INTERNATIONAL JOURNAL OF TECHO-ENGINEERING

ISSN : 2057-5688

ENERGY EFFICIENT NETWORK INTEGRATED SENSING SWARM OPTIMIZATION USING SMART SENSOR NETWORK LOCALIZATION

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Abstract:

Localization of nodes in the wireless sensor network (WSN) is a method of calculating the coordinates of unknown nodes using the assistance of nodes that are known. The efficiency of an WSN is significantly affected by precision of the localization. In this article, a node-localization method is proposed that is based on an algorithm that is bioinspired, dubbed Salp Swarm Algorithm (SSA). It is then compared with known optimization algorithms, such as particle swarm optimization (PSO), Butterfly optimization algorithm (BOA) and the Firefly algorithm (FA) and grey the wolf optimizer (GWO) under various WSN deployments. The results of simulations show that the proposed algorithm for localization is superior to other algorithms in terms of the mean localization error, computation time as well as how many localized Nodes are there.

Keywords: wireless sensor networks; fuzzy logic systems; genetic algorithms; optimization; en-route filtering; network lifetime; re-clustering

1. INTRODUCTION:

The parameter selection process is not determinate and several Metaheuristic strategies have been proposed in research to identify the best values. Most popular methods include Genetic Algorithm (GA), Particle Swarm Optimization (PSO) and Ant Colony Optimization. Recently, the Firefly algorithm has been proven superior to PSO for local search, and superior to GA for speedier convergence. Its global strategy for search used by Firefly algorithm isn't optimal, while it is not optimal for the Glow Swarm Optimization (GSO) algorithm has overcome the shortcomings of the Firefly algorithm. Based on a literature review the idea was to apply the GSO algorithm using a modified fitness function in order to determine the most optimal parameters.

A sensor network that is deployed randomly requires a protocol for the creation of a cluster, which partitions the network into different clusters in order to improve the network's duration and the optimization of the energy level of each sensor. A better routing optimization is an additional crucial element, as the most important applications, such as military, monitoring the environment, and disaster management of data routing are not important.

A gateway node linked to an device that has Internet access, collects all sensor information and makes it accessible in real-time to research organizations across the globe. In addition, a user-friendly interface that presented the information in a user-friendly way and allowed the ability to modify the system's configuration was developed.

II RELATED WORK

Wireless design is one method that has been used in new applications, including communication, low power integration sensing, and computation. Primitive accelerators and flexible interfaces can be used to assist aggressive system level optimizations. Flexible design of mica is a key block in the creation of effective application-specific protocols. This contributes a group interconnected primitives to allow cross-layer optimizations instead of deliberating constrained and standardized application interfaces. Mica does not support predefined protocols. Wireless technologies are moving in new directions due to the exploitation of deeply embedded wireless sensor networking.

Telos is a wireless sensor module that uses very low power to allow WSN examination. Telosb, a new mote structure, was created from scratch. It has four key objectives that aid investigations: enhanced software, ease of maintenance, lower power consumption, robustness of hardware, and improved software. WSN can be used in many applications, including intrusion detection. WSN uses a lot of energy to detect an intruder, but it is essential for WSN.

The algorithm was developed for energy-efficient intrusion detection. It also included analysis of the likelihood of detection. The authors have created models that are both multi-sensing as single sensing, and their focus is on energy efficiency.

There are many techniques that can be used to identify the reasons for delays and uncertainties in the transmission of messages. However, errors cannot be completely eliminated. This is a novel algorithm that uses additive digital monograms with homomorphic encryption. It allows for integrity and accessibility to WSN aggregation, which is not possible using the traditional end-to-end security method. WSNs and Adhoc are used to monitor and send data in potentially hostile. Although it offers the benefits of WSN and power asymmetry between the base station, the devices and the protocol, there are many flaws.

Arioua et al. (2016) Another new clustering method was proposed by Hadley. It used a combination of the Low Energy-Adaptive Clustering Hierarchy and the Minimum Transmission Energy protocols. Optimizing network communication has been made possible by the adoption of multi-hop communication as opposed to direct communication that is cluster filed. Simulations have shown the energy efficiency of routing approaches that are based on multi-hop clusters. This has led to a significant increase in network lifespan and has also provided enhanced energy performance for Wireless Sensor Networks (WSNs).

The first phase is the system initialization phase, during which keys that are public and private are created. The second phase is user registration phase, in which new users are identified by the network owner. Third phase is the packet pre-processing , where the packets are processed and ready to be sent. The final stage is the verification, in which the packets are checked for authenticity. Because this protocol is distributed, it is not a single point of failure , and data can also be shared over the network efficiently.

Fadel et al. (2017) Further, a cooperative channel assignment algorithm was proposed and an optimization-based honey bee mating method for routing. This method preserved high link quality even in harsh environments. Its performance was assessed based on packet delivery ratio, energy consumption and delay. This solution met the QoS requirements. Key management and authentication system is based on a simple symmetric cryptosystem that has minimal computational requirements. The drawback of this system is the potential for an adversary to take keys from sensors and then compromise the entire network, since the key is utilized for both the sender and receiver.

In Jinwei Liu et al. (2018), A Quality of Service (QoS), promising opportunistic routing procedures, is proposed. Geographic Opportunistic Routing is the basis of this work. It focuses on reliability, minimized delay, and maximizes efficiency. This is the work that selects the best forwarding candidates for WSN.

In this way the nodes that originate from them need to know the number of hops that are located from where the relevant nodes are situated. Each node must calculate the its height, which is the minimum number of hops required to get to the station at base. A given link's gradient is calculated using the difference between the node's size and the neighbors. The packets are sent to the node that has the greatest gradient. In this model, data aggregation as well as the traffic spreading was utilized to distribute the traffic equally. Because it ensures a equal traffic to the nodes, energy is conserved and the life span of the nodes is increased.

III METHODOLOGIES

OPTIMIZATION

The process of searching the most efficient solutions to an issue of particular interest was executed using several agents. The entire system is formed by the evolution of the agents, referred to as optimization. The system is able to evolve agents through their repeated iterations according to the rules set or series of mathematical equations. This system displays some more enigmatic features that result in self-organizing states that correspond to optimal conditions in the space of search. When these states are achieved the system will begin to converge. Thus, developing an efficient algorithm to optimize is similar to mimicking of a self-organizing system as well as its development.

A well-designed algorithm for optimization is essential to make sure that there are the best solutions. They can be classified into the stochastic or the deterministic. The latter refers to an algorithm that works in a way that is mechanistically stable and not random. In this case, the final solution will be found when the beginning of the process is at the same starting point. Examples of this include downhill simplex and hill climbing. Downhill Simplex and the Hill Climbing (HC). The latter algorithm has an element of randomness and thus the algorithm reaches an entirely different point in each algorithm, even though it has the same starting point. For instance, the HC which has random restart as well as The Genetic Algorithm (GA) are examples of these stochastic algorithms.

OPTIMIZATION METHODS

ISSN : 2057-5688

The Genetic Algorithm (GA) may be considered to be an algorithm for optimizing that is founded on the theories of Darwin on the evolution of biological life and reproduction. It also reflects the "the survival of the fittest" concept, developed by Holland along with his colleagues in the 1960s and 1970s. The algorithm was evolutionary , and classified as a search heuristic worldwide. It employs random searches within the decision space by using selection, mutation , and crossover operators.

ACO stands for **Ant Colony Optimization (ACO)** is an optimization method that is built on swarm intelligence and is influenced by the behavior of insects. The ants release an organic substance that is volatile , known as the pheromone , which aids in determining the shortest path of routes. When they move the ants continue to secrete pheromone on the ground, and they choose the path with the greatest concentration of pheromone. This method has proven to be the most effective method of marking the path for other ants to follow and also to generate optimal paths by studying the behavior of colonies of ants. This behavior of the insects is successfully mapped by electronic devices for solving various issues that require combinatorial.

An **Particle Swarm Optimization (PSO)** is being developed for a collection of random particles to identify optimal solutions using an iterative process. The particles are all optimized by an exercise in fitness function. The particle also has an acceleration rate to determine which direction random particles are traveling in, and that determines which direction flight as well as the distance that it will travel to the next solution.

In the case of the **Shuffled Frog-Leaping Algorithm (SFLA)** there could be a variety of solutions which have been identified by a collection of virtual frogs which are grouped and referred to as memeplexes, with each conducting a local search. Within each memeplex, all individuals frogs are able to hold thoughts that could be contaminated by the ideas of other frogs. After a set number of evolutionary steps for memetics are completed, the concepts are passed on to the memeplexes discovered through shuffling.

The process of data Compression (DC) The term "DC" involves a process whereby information stream could transform into a smaller bit information stream. According to the definition, the structure of the information that is rehashed is separated and eliminated by using encoders.

Communications Compression (CC) Communication Compression (CC) this case, the amount of packets that are received and transmitted is decreased, for instance it decreases the time of radio transmissions for a transceiver within WSN. Some of the key aspects of the information pressure calculation process is discussed in the accompanying section.

Lossless vs. Lossy: In lossless compression algorithms, specific information is achieved through decompression In lossy, the reproduced data isn't identical to the original information. Lossy calculations result in loss of data but ensures high-pressure ratios.

Data Aggregation: In many applications, just the summary of the sensor's data needed however, the original sample values in a summarised representation isn't enough. This is why aggregation requires the processing in-network of sensor data. However, it can be done in-network processing.

Data Correlation Sensor nodes are arranged closely to one another and the correlations between values sensed at different nodes are high, which is referred to as spatial correlation. Because sensor events are recorded in a continuous fashion, they are repeated

The discrete signals show high correlation, referred to"temporal correlation. The algorithms for data compression proposed for these correlations help in improving compressibility ratio.

Symmetric and. Asymmetric Symmetric calculations: In symmetric calculations the multifaceted nature of compressing and decompressing data is identical. If, however, there does be an the unbalanced, unpredictable nature of compacting and decompressing the way in which information is compressed is different.

Time-Stamp: With the help of time-stepping marks that are computerized it is possible to have the exact time at which the records are set.

The authenticity of both the digital and paper stamps are regarded as having the same level of authenticity, and for any sender, therefore it could be utilized to verify the authenticity of sender and thus the authenticity of message. (Uprightness)

Because a similar symbol is applied to both sides of the transmission to confirm the data, clearly the sender cannot deny that the data was transmitted by him/her. (Non-repudiation)

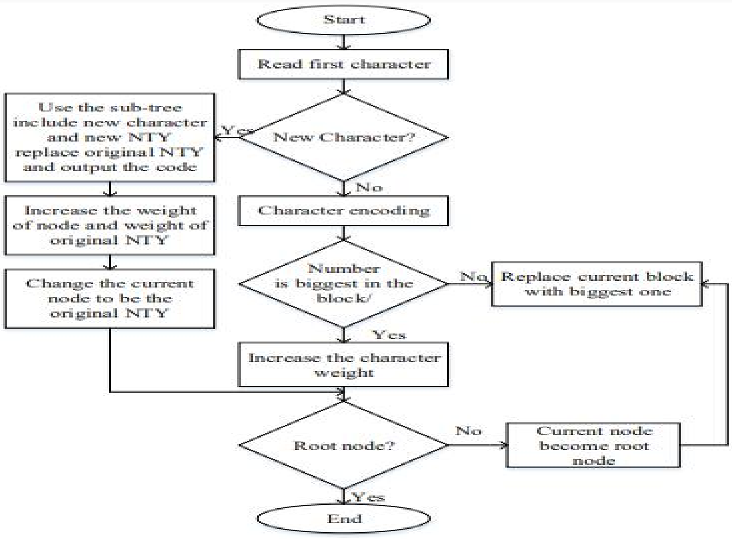

Figure 1 Process flow of compression based on Huffman coding

The GSO algorithm that is employed for optimizing an WSN method of localization was discussed. When selecting the optimal parameters with GSO algorithm GSO algorithm, the need to alter the parameters within EEHC is avoided. The optimizing of the parameters, m0 the , and the ones discovered within the EEHC is done. The GSO algorithm is used to record simultaneously and utilizes agents that conduct a scan of the search space which is correlated to the quality of the current position. The fitness was revealed by an aforementioned level of luciferin that is a glowing amount. The agent then moves to its next neighbor, which is randomly selected and announces a higher level of luciferin.

The deployment of nodes within WSN is a difficult job because of its unique characteristics like an ever-changing topology that is dynamic, a lack of central authority and a an architecture that is decentralized. An effective node deployment plan can simplify issues such as tracking, data collection, and communications in WSN. Furthermore, it will prolong the life of WSNs while reducing the energy usage. Sensor networks can be set up using a deterministic location, where the quality of service is ensured; or, with randomization, in which sensors can be scattered in an aircraft. While random deployment is preferred in many applications, it's currently impossible in the majority of situations because sensors are typically too costly for this degree of redundancy. Therefore, other deployments must be explored as a wrong node deployment could increase the amount of interference within the network. This chapter discusses the adjustment of the power transmission of each node of an WSN by analyzing how much residual power is left by nodes in different deployment schemes is described as a non-cooperative game that includes and does not include pricing.

Algorithm,

Step 1. Initialization the random cluster head, the position of glowworms and the local range of decision.

Step 2: Assess the fitness of glowworms.

Step 3. For each repetition Step 3: For each iteration, the

Step 4: For each glowworm, i

Step 5. If you think the number of glowworms was not enough the glowworm will extend its local decision-making range and locate additional glowworm.

Step 6: Update glowworms' luciferin value by luciferin update rule.

Step 7: Update movement of glowworms by using probabilistic mechanism.

Step 8: Refresh glowworms' decision range with the help of a the update rule for neighborhood ranges.

Step 9 If the criteria for termination is met, proceed to the at the end of algorithm.

If not, go to step 3.

The coverage of sensors is an important aspect of WSN. The way to set up sensors in a huge area can affect the performance of the network in the same way as the quality of communications. A rectangular area called 'A is chosen for the placement of sensors. Square grids, random as well as hexagonal and triangular topologies to deploy sensors, as shown in Fig.4.2 are thought of. The active nodes used to detect information and communicate at any moment is located on the vertices of the regular polygon

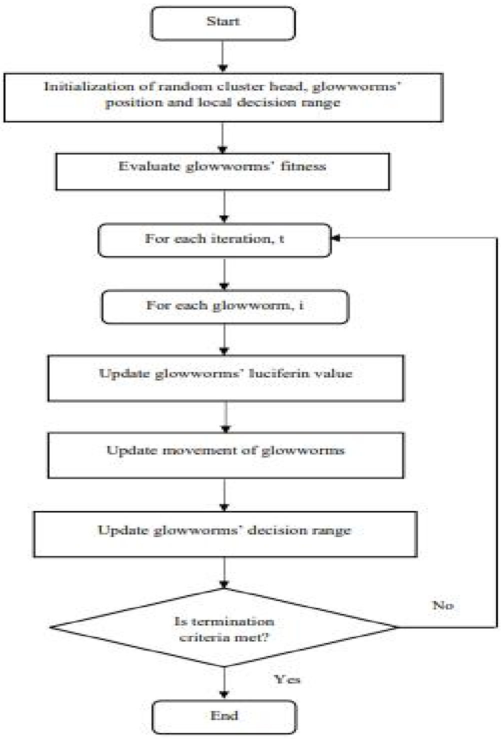

Figure 2 Work flow of the propose structure

IV PROPOSED MODELS

PSEUDOCODE FOR LINE OF INTERSECTION LOCALIZATION ALGORITHM

Input: Number of beacon nodes, the location of each beacon node's location, the number of unknown nodes, the range and size of the network

Output : Average Localization Error

Procedure Line_of_Intersection(beacon_count,unknown_count,range)

All sensor nodes are deployed and beacon nodes

Determine distance between beacon_node, unknown node

Procedure unknown_node(beacon_count, unknown_count, range)

for each beacon_node

$$D_i = \text{sqrt\_fun}((x - x_i)^2 + (y - y_i)^2)$$

Find the distance between the closest beacon nodes and the unknown node

$$m_1 = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$

Locate the line that connect the midpoints of the nearest beacon node, and the second beacon

$$m_2 = \left(\frac{x_1 + x_3}{2}, \frac{y_1 + y_3}{2}\right)$$

Locate the line that connect the midpoints of the nearest beacon node and the third closest beacon node.

$$x = \frac{x_1\left(\frac{y_2+y_4-2y_1}{x_2+x_4-2x_1}\right) - \frac{1}{2}\left(\frac{y_2-y_3}{x_2-x_3}\right)(x_1 + x_3) - \frac{1}{2}(y_1 - y_3)}{\left(\frac{y_2+y_4-2y_1}{x_2+x_4-2x_1}\right) - \left(\frac{y_2-y_3}{x_2-x_3}\right)}$$

Calculate using an empirical equation for the coordinates of x and of the unknown node. It is described as follows:

$$y = \frac{y_1\left(\frac{x_2+x_4-2x_1}{y_2+y_4-2y_1}\right) - \frac{1}{2}\left(\frac{x_2-x_3}{y_2-y_3}\right)(y_1 + y_3) - \frac{1}{2}(x_1 - x_3)}{\left(\frac{x_2+x_4-2x_1}{y_2+y_4-2y_1}\right) - \left(\frac{x_2-x_3}{y_2-y_3}\right)}$$

End for

End unknown_node procedure

Compute Average Localization for all estimated positions

End Line_of_Intersection procedure

This proposed Line of Intersection localization algorithm is implemented in MATLAB R2013a. This is done by changing the parameters of the network, such as the quantity of beacons used, quantity of sensor points as well as the size of the network. Simulation using 100 sensors and 100 beacons of transmission range of 10m are placed in a large network 500m by 500m.

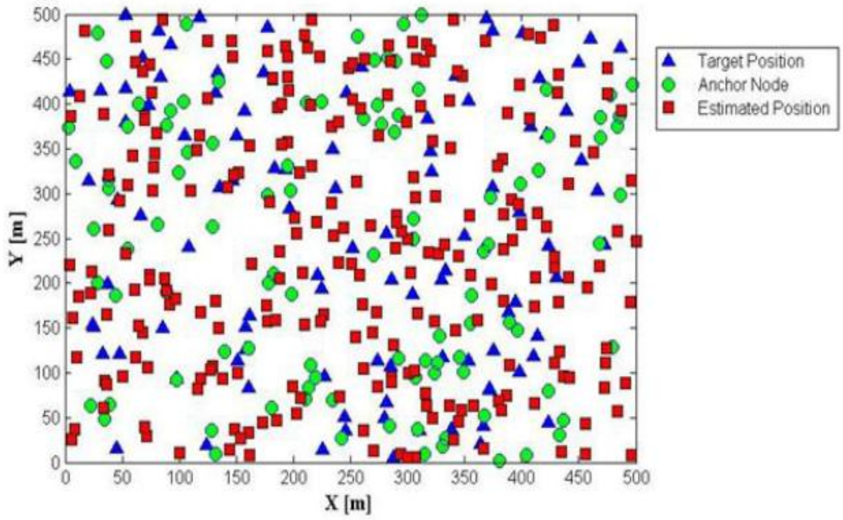

Figure 4 Deployment of nodes with network size 500m x 500m

This Line of Intersection localization algorithm is implemented using 100 sensors, and 100 beacons with areas of 10m, 15m and 20m, respectively. The localization error average for the four ranges is calculated in Table 4.1 with a fixed size network 100m x 100m. The average is calculated over 50 times. If there is a 10m range, error in localization will be 0.43 with a 25m the error is 0.20.

Table 4.1 Line of Intersection Localization with 100 Sensor nodes and 100 Beacon nodes

Range (m)	Average Localization Error (m)
10	0.43
15	0.42
20	0.30
25	0.20

In Table 4.1 it is evident that the error in localization decreases when the range of communication increases. The Average Localization error displayed for the distances of 10m, 15m, 20m, and the 25m for 100 sensors and 100 beacon nodes . The results are shown in Figure 5

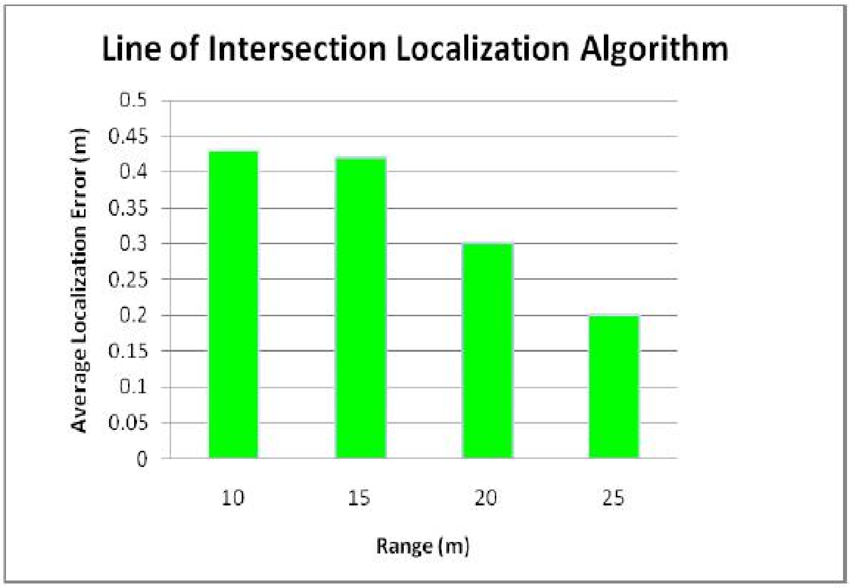

Figure 5 Average Localization Error with 100 Sensors and 100 Beacon nodes for LoI Algorithm

The average error of localization in the algorithm for line of intersection that has 250 sensors, and 250 beacons with areas of 10m, 15m and 25m, respectively, is summarized in Table 4.2. A fixed size network is 100m x 100m, the average is calculated over 50 times.

Table 4.5 Performance Comparison of CL, WCL SC-RSSI, MCL and LoI with Range = 10 m

NUMBER OF SENSOR NODES	CL	WCL	SC-RSSI	MCL	LOI
100	3.88	3.64	1.84	1.61	0.43
250	3.94	3.64	2.71	1.62	0.83
500	3.98	3.94	2.88	1.64	0.93
1000	3.99	3.97	2.98	1.74	1.14

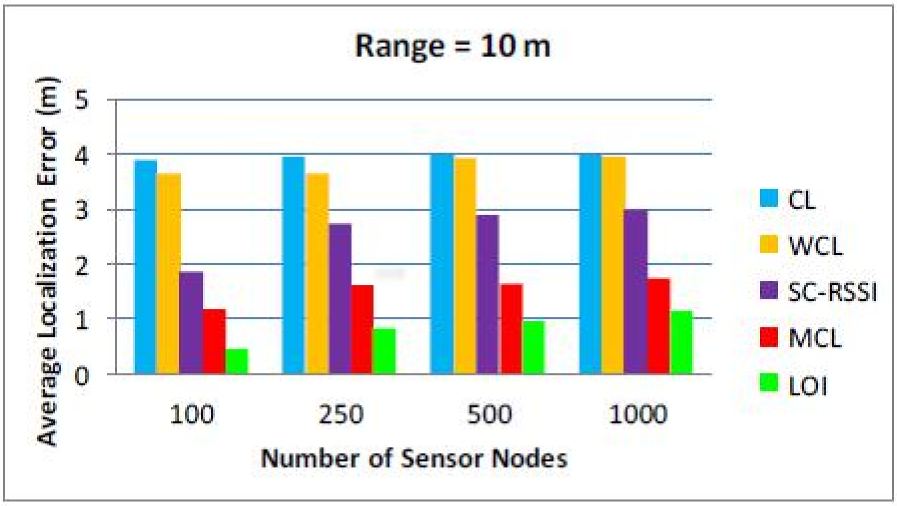

Figure 6 Comparison of average Localization Error for CL, WCL, SC-RSSI, MCL and LoI for range = 10 m

Table 3 Overall performance comparison of CL, WCL, SC-RSSI, MCL and LoI localization algorithms

FACTORS	AVERAGE LOCALIZATION ERROR (m)				
	CL	WCL	SC-RSSI	MCL	LoI
Energy efficient	Yes	Yes	Limited	Yes	Yes
Quality of service	Low	Low	Medium	High	High
Cost	Low	Medium	High	Medium	Medium
Formula for computation	Distance Formula	Distance Formula	Using RSSI	Distance Formula	Distance Formula
Estimated Error	High	High	Medium	Low	Very Low
Computational Complexity	O(N)	$O(N^2)$	$O(N^3)$	$O(N^2)$	$O(N^2)$
Time Complexity	Low	Moderate	High	High	Low
Accuracy	Low	Low	Medium	High	Very High
Power Consumption	Low	Medium	High	Medium	Medium
Scheme	Range Free	Range Free	Range Based	Range Free	Range Free
Position Awareness	No	No	Yes	No	No

Table 5 provides the overall performance of the centroid's average localization error, Localization, weighted centroid location self-corrected localization, self-corrected the modified centroid localization algorithms and the proposed Line of Intersection of localization algorithm. Line of intersection localization algorithm is estimated to have a low error and has extremely precise. Time complexity is lower in comparison to CL, WCL, SCRSSI and MCL. The computational complexity of MCL is the same with the complexity is that of WCL and MCL and lower than SC-RSSI.

V CONCLUSION

A brand-new line of code that is component of the Intersection Localization Algorithm is proposed. Simulation results demonstrate that the error in localization is reduced as well as the precision is significantly higher when compared with Centroid Localization, Weighted Centroid Localization Self-Corrected RSSI and modified Centroid Localization Algorithms. The error range of the Line of Intersection Localization Algorithm extends between 0.2 millimeters up to 1.14 meters, which is less and when the distance to transmit an individual node increases it is observed that the error in localization is reduced. Time complexity is less when compared to Centroid Localization, Weighted Centroid Localization, Self-Corrected RSSI Localization algorithm and Modified Centroid Localization Algorithms.Computational Complexity is reduced when compared to Weighted Centroid Localization and Self-Corrected RSSI Localization algorithm. Overall.

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