Analysis and Comparison of Localization Approaches in WSN: A Review

Bhupinder Kaur(✉) and Deepak Prashar

School of Computer Science Engineering, Lovely Professional University, Phagwara, Punjab, India
bhupinder.kaur.bhatia786@gmail.com, deepak.prashar@lpu.co.in

Abstract. Wireless Sensor Network (WSN) is made up of huge no. of sensing nodes those are known as sensor nodes. In WSN Localization for the unknown nodes, is significant task. Various techniques are available to solve this problem. Two main categories are rough and excellent. Rough categories require less detail to determine the position of unknown node, easy to implement and less complex and the excellent technique require more detail to determine the position and provide the accuracy about position of the node. In this review paper we are presenting the analysis of various localization algorithms and providing the comparison of performances and approaches.

Keywords: WSN · Localization · Anchor node · Unknown node Accuracy

1 Introduction

Wireless Sensor Networks (WSNs) is model of huge amount of sensing nodes. These nodes are known as Sensors. WSN is technique in which all the sensors sense activities in target area to check and control the activities [1]. All of the sensor nodes in WSNs works together to achieve one common goal as in military for target tracking. In WSNs, there can be one or few sink nodes, all the sensor nodes gather the data from target area and transfer it to sink node, sink node contain more energy, strong calculations and transmission capabilities [2]. Sensor node is essential part of the WSNs; hardware of sensor is consisting of four parts: power and power management module, sensor, microcontroller and transceiver [3]. Sensors collect the data from target area in form of signal such as light, vibration, chemical signal, temperature and change them into electrical signal then sent it to microcontroller, after that microcontroller process this data then transceiver sent this data, so that physical realization of communication can be achieved [3]. WSNs include five categories: terrestrial WSN, underground WSN, underwater WSN, multimedia WSN, and mobile WSN [4].

Terrestrial WSN: In this network nodes are placed in target area in ad hoc or pre-planned way. In ad-hoc, nodes are dropped into the target area randomly via plane and in pre-planned, placement models are used to place the nodes [4].

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Underground WSN: In this network nodes are buried in underground, mines, caves to check the activities and sink node is placed above the ground to transfer the information to base station [4].

Underwater WSN: In this network less number of nodes are used as compare to terrestrial WSN. These sensing nodes are costly and instead of using dense placement of nodes in terrestrial WSN, underwater WSN uses sparse placement of nodes [4].

Multimedia WSN: In this network particular area's activities are monitored and tracked by sensor nodes in the form of audio, video, images. These sensor networks are consists of less cost sensing nodes and in this sensing nodes are placed in target area in pre-planned way [4].

Mobile WSN: In this network sensor nodes moves in target area. As static nodes sense the target area, perform computations similarly mobile nodes also perform these functions. The difference is, in Mobile WSN data is transferred with dynamic routing while static nodes uses fixed routing. There are various issues that mobile WSN faces:- localization, energy, maintenance, self-organization [4]. WSNs are becoming more popular because these are used in various areas as in:- military, health, environmental, agricultural, domestic, industries [5]. In WSNs sensor nodes plays a vital role. So, in WSN some technical and design challenges are there in ad hoc deployment as typical calculations, less battery, fault tolerance, hardware constraints, network topology, production cost [1].

1.1 Applications of Wireless Sensor Networks

WSN performs a vital job in different areas. Some of the areas are military, environmental area, medical field, home and in others are also.

1. **Military Applications:** In military WSN is used for battlefield surveillance and in targeting system.
2. **Environmental Applications:** In Environmental WSN is used for forest fire detection, flood detection, earthquake detection, in air and water pollution.
3. **Medical Applications:** Wireless Sensor nodes are mostly useable now a day for the removal of cables and physical links in the middle of the patient and monitoring equipment.
4. **Home-related Applications:** WSNs applications are now reaches to the home users as technologies in the form of intelligent appliances.

1.2 Localization in Wireless Sensor Network

In WSN sensing nodes sense the particular area and transfer the details to the main station, but details received by sensor nodes is not useful if the location of sensor node is not known in case of ad-hoc deployment. As in forest area sensor nodes are dropped into forest via airplane, so after that when these node start to send the information, this information would not be meaningful if the exact position of node is not known. So after deployment of the sensor nodes, nodes have to find out its location in the network is known as localization [1]. Localization means determine the exact position of an event or activity where it is occurring. In WSNs the sensor nodes who know there position are known as anchor node (Beacon nodes or Landmarks) and the nodes who have to find out its position are known as unknown nodes (Free or Dumb nodes) [5]. To solve the problem of localization one method is to place all the sensor nodes manually, but this method will not work in case of large areas, dense forest, volcanoes areas. Another method is, connect all the sensors with GPS (Global Positioning System) this method is very costly when more sensing nodes are there in network [6].

2 Localization Process

In localization we are considering three topics those are shown below:

2.1 Position Determination Steps

The exact position of the sensing nodes is determined with following three steps [5].

1. **Distance or Angle Estimation:** In this node determine the distance or angle with anchor nodes.
2. **Position Computation:** From above step with the help of the distance or angle calculate position.
3. **Localization Algorithm:** This will help to determine the position of other sensors by using available information.

2.2 Location Measurement Technique

Three categories of location measurement are [1].

1. **Triangulation:** In this AOA (Angle of Arrival) calculations are collected at unknown node from three anchor nodes and trigonometric laws are applied on calculated data.
2. **Trilateration:** In this distance calculation are used at unknown node from three anchor nodes. Unknown node will receive (x, y, d) where (x, y) is detail of coordinates for anchor and d is distance in the middle of the anchor and unknown sensor. After that geometric calculations are performed to determine the position of unknown sensor.
3. **Multilateration:** In this more than 3 anchor nodes are used for the position calculation of the unknown sensor.

Figure 1 shows the three measurement techniques in which a, b, c, d are anchors and u is the unknown node.

2.3 Localization Schemes

Localization Algorithm are categorised into four part [7].

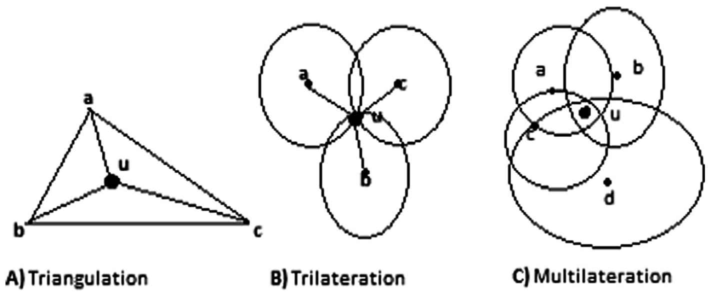

Fig. 1. Measurement techniques

GPS Basis/GPS Free: In GPS basis scheme all the sensor nodes are connected with GPS, this scheme provide the accurate position of all the nodes. But to connect all the sensor nodes with GPS is not possible, reason is GPS communicate in line of sight so due to the obstacles in the path if take the density of plants the GPS will not work and the another reason is GPS increases the cost of network. To solve this problem other scheme GPS free introduced in which instead of connecting all the nodes with the GPS only few sensors are getting connected with GPS those are considered as anchor node. In GPS free unknown nodes who have to find out there position will use the anchor nodes to find their position in the network [1].

Anchor Basis/Anchor Free: In anchor based scheme few of the nodes already knows its position because these nodes are placed by hand or connected with GPS [7]. Anchor nodes start the localization process to determine the location of another unknown node. Accuracy in anchor based scheme based on the amount of anchors. On the another hand anchor free scheme use neighbor distance information to find out the location of unknown nodes when there is no any anchor node [7].

Centralized/Distributed: In centralized scheme all the nodes depends on the sink node, another nodes no need to perform any calculations because all the communications are performed via sink node that perform all the calculations for the nodes. The advantage is it provides the more accuracy [7]. In distributed scheme all the nodes perform the calculations all the nodes perform localization algorithm and error increases [7].

Range Basis/Range Free: Different types of method are available to determine estimate of the distance or the angle in the middle of the nodes, to find the position of nodes. These estimates should be accurate because this information is used to calculate the position of the nodes and in the localization algorithm [5]. Various methods to find out the estimate of distance/angle are:- (i) RSSI (Received Signal Strength Indication) (ii) ToA (Time of Arrival) (iii) TDoA (Time Difference-of Arrival) (iv) AoA (Angle of Arrival).

- **RSSI:** In RSSI distance in the middle of the 2 nodes is calculated on the basis of the strength of the signal, which is reached to one of the node [5]. When the signal propagates its strength gets reduced. Two radio propagation models are Free space and Two-ray Ground formula for Free space formula is defined using Eq. (1) and Two-ray Ground formula is defined using Eq. (2).

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L} \tag{1}$$

$$P_r(d) = \frac{P_t G_t G_r h_t^2 h_r^2}{d^4 L} \tag{2}$$

P_t: Received signal strength, P_r: Transmitted Signal strength, G_t: Transmitter Antenna gain, G_r: Receiver Antenna gain, λ: Wavelength.

This method has some advantages and disadvantages also, advantage is this method requires less cost because the receivers are proficient to estimate the strength of the received signal and the disadvantage is noise and interference in communication provide less accurate results of localized node [5]. First time this technique is used by RADAR system [1].

- **ToA:** Another method to find out the distance in the middle of nodes is ToA that calculate the distance on the basis of the time [5]. Distance is directly proportionate to the time require by signal to transfer from one place to another point. ToA method requires synchronized nodes [5]. Distance is calculated using Eq. (3).

$$Dis = Sr(Tr - Ts) \tag{3}$$

In Fig. 2. Receiver estimate the distance by multiply the speed of the radio signal with time difference arrival of the radio signal.

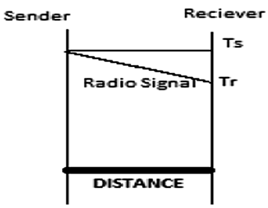

Fig. 2. Time of Arrival (ToA)

Ts: signal transmitted at time, *Tr*: signal received at time, *Sr*: Speed of the radio signal, *Dis*: Distance.

- **TDoA:** In TDoA use the hardware ranging scheme the sensor node is provide with speaker and microphones [8]. In this method transmitter sends a radio message and wait for some time ($T.de$) that can be equal to zero and then generate the pattern of chirp on the speaker [8]. When the receiver receives radio signal, receiver will record the time ($T.ra$) and switch on the microphone, after that microphone will detect the chirp pattern and the receiver will note the time ($T.so$). When the receiver have all the time $T.de$, $T.ra$, $T.so$ the receiver calculate the distance (Dis) with Eq. (4). Where $S.radio$ is speed of radio signal and $S.sound$ is speed of the sound [8].

$$Dis = (S.radio - S.sound) * (T.so - T.ra - T.de) \tag{4}$$

In Fig. 3. Sensor A (Sender) sends radio signal then after some delay sends sound signal now the Sensor B (Receiver) calculate the distance with arrival Time Difference-of two radio and sound signal [8].

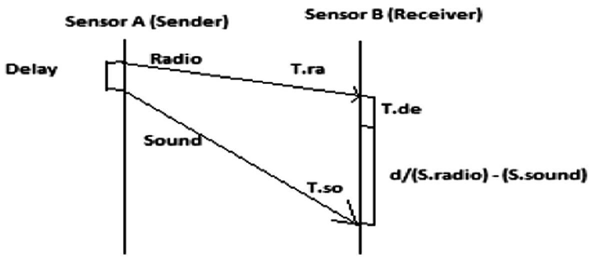

Fig. 3. Time Difference-of Arrival (TDoA)

- **AoA:** Some localizations method uses the data of AOA to calculate the position of the sensor. Detail of AoA is gathered using microphones/radio arrays those allow the receiving node to find out the orientation of the transmitting node [8].

In Fig. 4 Time Difference-of arrival of the signal to every receiver as well as the difference in the positions of the all recipient; allow the sensor node to determine the AoA of the signal.

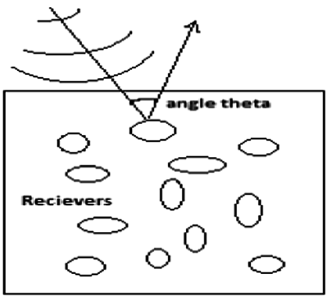

Fig. 4. Angle of Arrival (AoA)

- **Range Free:** The range free method do not use any measurement equipment so this method require less cost as compare to range basis method. Range free localization algorithm uses distance approximate algorithm to determine the location of node.

Range free method uses some anchor nodes to determine the position of the node [9]. Although the range free method yield less accurate result as compare to range based even then range based methods are used due to the less cost and these are appropriate for large network [9]. Various Range free algorithms are Centroid, DV-hop, APIT etc.

3 Literature Review

In related work we are going to review the basic localization and various improvement in localization approaches.

Sharma et al. has published Issues and Challenges in WSN [10], this paper is defining a various difficulties and problems that comes under the design of the WSN. These difficulties and problems have more effect on the WSN. This paper has defined difficulties and problems with following Fig. 5. Here few issues would be defined. As Energy in sensors for WSN is very important because more energy is consumed by sensors when they continuously sense the environment of target area, for data collection. Batteries that are giving energy to the sensors need to be replaced or again charged after the batteries of sensors have been consumed. So the major challenge for the researcher is to propose an energy efficient hardware and software or algorithm those works efficiently in WSN. Another issue is security that is also very important as WSN is used in battle fields, for surveillance. So the confidentiality of data, during the transmission in the middle of sensors or in the middle of sensor and base station is required. Because if there is no security then any third person can read the confidential data, can change the data that would not be good. So the researcher should take care of this issue also, to provide the security.

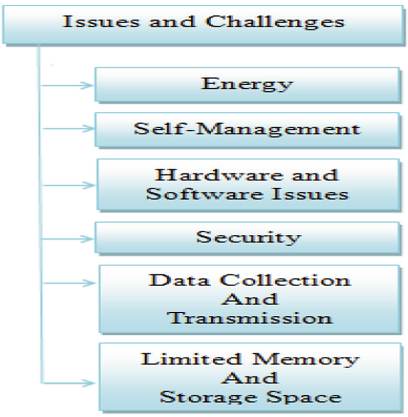

Fig. 5. Issues and challenges

Pal Singh et al. has published paper Critical Analysis of Distributed Localization Algorithms in WSNs [11] that defines the categories of localization method in WSN like GPS Based, Anchor Based, Computational based, and on range basis as mentioned in following Fig. 6. Computational has further two categories centralized and distributed. These all approaches have own advantages and disadvantages. Advantages come in form of more accuracy, less cost.

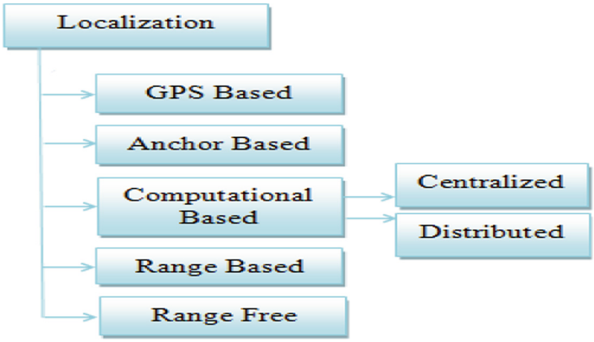

Fig. 6. Localizations

Bulusu et al. has proposed Centroid Localization Algorithm [12], that was consist of two phases. In the initial phase all the anchors broadcast their position data as packet to other unknown nodes that comes under the area of threshold. In the second phase unknown node determines the mean of co-ordinates of all the anchor who comes in area of threshold using following Eqs. (5) and (6).

$$X_u = \frac{\sum_{i=1}^{n} X_i}{n}, \tag{5}$$

$$Y_u = \frac{\sum_{i=1}^{n} Y_i}{n} \tag{6}$$

(X_i, Y_i) is co-ordinates of anchor node i and total number of anchors are n those comes under the area of threshold. This algorithm is easy to implement but it does not provides the best result and it requires complex method to set the threshold value.

Niculescu et al. Has published Ad Hoc Positioning System (APS) [13], this paper defines distributed and hop to hop positioning algorithm that uses DV routing and GPS positioning to give approximate position of the nodes, where few number of anchor nodes are available. The areas which are inaccessible uses plane for deployment of the node and distances to the anchors is transmitted with hop by hop propagation method, when node find out the distances up to equal or greater than 3 anchor nodes, then unknown node can calculate its position using GPS method. In this the nearest node of the anchor estimates the distance to anchor using direct signal strength measurement. The nodes those are not immediate neighbors of anchor would be able to calculate the distance to the anchor using these three ways, hop by hop-distance transfer methods are:- DV -hop, DV -Distance, Euclidean -Distance.

DV -hop and DV-distance Method:- Both methods use the basic distance vector exchange to transmit the distance information. DV -hop works in following three steps.

1. Calculate the least hop-count in the middle of the nodes.

In this anchors start flooding of the packet {(Xi, Yi,), hi, id}, where (Xi, Yi) detail of co-ordinates for the anchor i and (hi) detail of hop-count. Every unknown node preserve the table {(Xi, Yi), hi} for each anchor i, and receive the packet from least hop-count then after adding one in hop-count, transfer the packet to neighboring node. In this when the node receive the packet, node will collate its own hop-count with packet hop-count, if hop-count in node table is less than the hop-count for packet of anchor i, node will discard the packet, otherwise node will update the table hop-count and will add one in packet hop-count.

2. Determine Average Hop Size

In this step anchors determines the average-hop-distance using following Eq. (7).

$$AverageHop \quad Size_i = \frac{\sum \sqrt{(X_i - X_j)^2 + (Y_i - Y_j)^2}}{\sum h_i} \tag{7}$$

Now every anchor broadcasts the average hop size in network and node i which is unknown node calculate the distance (dis) from anchor i using Eq. (8).

$$\mathrm{dist_i} = \mathrm{AverageHopSize_i} \times \mathrm{h_i} \tag{8}$$

Now calculate the co-ordinates of unknown node by using the estimated distances into triangulation method. Here assume (Xu, Yu) are the co-ordinates of unknown node, (Xa, Ya) are the co-ordinates of anchor a nodes and tn is total no of anchor nodes. dist is defined as distance and get the co-ordinates using Eq. (9).

$$\begin{bmatrix} (X_u - X_1)^2 + (Y_u - Y_1)^2 = dist_1^2 \\ (X_u - X_2)^2 + (Y_u - Y_2)^2 = dist_2^2 \\ \vdots \\ (X_u - X_{tn})^2 + (Y_u - Y_{tn})^2 = dist_{tn}^2 \end{bmatrix}, \begin{bmatrix} X_1^2 - X_{tn}^2 + Y_1^2 - Y_{tn}^2 - dist_1^2 - dist_{tn}^2 \\ = 2 \times X_u \times (X_1 - X_{tn}) + 2 \times Y_u \times (Y_1 - Y_u) \\ \\ X_2^2 - X_{tn}^2 + Y_2^2 - Y_{tn}^2 - dist_2^2 - dist_{tn}^2 \\ = 2 \times X_u \times (X_2 - X_{tn}) + 2 \times Y_u \times (Y_2 - Y_u) \\ \\ \vdots \\ X_{tn-1}^2 - X_{tn}^2 + Y_{tn-1}^2 - Y_{tn}^2 - dist_{tn-1}^2 - dist_{tn}^2 \\ = 2 \times X_u \times (X_{tn-1} - X_{tn}) + 2 \times Y_u \times (Y_{tn-1} - Y_u) \end{bmatrix}$$

The above Equations can be modified as Following Equation in form of A and b.

$$\mathrm{A} = 2 \times \begin{bmatrix} (X_1 - X_{tn})(Y_1 - Y_{tn}) \\ (X_2 - X_{tn})(Y_2 - Y_{tn}) \\ \vdots \\ (X_{tn-1} - X_{tn})(Y_{tn-1} - Y_{tn}) \end{bmatrix},\ \mathrm{X}_u = \begin{bmatrix} X_u \\ Y_u \end{bmatrix},$$

$$\mathrm{b} = \begin{bmatrix} X_1^2 - X_{tn}^2 + Y_1^2 - Y_{tn}^2 - dist_1^2 - dist_{tn}^2 \\ X_2^2 - X_{tn}^2 + Y_2^2 - Y_{tn}^2 - dist_2^2 - dist_{tn}^2 \\ \vdots \\ X_{tn-1}^2 - X_{tn}^2 + Y_{tn-1}^2 - Y_{tn}^2 - dist_{tn-1}^2 - dist_{tn}^2 \end{bmatrix}$$

$$\mathrm{X_u} = (A^T A)^{-1} A^T b \tag{9}$$

Advantage of DV -hop is, it is cost effective and it is simplicity make its more useable. Disadvantage is, it can only work in identical network. Where as in **DV-distance,** distance in the middle of neighboring node is calculated using radio signal strength and is transmitted in the meter instead of hops. **Euclidian** method, transmit the true Euclidian distance instead of hop-count or distance in meter.

Zhang et al. has proposed Weighted Centroid Localization (WCL) Algorithm based on DV-Hop for WSN [14], a new algorithm that boosts the complexity of the algorithm as compare to DV-Hop algorithm. WCL algorithm calculates the position of the unknown sensor in the following two steps:

1. Determine the least hop-count in the middle of unknown and the anchor nodes, like DV-Hop.
2. In second step unknown node finds the co-ordinates with the following Eqs. (10) and (11).

$$x = \frac{\sum_{i=1}^{n} w_i X_i}{\sum_{i=1}^{n} w_i} \tag{10}$$

$$y = \frac{\sum_{i=1}^{n} w_i Y_i}{\sum_{i=1}^{n} w_i} \tag{11}$$

$$w_i = \frac{1}{hop_i} \tag{12}$$

Where w_i in Eq. (12) is weight of anchor i, and hop i is less hop-count in the middle of anchor i and unknown node. Weight factor is more when there is less number of hops in the middle of unknown and the anchor node. As in the second steps there is no any broadcast of packets that is the reason of less complexity and less consumption of power.

Zhang et al. has proposed An Improved Weighted Centroid Localization Algorithm Based on DV-Hop Algorithm for WSN [14], to provide greater exactness than the DV-Hop. This algorithm works in two steps:-

1. Calculate the least hop-count in the middle of unknown and the anchors.

In this phase each unknown node find out less no. of hop to every anchor and preserve the hop-count table, arrange the table according to less to more no. of hop-counts required to reach the every anchor node then choose the anchor whose hop-count is less.

2. Determine the position of unknown node

In this phase every anchor node using Eq. (7) will calculate the Average Hop Size, now unknown will calculate the Average of all Average Hop Sizes of anchors selected in step 1. Using Eq. (13). This algorithm will calculate the weight of node using Eq. (14). Now unknown will find out the location with Eqs. (10) and (11).

$$HopSize_{av} = \frac{\sum_{i=1}^{N} AverageHop \quad Size_i}{N} \tag{13}$$

$$w_i = \left(\frac{1}{h_i}\right)^{\frac{1}{n}} \tag{14}$$

w_i is the weight factor, h_i is hop-count and $n = \frac{HopSize_{av}}{r}$, where r is the interchange radius of node.

Fu et al. has proposed FDV -hop Localization Algorithm for WSN [15], algorithm in which second and 3rd step of basic DV-Hop algorithm is changed. It works in following three steps:

1. Calculate the least hop-count in the middle of unknown and the anchors, like DV-Hop.
2. In this step anchor i determines error of average hop size of anchor i, then with error and the hop-count, all anchors average hop size is weighted by unknown node. Average Hop size for anchor i is determines using Eq. (7). Now the actual distance D_{rij} in the middle of the anchor node i and j is calculated using Eq. (15).

$$D_{rij} = \sqrt{(X_i - X_j)^2 + (Y_i - Y_j)^2} \tag{15}$$

The measured distance in the middle of anchor i and the j is calculated using following Eq. (16)

$$D_{eij} = AverageHopSize_i * h_{ij} \tag{16}$$

Now the anchor i calculates the error for Average Hop Size i using following Eq. (17) where M is total anchor.

$$ER_i = \frac{\sum_{i \neq j}^{M} \left| D_{rij} - D_{eij} \right| \Big/ h_{ij}}{M - 1} \tag{17}$$

Now find out the weight (w_i) for each anchor using following Eq. (18), and calculate the Average hop-distance for unknown node using Eq. (19).

$$w_i = \frac{\frac{1}{ER_i} + \frac{1}{N_i}}{\sum_{j=1}^{M} \left(\frac{1}{ER_j} + \frac{1}{N_j}\right)} \tag{18}$$

$$AverageHop \quad Size = \sum_{i=1}^{M} w_i * AverageHop \quad Size_i \tag{19}$$

3. In the third step, it uses triangulation method with validation formulas to determine the co-ordinates for the unknown node.

This algorithm reduces the positioning error as compare to DV -hop and improves the accuracy.

Liu et al. has proposed Multi-Dimensional Scaling method for WSN [16], in this all the sensors in the network find out the far away matrix. When the matrix consists of distances in the middle of couple of nodes is obtained, give that matrix as input to Multi-Dimensional Scaling method in order to get respective position of the unknown node. Once respective position is obtained apply the shift, rotation, reflection on relative position according to anchor nodes to yield exact location for the nodes. The most interesting advantage of this method is it can determine the location of all unknown nodes at identical time rather than at discrete time. On another hand it calculates the respective position in the absence of the anchors. It is easy in implementation, less complex and provides exact solution.

Son et al. has proposed Hyperbolic DV-Hop Localization Algorithm [17], that defines a one new algorithm to make better correctness of the traditional DV- Hop. This algorithm changes the second and 3rd step of the DV-Hop.

1. Calculate the least hop-count in the middle of unknown and the anchor nodes, same as DV- Hop.
2. Determine Average Hop Size.

In this step instead of taking Average hop-distance of nearest anchor to the unknown node, this algorithm uses the average of Average hop-distances of all anchor nodes as Average hop-distance of unknown node using Eq. (20).

$$AverageHop\quad Size = \frac{\sum_{i=1}^{N} AverageHop\quad Size_i}{N} \tag{20}$$

Now calculate the distance using Eq. (8).

3. In third step to find out the co-ordinates of unknown node this algorithm uses the hyperbolic localization algorithm instead of using trilateration method.

This algorithm is much accurate as compare to traditional DV- Hop. Hyperbolic DV-Hop results 9.3% more accurate than the traditional DV- Hop.

Liu et al. has proposed The Performance Evaluation of Hybrid Localization Algorithm in WSNs [18], that works on the improvement of approximate point in triangle (APIT) and DV-hop Algorithm. In APIT new angle based method is used to find out, the unknown lies within the triangle of three anchors or not. In this if the unknown node is making a total of 360 degree angle with all the anchors, and then unknown node would be considered as lies in three anchors. This method to know the point in triangle or not is more accurate than previous methods. On the other side this paper has improved the DV -hop also. Both improved APIT and DV -hop helps to determine the position of unknown. In this Hybrid Localization Algorithm, all the unknown nodes would be localized with improved APIT, those lies in triangle of the anchors means making angle of 360 with three anchors and remaining unknown node who does not lies within the triangle of three anchors will be localized with improved DV -hop algorithm. This paper ensures this algorithm has less localization error as compare to basic APIT and DV -hop.

Mohamed et al. has proposed An Improved DV-Hop Localization Algorithm [19], in this two algorithms were proposed the first is equal zone based DV-Hop and Equal zone based DV –Hop with RSSI. The first one split the network area into sub areas, and unknown nodes in that sub area will find out there position using only the anchors who comes in that sub area. In the second algorithm again the network is divided into sub areas, and the unknown node will use the hop-count to find out the distance in the middle of itself and the anchor if they are not neighbouring node, but if they are neighbouring nodes then node will use RSSI method to find the distance. This algorithm improves the more accuracy as compare to basic DV-Hop algorithm.

Ma et al. has proposed Node localization of WSN Based on Secondary Correction Error [20], new algorithm for node localization Algorithm. In this orthogonal polynomial fitting is used to precise the distance error. After calculating the corrected distance with orthogonal polynomial it use least square method to find the location of the node and it creates the weight matrix. Now it processes the co-ordinates of unknown node. Simulation result shows that, this algorithm is decreasing the localization error and increasing the position accuracy.

Table 1. Comparison

Algorithm	Computational complexity	Accuracy	Energy consumption	Computational	Range based/range free
Centroid	Less	Less	Less	Distributed	Range free
Traditional DV-Hop	Medium	Less	More	Distributed	Range free
WCL	Less	Less	Medium	Distributed	Range free
IWCL-DV-Hop	Less	More	Medium	Distributed	Range free
Fixed DV-Hop	Medium	Improved	Medium	Distributed	Range free
MDS Based	Less	More	Medium	Centralized	Range free
Hyperbolic DV-Hop	Medium	Medium	More	Distributed	Range free
Hybrid (APIT and DV-Hop)	More	Improved	Medium	Distributed	Range free
IDV-HOP	Medium	Improved	Medium	Distributed	1^{st} Algorithm (Range free) 2^{nd} Algorithm (Range based/range free)
Secondary correction error	More	More	More	Distributed	Range free

4 Comparison of Algorithms

In this we are going to compare the different algorithm on the basis of the some parameters in tabular form with Table 1.

5 Issues and Challenges

In this review paper we defined various proposed localization algorithms for WSNs. In this part we are going to define the various research issues for the improvement of the node localization methods and challenges in WSNs. Above defined algorithms have advantages and disadvantages in form of accuracy, computational cost, energy consumption, computational, those become issues. Accuracy of node position is most challenging task in WSNs, and as well as localization of the node in 3D area is also a challenging phase. One more interesting challenge in WSNs is localization of node in Mobile Networks.

6 Conclusion

In this review paper we have given the basic introduction of WSNs, Localization Process, Localization Schemes, and review of the various node localization algorithms. We have given the review of research papers those are containing the localization algorithms from centroid algorithm and comparison is defined using some parameter in the above table. Some of the algorithms have more accuracy less computational cost and some of the algorithms are consuming more energy. After analysing these algorithms we identified no algorithm is too good because when one parameter gets improved the other parameter becomes an issue. So there is a further need of improvement in localization algorithms that can provide the more accuracy and should be able to meet the requirements of the localization as less energy consumption, less computational cost.

References

1. Priya, Malik, A.: A review on localization algorithms in wireless sensor networks. Int. J. Comput. Sci. Eng. Technol. **5**, 677–682 (2014). ISSN: 2229-3345
2. Du, T., Qu, S., Guo, Q., Zhu, L.: A simple efficient anchor-free node localization algorithm for wireless sensor networks. Int. J. Distrib. Sens. Netw. **13**(4) (2017). https://doi.org/10.1177/1550147717705784
3. IEC: Internet of Things: Wireless Sensor Networks Executive summary, p. 78 (2014)
4. Yick, J., Mukherjee, B., Ghosal, D.: Wireless sensor network survey. Comput. Netw. **52**(12), 2292–2330 (2008)
5. Protocols for Wireless Sensor (2009)
6. Alrajeh, N.A., Bashir, M., Shams, B.: Localization techniques in wireless sensor networks. Int. J. Distrib. Sens. Netw. **9**, Article ID 304628 (2013)
7. Bal, M., Liu, M., Shen, W., Ghenniwa, H.: Localization in cooperative wireless sensor networks: a review. In: 2009 13th International Conference Computer Supported Cooperative Work in Design, pp. 438–443 (2009)
8. Stojmenović, I.: Handbook of Sensor Networks: Algorithms and Architectures. Wiley, Hoboken (2005)
9. Kaur, A., Kumar, P., Gupta, G.P.: A weighted centroid localization algorithm for randomly deployed wireless sensor networks. J. King Saud Univ. – Comput. Inf. Sci. 1–10 (2016)
10. Sharma, S., Bansal, R.K., Bansal, S.: Issues and challenges in wireless sensor networks. In: International Conference on Machine Intelligence and Research Advancement, pp. 58–62 (2013)
11. Pal Singh, S., Sharma, S.C.: Critical Analysis of Distributed Localization Algorithms for Wireless Sensor Networks. Int. J. Wirel. Microw. Technol. **6**(4), 72–83 (2016)
12. Bulusu, N., Heidemann, J., Estrin, D.: GPS-less low cost outdoor localization for very small devices. IEEE Pers. Commun. **7**(5), 28–34 (2000)
13. Niculescu, D., Nath, B.: Ad hoc positioning system (APS) using AOA. In: IEEE INFOCOM 2003. Twenty-second Annual Joint Conference of the IEEE Computer Communications (IEEE Cat. No.03CH37428), vol. 3, pp. 1734–1743 (2001)
14. Zhang, B., Ji, M., Shan, L.: A weighted centroid localization algorithm based on DV-hop for wireless sensor network (2012)

15. Fu, C., Wang, X.: An improved DV-hop localization algorithm in wireless sensor network (2013)
16. Liu, L., Guntaka, K.K.: A non-iterative localization approach based on multi-dimensional scaling method for wireless, pp. 328–333 (2014)
17. Song, G., Tam, D.: Two novel DV-hop localization algorithms for randomly deployed wireless sensor networks (2015)
18. Liu, C., Liu, S., Zhang, W., Zhao, D.: The performance evaluation of hybrid localization algorithm in wireless sensor networks. Mob. Netw. Appl. **21**(6), 994–1001 (2016)
19. Mohamed, E., Zakaria, H., Abdelhalim, M.B.: Proceedings of the International Conference on Advanced Intelligent Systems and Informatics 2016, vol. 533. Springer, Heidelberg (2017). https://doi.org/10.1007/978-3-319-48308-5
20. Ma, X., Liu, W., Wang, Z.: Node localization of wireless sensor network based on secondary correction error. In: Chen, G., Shen, H., Chen, M. (eds.) PAAP 2017. CCIS, vol. 729, pp. 142–151. Springer, Singapore (2017). https://doi.org/10.1007/978-981-10-6442-5_13
21. Khamparia, A., Pandey, B.: A novel method of case representation and retrieval in CBR for e-learning. Educ. Inf. Technol. **22**(1), 337–354 (2017). https://doi.org/10.1007/s10639-015-9447-8
22. Khamparia, A., Pandey, B.: Knowledge and intelligent computing methods in e-learning. Int. J. Technol. Enhanc. Learn. **7**(3), 221–242 (2015). https://doi.org/10.1504/IJTEL.2015.072810
23. Khamparia, A., Pandey, B.: SpringerPlus **5**, 446 (2016). https://doi.org/10.1186/s40064-016-2101-0