ISSN: 2278 – 7798
International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 5, Issue 7, July 2016

Improve OLSR with Optimized Hybrid Particle Swarm Optimization in Zigbee

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ABSTRACT: ZigBee is a robust wireless communication standard which is based on IEEE 802.15.4. ZigBee technology is well suited to a wide range of energy management and efficiency applications in areas such as building automation; industrial, medical and home automation. The Optimized Link State Routing (OLSR) protocol is a route management protocol which is utilized for these mobile ad hoc networks. The paper shows a hybrid algorithm based on Invasive Weed Optimization (IWO) and Particle Swarm Optimization (PSO), named IW-PSO. IWO is a comparatively novel numerical stochastic optimization algorithm. By incorporating the reproduction and spatial dispersal of IWO into the conventional PSO, exploitation and exploration of the PSO can be improved and well balanced to get better performance. In this paper, it is introduced to change OLSR utilizing Hybrid Particle Swarm Optimization Invasive Weed Optimization which decreases the end to end delay and also enhances the network throughput.

Keywords: Optimized Link State Routing (OLSR), Ad-hoc Network, Invasive Weed Optimization (IWO), Particle Swarm Optimization (PSO)

I .INTRODUCTION

ZigBee-compliant products work in unlicensed bands worldwide, involving 902 to 928MHz (Americas), 2.4GHz (global) and 868MHz (Europe). The transmission distance is required to range from 10 to 75m, based on environmental features and power output. Same as Wi-Fi, Zigbee utilizes direct-sequence spread spectrum in the 2.4GHz band, with offset-quadrature phase-shift keying modulation. Channel width is 2MHz with 5MHz channel spacing. The 900 and 868MHz bands also utilize direct sequence spread spectrum but with binary-phase-shift keying modulation [11]. Raw data throughput rates of 40Kbps at 915MHz (10 channels), 250Kbps can be obtained at 2.4GHz (16 channels), and 20Kbps at 868MHz (1 channel) [11]. For any provided data quantity, transmitting at a higher data rate permits the Higher data rates at a provided power level imply there is less energy per transmitted bit, which normally implies decreases range [12].The normal 802.15.4 node is basically effective with respect to battery performance. You can require battery lifetimes from a few months to several years as a result of a battery-optimized network parameters and host of system's power-saving modes [12].ZigBee have three different techniques of routing data, every technique has its own benefits and drawbacks, which are; many-to-one routing, Ad-hoc On-demand Distance Vector (AODV) mesh routing and source routing. Link-state information is broadcasted over the network in a classic link-state algorithm. OLSR utilizes this mechanism, but as the protocol operates in wireless multi-hop scenarios OLSR message broadcasting is analyzed for bandwidth preservation. Optimization depends on a Multi Point Relaying mechanism. OLSR being table-driven, its operation involves updating and managing information in several tables. Table data depends on obtained control traffic, and the latter in turn is created from information fetched from tables. Route computation is also table driven [2]. OLSR describes 3 kinds of control messages:

Hello – Such messages are transferred to neighboring nodes and utilized for neighbor sensing and MPR computation.

TC – *TC* messages are link state signaling by OLSR. This messaging is analyzed by MPRs in several ways.

MID – Such messages are transferred by nodes running OLSR on more than one interface. They list all nodes and IP addresses utilized.

Particle Swarm Optimization [3] is another derivative-free and reliable optimizer replicating bird flocking. PSO algorithm is predicting for several optimization issues. It is casual and easy to observe in comparison of other computation intelligence methods. It obtained attention from the evolution field and is a research hot spot. Though PSO has high convergence speed, literature shows that PSO finds it complex to jump out of local optima, if it falls into minima. In literature, some techniques were proposed to enhance PSO performance, by combining it with other emerging computation mechanisms. Hybrid PSO, (HPSO) method merged a mutation operator and natural selection to solve premature convergence. By proposing roulette wheel selection based Cauchy mutation and evolutionary selection, HPSO highly decreased possibility of being trapped in local optimum. Invasive Weed Optimization [4], a bio-inspired numerical stochastic optimization algorithm, simulates natural weed nature in colonizing and determining place for development / reproduction. Some IWO properties as compared to other evolutionary algorithms are reproduction technique, spatial dispersal, and competitive exclusion. IWO procedure begins with starting a population [5]. A population of initial solutions is created arbitrarily in the solution space. Then population members generate seeds depending on comparative fitness in the population. The seed no. for every member changes linearly between Smin for worst member and Smax for best member. Seeds are arbitrarily distributed in the search space by distributed random no. with mean equal to zero and adaptive standard deviation.

In this paper an Invasive Weed Optimization (IWO) / Particle Swarm Optimization (PSO) based hybrid algorithm (IW-PSO) is implemented. Incorporating IWO reproduction / spatial dispersal into conventional PSO, improves the latter’s exploitation and exploration in addition to being well balanced [6]. IW-PSO obtains better OLSR performance.

II. RELATED WORK

A Bee Swarm Intelligence modeled survey algorithm was introduced by Karaboga and Akay [7]. Bee Swarm’s intelligent nature motivated researchers to develop novel algorithms. The work shows survey of algorithms depending on Bee Swarm’s Intelligence and its applications. Kumar and Singh [8] recommended routing optimization mechanisms utilizing swarm intelligence proposing preliminary MANET studies, and a Routing Optimization mechanism encouraged by Swarm Intelligence’s (SI) biological concept.

Hybrid Tabu search (TS) and PSO were introduced to create fuzzy controller with three rules introduced by Talbi and Belerbi [9]. The algorithm dynamically adjusts Fuzzy Rules and membership functions according to atmosphere. PSO Algorithm computes best solution and best neighbor by TS at each iteration and this decreases computation time and iterations while assuring accuracy and least response time. The algorithm was examined on the inverted pendulum’s control angle. Combination of route life prediction algorithm and PSO algorithm to choose flexible MANET routes was proposed by Priyadharshini and Rubini [10].

PSO being utilized for network centric localization aims creates in-network navigational decisions, obviating centralized control and decreases delay and congestion. So, this technique is efficient in MANETs including huge deployment, node mobility and restricted energy. Shirkande and Vatti [11] proposed a review on several Ant Colony based Routing Algorithms for MANETs and WSN. The algorithms comparisons were based on performance metrics, pheromone function chooses next node, simulator employed and energy awareness. An algorithm showing enhanced TS and improved PSO for accuracy was introduced by Khatibzadeh, et al., [12]. This technique determined less accuracy and more speed utilizing PSO. A Hybrid Intelligence TS-PSO based Algorithm developed by Xu, et al., [13] overcame PSO Algorithm in solving Combinatorial Optimization problems and avoided TS algorithm falling into local optimum, with an increase in convergence speed.

When Particle Swarm and TS Algorithms were integrated, results represented that it had feasibility and convergence accuracy. In comparison of conventional Scheduling Algorithm it embodies superiority. Hybrid techniques in network Optical Routing with QoS based on PSO and GA were recommended by Edward, et al., [14] represented performance to solve NP-Complete Routing problems.

III. PARTICLE SWARM OPTIMIZATION (PSO)

Particle Swarm Optimization (PSO) increases aims to determine parameters through exploring search space for an issue. This method is from Swarm Intelligence and evolutionary calculation [14]. Swarm Intelligence depends on swarming habits of birds / fish, and evolutionary computation positions a local / global maximum. PSO algorithm shows every solution as a ‘bird’ in the search space and calls it a ‘particle’. Objective functions measure candidate solutions, working on resultant fitness values. Candidate solution and computed fitness velocity provide the location of the particle. It remembers best fitness value it obtained during the operation of algorithm’s, referred to as individual best fitness, and candidate solution which obtained it being called individual best position ‘pbest’. Best fitness value between all swarm particles is known as global best fitness, and candidate solution which achieved this fitness is known as global best position/global best candidate solution 'gbest'. PSO algorithm involves 3 steps reiterated till stopping criteria is satisfied [14]:

1. Evaluation of every particle's fitness.
2. Individual / global best fitness and positions updated
3. Velocity / position of every particle updated.

A directed graph G = (V, E) describes a communication graph, where V is a group of n nodes and E a group of m edges. Every edge has parameters of jitter, connection quality and packet dropped.

IV. INVASIVE WEED OPTIMIZATION (IWO)

IWO algorithm is a numerical stochastic search algorithm mimicking natural weed colonizing nature, discovering a proper place for development / reproduction. Some IWO features in comparison of other EAs are reproduction way, spatial dispersal and competitive exclusion. There are 4 steps for the algorithm as explained below [5]:

1)Initialization of a population: A no. of weeds are arbitrarily distributed over the search space (*D* dimensional). Every generation's initial population is termed as $X = \{x1; x2, . . . , xm\}$.

2) Reproduction: Every population member *X* creates seeds in a particular area centered at own position. No. of seeds created by $xi; i \in \{1, 2, . . ., m\}$, depends on relative fitness in the population related to both, worst and best fitness.

3) Spatial Dispersal: Produced seeds are arbitrarily scattered over d-dimensional search space through generally distributed random no. with zero mean and variance σ2.

4) Competitive Exclusion: If a plant has no offspring then it becomes extinct; else they can take across the world. Thus there should be some competition among plants to restrict maximum plant no. in a population. Initially, plants in a colony reproduce frequently, and all weeds are involved in the colony, till the plants no. arrives a highest value of *pop max*

A meta-heuristic algorithm mimicking weed colonizing nature is Invasive Weed Optimization (IWO) [15].

If sd_ max and *sd_* min are the maximum and minimum standard deviation and if *pow* is a real number , then the standard deviation for a specific iteration may be provided as follows:

This confirms that the possibility of dropping a seed in a far region reduces nonlinearly with loops, resulting in grouping fitter plants and removing unsuitable plants. Thus , this is an IWO selection technique.

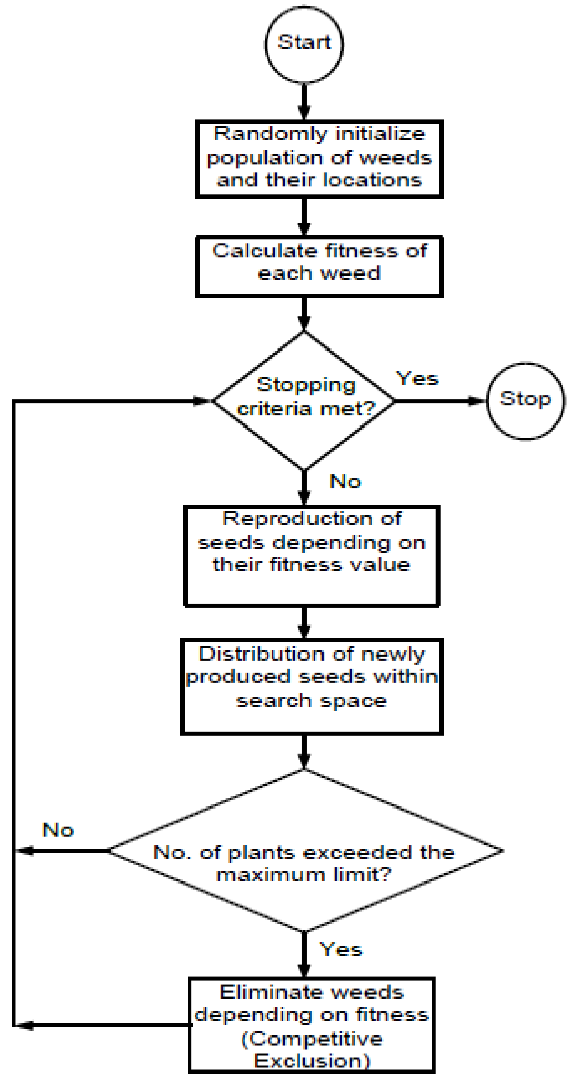

Figure 1 Invasive Weed Optimization Algorithm Flowchart

V. SIMULATION STUDY AND RESULTS

The simulation setup contains 20 nodes. The nodes are scattered over 60 km by 60 km meter with the trajectory of every node being random. Every node operates a multimedia application over UDP. The data rate of every node is 11 Mbps with a transmission power of 0.005 watts. The simulations are operated for 400 sec. The parameters utilized in the OLSR [16] routing protocol is indicated in Table 1 below:

ISSN: 2278 – 7798
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Volume 5, Issue 7, July 2016

Table 1. Simulation Parameters

Simulation Parameters	
Examined Protocols	OLSR
Number of Nodes	200
Types of Nodes	Mobile
Simulation Area	60 x 60 km
Simulation Time	18 min
Mobility	50 m/s
Pause Time	200 seconds
Performance Parameters	Throughput
Traffic type	Http
Mobility model used	Random waypoint
Data Type	Constant Bit Rate (CBR)
Packet Size	512 bytes
Wireless LAN MAC Address	Auto Assigned
Physical Characteristics	IEEE 802.11g (OFDM)
Data Rates(bps)	48 Mbps
Buffer Size(bits)	100000

The modified OLSR Routing Protocol performance of end to end delay is described below in Fig 2.

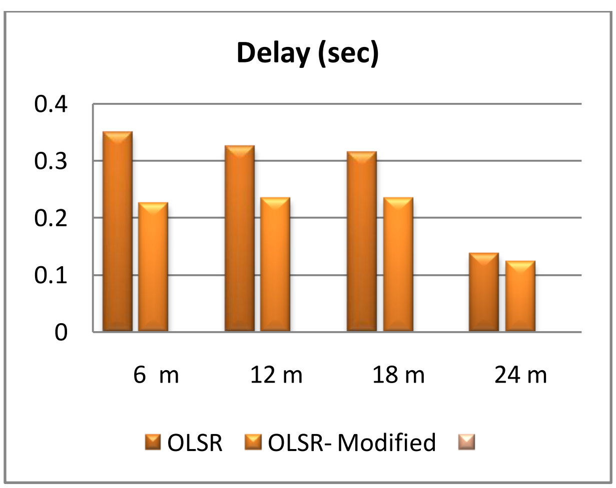

Figure 2: End To End Delay of OLSR and Modified OLSR

The performance of the introduced optimized OLSR is better as compared to the OLSR in terms of end to end delay. Figure 2 represents that Modified OLSR performance is best. Throughput is illustrated in Fig 3 that clearly states that Modified OLSR gives better throughput in terms of bits/sec.

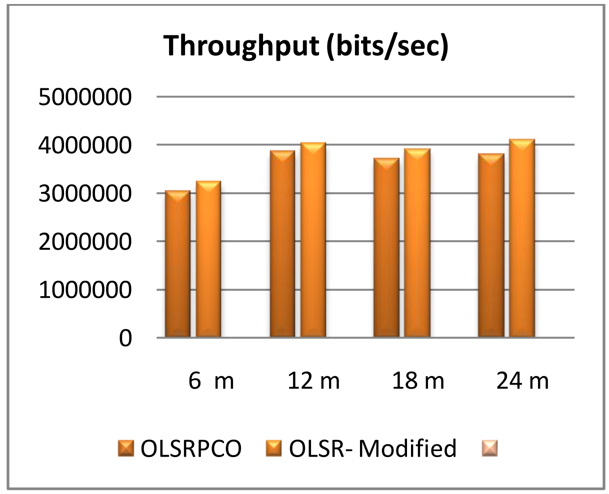

Figure 3: Throughput of OLSR and Modified OLSR

CONCLUSION

In OLSR, link state information is created only by nodes selected as MPRs. Hence, a second optimization is obtained by decreasing the no. of control messages broadcasted in the network. As a third optimization, an MPR node may select to report only connections between its MPR selectors and itself. Thus, as opposite to the classic link state algorithm, partial link state information is scattered in the network. This information is then utilized for route finding. OLSR offers optimum routes (with respect to no. of hops). The performance with respect to packet data dropped enhances considerably with the usage of introduced optimized OLSR. With increment in time the introduced optimized OLSR drastically decreases the no. of packets dropped in comparison of both OLSR and modified OLSR. The introduced OLSR obtains better throughput as compared to the conventional OLSR and modified OLSR.

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