DESIGN AND EVALUATION OF DISTRIBUTED LOCALIZATION ALGORITHM IN WIRELESS SENSOR NETWORKS

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By

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ABSTRACT

Wireless Sensor Network is a network that is consists of large number of sensor nodes, that are known as sensors. Wireless Sensor Network is technique in which all the sensors sense activities in target area to check and control the activities. .All the sensor nodes in network work together to achieve one common goal, as in military for target tracking. In network there can be one or few sink nodes, all the sensor nodes collect the data from target area and send it to sink node, sink node contain more energy, strong calculations and transmission capabilities. After reading many research paper of Wireless Sensor Network, I choose the super domain as challenges. I found research paper for challenges, and I choose the localization of sensor node as sub domain. I found many research papers for localization of node. Localization of sensor node is very challenging task in Wireless Sensor Network.

Keyword: Wireless Sensor Network, Anchor Node, Unknown Node

DECLARATION STATEMENT

I hereby declare that the research work reported in the Dissertation -II entitled "DESIGN AND EVALUATION OF DISTRIBUTED LOCALIZATION ALGORITHM IN WIRELESS SENSOR NETWORKS" in partial fulfilment of the requirement for the award of Degree for Master of Technology in Computer Science and Engineering at Lovely Professional University, Phagwara, Punjab is an authentic work carried out under supervision of my research supervisor Mr. Deepak Prashar. I have not submitted this work elsewhere for any degree or diploma.

I understand that the work presented herewith is in direct compliance with Lovely Professional University's Policy on plagiarism, intellectual property rights, and highest standards of moral and ethical conduct. Therefore, to the best of my knowledge, the content of this dissertation represents authentic and honest research effort conducted, in its entirety, by me. I am fully responsible for the contents of my dissertation work.

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SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the M.Tech Dissertation/dissertation proposal entitled "**DESIGN AND EVALUATION OF DISTRIBUTED LOCALIZATION ALGORITHM IN WIRELESS SENSOR NETWORKS"** submitted by **Bhupinder Kaur** at **Lovely Professional University, Phagwara, India** is a bonafide record of her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree.

Signature of Supervisor

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CHAPTER 1
INTRODUCTION

1.1 WIRELESS SESNOR NETWORK

Wireless Sensor Networks (WSNs) are consists of large number of recognizing 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 the sensor nodes in Wireless Sensor Network (WSN) work 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 collect the data from target area and send 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 consist 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].

1.2 Wireless Sensor Network Types

WSNs contain different types: terrestrial WSN, underground WSN, underwater WSN, multimedia WSN, 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].
- **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 sensor nodes are used as compare to terrestrial WSN. These sensor nodes are expensive 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 activities are monitored and tracked by sensor nodes in the form of audio, video, images. These sensor

networks are consists of less cost sensor nodes and in this nodes are placed in target place in pre-planned way [4].

- **Mobile WSN:-**In this network sensor nodes moves in target area. As static node 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].

1.3 Applications of Wireless Sensor Networks

WSNs are playing very important role in different areas. Some of the areas are military, environmental area, medical field, home.

- **Military Applications:-**In military WSN is used for battlefield surveillance and in targeting system.
- **Environmental Applications:-**In Environmental WSN is used for forest fire detection, flood detection, earthquake detection, in air and water pollution
- **Medical Applications:-**Wireless Sensors are highly preferable nowadays for the reduction of cables and physical links between patient and monitoring equipments.
- **Home-related Applications:-**WSNs applications are now extends to the home users as technologies steps to the smart home utilization.

1.4 Challenges in Wireless Sensor Networks

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 an 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].

- **Energy:-**As sensor nodes most of the time are used in non-accessible environment (volcano monitoring) area, So the sensor needs to depend on their battery. Because replacing of node again and again is not good, So one of the biggest challenge in WSN is energy saving. Energy saving is main factor that effects the life span of the WSN.
- **Self Management:-**Once a WSN deployed it should be able to work without human interference. WSN should be able to handle the network configuration, adaption, maintenance and repair by itself.

- **Hardware and Software Issue:-**WSN consist of huge nodes, so WSN is used only if sensors are less expensive. Flash memory is used in WSN because it is not expensive.
- **Security:-**Security is also major issue in WSN because when after recognizing the data by sensors is transmitted to the sink or between the nodes, it can be result as eaves dropping that can be dangerous in case of military application, health care application. So the confidentiality is must. Base station must have ability to check the data is coming from correct or authenticated sender instead of unauthorized person.

1.5 Localization in Wireless Sensor Network

In WSN sensor nodes sense the target area and transmit the information to base station, now the information received by the 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 aeroplane, so after that when these node start to send the information, this information would not be meaningfull if the exact position of node is not familiar. 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. The another way is to connect all sensor with GPS (Global Positioning System) this method is very costly when huge number of sensing nodes are there in the network [6].

1.5.1 Localization Process

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

- **Distance or Angle Estimation:-**In this nodes determine the distance or angle with the anchor nodes.
- **Position Computation:-**From above step with the help of the distance or angle calculate position.

- **Localization Algorithm**:-This will help to find out the position of other sensor nodes by using available information.

1.5.2 Location Measurement Techniques

Three categories of location measurement.

- **Triangulation**:-In this AOA (Angle of Arrival) calculations are collected at unknown node from three anchor nodes and trignometric laws are applied on calculated data.
- **Trilateration**:-In this distance calculation are used at unknown node from three anchor nodes. Unknown node will receive (x, y, d) where (x, y) are the coordinates of anchor node and d is the distance between anchor and unknown node. After that geometric calculation would be performed to determine the position of unknown node.
- **Multilateration**:-In this more than three anchor nodes are used to find out the location of the unknown node.

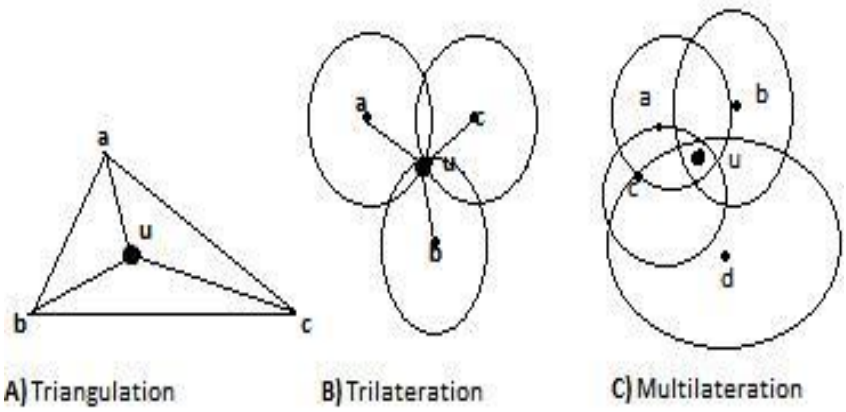

Figure 1.1: Measurement Techniques

In the Figure 1: a, b, c, d are anchor nodes and u is unknown node.

1.5.3 Localization Schemes

Localization Algorithms are categorised into four parts:-[7].

- GPS Basis /GPS free
- Anchor Basis /Anchor Free
- Centralized / Distributed
- Range Basis /Range Free
- **GPS Basis /GPS free**:-In GPS basis scheme every sensor node is connected with GPS, this scheme provide the accurate position of every node. But to connect

every node 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 increase the cost of the network. To solve this problem other scheme GPS free introduced in which instead of connecting all the nodes with GPS only few nodes are connected with GPS and those are known as anchor. In GPS free unknown nodes who have to find out there position will use the anchor nodes to determine there 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 find out the location of other unknown nodes. Accuracy in anchor based scheme depends on the amount of anchor nodes. On the another hand anchor free scheme use neighbour distance information to find out the position of the 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 find out estimate of distance/angle between the nodes to calculate the position of the nodes. These estimates should be accurate because this information is used to calculate the position of the nodes and in localization algorithm [5]. The 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 the distance between the two 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 Equation(1) and Two-ray Ground formula is defined using Equation(2).

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

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

P_t :-Received signal strength

P_r :-Transmitted Signal strength

G_t :-Antenna gain of transmitter

G_r :-Antenna gain of receiver

λ :-Wavelength

This method has some advantages and disadvantages also, advantage is this method requires less cost because the receivers are able 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:-The other method to find out the distance between nodes is ToA that calculate the distance on the basis of the time [5]. Distance is directly proportional to the time required by the signal to transfer from one point to another. This method requires the synchronized nodes [5]. Distance is calculated in ToA using following Equation (3).

$$Dis = Sr(Tr - Ts) \quad (3)$$

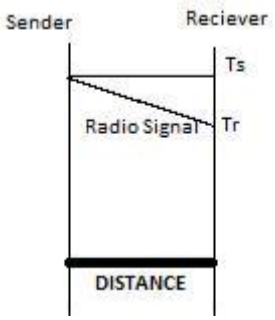

Figure 1.2: Time of Arrival (ToA)

Ts :-signal transmitted at time

Tr :-signal received at time

Sr :-Speed of the radio signal

Dis :-Distance

In Figure 2: receiver estimate the distance by multiply the speed of the radio signal with time difference arrival of the radio signal.

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 receive the radio signal, receiver will note the time (*T.ra*) and switch on there 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 Equation (4). Where *S.radio* is speed of radio signal and *S.sound* is speed of the sound [8].

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

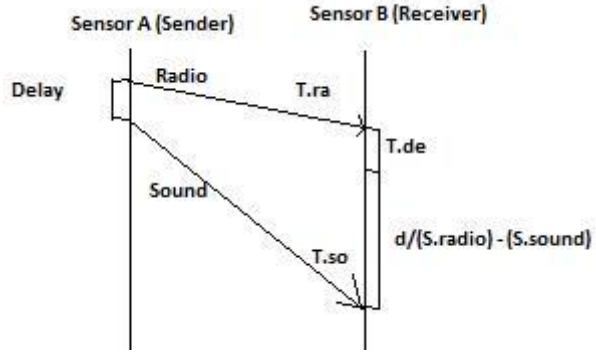

Figure 1.3: Time Difference of Arrival (TDoA)

In Figure 3: Sensor A (Sender) sends radio signal then after some delay sends sound signal now the Sensor B (Reciever) calculate the distance with arrival time difference of two radio and sound signal [8].

AoA:-Some localizations method uses the data of AOA to determine the location of the sensor. Data of AoA is gathered using microphones/radio arrays those allows the receiving node to dertermine the direction of the transmitting node [8].

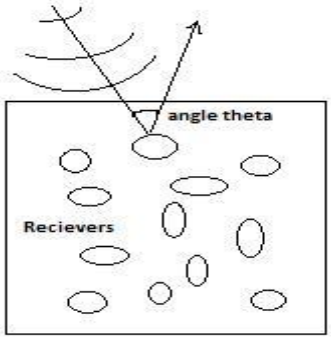

Figure 1.4: Angle of Arrival (AoA)

In Figure 4: time difference of arrival of the signal to every receiver and the difference in the positions of all the receivers, allow the node to evaluate the AoA of the signal.

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 the distance approximate algorithm to determine the location of node. Range free method uses some anchor nodes to find the location 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]. Range free algorithm contains Centroid Algorithm, DV-hop Algorithm, APIT etc [2009].

CHAPTER 2
REVIEW OF LITERATURE

Dragos Niculescu et al, has proposed Ad Hoc Positioning System [10] that is distributed and hop by hop positioning algorithm which uses distance vector routing and GPS positioning to provide approximate location 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 estimate the distance to anchor using direct signal strength measurement. The nodes that are not immediate neighbours of the anchor will be able to calculate the distance to the anchor using these three methods, hop to hop distance transfer methods are:- DV Hop, DV- distance, Euclidean.

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

1. Calculate the minimum hop count between the unknown node and the anchor nodes.

In this every anchor broadcast the packet $\{(X_i, Y_i), h_i, id\}$, where (X_i, Y_i) are co-ordinates of the anchor i and h_i is hop count. Every unknown node preserve the table $\{(X_i, Y_i), h_i\}$ for each anchor i, and receive the packet from minimum hop count then after adding one to hop count, forward the packet to neighbouring node. In this way when the node receive the packet, node will compare its own hop count with packet hop count, if the node table hop count 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. Calculate Average Hop Size

In this each anchor node calculate the average hop distance with following Equation (4).

$$AverageHopSize_i = \frac{\sum \sqrt{(X_i - X_j)^2 + (Y_i - Y_j)^2}}{\sum^{\#}_i} \; i = j \text{ all anchors } j \qquad (4)$$

Now each anchor node broadcast the average hop size in network and node i which is unknown node calculate the distance (dis) from anchor using Equation (5). i

$$dis\ i = AverageHopSize_i * h_i \qquad (5)$$

3. Now calculate the co-ordinates of unknown node by using the estimated distance into triangulation method.

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 between neighbouring 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.

Bulusu et al, has proposed Centroid Localization Algorithm [11] which was consist of two phases. In the first phase all the anchor nodes broadcast their position information as packet to other unknown nodes who comes under the area of threshold. In the second phase unknown node determine the mean of co-ordinates of all the anchor who comes in area of threshold using following Equation(6) and Equation (7).

$$X_u = \frac{\sum_{i=1}^{n} X_i}{n} \quad , \tag{6}$$

$$Y_u = \frac{\sum_{i=1}^{n} Y_i}{n} \tag{7}$$

(X_i, Y_i) is the co-ordinates of anchor i and n is total number of anchors 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.

Ning Yu et al, has proposed a new Limit DV-Hop (LDV-Hop) Algorithm [12] this algorithm yield more accuracy in node localization, reduce the no. of communication messages, cost and power consumption as compare to DV-Hop algorithm. This algorithm uses the threshold value N at the time of packet broadcast. LDV-Hop algorithm works in following three steps:-

1. Calculate the minimum hop count between unknown and anchor nodes.

In this every anchor node broadcast the packet $\{(X_i, Y_i), h_i, id\}$ and each node preserve the table $\{(X_i, Y_i), h_i\}$ for each anchor i. The receiving node keep the least hop count and discard the packet from the same anchor i having max hop count. When the received packet contain the less hop count than the threshold N the hop count is added by 1 and forwarded to the neighbour, other wise packet will discarded.

2. Calculate the Average hop Size and Distance with Equation (4) and Equation (5).
3. Now calculate the co-ordinates of unknown node using Equation (8).

$$(X_1 - X_i)^2 + (Y_1 - Y_i)^2 = d_1^2$$
$$(X_n - X_i)^2 + (Y_1 - Y_i)^2 = d_2^2 \quad (8)$$

(X_i, Y_i) is co-ordinates of unknown node and $(X_1, X_2 .....X_n)$ are anchors.

B.Zhang et al, has proposed A Weighted Centroid Localization Algorithm Based on DV-Hop Algorithm for WSN [13], to provide greater accuracy than the DV-Hop. This algorithm works in two steps:-

1. Calculate minimum hop count between the unknown node and the anchor nodes.

In this phase each unknown node find out less no. of hop to each 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. Calculate the location of unknown node

In this phase every anchor node using Equation (4) will calculate the Average Hop Size, now unknown node will calculate the Average of all Average Hop Sizes using Equation (9). This algorithm will calculate the weight of node using Equation (10). Now unknown will find out the location with Equation (11) and Equation (12).

$$HopSize_{av} = \frac{\sum_{i=1}^{N} AverageHopSize_i}{N} \quad (9)$$

$$w_i = \left(\frac{1}{h_i}\right)^{\frac{1}{n}} \quad (10)$$

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

$$x = \frac{\sum_{i=1}^{n} w_i X_i^n}{\sum_{i=1}^{n} w_i} \quad (11)$$

$$y = \frac{\sum_{i=1}^{n} w_i Y_i^n}{\sum_{i=1}^{n} w_i} \quad (12)$$

Sukhwinder Sharma et al, has published Issues and Challeneges in WSN [14] paper that is defining a various difficult ties 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 Figure: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 design an energy efficient hardware and software or algorithm those works efficiently in WSN. The 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 between sensors or between 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 security.

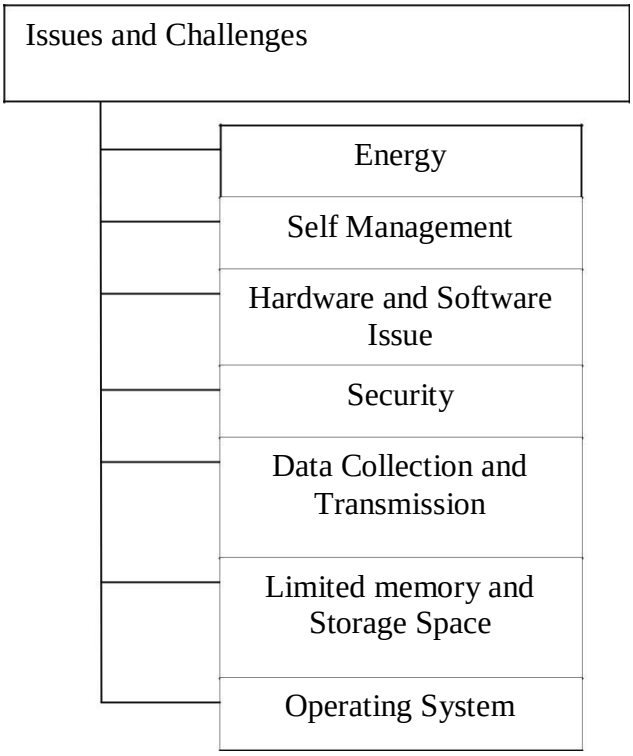

Figure 2.1: Issues and Challenges

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

1. Calculate the minimum hop count between the unknown node and the anchor nodes, same as DV-Hop.
2. In the second step anchor *i* determines error of average hop size of anchor *i* , then with error and hop count, all anchors average hop size are weighted by unknown node. Average Hop size for anchor *i* is calculated using Equation (4). Now the actual distance D_{rij} between anchor *i* and *j* is calculated using Equation(13).

$$D_{rij} = \sqrt{(X_i - X_j)^2 + (Y_i - Y_j)^2} \quad (13)$$

The measured distance between anchor i and *j* is calculated using following Equation(14).

$$D_{eij} = AverageHopSize_i * h_{ij} \quad (14)$$

Now the anchor *i* calculates the error for Average Hop Size *i* using following Equation(15) where M is total anchor.

$$ER_i = \frac{\sum_{i \neq j}^{M} \left| D_{rij} - D_{eij} \right| / n_{ij}}{M - 1} \quad (15)$$

Now find out the weight (w_i) for each anchor using following Equation (16), and calculate the average hop distance for unknown node using Equation (17).

$$w_i = \frac{\frac{1}{ER_i} + \frac{1}{N_i}}{\sum_{j=1}^{M} \left(\frac{1}{ER_j} + \frac{1}{N_j} \right)} \quad (16)$$

$$AverageHopSize = \sum_{i=1}^{M} w_i * AverageHopSize_i \quad (17)$$

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

This algorithm reduces the localization error as compare to DV-Hop and improve the accuracy.

Abdelali. Hadir et al, has proposed An Improved DV-Hop Localization Algorithm for WSNs [16] to reduce location error and to obtain much location accuracy. This algorithm changes the second step of the DV-Hop algorithm and works in following three steps:-

1. Calculate the minimum hop count between anchor and unknown node.

2. Calculate the Average Hop Size.

In this step anchor i calculate the average hop size according to following improved method using Equation (18).

$$HopSize = \frac{\max(\ hop_i\ ) + \min(hop_i\ )}{2} \tag{18}$$

In the above Equation hop i , is hop size of anchor i .

Hop i , is calculated using following Equation(19), In the same way calculate the hop size of all the anchors. Where da_1a_2 is distance between anchor a_1 and a_2 , da_1a_3 is distance between anchor a_1 and a_3 .

$$hop_i = \frac{da_1a_2 + da_1a_3}{hop_{1,2} + hop_{1,3}} \tag{19}$$

Hop i (a_1 , a_2 , a_3) , the above Equation is calculating the hop i for anchor (a_1), in the same way calculate the hop i for all anchor. Now fill that maximum and minimum value in above Equation for average hop size. After calculating the average hop size unknown node M will calculate the position by estimating the distance using following Equation (20).

$$dA_i\ M = hop_i * hopsize \tag{20}$$

Now finally the co-ordinates of the M is determined by multilateration method.

In this algorithm when communication range increases the localization error of each node is reduces.

Guozhi Song et al, has proposed Hyperbolic DV-Hop Localization Algorithm [17] to improve the accuracy of the traditional DV-Hop algorithm. This algorithm changes the second and third step of the DV-Hop algorithm.

1. Calculate the minimum hop count between the unknown node and the anchor nodes, same as DV-Hop.
2. Calculate Average Hop Size.

In this step instead of using the average hop distance of nearest anchor to the unknown node, this algorithm uses the average of average hop distances of all anchor nodes as the average hop distance of unknown node using Equation (21).

$$AverageHopSize = \frac{\sum_{i=1}^{N} AverageHopSize_i}{N} \tag{21}$$

Now calculate the distance using Equation (5).

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 more accurate than the traditional DV-Hop algorithm. Hyperbolic DV-Hop results 9.3% more accuracy than the traditional DV-Hop algorithm.

Lichuan Liu et al, has proposed A Non-iterative Localization Approach Based on Multi-dimensional Scaling Method for WSNs [18]. In this all the nodes in the network find out the distance matrix. When distance matrix consists of distances between 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 the exact location of 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 the another hand it calculates the respective position in the absence of the anchor nodes. It is easy in implementation, less complex and provides exact solution.

Chungang Liu et al, has proposed The Performance Evaluation of Hybrid Localization Algorithm in WSNs [19] that works on the improvement of approximate point in triangle (APIT) and DV hop Algorithm. In APIT new angle based method is used to determine, the unknown node lies with in 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, 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 node. 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 with in 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 algorithm

Santar Pal Singh et al, has published paper Critical Analysis of Distributed Localization Algorithms in WSNs [20] that defines the categories of localization

method in WSN like GPS Based, Anchor Based, Computational based, and on range basis as mentioned in following Figure 6:

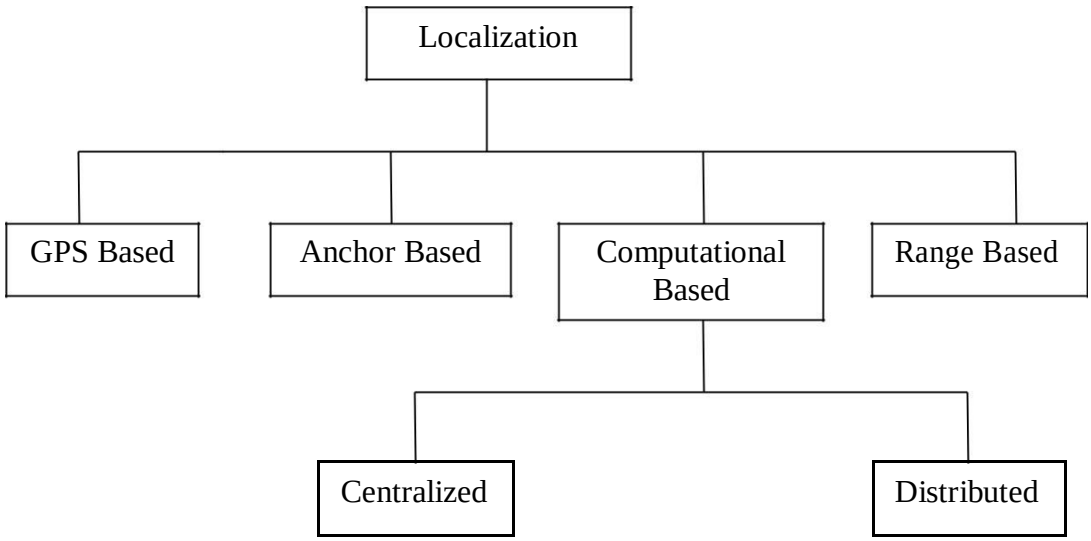

Figure 2.2: Localization Categories

Each Method has its own merits and demerits. This paper also defines further categories of distributed techniques under Computational based such as localization on the basis of anchor, hop basis, relaxation basis.

Xiaoxu Ma et al, has proposed Node localization of WSN Based on Secondary Correction Error [21] 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 uses the least square method to find the position of the node and it creates the weight matrix. Now it process the co-ordinates of unknown node. Simulation results shows that, this algorithm is decreasing the localization error and increasing the position accuracy.

CHAPTER 3
SCOPE OF STUDY

WSNs is consists of large number of recognizing nodes. These nodes are known as Sensors. In WSN numbers of issues and challenges are there in which Localization is main challenge , in WSN location of sensor node plays an vital role, without location of node data collection is not worthy. Because if the position of sensing node is not known, then corresponding action would not be taken efficiently.

3.1 PROBLEM FORMULATION

The problem statement "DESIGN AND EVALUATION OF DISTRIBUTED LOCALIZATION ALGORITHM IN WIRELESS SENSOR NETWORK", shows the aim of research is to design a new distributed localization algorithm to improve the localization error and to make the comparison with existing algorithms parameters. The new algorithm would be proposed that would be divided into two parts, first part would be used to find the co-ordinates of nodes those are not immediate neighbour of anchors and second part of algorithm would be used for unknown nodes those are immediate neighbour of three anchors.

CHAPTER 4
OBJECTIVES

Localization in WSN is very challenging task in form of estimating the accurate position of node. Various localization algorithms are available for localization of sensor in WSN that can be divided into various classes such as distributed and centralized, range basis and range free, anchor basis and anchor free.

1) To study and analyse the existing distributed localization algorithm.
2) To propose a new range free distributed localization algorithm in WSN.
3) Implementation of the proposed algorithm.
4) Comparison of proposed algorithm with existing localization algorithm.

CHAPTER 5
RESEARCH MATHEDOLOGY

5.1 Tool Used

MatLab stands for Matrix Laboratory, MatLab is software that helps to impose the practical scenarios in various fields such as mathematical, engineering, artificial intelligence and in research work. It comes in various versions like 1.0, 2, 3……..9.2, 9.3, version 9.3 is released on September 2017. Matlab can support different interfaces like Java, .Net, Perl, whereas for the database it supports Xml and Sql. For the convenient use there are some predefined libraries that execute inbuilt functions. MatLab helps to import the direct external files as any code in different language such as C, C++, Java.

5.2 Research Methodology

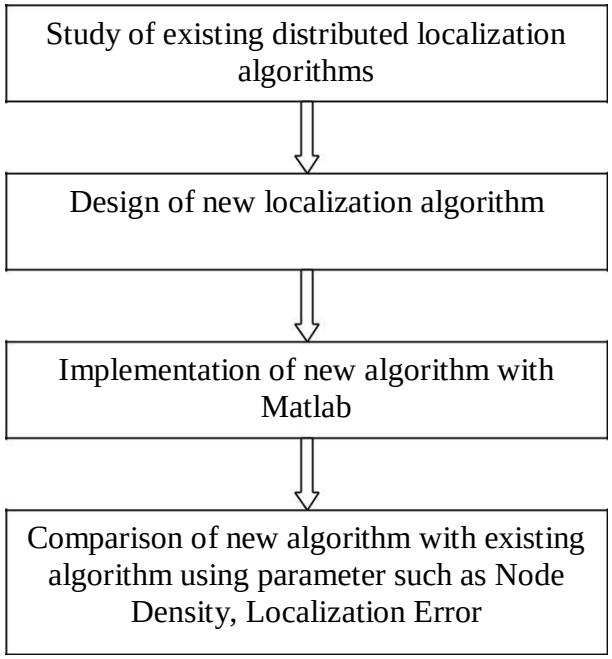

Figure 5.1: Flow Chart

1) Various distributed localization algorithm are studied in the first step, various issues in localization are explored such as how many nodes are localized, error in localization, cost, overhead, number of anchor nodes. Study explore there is a need of new algorithm, that can solve or improve the result of these issues.
2) Design of new localization algorithm shows, the nodes will get deployed randomly in network, total number of node, number of anchor and unknown

nodes, range of nodes. After deployment new proposed localization algorithm will start the localization of the unknown nodes.

3) Implementation of new proposed algorithm using Matlab, Matlab stands for MATrix LABoratory will write the code for algorithm in Matlab to get the output.
4) After implementation, will make comparison with existing Algorithm using different parameters such as localization error of existing and new algorithm, Node Density of existing and new algorithm, more different parameters will also be used to make comparison with existing and new algorithm.

The following flow chart is defining how the new proposed algorithm will work, simply first of all it will deploy the nodes, after that code will execute and will give the result after that make the comparison with others existing algorithm parameters like number of node localized, localization error, localization accuracy, Node Density.

CHAPTER 6
EXPECTED OUTCOMES

Following are the two expected outcomes.

1. The new proposed algorithm will reduce the distance error, because localization of sensor node is depended on the distance between the nodes, distance error have huge impact in the localization of the node.

2. Localization error of the unknown nodes will reduce, because when the distance error will reduce, localization accuracy will improve and overhead will reduce.

CHAPTER 7
SUMMARY AND CONCLUSION

This report is giving the introduction of the WSN with its types, applications and challenges. Report is defining a Localization of node in WSN is very challenging task. Localization is challenging task because to connect each node with GPS is very costly, So to reduce the cost, improve the localization accuracy, and to reduce the localization error various algorithm are available. In literature survey various localization algorithms are defined to get the better accuracy for node localization. In the research work report is defining new proposed algorithm will be used to find the position of the unknown node

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