Development of Channel Estimation Strategy using MMSE in OFDM Wireless System

Anil Rajak[1] , Prof. K. K. Tiwari[2]

[1] *M-Tech Research Scholar,* [2] *Research Guide, Deptt. of Computer Science Engineering,*

Satyam Education & Social Welfare Society Group of Institutes, Bhopal

Abstract - The outperforming stage of wireless communication system need to be developed for reliable delivery of the information. Every wireless communication system has a major influence by the information transferring media (channel). The behavior of wireless channel is quite varying in nature so that the predictions of noises disturbing signals is very crucial task. So the estimation of channel play a very important role make wireless communication system better. Here the channel estimation is done and the mean square error is calculated for proposed methodology using 4-QAM Modulation and Median Filter.

Keywords - Channel Estimation, Median Filter, MSE, 4-QAM and BPSK.

I. INTRODUCTION

The wireless transmission technology allows people to communicate without any physical connection. In recent decades, there is more rapid development of wireless mobile communications, from the initial 1G analog mobile communication system. Currently, 4G mobile communication system has been started in the world and begun the trial. Development of mobile communication is shown as following steps. The 1G mobile communication system mainly uses analog technology and frequency division multiple access (FDMA) technology. Due to bandwidth constraints, mobile communications cannot do long distance roaming, but only be a regional mobile communications system. The main drawback is low spectrum utilization and signaling voice traffic interference. The 2G mobile communication alternatives 1G mobile communication system and completed changes from analog to digital technology. It mainly uses the time division multiple access (TDMA) technology and code division multiple access (CDMA) technology. Its main business is voice, and the feature is to provide digital voice services and low-speed data services. However, due to the limited bandwidth, application of data services is limited, and cannot achieve high rates of business such as mobile multimedia services. The concept of 3G mobile communication is proposed by the International Telecommunication Union (ITU) in 1985 originally, and was officially named as International Mobile telecom System 2000 (IMT2000). In May 2000, it finally passed the 3G mobile communication air interface standards, and was officially named as IMT2000 wireless interface specification. This specification includes two types of CDMA and TDMA. Its main features include support for multimedia services, data transmission rate of at least 384kbit/s, and global roaming. Compared with the 1G and 2G, high-speed data transmission and broadband multimedia service can be achieved in 3G communication system. However, because of different standards of regional communication systems, 3G is still unable to meet the future requirements of higher data transfer rates.

Therefore, 4G mobile communication system, with the OFDM modulation technique, started to enter the horizon and became a research hotspot. For high-volume and highspeed wireless mobile communication systems, OFDM is a promising modulation scheme, and will play an increasingly important role in the future development of wireless mobile communication network.

II. APPLICATION OF OFDM

OFDM is a multi-carrier transmission technology in wireless environment, and can also be seen as a multi-carrier digital modulation or multi-carrier digital multiplexing technology. Because of using of orthogonal carrier technology without interference and no guard band between single carriers, OFDM system requires much less bandwidth compared with the conventional frequency division multiplexing (FDM) system, and gets higher bandwidth utilization. Theoretical formation of OFDM and application starts in the area of wireless mobile communication, which is based on discrete Fourier transform (DFT). The sub-carriers overlap 1/2 between them but remain orthogonal to each other. The signals are separated by demodulation in the receiver. To reduce the complexity of multicarrier system, in 1977, S.B. Weinstein and P.M. Ebert [3] proposed following theories, ―Before passing the filter, the spectral shape of sub-carrier is a sinc function and non-band limited. DFT can do modulation and demodulation of multi-carrier baseband. The empty slot between symbols can be used as a guard interval to eliminate ISI‖. In 1980, A. Peled and A. Ruiz replaced the empty slot as cyclic prefix (CP) in order to satisfy the orthogonality of each carrier in dispersive channels. In 1985, Cimini [3] applied the OFDM to wireless cellular mobile communication system, and established the OFDM

wireless mobile communication systems theory. OFDM is widely applied from theory to practice. In the past decade, the rapid development of large scale integrated circuit technology and realization of a large number points high-speed FFT promote the wide application of OFDM theory. At present, OFDM has been widely used in broadcast audio and video and civilian communications, including asymmetric digital subscriber line (ADSL), digital audio broadcasting (DAB), digital video broadcasting (DVB), high definition television (HDTV), wireless local area networks (WLAN). Because of the dramatic increasing of mobile users, mobile speed and amount of data transmitted, there are still many problems of OFDM to be resolved in the high-speed mobile environment. And one of the problems is the channel estimation.

III. PROPOSED METHODOLOGY

The wireless communication system is the best to estimate for lower mean square error and for such aim we need the efficient technique to improve system. The same aim considered here to make system better by estimating the channel performance and minimizes the MSE.

In below figure the proposed system is explained in major blocks in which the system is divided. The major blocks are in the sequence i.e. modulation, OFDM Modulation, Channel Part, OFDM Demodulation, proposed technique i.e. LS/MMSE Estimation and Median Filtering.

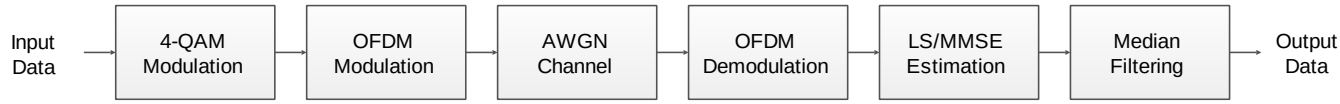

Fig. 3.1 Block Diagram of proposed methodology

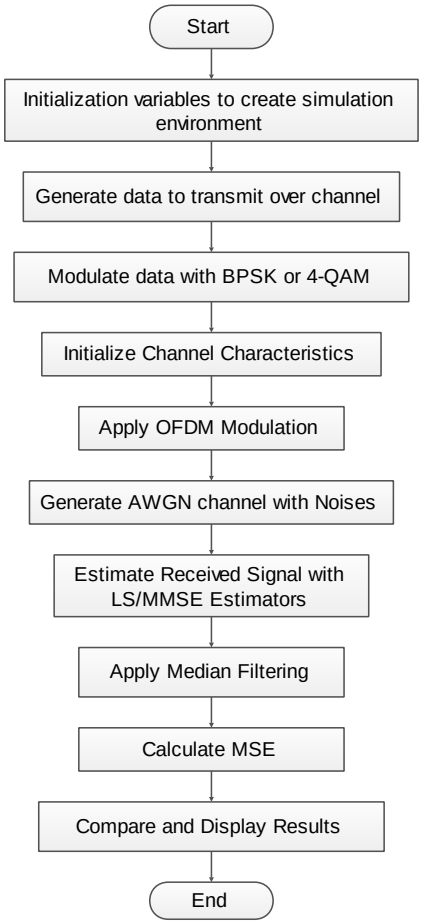

Fig. 3.2 Flow chart of proposed methodology

The above system is implemented on simulation tool and the flow of execution of algorithm is shown in below figure.

The flowchart of proposed approach is given in the figure below. The steps are as follows:

a. *Start of simulation*
b. *The system need to be initialized before starting of simulation*
c. *For system analysis data is generated*
d. *Modulate signal with BPSK or 4/8/16-QAM*
e. *Characteristics of the channel is initialize*
f. *Applying OFDM Modulation*
g. *Transmitting through AWGN channel with adding Noises*
h. *Now signal is estimated with MMSE estimators*
i. *In addition with estimators median filtering is applied to improve the performance*
j. *Calculation of MSE*
k. *Compare and display results*
l. *End of simulation*

IV. SIMULATION RESULTS

The proposed system is explained in the previous system implemented with the help of simulation tool and outcomes of the methodology is shown in below figures. In Fig. 4.1 the proposed methodology with system is evaluated with MMSE estimator and to enhance the performance means to reduce system error median filtering is applied.

By the use of median filter the performance of the system using least square estimation and minimum mean square error is improved. The below results are obtain by applying 4-QAM modulation technique.

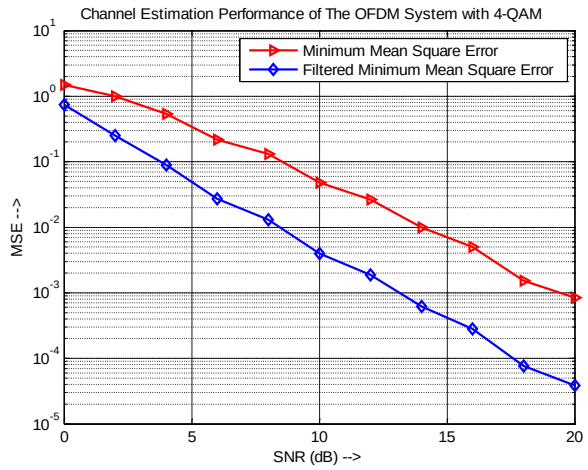

Fig. 4.1 Simulation results of Mean Square Error (MSE) with 4-QAM Scheme and Median Filter

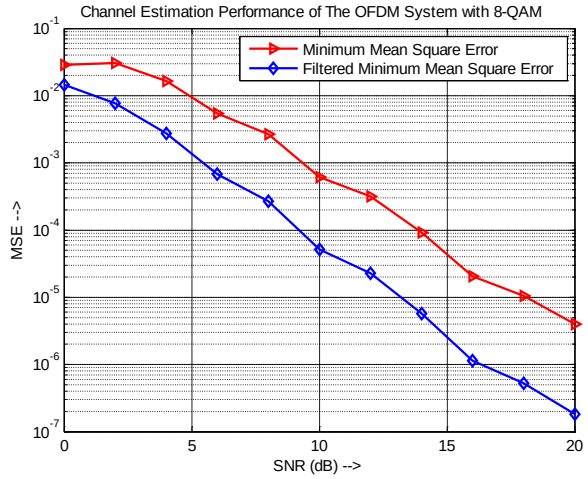

Fig. 4.2 Simulation results of Mean Square Error (MSE) with 8-QAM Scheme and Median Filter

From the results it can be observed that the blue graph i.e. MMSE with median filtering is optimum performance in terms of mean square error (MSE).

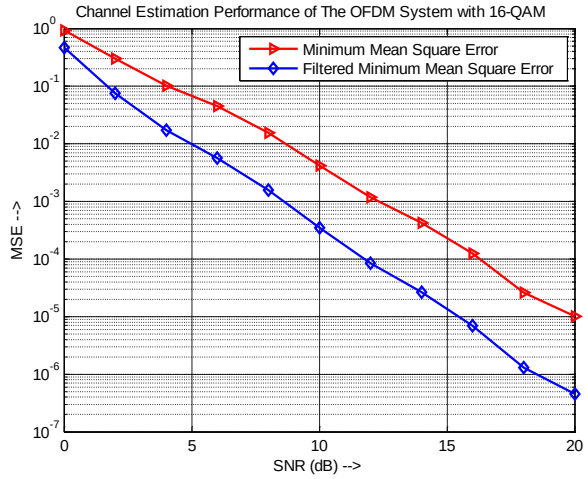

Fig. 4.3 Simulation results of Mean Square Error (MSE) with 16-QAM Scheme and Median Filter

In Fig. 4.2 the proposed methodology with system is evaluated with MMSE estimator and to enhance the performance means to reduce system error median filtering is applied. By the use of median filter the performance of the system using least square estimation and minimum mean square error is improved. The below results are obtain by applying 8-QAM modulation technique. From the results it can be observed that the blue graph i.e. minimum mean square error with median filtering is optimum performance in terms of mean square error(MSE).

In Fig. 4.3 the proposed methodology with system is evaluated with MMSE estimator and to enhance the performance means to reduce system error median filtering is applied. By the use of median filter the performance of the system using least square estimation and minimum mean square error is improved. The below results are obtain by applying 16-QAM modulation technique. From the results it can be observed that the blue graph i.e. minimum mean square error with median filtering is optimum performance in terms of mean square error(MSE).

V. CONCLUSION AND FUTURE SCOPE

The OFDM based wireless communication system is channel estimated and after studying of various effective techniques, here minimum mean square error(MMSE) are taken into consideration for estimation of channel and to reduce the mean square error (MSE) median filtering(MF) is used followed by MMSE estimators. After analysis of the system using 4/8/16-QAM modulation techniques it is found that the when MMSE is used with 4/8-QAM the MSE is better and if MMSE is used with 16-QAM than also MSE is more better. Now with the less complex modulation technique i.e. BPSK is preferred over other. So that BPSK is best with median filtering.

In the future more effective estimators make great change in the system with proposed median filtering technique and more efficient modulation enhance the system performance and reduce mean square error (MSE).

REFERENCES

[1] Rappaport, T., Wireless Communication: Principles and Practice. New Jersey: Prentice Hall, 1996.

[2] Chang, R., “Synthesis of band limited Orthogonal Signals for multichannel data transmission.” Bell System Technical Journal. vol. 46, (December 1996): pp. 1775-1796.

[3] Proakis, J., Digital Communications. New York: McGraw-Hill, 1998.

[4] Torrance, J., and Hanzo, L., "Comparative study of pilot symbol assisted modem systems." Proceedings of IEEE conference on Radio Receivers and Associated Systems, Bath UK, (September 1995): pp. 36-41.

[5] Weinstein, S. and Ebert, P., "Data Transmission by Frequency Division Multiplexing using the Discrete Fourier Transform." IEEE Transaction Communication Technology.vol. COM-19, (October 1971): pp. 628-634.

[6] Bello, P. A., "Selective Fading limitations of the KATHRYN modem and some system design considerations." IEEE Transaction Communication Technology. vol.COM-13, (1965): pp. 320-333.

[7] Zimmerman, M. and Krisch, A., "The AN/GSC-10/KATHRYN/ variable rate data modem for HF radio." IEEE Transaction Communication Technology. vol.CCM-15,(April 1967): pp.197-205.

[8] Hirosaki, B., "An analysis of automatic equalizers for orthogonally multiplexed QAM systems," IEEE Transaction Communication Technology. vol. COM-28, (January 1980): pp. 73-83.

[9] Peled, A. and Ruiz, A., "Frequency Domain Data Transmission using Reduced Computational Complexity Algorithms." Proceedings of International Conference on Acoustics. vol. 3, (April 1980): pp. 964-967.

[10] Ketel, I., "The Multitone Channel." IEEE Transaction on Communication. vol. 37, (February 1989): pp. 119-124.

[11] Fazel, K. and Fettis, G., "Performance of an Efficient Parallel Data Transmission System." IEEE Transaction Communication Technology. (December 1967): pp. 805-813. 46

[12] Meyr, H., Moeneclaey, M. and Fechtel, S. A., Digital Communicatio Receivers. John Wiley and Sons, 1998.

[13] Li, Y., Seshadri, N. and Ariyavisitakul, S., "Channel Estimation for OFDM systems with transmitter diversity in mobile wireless channels." IEEE J. Select. Areas Communication (March 1999): pp. 461-470.

[14] Moher, M. L. and Lodge, J. H., "TCMP- a modulation and coding strategy for Rician fading channels," IEEE Trans. Communication Technology. (December 1967): pp.805-813.

[15] Aghamohammadi, A., Meyr, H., and Asheid, G., "A new method for phase synchronization and automatic gain control of linearly modulated signals on frequency flat fading channels," IEEE Trans. Communication Technology. (January 1991): pp.25-29.

[16] Cavers, J. K., "An analysis of Pilot symbol assisted modulation for Rayeigh fading channels." IEEE Transaction on Vehicular Technology. vol. 40(4), (November 1991):pp. 686-693.

[17] Moon, JAe Kyoung and Choi, Song In., "Performance of channel estimation methods for OFDM systems in multipath fading channels." IEEE Transaction on Communication Electronics. vol.46, (February 2000): pp. 161-170.

[18] Tufvesson, F., Faulkner, M., Hoeher, P. and Edfors, O., "OFDM Time and Frequency Synchronization by spread spectrum pilot technique." 8th IEEE Communication Theory Mini Conference in conjunction to ICC'99, Vancouver, Canada, (June 1999): pp. 115-119.

[19] Tufvesson, F. and Hoeher, P., "Channel Estimation using Superimposed pilot Sequences," IEEE Trans. Communication (March 2000).

[20] Moon, T. K., "The Expectation Maximixzation Algorithm." IEEE Signal Processing Magazine. vol. 13, (November 1996): pp. 47-60.

[21] Xiaoqiand, Ma., Kobayashi, H. and Schwartz, Stuart C., "An EM Based Estimation of OFDM Signals." IEEE Transaction Communication. (2002).