ISSN (Online) : 0974-5645
ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, *Vol 8(5), 438–444, March 2015*
DOI : 10.17485/ijst/2015/v8i5/60478

Design and Analysis of Novel Modified Cross Layer Controller for WMSN

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Abstract

Wireless Multimedia Sensor Networks (WMSNs) are swell systems of wirelessly networked systems that consent reclaiming moving images, still images, scalar sensor information and audio information. It is an essential factor of grave networks to safeguard the function of tactical national transportation, afford maintain to work against emergencies and coercion and improve transportation for tactical armed functions. It needs the sensor network customary to be re-consideration in sight of necessitate for technique to fetch multimedia data with a pre-described stage of Quality of Service (QoS) to permit these functions. By believing MIMO modulator, Architecture of the Modified Cross-Layer Controller is proposed. Then using this concept, Signal-to-Noise Ratio (SNR), Bit Error Rate (BER), Symbol Error Rate (SER) and Average Mean Square Error (AMSE) are measured with using MATLAB program and the same is compared with other signal processing approaches named Least Square method and Minimum Mean Square Error method. The same concept is used to reduce area, power and to increase speed of the system with the help of VHDL program. Simulation results show that the proposed Modified Cross-Layer Controller can successfully improve the data gathering performance in wireless multimedia sensor networks. In this research, life cycle improvement of the system is proposed. The goal of our proposed work is to vigorously review the routing method outflow and the constraint of the multimedia function to make sure an adequate quality of service. Simulation results show that our solution is efficient and gives better performance than other methods.

Keywords: Life Cycle Improvement and Performance Estimation, MIMO Modulator, Modified Cross-Layer Controller, Quality of Service

1. Introduction

Wireless Sensor Networks (WSN) has haggard the interest of the research area, obsessed by an affluence of imaginary and realistic braves. Momentous results in this area have ushered in a pour of communal and armed applications. Since now, mainly deployed wireless sensor networks evaluate scalar corporal phenomena like pressure, humidity and temperature. In common, the applications they are intended for have small bandwidth claims and are typically setback liberal. Further lately, the accessibility of cheap hardware for instance CMOS microphones and cameras that preserve universally detain multimedia substance from the surroundings has fostered the improvement of WMSNs. That is, networks of wirelessly consistent mechanisms that can get back audio and video streams, scalar sensor data and still images[1]. These networks will be a solution component of task momentous networks to shield the function of deliberate general communications, offer prop up for tragedy and calamity intrusion and increase communications for planned armed functions to enable innovative functions like passage enforcement, control systems, multimedia scrutiny, superior health heed liberation, structural health monitoring and industrial process control. A lot of uses depicted over entail the sensor network pattern to be re-consideration in scrutiny of require conveying multimedia substance with pre-described range of quality of service (QoS)[2].

To distributive split a usual wireless channel between clumsy mechanisms, *Carrier Sense Multiple Access with*

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Collision Avoidance (CSMA/CA) has confirmed to be a successful method[3]. The module is based on the MIMO communication method. To consent low power spending, high speed data rate communications, the MIMO advanced cross layer method has the latent, which build it a perfect option for WMSNs. To enable high speed data rate, the modified cross layer controller is claiming for WMSNs, particularly low power utilized wireless communications. At last, the small power spectral density allows armed secret functions; although the bulky direct bandwidth allows well instance pledge for exact point evaluation and network management[4].

The rest of the paper is planned as follows. In Section II, the earlier work on Ultra Wide Band technology is conversed. In Section III we summarize the most important design opinions, and explain the anticipated advanced cross-layer controller. In Section IV, we bring in the unhurried QoS and method forming with MIMO. In Section V, we describe the life cycle parameters. In Section V, we converse performance estimation consequences while in Section VI we describe the most important conclusions.

2. Related Work

Physical layer facet of the UWB technology has a huge prose. Remarkable wide surveys of the UWB transmission technique and localization techniques for UWB methods are offered in the history. Time-Hopping Impulse Radio UWB (TH-IR-UWB) is a multiple access method, time asynchronicity, non-zero cross-correlation among time hopping sequences among for proper MAC and upper layer results and causes the sturdy upshot of multipath transmission is needed, similar to CDMA. Yet, upper layer results for multi-hop wireless networking with UWB are immature[5]. In[6] Martello et al. examine the difficulty of joint rate and power assignment for TH-IR-UWB, and originate it as an optimization problem. An unsynchronized MAC protocol for low-power UWB devices is suggested, depends upon the over result[7].

3. Design Opinions and Modified Cross-Layer Controller

In this chapter, the subsequent opinions are directed the devise system. The advantages of the devise are reviewed in analysis of the recital points and of the traits of WMSNs[5], and illustrate the modified cross-layer control architecture of the MIMO modulator.

3.1 QoS Maintain Imposed by Modified Cross-Layer Architecture in Network Layer

The packet-level service isolation in terms of end-to-end packet error rate, delay and throughput given by the suggested system offers QoS shore up at the network layer. The modified cross-layer controller architecture is shown in Figure 1.

3.2 Geographical Forwarding

In the sort of centimeters, Time-based localization methods in MIMO permit ranging exactness[8]. Therefore, to provide QoS, the unit controls geographical sequences. Situation abilities are required in sensor networks to correlate corporal denotation to the data collected by sensors. Furthermore, awareness of the location of all network systems permits for scalable steering explanations[9].

3.3 MAC Layer

In WMNs, two feasible intends subsist for MAC protocols. WMNs are intended to effort as single channel or multiple channels concurrently[10].

3.3.1 Single Channel MAC

3.3.1.1 Revising Surviving MAC Protocols: By exercise, revising the backoff procedures will modify CSMA/CA parameters. But, that solution not able to generate momen-

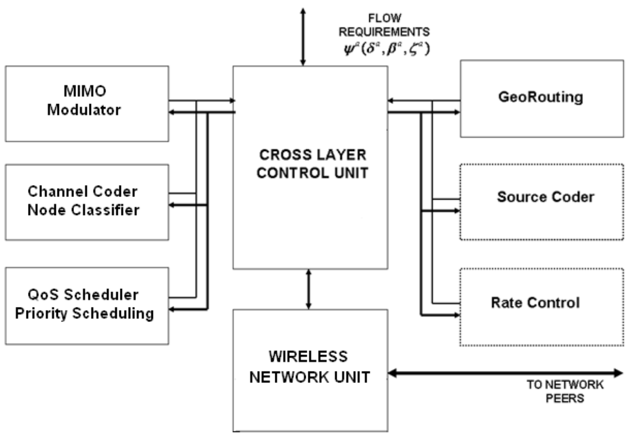

Figure 1. Architecture of the Modified Cross-Layer Controller.

tous progress in throughput. Since it cannot decrease the concern of conflicts among neighboring nodes[10].

3.3.1.2 Design of Cross Layer: It occupies two most important methods. 1. Directional antenna, based on MAC and 2. Power controlled MACs. To eliminate the exposed nodes, directional antennas are used. This method is used to decreases the uncovered nodes situate by lesser the communication power level. The main application is increasing the spectrum recycle cause in WMNs. Though, WMNs distributes the similar disadvantage of the previous in maximizing the number of ignored potential interfering nodes[10].

3.3.1.3 Innovative MAC Protocols Proposal: Random access methods such as CSMA/CA are not competent. Since the meager scalability in multi hop networks. As a result, CDMA or TDMA is inevitable[10].

3.3.2 Multi Channel MAC

To improve capacity and network performance for WMNs, multi channel MAC is used. Based on the hardware platform, there are different MAC protocols for multichannel MAC[10]. That is,

3.3.2.1 Single Transceiver MAC Protocol for Multichannel: It has only one transceiver, so that each node only one channel is active at a time. Although the remaining nodes can operate concurrently on various channels. To manage transmission among network nodes, MAC protocols are used[10].

3.3.2.2 Multi Transceiver MAC Protocol for Multichannel: By having a number of RF end-chips and baseband processor units on a radio, the scheme is supported by a number of concurrent channels. One MAC layer is required to direct a number of channels[10].

3.3.2.3 MAC with Multi Radio: Here, every network has multiple sovereign radios and its individual physical and MAC layers. Because of the reason, the setup requires a effective MAC protocol to manage data in the entire channels [10].

4. Quality of Service and Method Forming with MIMO

To improve the QoS for WMSNs, the following parameters are considered. In Section V, the same parameters are compared between three approaches namely: i) Least Square Method (LSM), ii) Minimum Mean Squared Error (MMSE) and iii) Improved Cross-Layer Approach was discussed.

4.1 Signal to Noise Ratio

Signal-to-Noise Ratio (SNR) is a calculation used in communication and networks that evaluates the range of a preferred signal to the range of surrounding noise. It is described as the ratio between signal power and the noise power. It is measured by the unit in decibels.

SNR is described as the power ratio between a background noise and signal noise. SNR is used in a relaxed way to pass on to the ratio of useful data to fake or unrelated information in a discussion or barter.

$$SNR = \frac{{}^{P}signal}{{}^{P}noise} \tag{1}$$

where, P is average power. In WMSN, the same system bandwidth and the same equivalent points, both noise and signal power should be calculated. The values of noise and variance of the signal are identified and the zero-mean signal. Then,

$$SNR = \frac{\sigma^2 signal}{\sigma^2 noise} \tag{2}$$

4.2 Bit Error Rate

To find out the quality of a multimedia data communication, measurement of Bit Error Rate (BER) is the most significant idea. It is measured by counting the number of errors and to compare the bits between transmitter and receiver. BER defines that the ratio between error bits received and the number of bits received.

$$BER = \frac{{}^{N}Err}{{}^{N}bits} \tag{3}$$

4.3 Symbol Error Rate

In data communications and networks, modulation rate or symbol rate or baud is the number of symbol changes ended to the communication medium per second using a digitally modulated signal. The modulation rate is used by the unit in baud or symbols/second. The symbol duration time is denoted by T_s and it can be calculated as:

$$T_s = \frac{1}{f_s} \tag{4}$$

where f_s is the symbol rate.

4.4 Mean Squared Error

The Mean Squared Error (MSE) is a measurement of the average square value of the errors. It is a difficult operation, consequent to the determined range of the quadratic loss or squared error loss. Due to randomness or the estimator doesn't account for information, difference occurred and it can create a perfect estimation.

If, Y is the vector of the true values and $\hat{Y}$ is a vector of n predictions, then the MSE of the interpreter is measured:

$$MSE = \frac{1}{n}\sum_{i=1}^{n}\left(\hat{Y}_i - Y_i\right)^2. \tag{5}$$

4.5 Multiple-Input and Multiple-Output (MIMO) Modulator

In radio, to get better communication performance, MIMO is used with several antennas at both the transmitter and receiver. It is one of many types of smart antenna method. The radio channel hauling the signal to facilitate the provisos input and output pass on and the devices not having antennas[11].

4.5.1 *Functions of MIMO*

MIMO can be separated into three important groups called spatial multiplexing, diversity coding and precoding.

In the finest meaning, precoding is multi-stream beam forming. It is considered to all spatial processing that appears at the transmitter in many common terms. The identical signal is emitted as of each the transmit antennas along with suitable gain loading. Because in beam forming, receiver input has higher signal power. By creating signals released from various antennas add up gainfully and to minimize the multipath fading effect, the advantages of beam forming are maximized the gain of received information. In the lack of distributing, beam forming consequences in a fine distinct directional mold, although in distinctive cellular predictable beams are bad correlation. The transmission beam forming decrease the signal strength at every one of the reception antennas and many precoding flows is used, if the many reception antennas utilized. The precoding obliges facts of channel state information (CSI) at the transmitter[11]. Wireless MIMO system was shown in Figure 2.

MIMO transreceiver arrangement needed spatial multiplexing. In that, a high data rate signal is divided into several lower rate streams and in the same frequency channel all streams are send by a various transmit antenna. The receiver is split these data rate signals into many parallel data rate signals, if they signals received by reception antenna group with suitably unusual spatial marks. For maximizing channel strength at SNR, Spatial multiplexing is a most dominant method. By using minimum number of antennas in transmission and reception, the spatial streams are limited. Channel information is transmitted or not, spatial multiplexing is used. It can also be used for concurrent transmission with many receptions called as space division method for multiple accesses. Good separability permitted by the preparation of receivers with unusual spatial marks.

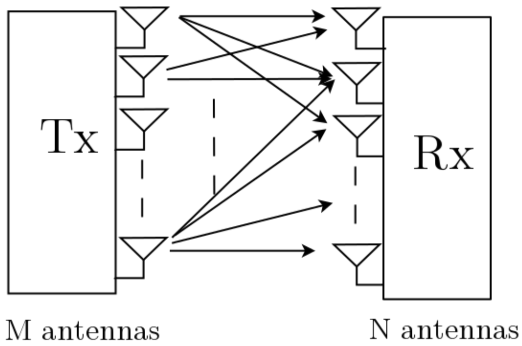

Figure 2. Schematic of a wireless MIMO system with M transmit antennas and N receiving antennas.

If there is no channel information in transmitter, Diversity Coding methods are used. A single data rate signal is transmitted in diversity techniques and the stream is coded using a method known as space time coding. All the transmit antennas with full orthogonal coding is emitted the signal. To improve signal diversity, this method utilizes the self-sufficient trending in the multiple antenna ties. As increasing channel information increases the array gain in diversity method.

5. Life Cycle Improvement

5.1 Hot Carrier Effects

Hot carriers moving with diffusion velocity can root sponging effects at the drain side of the channel called as Hot Carrier Effects (HCE), if a MOS transistor is operated below pinch-off condition also called as saturated case. To make electron-hole pairs by Impact Ionization these carriers have adequate energy shown in Figure 3. The produced mass alternative carriers can also be gathered by

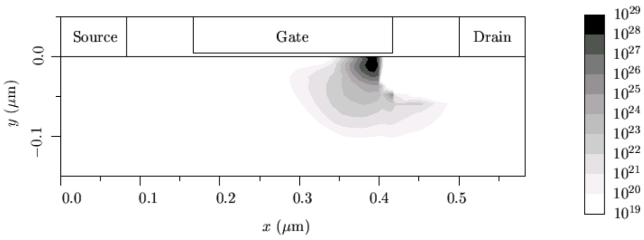

Figure 3. Impact Ionization in units of device β in the on-state.

the drain or inserted into the gate oxide. The produced bulk carriers make a mass current which can be used as a calculable amount to verify the range of impact ionization.

Carrier injection into the gate oxide can guide to hot carrier deprivation causes such as threshold voltage varies due to engaged ambushes in the oxide. Hot carriers can also produce ambushes at the silicon-oxide interface called as fast surface states top to secondary verge sway corrosion and anxiety induced drain seepage.

5.2 On-Chip Negative Bias Temperature Instability

Negative Bias Temperature Instability (NBTI) is a most important consistency apprehension in nowadays CMOS method. NBTI is a grave front end consistency apprehension for pMOSFETs. Similar to other consistency concerns, it results in mechanism limitation shifts in time, which in rotate reasons digital and analog circuit feat drift and collapse. NBTI also have lifetime of a specific method node is dogged by short time speed up anxiety and extrapolation of calculated data to end-of-life at use circumstances. To select correct stress conditions such that the fault liable for NBTI is only picking up the pace is important and no new fault creation modes get activated.

5.3 Electro Migration

Electro Migration (EM) consistency has suit a rising anxiety for Cu intersects in advanced methods nodes. The interface among the dielectric circulation barrier and copper, metal barrier worth and metallization homogeneity are all serious to EM performance. Multiple methods extended at Novellus have established considerable EM development devoid of compromising strain migration[12].

It is more and more related by the electronic circuits in physical design of. In interconnect, unnecessary current density pressure are caused. In recent years, the constant decrease of circuit attribute sizes has provoked the problem. To believe Electro migration linked specific factors through physical design, it is a significant reliability concern. Here, the electro migration difficulty is introduced on its connection to current density. Different physical design limits are presented and that affected electro migration. At last, an electro migration conscious physical design flows are introduced[13].

Moreover, the propensity of wires to electro migration based on crumb size and thus on the sharing of crumb sizes. Lesser crumbs support substance transport, since there are many transport channels than in crude crumbed material. Diffusion methods rooted by electro migration can be split into (a) grain boundary diffusion (b) bulk diffusion and (c) surface diffusion shown in Figure 4[14].

6. Performance Estimation

To evaluate the performance of the considered result, we have urbanized three software simulation tools. That is a MAC layer simulator of the MIMO modulator controller in Matlab to evaluate for an OFDM System, a MIMO-OFDM simulator in Xilinx to reduce area, power and to improve the speed of the system, and the life cycle improvement in Multisim to improve the life time of the system. By using Matlab software, we compared three approaches namely: i) Least Square Method (LSM), ii) Minimum Mean Squared Error (MMSE) method and iii) Improved Cross-Layer Approach of signal processing to know about the performance of the system. For this, we have considered some parameters namely: SNR, BER, Average MSE, Symbol Error Rate and Throughput. The Performance evaluation for an OFDM System with LS/MMSE/CLA Estimator based receivers are shown in Figure 5.

The performance of MIMO-OFDM simulator using Xilinx Software was mentioned in comparison table between existing and proposed cross-layer approach. It was shown in Table 1.

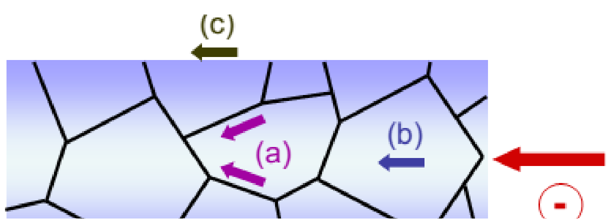

Figure 4. Diffusion Method[14]

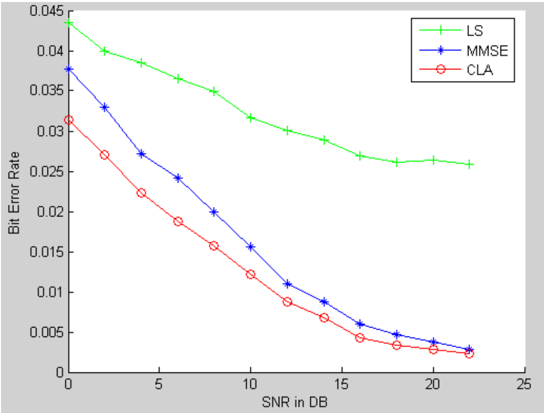

Figure 5. (a)

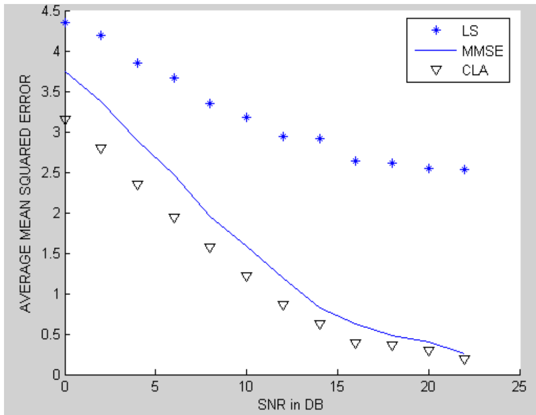

Figure 5. (b)

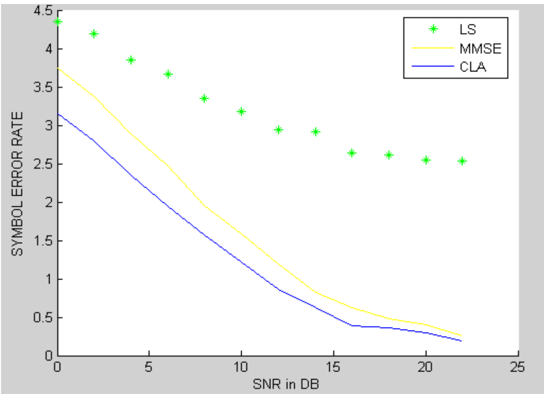

Figure 5. (c)

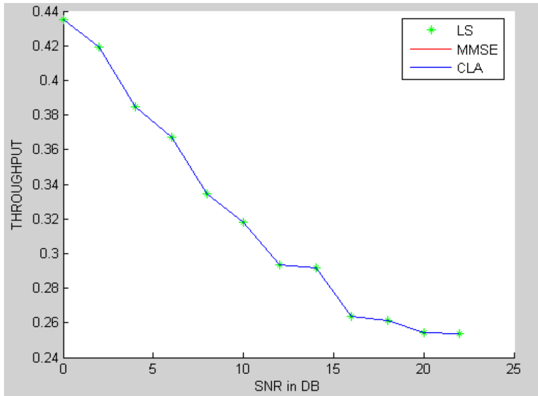

Figure 5. (d)

Figure 5. Performance evaluation for an OFDM System with LS/MMSE/CLA Estimator based receivers (a) Plot of SNR versus BER, (b) Plot of SNR versus AVG MSE, (c) Plot of SNR versus Symbol Error Rate and (d) Plot of SNR versus Throughput.

Table 1. The performance of MIMO-OFDM simulator

Parameter	Existing Cross-Layer Approach	Improved Cross-Layer Approach
Area	125260 Kilobytes	111700 Kilobytes
Power	280.97mW	221mW
Speed	8.474ns (6.741ns logic, 1.733ns route)	5.822ns (4.787ns logic, 1.035ns route)

7. Conclusion

We have explained the design of modified cross-layer controller to provide better QoS in WMSN based on MIMO modulator. The architecture is based on an new intend that aims at given that demarcation in the domains of Signal-to-Noise Ratio, Bit Error Rate, Symbol Error Rate and Average Mean Square Error based on a modified cross-layer controller. Performance estimation shows that the architecture is a gifted solution to convince the performance intentions of WMSNs.

8. References

1. Akyildiz IF, Melodia T, Chowdhury KR. A survey on wireless multimedia sensor networks. Computer Networks. 2007, Mar; 51(4):921–60.
2. Pudlewski S, Melodia T. A distortion-minimizing rate controller for wireless multimedia sensor networks. Comput Commun. 2010. doi:10.1016/j.comcom.2010.02.016.

3. Melodia T, Akyildiz IF. Cross-layer Quality of Service support for UWB wireless multimedia sensor networks. Proceedings of IEEE Communications Society Subject Matter Experts. IEEE INFOCOM; 2008.
4. Akyildiz IF, Melodia T, Chowdhury KR. A survey on wireless multimedia sensor networks. Computer Networks. 2007; 51:921–60.
5. Melodia T, Akyildiz IF. Cross-Layer QoS-Aware communication for ultra wide band wireless multimedia sensor networks. IEEE J Sel Areas Commun. 2010, Jun; 28(5):653–63.
6. Cuomo F, Martello C, Baiocchi A, Capriotti F. Radio resource sharing for Ad-Hoc networking with UWB. IEEE J Sel Areas Commun. 2002, Dec; 20(9):1722–32.
7. Merz R, Widmer J, Boudec J-YL, Radunovic B. A Joint PHY/MAC architecture for low-radiated power TH-UWB wireless Ad-Hoc networks. Wireless Communications and Mobile Computing Journal. 2005, Jul; 5(5):567–80.
8. Gezici S, Tian Z, Giannakis GB, Kobayashi H, Molisch AF, Poor HV, Sahinoglu Z. Localization via Ultra-Wideband Radios. IEEE Signal Processing Mag. 2005, Jul; 22(4):70–84.
9. Melodia T, Pompili D, Akyildiz IF. On the Interdependence of distributed topology control and geographical routing in Ad Hoc and sensor networks. IEEE J Sel Areas Commun. 2005, Mar; 23(3):520–532.
10. Akiyildiz IF, Wang X. A survey on wireless mesh networks. IEEE Radio Communications. 2005, Sep; p. s23–s30.
11. Ramprabu G, Nagarajan S. Performance analysis of communication processor for WMSN. Int J Adv Res Comput Sci. 2013, Jan-Feb; 4(2):209–12.
12. Ramprabu G, Nagarajan S. Implementation of life cycle improvement for WMSN. IJAIEM. 2013 Jun; 2(6):422–8.
13. Lienig J. Introduction to electromigration-aware physical design. Proceedings of the 2006 International Symposium on Physical Design. 2006, Apr; p. 39–46.
14. Lienig J. Electromigration and its impact on physical design in future technologies. Proceedings of the 2013 ACM International Symposium on Physical Design (ISPD). 2013. p. 33–40.