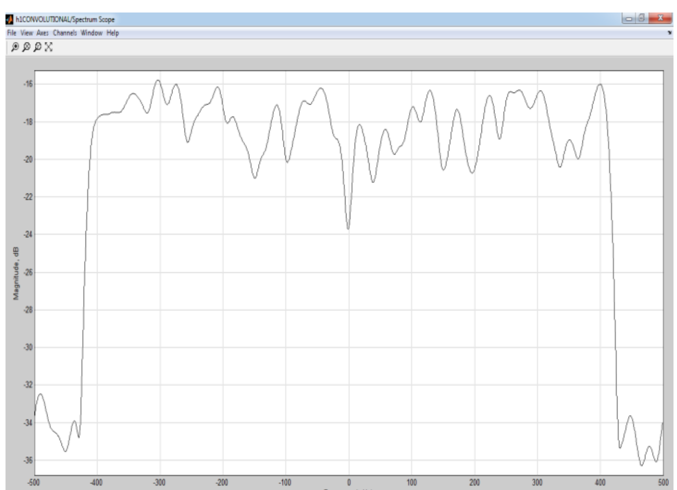

Figure 4. Received Signal of HIPERLAN.

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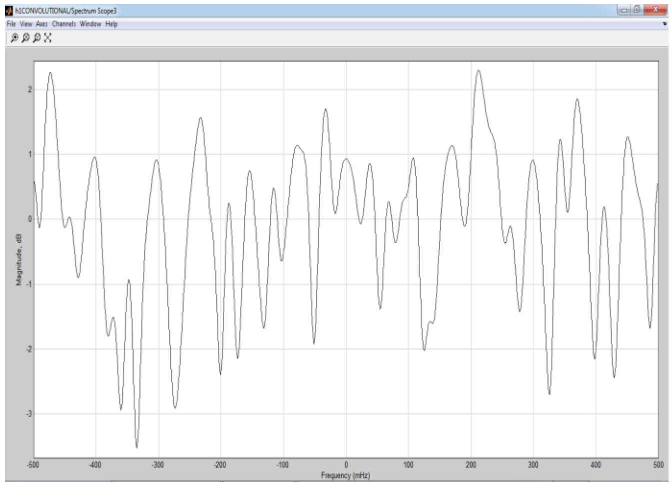

Figure 5. Received Signal of HIPERLAN After OFDM Modulator.

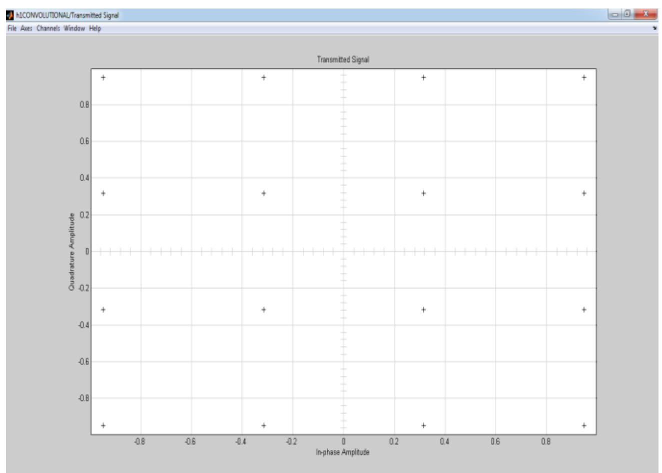

Figure 6. Constellation Plot of Transmitted Signal of HIPERLAN.

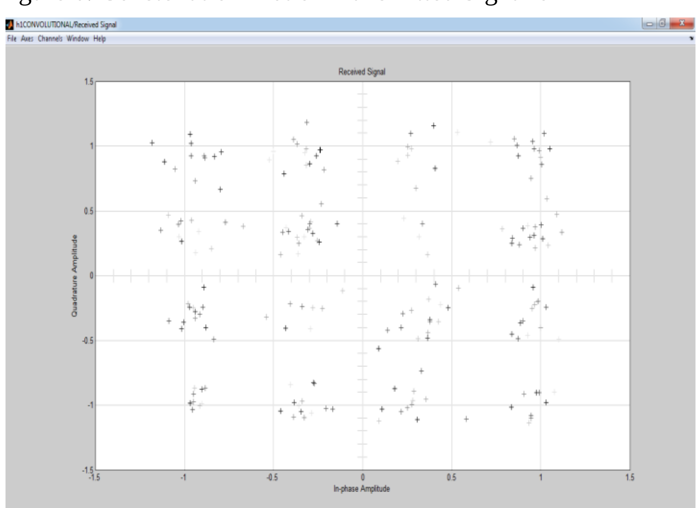

Figure 7. Constellation Plot of Received Signal of HIPERLAN.

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The Figure shows the transmitted and received signal of HIPERLAN system. To plot these signals spectrum scope is used. The Spectrum Scope block computes and displays the periodogram of the input. From the plot of transmitted and received signal it is clear that the received signal is so much distorted as comparison to transmitted signal due to channel.

The Scatter Plot Scope displays constellation diagram of a modulated signal, to reveal the modulation characteristics, such as pulse shaping or channel distortions of the signal. The scatter plot also shows the strength of the signal at any point in the coverage area.

The simulation results are plotted in term of the performance of HIPERLAN system that is transmitted, received signal. Now the Bit Error Rate (BER) of HIPERLAN system is analyzed. First calculate the BER for the ADSL system with different interleaving schemes such as Matrix, Helical, Random, Convolutional and Block interleaver. The BER is calculated with error rate calculation block. In this block the transmitted and received signals are compared to calculate the BER.

The Error Rate Calculation block compares input data from a transmitter with input data from a receiver. It calculates the error rate as a running statistic, by dividing the total number of unequal pairs of data elements by the total number of input data elements from one source. This block can be use to compute either symbol or bit error rate, because it does not consider the magnitude of the difference between input data elements. If the inputs are bits, then the block computes the bit error rate. If the inputs are symbols, then it computes the symbol error rate.

Table 1. BER of HIPERLAN with Block Interleaver

Bit Error Rate	0.000001222
Total Error Bits	44
Total Bits	36000000

Table 2. BER of HIPERLAN with Convolutional Interleaver

Bit Error Rate	0.5001
Total Error Bits	18000000
Total Bits	36000000

Table 3. BER of HIPERLAN with Matrix Interleaver

Bit Error Rate	0.00000133
Total Error Bits	48
Total Bits	36000000

Table 4. BER of HIPERLAN with Helical Interleaver

Bit Error Rate	0.4999
Total Error Bits	18000000
Total Bits	36000000

Table 5. BER of HIPERLAN with Random Interleaver

Bit Error Rate	0.000001361
Total Error Bits	49
Total Bits	36000000

From these tables it is clear that while analyzing the different interleaving schemes for HIPERLAN, the block interleaver, random interleaver and matrix interleaver perform better as compare to convolutional interleaver or helical interleaver. The Block interleaver accepts a set of symbols and rearranges them, without repeating or omitting any of the symbols in the set. The number of symbols in each set is fixed. The interleaver's operation on a set of symbols is independent of its operation on all other sets of symbols. So it has less operational complexity as compare to other interleavers. So block interleaver performs better than convolutional interleaver.

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IV. CONCLUSION

In the present scenario, massive growth in wireless and mobile communications, the emergence of multimedia applications as well as high-speed Internet access and the deregulation of the telecommunications industry are the key drivers towards a new demand for radio-based broadband access networks. The telecommunication companies designed many multiple access technologies for occuping maximium number of users without changing the frequency bandwidths. One of these systems called High Performance Radio Local Area Network shall provide high-speed communications between mobile terminals and various broadband infrastructure networks by using Othogonal Frequncy Division Multiple Access. As the number of users increases the complexity of system increases.

So HIPERLAN system is designed to withstand with interference and fading in communication channel. Channel coding and Interleaving is needed for a system in order to sustain in any type of environment especially in multipath fading channel.By observing the results it is found that when Block Interleaver is used with Convolutional Encoding under the influence of AWGN channel the BER is less than the other interleaving schemes. From transmitted signal and received signal of the HIPERLAN it is clear that in case of block interleaving the distortion is very less. Similarly the scatter plot shown better signal strength in case of block interleaver. So, It is concluded that block interleaving is best suited scheme for proposed system with minimum bit error rate.

REFERENCES

[1]. Qi Wang, Rong Zhang, Lie Liang Yang and Lajos Hanzo, "Non – Orthogonal Multiple Access: A Unified Perspective", IEEE Wireless Communications, pp. 1-7, 2018.
[2]. Anugrah Nair, Gaurav Gupta and Kartik Srinivas, "Review On Multiple Access Techniques Used In Mobile Telecommunication Generations", International Research Journal of Engineering and Technology, Vol. 5, Issue 10, pp. 350-354, 2018.
[3]. Aasheesh Shukla and Vinay Kumar Deolia, "Performance Analysis of Chaos Based Interleaver in IDMA System", International Journal on Communication Technology, vol. 7, issue 4, pp. 1397-1401, December 2016.
[4]. Ankita Jhamb, "A Review On Interleave Division Multiple Access In Underwater Communication", International Journal of Engineering Development and Research, Vol. 4, Issue 4, pp. 873-876, 2016.
[5]. Constantine Coutras, " Priority Levels in a HIPERLAN Based Forwarding Mechanism for Intermittent Connectivity", ICN 2015 : The Fourteenth International Conference on Networks, pp. 1-7, 2015.
[6]. Kamlesh Kumar, Ravi Antil and Rajnarayan Sharma, "802.11a Synchronizer Performance Analysis (Simulation)", International Journal of Computer Science and Mobile Computing, Vol. 4, Issue 1, pp. 246 – 253, 2015.
[7]. Shweta Bajpai and D. K. Srivastava, "Performance Analysis of IDMA Schemes using different Coding techniques with receiver diversity using Random Interleaver", International Journal of Science Research Engineering & Technology, vol. 3, issue 6, pp. 1008-1012, September 2014.
[8]. Sweta Singh and Parul Malhan, "A Review Paper on Multiple Access Techniques for Mobile Communication", International Journal For Innovative Research in Technology, Vol. 1, Issue 6, pp, 1244-49, 2014.
[9]. Mohammed Aboud Kadhim, Falah Hasan and Sabah Shehd Abdulabas, "A New Interference Mitigation Technique of HiperLAN/2 Transceiver with Multiple Antennas", Journal of Information Engineering and Applications, Vol. 4, No.11, pp. 62-74, 2014.
[10]. Adnan Hussein Ali, Ali Nihad Abbas and Maan Hamad Hassan, "Performance Evaluation of IEEE802.11g WLANs Using OPNET Modeler", American Journal of Engineering Research, Vol. 2, Issue 12, pp. 9-15, 2013.
[11]. Anshu Aggarwal and Vikas Mittal, " Implementation of Different Interleaving Techniques for Performance Evaluation of CDMA System", International Journal of Application or Innovation in Engineering & Management, Vol. 2, Issue 5, pp. 337-342, 2013.
[12]. Rupesh Singh, "Multiple Access Techniques for 4G Mobile Wireless Network", International Journal of Engineering Research and Development, Vol. 5, Issue 11, pp. 86-94, 2013.
[13]. Kiran Bondre, " BER Performance Comparison of HIPERLAN/2 for different modulation schemes with ½ and ¾ code rates", International Journal of Engineering Research and Applications, Vol. 2, Issue 3, pp.1398-1400 1398, 2012.
[14]. Kiran Bondre and Shubhangi Rathkanthiwar, " Performance of HIPERLAN/2 for 16QAM, with ¾ code rate with and without Rapp's model", International Conference ACCTA-2010, Vol.1, Issue 2, pp. 299-304, 2010.
[15]. Xue Li, Ruolin Zhou, Chakravarthy V., Hong S. and Zhiqiang Wu, "Total Intercarrier Interference Cancellation for OFDM Mobile Communication Systems", 7th IEEE Consumer Communications and Networking Conference, pp. 1 – 5, 2010.

DOI: 10.17148/IJARCCE.2023.12128

[16]. Wu X.H., Kishk A.A. and Glisson A.W., “MIMO-OFDM radar for direction estimation”, IET Radar, Sonar & Navigation, Vol. 4 , Issue 1, pp. 28 – 36, 2010.

[17]. Rajiv Kumar, Vinod Kumar, Maninder Singh and Sarla Kumari, “Comparison of CDMA and OFDM Using Simulink”, International Journal of Wireless Communication and Simulation, Vol. 2, Number 1, pp. 39 – 50, 2010.

[18]. Leonardo Betancu, Narcis Cardona, Andres Navarro and Lara Traver, “A Statistical Channel Model for On Body Area Networks in Ultra Wide Band Communications”, IEEE Latin – American Conference on Communications, pp. 1 – 6, 2009.