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# Improving Packet Delivery Ratio in ZigBee Network using Genetic Algorithm and Simulated Annealing Algorithm

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***Abstract*— Genetic Algorithms and Simulated Annealing Algorithms (GASA) in a multichannel approach increases efficiency for ZigBee Networks. This study sought to increase the Packet Delivery Ratio (PDR) through the interference mitigation techniques for multi-channel technology. Furthermore, ZigBee and Wireless LAN (WLAN) both operate on the 2.4 GHz band, referred to as the industrial, scientific, and medical. Based on a cluster-tree construction protocol in multi-channel Wireless Sensor Network (WSN) can be used for robust data transmission. ZigBee faces severe interference problems in the presence of WLAN and we developed novel interference mitigation avoidance technique to improve conditions for the coexistence of ZigBee and WLAN.**

***Index Terms*— Packet delivery ratio, Wireless sensor networks, Multi-Channel, ZigBee**

## I. INTRODUCTION

In recent times, developments in Micro-Electro-Mechanical Systems (MEMS) equipment, digital electronics and wireless communications ought to empower the growth of low-power, low cost, multifunctional nodes are trivial in size and interrelate unchained in small spaces. Centered on the concerted strength of a huge quantity of these insignificant Wireless Sensor Network (WSN), sensor nodes are independent and control unattended. So, it is extensively deployed in atmosphere, health, home-grow, military and other profitable areas [1]. ZigBee is a different standard envisioned for low-cost strategies in home panels, computer peripherals and automation. It qualifies the broad-based distribution of wireless networks through low power, low-cost resolutions [2, 3]. The low-rate wireless network well-defined through the ZigBee Alliance and established in the IEEE 802.15.4. The standard is directing to be a low control, low-cost resolution for schemes entailing of unendorsed assemblies of policies in firms, factories and workplaces. Predictable uses for ZigBee are constructing automation, security methods, remote meter reading and isolated control and computer peripherals [2]. ZigBee grosses full gain of a commanding physical radio quantified by IEEE 802.15.4. For ZigBee associations of firms controlled to progress provisions covering the network, application profile layers so that viable prospective of the principles could be appreciated [3, 4].

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Observing at ZigBee the key add-ons or changes in terms of the coalition mission declaration are open standard, networked, and low power. The standard 802.15.4 also states of a 10m range and POS (Personal Operating Space) but make out the probability for bigger series at minor data amounts [4]. So, through the drivers of easiness, extended battery life, interacting competencies, short cost and consistency, ZigBee should be extensively used in personal health care, building automation, PC & amp; peripherals, customer electronics, trade control, occupied/light and viable controller [3]. Operating frequency for ZigBee is 2.4GHz.

## II. Literature Review

After Motivation on the ZigBee kit, a Nanoscale Wireless Sensor Networks (NWSNs) with close loop of sign is anticipated. In the NWSNs network layer and the Medium Access Control (MAC) layer of ZigBee is absolutely taken completed, and a fresh node, together its software and hardware execution, is considered that assimilate the ZigBee module and WSN node organized. An incorporated WSN access attained in this recognition presented a proficiency of distributing data, concerted managing and real time observing. At the comparable time, it also seen the need of evolving of records attaining and switch scheme in industrial automation. Conversely, the apprehension and the presentation of NWSNs in industrial still essential greatly further investigate and assessment. But then all of the features have revealed that the NWSNs will require a massive array of projections [5]. The performance of Multi-Channel Cluster Tree (MCCT) protocol is improved with Adaptive Cross Approximation (ACA) algorithm to reduce the possessions of hardware confines and empower employment of multi-channel machinery in cases where Wi-Fi and Zigbee networks concur. Every sensor node surrounded by the system successively probes all channels by carrying out PDR extents order to regulate their tenure level. The director achieves designs for every channel to certify that every node donates to the assortment of the optimum channel in agreement with proven significances. Every sensing area is dispensed a diverse channel to evade impacts and reserve Packet Delivery Ratio (PDR). Dimensions attained in the real-world execution validate that the anticipated multichannel technology could escalate the toughness of the given network. star pacts norms only channel with several transmission intermissions in order to augment the PDR; though, the quantity of effect increases with a rise in the quantity of working nodes. The mixture of ACA process with multi-channel dispensation makes conceivable to augment the program concert for all nodes and raise PDR for all nodes to among 94 and 99%. Further research combines a greater number of wireless strategies in demand to progress the series of the method [6]. Subsequently sensor nodes are motorized by non-rechargeable battery, network period is restricted. In order to advance energy convertible and promote period of the network and significant to increase abilities like access channel mechanism, communication protocol and routing. An Adaptive WLAN Interference Mitigation algorithm gives improved ZigBee performance than another algorithm [8]. Adaptive channel system for a multiple channel wireless network describes a decision function for the channel [9]. Multiple channel communication planned as alternate to adaptive routing method for mitigating the effect interference and link undercurrents in WSN [10]. Analysis of multi and single channel message over a direct in the terms packet reception ratio, temporal correlation of losses, frequency correlation of losses and maximum burst loss. A WBASN (Wireless Body Area Sensor Network) consists of several sensors and coordinator to monitor the organic signals. It can be complete by using Interference Mitigation method [11]. A two-layer structure that is WLAN and WPAN of Zigbee network can be executed to decrease the intermediate wireless nodes and unbalance load on gateway node [12]. End nodes connected with sensors and cooperative the readings to the base station. from the node's sensor readings, the host computer is answerable for structure of data base [14]. These two schemes are collaborating using wireless long-distance range and transmission method. solar panels are fast an ever-increasing foothold in culture particularly on the top of the houses for local electrical appliances [24]. An ad hoc wireless sensor indirect network consists of a quantity of small and nodes connected using actual ZigBee networks [29]. The network consists of coordinator which wirelessly collect humidity and temperature data from several nodes that are answerable to provide persons data. Each sensor is developed from ZigBee wireless module based on ZigBee/IEEE 802.15.4 standards, Arduino based microcontroller, and humidity and temperature sensor devices. The ZigBee network is extra suitable for low data rate. ZigBee network is original wireless technology with the characters of low consumption, less complexity and low cost [30].

In WSN there are issues in three different categories such as underlaying operating and internal platform system, network services and communication protocol [32]. Zigbee network is consist of end device, repeater and coordinator each element has different specification such as temperature monitoring. It is demonstrated in outdoor under 50meters and in indoor less than 20meters distance by using JN5168 development board [36]. The successful packet transmission and the effect of bandwidth on the network is analyzed by determining the

number of nodes and minimum length. The probability of dependence is determined for both cases i.e., the presence and absence of noise in the channel. With the emergence of metaheuristic-based optimization algorithms, there has been a significant improvement in the energy efficiency and overall performance of the WSNs and Zigbee protocols [33].

## III. Purpose Methodology

### *A. MOEA (Multi-Objective Evolutionary Algorithm)*

The MOEA (Multi-Objective Evolutionary Algorithm) is defined. Distinct former problem optimization systems like the least square method, this method could attain the universal optimum resolution, and does not certainly drop into local optimum resolutions. The MOEA algorithm is segmented into the subsequent four stages.

Step 1: Modify single population with N individuals arbitrarily, and then use innate operators such as mutation, tournament selection and crossover to produce one offspring population.

Step 2: Combine population with offspring population, and generate single population with 2N individuals. Then, procure incompatible non-dominated fronts over organizing built on non-domination.

Step 3: Fill non-dominated fronts into the next populace with N individuals.

Step 4: If quantity of growth compeers does not outstrip the supreme assessment set in progress, the system endures.

### *B. HSSA (Hybrid Simulated Annealing Algorithm)*

Hybrid SAA system chiefly includes 4 stages: Initialization of mutation, crossover, populace vector & selection phase: The steps given below elucidate the Hybrid SAA working: The network involves of set of nodes and is represented as in equation 1,

$$S = \{s1, s2, s3, s4 \ldots...sn\} \ldots\ldots\ldots (1)$$

- The cluster heads are nominated from set of nodes.
- The set of nodes are connected to cluster head to form a cluster.
- The range of random value is [0,1] from this population vector is initialized.
- The succeeding step involves mutation tracked by crossover is used in assortment method to choose next Gen vectors.

The model of radio degeneracy embraces two units the receiver and transmitter that established apart by distance d. The communication sector comprises the amplifier to transmit electronics and the receiving electronics are portion of receiving sector; that conveys the information in form of bits. It is assumed that rectangular filed contains of nodes. The nodes require $E_{TX}$ quantity of energy to communicate and to receive the K data over a distance d is amount of energy $E_{RX}$ are given as follows in equation 2 and 3:

$$E_{TX} = 0\begin{Bmatrix} kE_c + k\varepsilon_{AF} d^2, d \le d_0 \\ kE_c + k\varepsilon_{Amp} d^2, d \le d_0 \end{Bmatrix} \ldots\ldots\ldots (2)$$

$$E_{RX} = kE_c \quad \ldots\ldots (3)$$

The energy distributed to transfer data of single bit is indicated as '$E_c$'. The phase of intensification from the transmission amplifier in the free space is specified by '$\varepsilon A_F$' and amplifier coefficient consenting for multi-path is stated by '$\varepsilon A_{mp}$'. The observations about network are noted.

The observations about network are noted.

- In network it measured that nature of nodes is quasi-stationary.
- The sensor nodes be contingent on their distance to also the base station.
- Nodes don't know about their own location.
- All network node is like kind.
- Nodes organize and need no monitoring when they are organized.
- Power levels in each node are fixed.

*Performance Metrics*

- k, packet size
- $E_c$

The energy expended to communicate data by single bit.

- No of nodes
- Initial energy of nodes
- Analysis of given number dead node to number of iterations

This analysis shows that variation in the number of iterations to change in number of dead nodes.

- Analysis of given number active node to amount of iterations.

This analysis shows that when number of nodes in profile changes then alive nodes increases.

- Analysis in residual energy to number of iterations

This analysis shows that when number of rounds changes then remaining energy of Zigbee.

- Analysis throughput with respect to number of iterations

This shows how the proposed method performs with respect to further method such as HAS, MHSA, LEACH and DE algorithms in the form of throughput.

## IV. Results And Discussions

The results are evaluated based on proposed algorithm, the transmission cycle time for different intervals, Round (Node (a), node(b), node(c), node(d), node (e), node(f), node(g), node(h)) vs Packet delivery ratio has been analyzed and validated between ACA algorithm and novelty GASA optimization. From this simulation results, GASA optimization novelty methods increase the PDR of all nodes compare than previous ACA methods illustrated in Figure.1,2 and 3.

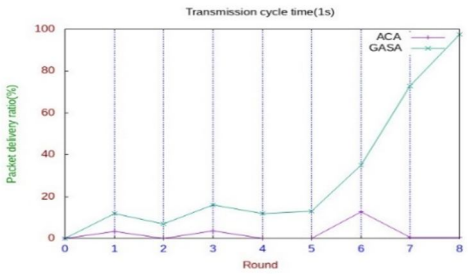


Figure 1. Transmission cycle vs PDR for 1 sec

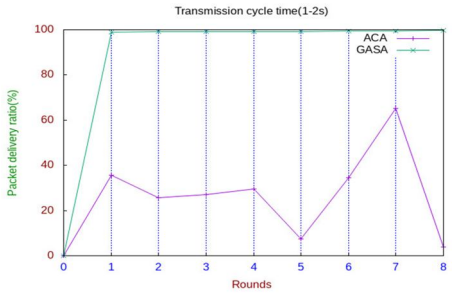


Figure 2. Transmission cycle vs PDR for 1-2 sec

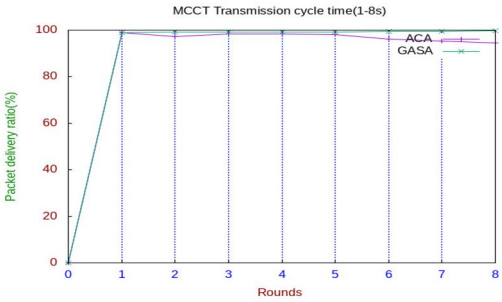


Figure 3. Transmission cycle vs PDR for 1-8 sec

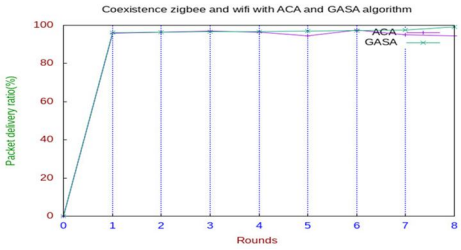


Figure 5. Performance of ACA and GASA for coexistence of Zigbee protocol and Wi-Fi

The Coexistence ZigBee and wifi with and without algorithm is illustrated in Figure 4 and Figure 5, round vs Packet delivery ratio has been analysed and the PDR of all nodes increases using algorithm compare to In the above Figure 4 and Figure 5 without using algorithm.

## V. Conclusions

This paper addressed the problem of coexistence between Zigbee protocol and Wi-Fi in a multichannel environment using a hybrid GASA optimization algorithm. The Packet Delivery Ratio for GASA optimization novelty methods increase compared to ACA algorithm. The modified multichannel protocol with GASA algorithm minimizes effect of interface.

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