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Retrospection on localization techniques for positioning nodes in Wireless Sensor Networks

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Abstract*: *Wireless Sensor Networks have highly scattered, self-organized nodes that can detect, compute, and transmit the information collected at different nodes in the network. These nodes spread over a specific topographical zone. They enhance the instantaneous formation of the network. Knowing the current location of a node is a crucial and cardinal requirement for any application promulgated in WSN. Once the locations of the sensor nodes can be precisely positioned, there are ample of probabilities for the data transmission of the network to be excelling inefficiency. Location responsiveness enables essential network features such as coverage, routing, deployment, topology control, clustering, boundary discovery, target tracking, rescue, and other location services. Hence, WSN localization has become a breath and backbone arena that ostentatiously attracted significant research interest. Our work traces a compilation of all the dynamic research in sensor networks on localization techniques and emanates eminent understanding of it.

Keywords: Localization, Position, Sensor, Sensor Networks.

I. INTRODUCTION

A cluster of sensor nodes that are linked together in a sensor field to carry on an application-oriented task [4] is called Wireless Sensor Network (WSN). The nodes situated at various places in the sensor field. They have the potential to sense data in any environment, process the data and communicate them to the neighborhood sensor nodes. Amid these, at least one node shall assist as a sink node that is proficient of cooperating with the user [24]. Either openly or implicitly with help of internodes, these nodes align as a link.

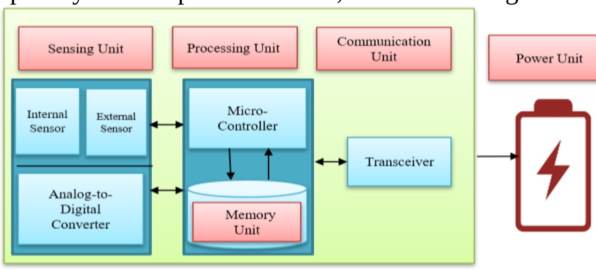

Fig.1. Components of Sensor node

The various components of the sensor node as exhibited in Figure 1 are sensing unit, processing unit, a communication unit, memory unit, and power unit [25]. The responsibility of a sensing unit is just the transfer of messages in short distances.

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They comprised of an external and internal sensor. This assists in perceiving the information from the physical world. To convert the collected analog signals to digital signals, they provided with an Analog-to-Digital Converter (ADC) [1]. The processing unit will process the received signals. Else, to the above cited it has the accountability of controlling other components in the node that enables to process, run algorithms and cooperate with other nodes. Memory unit has an inbuilt memory unit like Random Access Memory (RAM), Read-Only Memory (ROM), or external storage [26]. The communication unit's job is to commune with other nodes and the rest of the segments of WSN. The transceiver is the most power-consuming unit. The power unit is responsible for supplying node energy. Small batteries or capacitors are equipped in the sensor nodes to produce small-sized and low-cost devices [2].

II. PERFORMANCE ISSUES IN WSN

Unpredictable condition prevails in network's performance in the transmission of information. They are likely to cause hazards in the environment in the wireless networks.

A. Hardware

The sensor may be built-in or made of additional hardware. That results in a cost hike, more power consumption, and an increase in the size of the node. Further, the additional hardware needs elaborately considered with careful analysis for cost and low-power requisite [31].

B. Time Synchronization

The target is to proffer a period for local clocks of nodes in sensor networks. A crucial role is played frequently in real-time for this type of real-world monitoring applications. However, offering it becomes a perplexing task by its different challenging characteristics traits of sensor networks.

C. Node Deployment

The sharing of nodes relies on the application. Categorized as deterministic and randomized. During the random node distribution option of optimal clustering is essential to permit connectivity and enhance efficient energy network operation. Every sensor node should be self-managing and adapt to failure in any environment.

D. Middleware

This is a runtime environment bestows the hardware, operating systems, network, and applications. Middleware can synchronize multiple applications with system services and so it covers the complexity of the network.

E. Data Aggregation

To collect data out of sensors and frame meaningful information after excluding the duplication. Innumerable protocols it is adapted to attain data transfer optimization and efficiency of energy. The minimal shortest route between the pairs of end nodes traced out by traditional address-centric routing. The data fusion–centric routing establishes routes leading the most extensive degree of data aggregation.

F. Medium access schemes (MAC)

MAC protocols operate the radio of the nodes that must possess low latency and high throughput directly in the network. For the variation in the topology, the network should adjust to the variations in the size and node density. Few nodes may join, some may perish over time, and the meagre figure of nodes may migrate to separate sites.

G. Quality of Service (QoS)

Energy management is essential than the class of data sent. The network brings down characteristics of the results while the energy gets exhausted or drained. Energy-aware routing protocols needed for lessening the energy dissipation in the nodes. It aids in increasing the network's lifetime.

H. Security

WSN is susceptible to various threats and risks. A hacker may intrude into the integrity of the data, inject false messages, squander the resources of the network and convert the sensor node to adhere to them. For safety sake, security protocols should be used to address security issues.

I. Network layer Issues

The network layer liable aimed at issues in routing and in transfer of the data from nodes to the BS. It plays a vital role in divulging the power-efficient route to attain the network lifetime optimized. In route maintenance, the routing protocol used in case of failure of the node due to environmental interference. The routing protocol should allow redundancy because the nodes are data centric. This improves power and bandwidth utilization. Multi-path protocols used in case of a path failure.

J. Operating System (OS)

For efficient performance to deal with various entities such as memory and resources in a constrained environment, an OS framework is to be well equipped. The OS have inherent to minimize the depletion of energy. The choice can be application-specific and hardware independent [50].

L. Transport layer Issues

The transport layer provides end-to-end consistent message transfer that may suffer if the position of the nodes did not fix. The protocol should transmit the fragmented segments in order. It must be reliable for delivering data under extreme conditions. The limit in bandwidth results poor communication with loss of data.

K. Localization

In emerging WSN applications, it is crucial to know a global coordinate of the node to send and receive data. The network consists of known or beacon or reference or anchor nodes, which recognizes location. The nodes that do not know their locations called unknown or target node. The problem of establishing the location of the sensor's node after positioned is called localization [24]. Built on the data of the reference nodes, the locations can be determined using hop techniques. Firstly, the one-hop localization estimates the place of the unknown node by communicating directly with the reference node, i.e., a one-hop reference neighbor. Physical locations of these nodes obtained through the Global Positioning System or arrived according to the known distribution but not calculated assessed based on localization system. Even though the built-in GPS receiver used in finding the location that may be utilized point out the spot, nevertheless this is not adequate for WSNs since GPS receivers are not affordable and power consuming. The other technique is multi-hop localization. In vague to pinpoint the position of the unknown node through deploying the hop distance. The process of broadcasting the location coordinates by the multi-hop localization called flooding [62]. The steps in the localization process displayed in Figure 2, here the input hangs on the estimation of distance or angle to the anchor node or using position based on the position. Then the localization algorithm is applied to get the output.

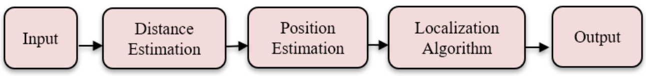

Fig.2. Steps in Localization

III. CONTRIBUTION AND PAPER ORGANIZATION

The remainder of the paper prepared as follows: Section IV discloses classification of localization algorithms in WSNs, followed by its assessment within the types. Section VII unfurls with comparative study on WSN Localization. Section VIII gives a brief retrospective discussion on results of state-of-the-art algorithm in localization. Finally, Section IX concludes, and future work is given.

IV. CLASSIFICATION OF LOCALIZATION ALGORITHM

1. Based on Computation or Data processing

1.1 Centralized localization algorithm

The info from all the nodes sent to the BS, as shown in Figure 3(a). BS calculates the location and forward to respective neighbor. When sent through a discrete node computation cost and energy is low. The data transmission causes latency; hence, there is a lack of ability to access data in a proper way as well as insufficient scaling in the network.

1.2 Distributed localization algorithm

There is no clustering process as shown in Figure 3(b), and every node estimates its position. It brings down the bottleneck in traffic. Scalability and less storage requirements make the cost high [53].

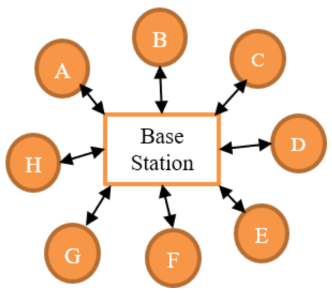

Fig.3(a). Centralized

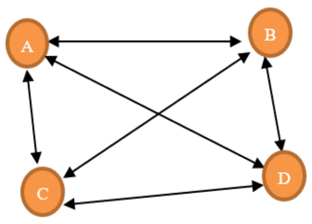

Fig.3(b). Distributed

2. Based on Transmission range

2.1 Range -based localization algorithm

The techniques in localization consider the distance or angle [25] as the necessary parameters and define:

- **Lateration**: Distance between the nodes used as a parameter to evaluate the location.
- **Angulation**: Angle between the nodes used as a parameter to guess the location.
- **Multilateration:** The location of nodes estimated from more than three-node distances.
- **Trilateration**: The place of the node estimated from three-node distances. The target node location calculated by using the connection of three circles of the three nodes respectively. The coordinate of the unknown node listed as in Equation (1), (2), (3). Where A, B, C are nodes, (X_a,Y_a),(X_b,Y_b), (X_c, Y_c) are coordinates of A, B, C and d_a, d_b, d_c are distances between the nodes

$$\sqrt{(X-X_a)^2+(Y-Y_a)^2}=d_a \quad (1)$$

$$\sqrt{(X-X_b)^2+(Y-Y_b)^2}=d_b \quad (2)$$

$$\sqrt{(X-X_c)^2+(Y-Y_c)^2}=d_c \quad (3)$$

- **Triangulation:** The position of the node [illegible]d using the angle of the target node from the known node. Trigonometric functions Sine and Cosine are used and represented in Equation (4), (5), (6), (7). Where A, B, C are angle of nodes, a, b, c are coordinates.

$$\frac{a}{sinA}=\frac{b}{sinB}=\frac{c}{sinC}=constant \quad (4)$$

$$CosA=\frac{b^2+c^2-a^2}{2bc} \quad (5)$$

$$CosA=\frac{a^2+c^2-b^2}{2ac} \quad (6)$$

$$CosA=\frac{a^2+b^2-c^2}{2ab} \quad (7)$$

(i) Timing-based Algorithm

The distance amid two nodes estimated by measurement of a communication signal in terms of time.

- **Time of Arrival (TOA)**

It is the measurement of distance as given in Equation (8) between the beacon and target node as in Figure 4 and proportionate to the propagation time of the signal. It gives high accuracy and requires synchronization. Where V is velocity of signal, t_1, t_2 are signal sent and received time.

$$Distance=v(t_1-t_2) \quad (8)$$

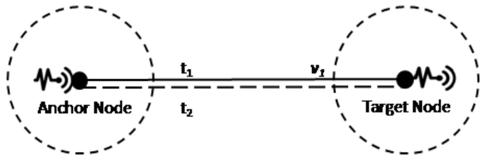

Fig.4. Time of Arrival

- **Time Difference of Arrival (TDOA)**

As stipulated in equation (9), TDOA be subject on the measurement of Time Of Arrival (TOA). This aids in measuring the signal of the transmitter to neighboring receiver nodes by the distance, as shown below in Figure 5. It has recorded high accuracy by its additional hardware. This results in excessive cost. Where V is velocity of signal and t_1, t_2, t_3, t_4, are signal sent and received time

$$Distance=(v_1-v_2)(t_4-t_2-t_{wait}) \quad (9)$$

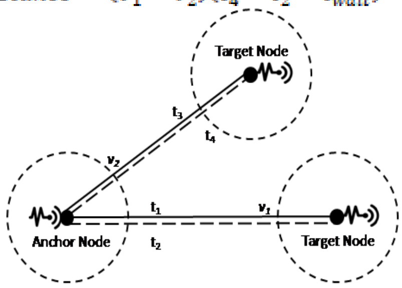

Fig. 5. Time Difference of Arrival

(ii) Directionality-based Algorithm

The direction of the signal received from a node is stately to guess the angle of the sender node.

- **Angle of Arrival (AOA)**

Each sensor evaluates the relative angles concerning the received radio signals. An antenna and complex hardware are required. Within a few degrees range of transmission, it gives high accuracy. It needs extensive signal processing that hikes the hardware cost.

(iii) Signal-strength-based Algorithm

Using the received signal, the distance between two nodes of theoretical or empirical models are computed

- **Received Signal Strength Indicator (RSSI)**

The widely practiced technique for indoor and outdoor environments especially for improving accuracy is RSSI. Also, it depends upon the radio frequency in the distance measurement between sender and receiver, as in Figure 6. The resultant signal strength keeps diminishing, as distance to the receiver node is wider. The signal strength is inversely proportional to squared distance as explained in Equation (10). This indicator enormously related to obstacles that compel it hard for achieving a model mathematically in a real-world environment. Where L is system loss factor, P_t is transmitted power, G_r is receiver antenna gain., λ is wavelength of the signal, G_t is transmitter antenna gain, $P_r(d)$ is Received power at a distance d.

$$P_r(d)=\frac{P_tG_tG_r\lambda^2}{(4\pi)^2d^2L} \quad (10)$$

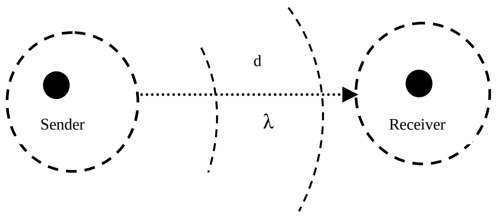

Fig. 6. Received Signal Strength Indicator (RSSI)

2.2 Range-free localization algorithm

It does not use distance to estimate the location instead uses detecting features like wireless connectivity, localization event detection and anchor node proximity. Due to the hardware limitations of these devices, the output is cost-effective.

(i) Distance Vector Hop

Through the hop count, DV hop detects the distance between nodes.

At least three anchor nodes are involved in broadcasting coordinates with hop count through the network [17]. Hop count gets incremented when a neighbor node receives data. Almost all known nodes compute the shortest route from other nodes, and all unknown nodes also compute the shortest route from all known nodes. Usually, unknown nodes use a triangulation routine to find their positions from three or more known nodes employing hop count to gauge the shortest distance [4]. The formula for average hop distance mentioned as the distance between two nodes in the number of hops. An example with five nodes A, B, C, D, and E shown in Figure 7 estimating its average hop length and distance between unknown to known node. Where a,b are anchors, N is Number of anchors in the network, $Hopcount_{a,b}$ is the distance between anchor A to B, $(X_a,Y_a),(X_b, Y_b)$ are coordinates of anchors A and B, d_b is the distance between unknown to known node, $AverageHopDistance_a$ is hop Distance of unknown node, $HopCount_b$ is hop counter from unknown to anchor b.

ALGORITHM

Step 1: Receive broadcast packet from anchor node A, B
Step 2: Initialize Hopcount =0
Step 3: Each node N maintains: Table $((X_a, Y_a),(X_b, Y_b)$, Hopcount)
Step 4: if $PacketReceived_a$ || if $Hopcount_{Rcvd}$ <Hopcount then Hopcount is updated, $PacketReceived_a$ forwarded in the network , Hopcount++;
Step 5: if $PacketReceived_{Hopcount}$> Hopcount Then PacketReceived is discarded Until all the nodes know Minimum hopcount
Step 6: Calculate AverageHopDistance from unknown to known node

$$AverageHopDistance_a = \frac{\sum_b^N \sqrt{(X_a - X_b)^2 + (Y_a - Y_b)^2}}{\sum_b^N Hopcount_{a,b}}$$

Step 7: Calculate the distance from unknown to known node

$$d_b = AverageHopDistance_a \text{ X } HopCount_h$$

Step 8: Calculate the unknown node Coordinates by Polygon method

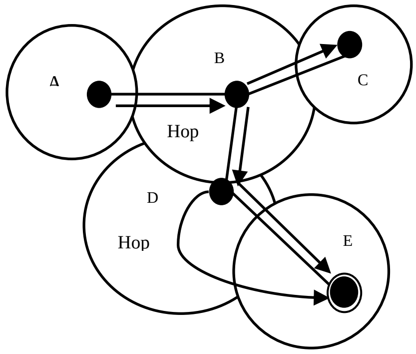

Fig.7. DV Hop Localization

(ii) Hop Terrain

Like the DV hop method, the hop terrain used in outcome of the distance concerning a known and an unknown node. There are two fragments in this method [54]. In the first fragment, an unknown node estimation its location from the known node by means of average hop distance formulation, which is the distance between nodes/total numbers of hops. Initial position evaluation as viewed in Figure 8; the second part is the transmission of the initial estimated position to the neighbor nodes. A node processes its position until the final position met using least square method [52].

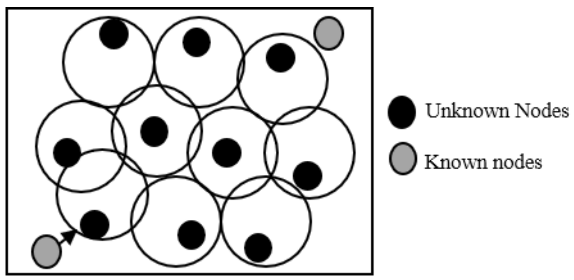

Fig.8. Hop terrain

(iii) Approximate Point in Triangulation

The known nodes avail position coordinates from external devices like GPS or transmitters in APIT. The unknown node gets place from overlapping triangles, as portrayed in Figure 9. Out of the known nodes, the unknown nodes retain a table with the information on known node ID, location, and signal strength after receiving signal messages. Unknown nodes choose on any three known nodes from the triangle area form known as the PIT (Point In Triangulation) test. The PIT test continues the precision of an unknown node positioned by arrangement of three known nodes.

ALGORITHM

Step 1: Receive location beacons (X_i, Y_i) from n anchors.
Step 2: Intersect=Φ //the set of triangles in which i reside
Step 3: For each triangle $T_i \in \binom{n}{3}$ triangles
Step 4: If (Point-In-Triangle-Test (T_i)= =TRUE)
Step 5: Intersect = Intersect $\cup \{T_i\}$
Step 6: If (accuracy (Intersect)>enough), Break
Step 7: Estimated Position=COG ($\cap T_i \in$ Intersect
/*Center of gravity (COG) calculation*/

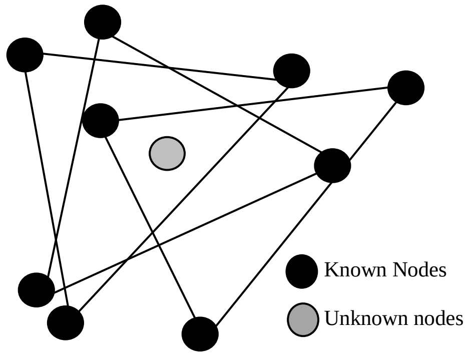

Fig.9. Approximate Point in Triangulation

(iv) Gradient Algorithm

Multilateration is deployed in the unknown node to sense its position. The gradient begins by known nodes and aids unknown nodes to find their location from three known nodes by opting multilateration. The initial value of hop count value is set to zero and increased while broadcasted to the neighboring nodes. Every sensor node pulls out the data on the shortest route from known nodes. The steps of the algorithm are initially the known node broadcasting signals that include coordinate and hop count value. Following this, the unknown node computes the shortest route amongst them and the known node through which it collects signals. Finally, an error equation used to get a minimum error in which node determines coordinate by multilateration.

(v) Centroid Algorithm

This algorithm demands a smaller number of computations with minimum communication costs. Among the algorithms, the centroid algorithm is the most straightforward range-free algorithm. Here all the unknown nodes find positions as the centroid of all acknowledged information from the known nodes within their respective range. However, each beacon node assumed to be inside a circle, this can interconnect with them. If there are four known nodes within a circular sort and there remains one unknown node, the estimated location for the beacons is the centroid value. By the usage of the centroid formula, the accuracy is high compared to other algorithms. However, the accuracy and the beacon node's density of the estimate location are subject to on the type of sharing; more uniform the network, more raises the localization accuracy.

ALGORITHM

Step 1: Receive the location from n neighbor beacon nodes (X_i, Y_i)

Step 2: Then, Calculate location of unknown nodes (X,' Y') using centroid Formula

Step 3: if n ≥ 3 then

X − coordinate and Y – coordinate calculated as

$$(X', Y') = \frac{\sum_{i=1}^{n} x_i}{n}, \frac{\sum_{i=1}^{n} y_i}{n}$$

end if

Step 5: Repeated for all unknown nodes

3. Based on Accuracy or granularity of information

3.1 Fine-grained localization algorithm

Anchors are potential enough to know their locations by GPS or manual alignment [31].

The distance between estimated and neighbor node typically called reference points produce high accuracy information in location of the node. Trilateration or triangulation method is engaged to compute the location of the target node.

3.2 Coarse-grained localization algorithm

It estimates the target node location from its proximity to the available anchor nodes. To provide location of anchor node, place the node at stationary locations. Here location estimated by GPS or pre-setup from a location server.

4. Based on Mobility

4.1 Mobile localization algorithm

The mobility of a node will give better performance in relations to cost, coverage, and accuracy. Challenges are inevitable when a mobile node in the network used to discover the path with minimum distance, rate of the localization and energy efficiency issues [36]. The difficulty of agility in WSNs has lately grown too much concern as uses of mobile sensor nodes increased [58].

4.2 Static localization algorithm

Some nodes are static and confined in one place. Many localization algorithms designed for static nodes [51].

5. Based on Anchor nodes

5.1 Anchor based localization algorithm

The nodes know their positions manually or by GPS. Target nodes localized by the known nodes are liable on the total of known nodes that affects accuracy.

5.2 Anchor free localization algorithm

The sensor nodes do not entail anchor nodes. Hence, the algorithm provides node positions that imply the location of the sensor nodes relative to each other [2].

6. Based on GPS

6.1 Non-GPS based localization algorithm

Without any additional hardware, the distance between the nodes computed. The localization begins from the known node and resorts to connectivity information to measure the hop count with the nodes in the network.

6.2 GPS based localization algorithm

The localization accuracy is too high; each node in the network needs a discrete GPS tracker. However, in a closed environment using GPS in all the nodes is unfeasible.

7. Based on Region or Operating environment

7.1 Indoor localization algorithm

The localization of the sensor node inside the building will be more perplexing due to the deficient performance of GPS tracking. Where the environment is crowded and can have barriers like doors and walls, making the distance measurement as a tough task. Therefore,it is almost terrible to identify all nodes. The coverage of the wireless transmitter constrained due to signal attenuation. Wi-Fi hotspots, RSS fingerprint are capable solutions by its high accuracy and low infrastructure cost[18].

7.2 Outdoor localization algorithm

GPS is used to know the absolute position. However, accuracy tracking is not acceptable for the sports environment. In this kind of environment, the node to be estimated can be anywhere in the range.

8. Based on communication

8.1 Non-Cooperative localization algorithm

The location of each node established autonomously by using only source-anchor distance measurements [56].

8.2 Cooperative localization algorithm

Group of sensor nodes use distance measurement to estimate both position and angle of neighbor nodes, which trigger increased accuracy [37]. The notion in the rear is differential GPS, by which erroneous GPS measurements revised with range measurements from base stations using anchor nodes. It does not require additional hardware in some resource-constrained networks, and it results in cost-effectiveness along with high-energy consumption [32].

9. Based on Node density

9.1 Sparse localization algorithm

For many ranging systems, the distance measurement is much less than that of communication ranges [2]. The accuracy for estimating the localization declines rapidly due to the lack of anchor nodes [47].

9.2 Dense localization algorithm

Accurate and efficient fingerprinting-built localization techniques depend on dense anchor nodes.

10. Based on Coordinates

10.1 Absolute localization algorithm

The sensor node needs additional hardware like GPS receiver to locate its position. The coordinates like latitude, longitude and altitude used. It obtained by a simple linear transformation and some reference nodes. Hence, it is easy to understand by a user [49].

10.2 Relative localization algorithm

Based on the application prerequisite, positions are either absolute or relative. Distance or angle defined by manual configuration or by some reference. This reduces overhead.

V. COMPARATIVE STUDY

In recent years, an extensive selection of localization algorithm for WSN introduced. Nasir et al [44] proposed Energy Harvesting Underwater Optical Wireless Sensor Networks (EH-UOWSNs) based on RSS localization structure, where seawater pose substantial encounters on the optical signal cause and network loss of range estimation. This reduces errors in estimating the shortest paths. Simulations reveal that the EH-UOWSNs, virtuous approach to get tough and precise results. Anjana et al. [7] presents a fault-resilient system for localization. This yields high precision with low communication overhead. The trial outcomes showed a direct connection amid the accuracy and range in localization. The Reference Point Group Mobility (RPGM) used to generate traces of mobile nodes by BonnMotion tool. Hence, Fault- Resilient Localization (FRL) is an energy efficient localization system for UWSNs.

Likewise, Nasir et al. [47] proposed a sturdy 3-D technique in localization for moderately linked UOWSNs, which can put up the outliers and enhance accuracy in the assignment of the known nodes. Xuan et al. [46] provides interesting solution for the problem in localization by developing the conditions under two sub-networks uniquely merged. The output displays that more than 90% of nodes in sparse 3-D networks localized. Yunfeng et al. [9] proposed a Range-Based Multilateral Accumulation Method (RBMAM), designed for large-scale, high-efficiency and high precision underwater networks. Here performance estimated along with LSM and ALS that prevails predominately and largely practiced in localization. Simulation evidences that accuracy in locating nodes and higher efficiency ideal for large-scale UWSN localization. Indoor localization [35] has been widely considered for the past decade. Among, RSS based localization of wireless techniques such as Wi-Fi or Bluetooth are widespread methods [36] due to its use in standard mobile devices, by providing relatively low infrastructure cost. To aim high localization accuracy by RSS fingerprint-based techniques, latest approaches have performed fusion between RSS-based localization and the user motion model [37].

Safa [3] proposed a novel method that exactly focuses in locating sensor by reducing power depletion and memory requests. Xiaoyong et al. [4] put forwarded a novel approach for multi-hop localization in WSN, based on nonlinear mapping and learning algorithm. Its performance analyzed, and the result shows high performance in location estimation adaptability. Fatemeh et al. [36] presents a meagre cost completely distributed in WSN localization technique, with appreciable accuracy. Experimental results unfold that this anticipated algorithm excels other range-free methods in homogeneous and heterogeneous WSNs. For performing with high precision of node localization in anisotropic WSNs with holes, Shi et al. [6] presented a Heuristic Multi-Dimensional Scaling (HMDS) algorithm. The Euclidean distance between nodes found by the virtual node and creating the shortest paths. This done by deploying the heuristic way through that it used to calculate accurate locations. This algorithm is precise and efficient compared to state-of-the-art methods in anisotropic WSNs. Saber et al. [5] proposed and executed a new process for geographic routing depending on a weighted centroid localization method, where the positions of target nodes are computed using fuzzy logic method. This method practices flow calculation over wireless channel to calculate the distance separating the anchor and sensor nodes. Huai et al. [8] put forward two localization methods. Here tri-directional coil affixed at an arbitrarily oriented position. They serve as both magnetic induction transmitter and receiver for wireless communications. This descends in approximating the distance of transmission and the polar angles based on the signals of to every known node. Kangshun et al. [10] presented a study for bringing up the precision in field of coal mines for the mobile node localization. Eke to nullify the influence affected by moving direction-offsets that hosted by the positioning systems.

The ranging model obtained examined within the probabilistic framework. The suggested algorithm based on an overlapping self-adjustment approach and the anchor node selection. With low message transformation power consumption reduced. Pei et al. [18] put forward target node localization by data from both its one-hop and two-hop neighboring nodes. Thereafter Chebyshev center model coined to place a single target into its estimative region by a non-convex optimization problem overcome by Alternating Direction Method of Multipliers (ADMM) based PEPA. By presenting a hierarchical scheme, the Parallel Efficient Projection Algorithm (PEPA) extensively used to localize multiple targets with minimal communication cost. In addition to the above, a new heuristic error correction mechanism suggested enhancing the positioning precision. Amir et al. [17] present power saving on-demand protocol for the WSN-oriented indoor localization platform, the nodes sustained in a low energy idle listening mode by low energy built-in wake-up receiver. This starts only when a localization demand arises. This method allows motion time of the node that increases its battery life. Subrata et al. [45] presented method Minimization of Error in Multihop System (MEMHS). An ideal positioning approach led by placing maximum number of nodes in the network. The proposed algorithm has enhanced performance in error correction.

VI RESULTS AND DISCUSSION

We summarize the comparison outcomes against the performance parameter of localization algorithms in Table I. Here, we can infer that distributed algorithms are often more substantial than centralized algorithms. The centralized algorithms are proved by demonstration to be appreciable in the performance. However, distributed algorithms excel while sparsity of the network model was taken into consideration. In distributed method, computation cost and inter-node communication more than message transfer between base station and neighbor node. Likewise, range-free gives high accuracy. Similarly, paralleled to outdoor localization, indoor localization is more thought provoking due to the deficient performance of GPS underneath a covering. Most of the algorithm influence due to mobility problem along various environmental discontinuities. The effect of sensor node density is not of much important for GPS free, as in GPS based.Table II shows the evaluation of existing localization techniques. The work presented in [5] – [6], [18], [37] describe range free algorithms. Generally, range free algorithms do toil very proficiently in unfriendly locations. Although precision may be high, scalability is low, and cost greater [5] [6]. Energy efficiency is missing both in [18][37], Localization error is low in [5][18][37]. Range based proposed in [10], [45], [48]. While node deployment is enticing with the prohibitive cost, these solutions are not acceptable, whereas energy efficient gives a promising future in the [45] and [48].
Devoid of low energy efficiency [9] is low cost, high accuracy, the localization error is low using MMSE method when the nodes deployed randomly. By its vanquishing nature hybrid category of localization [11] presents favorable low-cost factor, low localization error, high accuracy proposed an accurate mobile localization algorithm in a mine environment using LSM with uniform node deployment. An emerging category of localization proposed in [46] using a scalable error correction technique for the nodes deployed optimally over the network has proven energy-efficient and high accuracy. The results suggested in [4] and [8] offer a higher accuracy, lesser cost, and are very scalable. Looking into [10], the localization error alarms high that will not be a choice to remunerate localization in large area, though the accuracy is attractive and alluring despite low and energy efficiency is acceptable for underwater optical sensor networks [45]. The preceding solutions can only find position of minor part of nodes, but the algorithm proposed in [47] progress a new methodology to find conditions that two components distinctively combined in 3-D space. By this method, it meritoriously overwhelms error propagation in computing optimal component mergence parameters. HDMS algorithm used to find the Euclidean distances between nodes [7]. Using this algorithm communication complexity and computational complexity are applicable for the large-scale networks. Even though the rest of the caliber is conducive, yet cost factor is high for the hop-based category. It may be comparatively, and consent granted for the results tested in MATLAB.

Table -I: Performance parameter analysis of localization algorithm categories

Category	Localization Technique	C	AC	S	EE	HS	SC	PC	TS
Centralized	MDS, SDP	H	H	Y	H	L	N	H	R
Distributed		L	L	Y	L	H	Y	L	NR
Range -based	RSSI	L	A	Y	H	L	Y	H	NR
	TDOA	L	H	Y	H	A	Y	H	R
	TOA	H	A	Y	L	H	Y	A	R
	AOA	H	L	N	N	H	Y	H	NR
Range-free	DV Hop	L	A	Y	H	L	N	L	R
	Hop Terrain	L	A	N	H	L	Y	L	R
	APIT	L	H	Y	H	A	Y	A	NR
	Centroid	L	H	Y	L	D	Y	H	NR
	Gradient	L	A	Y	H	A	Y	L	NR
Fine -grained		L	H	N	L	H	Y	L	R
Coarse-grained		L	L	Y	H	L	Y	H	NR
Anchor based		H	L	N	H	H	Y	H	R
Anchor free		L	A	Y	L	N	N	A	NR
GPS based		H	H	Y	H	H	N	H	R
GPS Free		L	A	N	L	L	Y	A	R

Abbreviation

AC-Accuracy	S-Security	EE-Energy efficiency
O-Optimum	A-Average	TS-Time synchronization
SC-Scalability	R-Required	PC-Power consumption
R-Random	D-Depends	ND-Node Deployment
C-Cost	H-High	LE- Localization error
Y-Yes	L-Low	NR-Not required
N-No		HS-Hardware size

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Table -II: Comparative analysis of recent localization algorithms

Year/ Ref.	Category	Proposed System	Technique/Method Used	Parameters	ND	EE	AC	LE	C	Simulation	Network Area(m^2)
Safa, et al. 2014[3]	Distributed	Hybrid DV-Hop (HDV-Hop) Algorithm	-Linear Least Square (LLS) -Non-Linear Least Square (NLLS)	-Number of sensors -Number of Anchors -Area size	D	Y	H	L	H	NS-2 MATLAB	0.1km to 19 km2
Xiayong, et al. 2015[4]	Range-free	Kernel Ridge Regression – Multi-hop Localization (KRR-ML)	-Kernel based regression framework -Learning method	-Hop-count information -Position information	R	Y	H	L	H	MATLAB	300 x300
Shizhang, et al. 2017[6]	Range base/ Range free	Heuristic Multi-Dimensional Scaling (HMDS) algorithm	Heuristic Approach	-Euclidean distances -Number of anchors -Communication range error	R	N	L	L	L	MATLAB	100x100
Saber, et al. 2017[5]	Range free	Intelligent mechanism for routing Data based on node localization (IMRL)	-Weighted centroid localization technique -Fuzzy logic method	-Energy consumption -Packets -Number of dead nodes -Transmission time	R	Y	H	A	H	MATLAB	100x100
Anjana, et al. 2017[7]	Mobile	Fault-Resilient Localization scheme (FRL) for UWSNs	Multiple linear regression technique	-Simulation time -Communication range -Packet size	D	Y	H	L	L	MATLAB Aquasim	10 km to 500 km
Huai, et al. 2018[8]	Sparse	Rotation Matrix (RM)-based method Distance-based method	Minimum Mean-Square Error (MMSE)	-Space size -Coil radius -Excitation current	R	N	H	L	L	MATLAB	20m
Yunfeng, et al. 2018[9]	Range based	Range-Based Multilateral Accumulation Method (RBMAM)	-Least Square Method (LSM) -Area Localization Scheme (ALS)	-Distance -GPS data	R	Y	H	H	H	MATLAB	5000x 5000
Fatemeh, et al. 2018[36]	Range free	A distributed cooperative and range-free localization algorithm (DCRL)	Heuristic Method	-Target neighbors -Anchor nodes	D	N	H	L	L	MATLAB	200x200
Kangshun, et al. 2018[10]	Hybrid	An accurate mobile localization algorithm in a mine environment	-Error probability approach -Ooverlapping self-adjustment method -LSM	-Distance -Time -Distance Error	U	Y	H	L	L	MATLAB	300x8x6
Subrata, et al. 2019[45]	Hop based	Modified Minimization of Error in Multihop System M-MEMHS	Scalable error correction technique	-Number of nodes -Transmission range	O	Y	H	L	H	MATLAB	180x180
Pei, et al. 2019[18]	Range free	ADMM-based parallel efficient projection algorithm (PEPA)	-Chebyshev center model -Nonconvex optimization method	-Number of Anchor nodes -Communication range	R	N	H	L	L	MATLAB	100x100
Nasir, et al. 2019[44]	Range based	Energy Harvesting Underwater Optical Wireless Sensor Networks (EH-UOWSNS)	The minimum unbiased variance estimation method	-Number of Anchor nodes -Coordinates	R	N	H	L	H	MATLAB	100x100
Xuanlin, et al. 2019[46]	Range based	Component-based localization (CBL)	-Algebra-based approach -Patch-and-stitching strategy	-Node degree -Anchor ratio -Distance measurement error	D	Y	H	L	H	MATLAB	10Rx10R x10R
Nasir, et al. 2019 [47]	3D Deployment	Robust 3D localization for UOWSNS	Low-rank matrix approximation method	-Number of Anchor nodes -Coordinates	R	N	H	L	H	3D environment	10x10x 10

CONCLUSION

In this paper, we explore and expedite the choice of prevailing adequate localization algorithms with various parameters and techniques. By combining data with various physical values from different localization narrowed down to the progress of many kinds of open research challenge. This will enhance in acclimatizing the localization errors and achieve high precision in large-scale centralized network localization to decrease the computational complexity. The performance issues had to venture into several tough tasks quoted by the above-cited WSN features on the one hand and the demands of the applications on the other. The latest research show that mobility in WSNs improves the volume of data in the network, addressing delay and latency glitches.

In future work, to promote the positioning of node on vast region and to improve performance, usage of intelligent techniques is optimal. Likewise ,discovery of efficient energy routing protocol intended for robustness, and to find accuracy in peer-assisted localization there is a desperate need for the still tuned potent technologies for specific need and application like Internet of Things, UWSN domain and human-machine cooperation

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