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A COMBINATION OF WIRELESS AND OPTICAL MODE COMMUNICATION IN SENSOR NETWORKS FOR EFFICIENT DATA TRANSMISSION

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Abstract: Wireless sensor network is one of the subsets of wireless technology providing significant research and development interest from various domains of engineering. They are mostly used in remote terminal unit which may be in remote location for data aggregation, SCADA operation, data collection. Their power consumption as well as the cost is very less. The rapid positioning of these sensors have served as an advantage and has applications in the field like recovery after the disaster, surveillance in military, administration in health sector and etc..., and do not require human intervention. Nodes consist of sensor devices. These sensor devices sense the parameters to be measured and pass this value to a transceiver unit. This unit forwards the data to a remote location where it is monitored for controlling certain operations. Wireless communication provides long range transmission using Multi-Hop topology. The interference causes degradation of data quality and makes it difficult to control the distributed units through automation. Preserving the accuracy of data that is to be transmitted and providing fastest data transmission rate for appropriate data exchange in the network is important. Hence, optical fiber communication has gained research interest due to offered large bandwidth and less interference to multi access communication. The proposed solution is concentrated to develop a spectrum allocation in WSN Optical Communication model with reference to offered service rate and therefore the interference margin. The dynamic behavior of modulation control, leads to a higher resource utilization, lower computation overhead, higher accuracy and higher offered throughput.

Index Terms: Multi-Hop topology, Optical Fiber Communication (OFC), Wireless Sensor Networks (WSN)

I. INTRODUCTION

The growth in the field of Wireless Communication has given way to many other communication approaches for exchanging the data which leads to high resource utilization and offers greater system efficiency. Systems such as hybrid network, heterogeneous network, cognitive network, Ad-hoc network, wireless sensor network are few of the examples of advanced networks. With each of these networks there is an improvement in resource utilization, throughput, data accuracy, service compatibility, etc. Among these approaches, wireless sensor network are used for various critical monitoring applications such as the power plants, medical data monitoring, distributed industries, military applications, corporate applications etc. Wireless Sensor Networks (WSNs) find their applications in many isolated and engineering applications. Besides the advantages, efficient routing protocol improves the efficiency of these WSNs. This routing protocol plays an important role in transmission of data from sensors. These sensors which are used can have certain limitation in resources like bandwidth, power and inconstant network topology with data being redundant. In WSN, there exist multiple paths to exchange information for every node. These paths also route the information between the nodes. The nodes are connected through various nodes increasing the throughput thus allowing various information's to be transmitted at a time through multiple paths. This kind of routing over multiple paths increases the life time of network. Balancing the energy consumption of each node by shunting messages through multipath also elevate stability and reliability. Therefore, it can provide much better service for network applications. Even in multipath routing the issue of congestion is predominant, which results in blockage leading to the decrease in throughput of the system. For improvement in resource optimization and throughput, optical networks are integrated to offer higher optical spectrum. Studies show that various approaches were made by the researchers in this domain. Zahurul et al in [1] defined a method where the data exchange happens in real time. The author has discussed micro grid system with sensor nodes and optical communication methods for exchanging the data between the nodes. L. Alwis et al in [2] explained the optical fiber sensor (OFS) in communication. In [3] Joel Villatoron and Josebazubia defined various sensors and their structure of communication for future generation OFS communication. Photonic Crystal Fiber (PCF) technique in OFS is outlined by A. Xenakis et al in [4]. The technique provides improvement in the efficiency of data exchange. In [5], Zilong Liao et al defined a simulated Annealing (SA) approach. Cluster based scheme was discussed in [6], Guodong Sun et al. To conserve energy, based on conservation RF-MAC protocol was recently proposed by Junaid Ahmed Khan et al in [7]. In this approach the method of energy transmission via RF media to recharge the distributed nodes over wide distributed nodes is defined. Joint optimization considering hardware power consumption is investigated in [8-10]. S

ISSN- 2394-5125 VOL 7, ISSUE 09, 2020

Taruna et al[11] define Cross Layer Optimization technique where coding was introduced at network abstraction layer (NAL). The buffer based congestion control following buffer Management and relative quality of Service (QoS) was mapped to schedule the rate of data traffic flow. Among the communication approach, the light modulation has limitation of interference due to refraction and reflection of optical beam over the fiber units. It is hence, required to develop an adaptive modulation for spectrum allocation in optical means for interference control and throughput enhancement. The approach of wireless sensor network communication is outlined in 2. Section 3 presents the conventional optical modulation scheme for WSN-optical communication. Section 4 presents the proposed adaptive interference mitigation in WSN-OC architecture. Simulation result is outlined in section 5. Section 6 outlines the conclusion for the developed approach.

II. WSN COMMUNICATION

WSNs are used in the physical monitoring. They have the advantage of being located far off from the actual point of occurrence. The WSNs are used for aggregation and collection of data from a remote location. The task of a routing protocol is to provide increased throughput. Wireless sensor network has multiple sensor nodes to sense the environmental conditions and also to generate sensor readings which are then delivered to certain nodes through multi hop path. The nodal positions can be pre-defined. The requirement of optimal coverage and connectivity constraints are also met. The sensors in the observing unit captures the data, code and transfers to nearest neighbor. The range can be extended and the information bits can be retained but there may be certain interference and congestion.

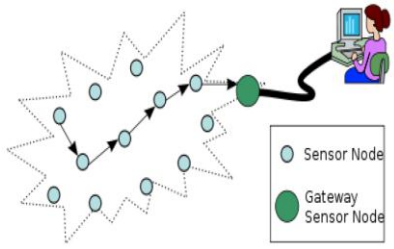

Fig.1. Basic WSN architecture

A typical WSN has multiple nodes connected to sensors and has a radio transceiver with antenna, a microcontroller, an electronic circuit for interfacing with the sensors and a battery or an embedded sort of energy harvesting. The size and cost of the sensor node may vary. The topology also can vary from star network to a complex multi-hop wireless mesh network. To achieve a higher throughput, WSN are integrated with optical communication because of its high bandwidth.

III. OPTICAL MODULATION

Optical communication systems are provides higher bandwidth and are very much in use. Improvement in the rate at which the data is transmitted and in bit-error performance is of high priority so as to acknowledge the complete potential of the medium. The receiver has to be designed in such a way that it eliminates the noise present in the received signal. The visible light spectrum provides the potential for high-speed broadband communications. In the optical mode communication, the estimation operation of the signal received is performed based on the thresholding of the magnitude value. However, the decisions are erroneous under dynamic interference model. Hence, in this paper an optimal estimation based on adaptive threshold margin is proposed.

IV. WIRELESS SENSOR-OPTICAL COMMUNICATION

A large amount of interference is observed at the source side. These noises are to be eliminated as it could result into multiplicative noise during communication in light propagation. To minimize the noise effect, in this paper new threshold logic based interference minimization logic is developed. This approach minimizes the noise level based on the derived noise margin developed from the discrete input value. In the signal propagation when noise is added it illustrates a random pattern. To detect the available signal and the noise level, the signal is sampled in a discrete manner and the average energy variation is considered. The receivers in the Wireless Communication System are designed in such a way that the noise that exists is considered as additive noise because of the channel characteristics and receiver electronics. In OFCs, light sources generate the optic beams that carry the information. The photo detector and the amplification circuitry have to be optimized, maintaining the SNR in order to detect the weakest possible optical signals.

In a shot-noise-limited system, the amount of electron produced during the bit interval is taken by the photo detector and is compared with the threshold. If count is greater than the threshold a 1 is transmitted else it is a 0. Errors do occur when the required threshold is not met. 1's and 0's errors do occur when we try to increase or decrease the threshold. Errors are minimal when the threshold is optimum. Consider [Figure 2(a)] gives the ideal current, followed by the actual current with noise and filtering [figure. 2(b)], which is then sampled at the end of each bit appearing in [figure. 2(c)]. The amplitude of

ISSN- 2394-5125 VOL 7, ISSUE 09, 2020

each sample will be compared with a reference value. If sample exceeds the threshold then a 1 is processed else a 0 [Figure 2(d)].

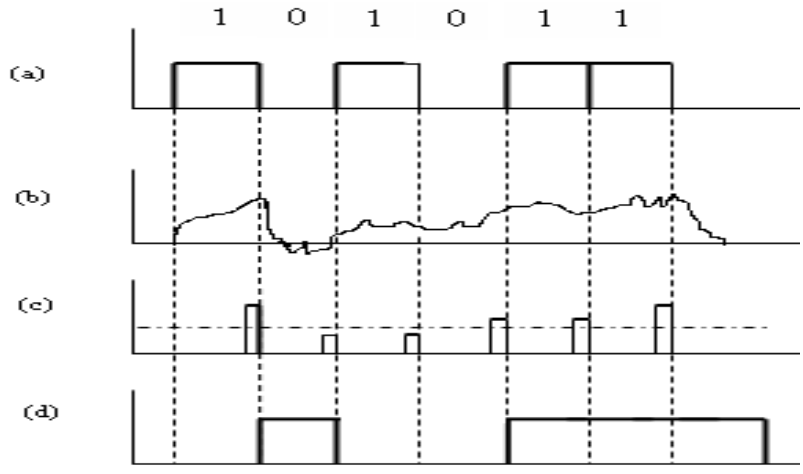

Fig.2. (a) Ideal receiver current (b) Actual current (c) Sampled current (d) resulting data pattern

When a one is received, the ideal current is constant. Chances are there that when the noise adds out of phase the errors occur and the total might go below the threshold.

V. SIMULATION RESULT

The nodes are deployed randomly [figure 3].

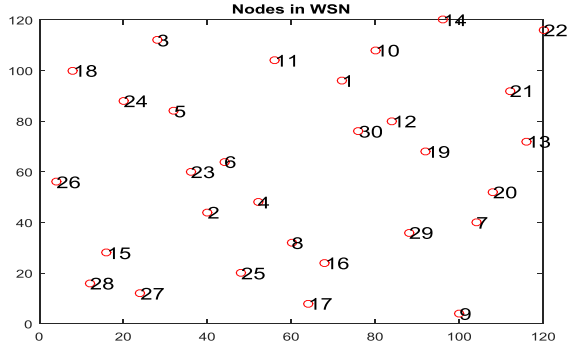

Fig.3. Randomly deployed nodes

Figure 4 shows the nodes and the registration area.

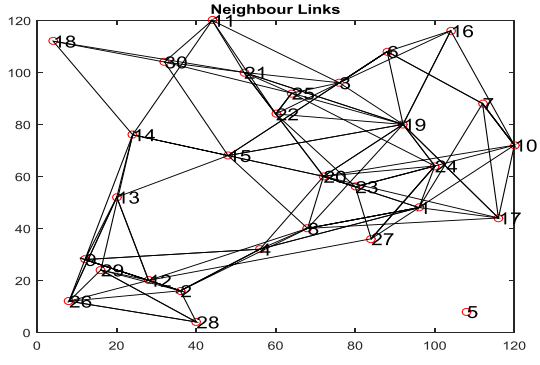

Fig.4. Registered link nodes

ISSN- 2394-5125 VOL 7, ISSUE 09, 2020

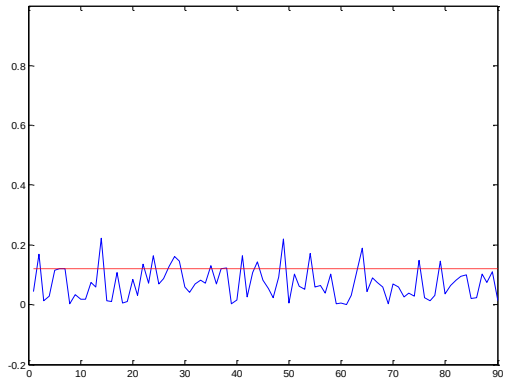

Fig.5. Signal effected by noise when SNR=30

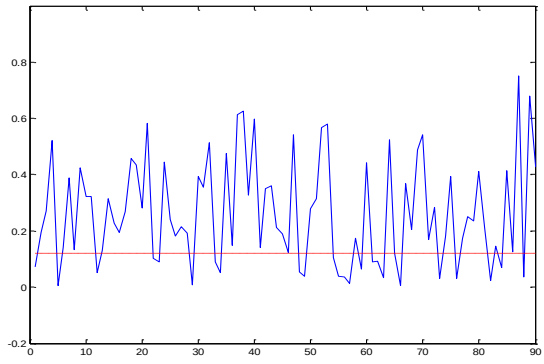

Fig.6. Signal effected by noise when SNR=20

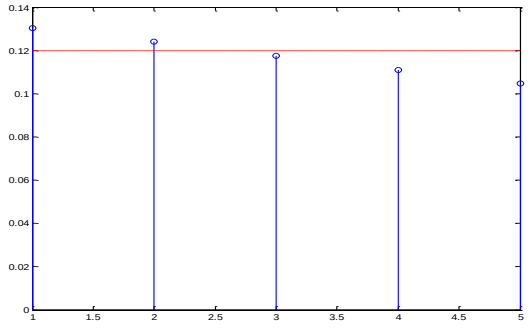

Fig.7. Bit 0 detection when Samples = 5

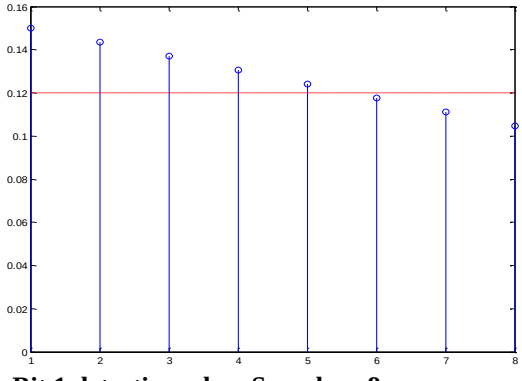

Fig.8. Bit 1 detection when Samples =8

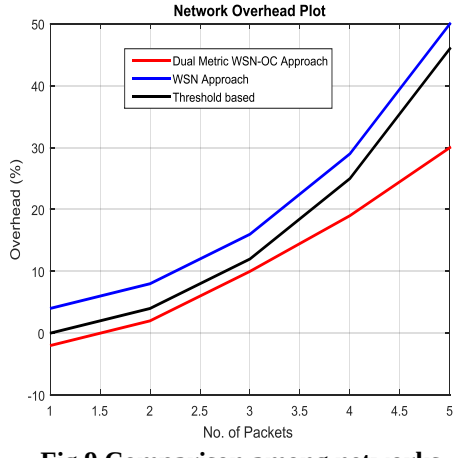

Fig.9.Comparison among networks

VI. CONCLUSION

The approach is found accurate when compared with the thresholding approach. Simulation and Observation shows that the percentage error falls when the samples that are considered for prediction using Adaptive Filtering increases.

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