LOCALIZATION USING HYBRID MULTILITERATION APPROACH IN WIRELESS SENSOR NETWORK

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Dedication

To my Creator, Parents and Family.
Without their support I would not have been able to survive and learn. Without my Late Father, I would not be able to climb even the first step and to reach where I am now. May Allah Help, for more endeavours to come.

Hamniece Hafeez Siddiqui

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Abstract

Wireless sensor networks are used in the field of civilian as well non-civilian purpose. Civilians use it for the seismic monitoring, environmental condition monitoring and condition monitoring. The coverage area of the wireless sensor network has now become vast, which includes the security, health services and last but not least the target tracking. The target tracking is a method, which detects the target's location through estimation. This is done with the help of sensor network, they are positioned and they know their own position as well. In order for this to work, they calculate different information, they collect information, they forward the data, and this whole process requires detailed monitoring. Keeping all the things in mind, the estimation data for the target needs to be accurate and reliable, since target tracking is a result critical process. To address the issues that occur during the process of target tracking, we study different schemes like the Received Signal Strength Indicator (RSSI), Global Positioning System (GPS), trilateration and multiliteration. Although each has contributed towards the research process, but they have drawbacks which are discussed. Therefore, this research has been proposed, which will tackle the issues that are faced. A new technique of dynamic clustering which is based upon target tracking. The proposed technique uses a hybrid approach based on RSSI and multiliteration to accurately detect the target. Rigorous simulations are performed and the simulation results that the new schemes have better results in terms of accuracy for detecting the target, which is under the surveillance area.

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LIST OF SYMBOLS

μ, – Mean

σ – Variance

φ – Probablity Distribution Function

CHAPTER 1

INTRODUCTION

In the recent era of evolvement in technologies, the domain of information technology has evolved at a considerable speed. All the technologies have advanced to a level on which they alongside fulfilling their purpose as a necessity are now giving additional services as a commodity. The process of evolving remains constant let it be the field of information technology or any other respective field. Narrowing the evolvement process to the wireless sensor domain, the purpose starting from detection of weather anomalies terrestrial tracking [1], security purposes, to industrial fluid level detection [2, 3], and to collect data from where under normal circumstances would be considered almost not possible, they work as human senses like eyes [4] to collect data. These have been made possible with the advancement of the domain of wireless sensor networks. The wireless sensor networks in a short span has expanded the uses domain. Wireless sensor networks are comprised of many networks that are placed on the area under observation, or to simply to put they are placed where the data is to be collected [5]. The application uses of wireless sensor range from environmental data collection and pressure [6][6], to molecular data collection. The range of uses depends upon from the user perspective, that in what field, the wireless sensor is implemented, though in order to collect data various sensors are to be implemented and then data transmits to the respective sink node and then transferred to the base station [7]. The wireless sensor has an important role in the seismic monitoring.

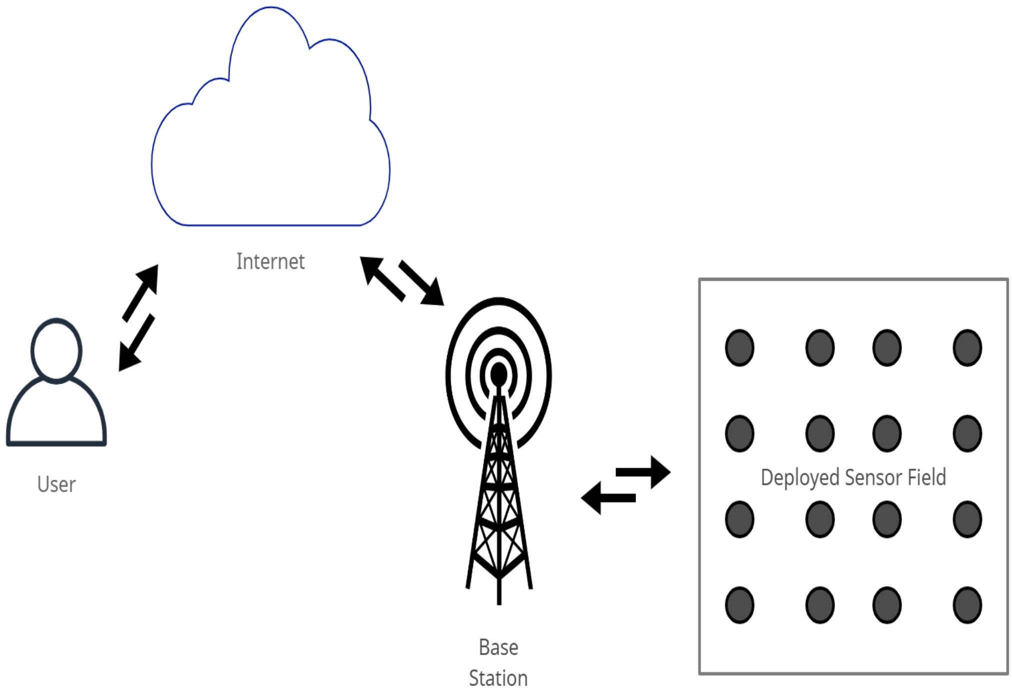

Figure 1.1: Working of Wireless Sensor Network

The wireless sensor networks although now has many field usages, but at the initial level and one of the most used application is the target detection by the military perspective [8]. It is used to accurately detect the position of the target in a specified deployed area, as the time passed the technology that was once available to the military sector has now been available to the public with the use of safety and security feature like surveillance [9]. Using it one can easily be secured after the field area has been deployed. Wireless sensors imitate as a motion detection [10] in which once entered a rogue entity will get itself detected by the wireless sensor and inform the respective entity through a series of action. The sensor works in groups to gather the data of the rogue entity, since the computational power of the wireless sensor is low so an individual sensor will not be able to the task in a standalone fashion. The sensor may work in triangulate deployment to work out the position. These sensors condition may tell whether they are just sending the data i.e. unidirectional or sending or receiving at the same time i.e. bidirectional [11]. This however depends upon in what way the network infrastructure has been deployed to collect the data, but keeping the energy parameter and the computational power of the sensor the wireless sensor are mostly unidirectional and the reason is that if they send and receive data at the same time. The power consumption will lead to disabling of the sensor and thus causing the result to be faulty. One can take the sensor structure as a smart object infrastructure [12]. The Sensor also known as nodes are implemented in a cluster formation. The number of nodes depends upon the size of the network and the area to be covered so the sensor range may consist of few to thousands depending upon how you are to collect the data. These sensor are made of transmitter, which communicate the data by collecting it from one and send it to the desired location, the nodes then communicate with each other with the help of radio signals [12] They once deployed are connected to a base station to which the data is sent. The data is sent in the form of clustering scheme, where one node may act as a sink and all the data is collected by it and then forwarded to the base station. The second in terms of physical infrastructure is the power source, since the sensors are small so the power option has to be closely studied and the data to be sent should be minimum and only the required data is to be sent so that the preserve energy and last longer. Lastly the computational circuit. Since they are small so we cannot put on a complex circuit because if we do that the power and cost would skyrocket making the sensor as a non-feasible option. The circuit mainly is mainly used a unidirectional sender of data in the form of radio signals [11]. When the deployment phase is complete the data is then forwarded to the base station, but keeping in view the third point that the data is not sent directly from the node to the sensor due to limited computational ability, it is sent through the multi-hop framework. It will forward the data to the closest node and the node will send it to the closest sink node and then forward it to the base station. These sensors have taken over the

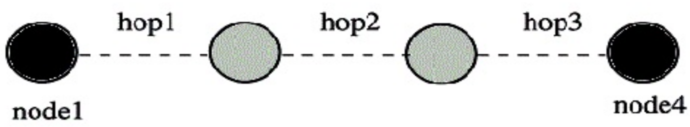

Figure 1.2: Multi-hop Architecture

traditional way of how the data is recorded manually. The sensors made the work of collecting data more precise, the data collection process may be in a continuous fashion or in a periodic manner that may include a time interval, in which the data is collected after intervals. Lastly, the data collection may be in the form of action, as if for instance any event occurs and the sensor in turn record the data. This is made possible by the wireless sensor because of the presence of actuators [13].Actuators work based on radio signals. They need the energy to calculate the data, while in the case of multi sensors approach. The different sensors work in collaboration with each other to calculate the data for better results.

The wireless sensors though having an extensive usage backgrounds the target tracking is still one of the most application, still in to the uses, the wireless sensors in a multi-mode know the position of themselves and the neighboring node. This is done for two reasons one reason is to calculate the position of the target. The second reason is that it is to verify that the data is from an authentic neighboring node and not an unauthenticated source, because of this we know that the data received is from an authenticated source and not from any unreliable source [14]. [14]. Since we are collaborating with different sensors and the main thing now which is considered is that, we are not controlling each sensor alone but we are working towards a parallel approach of wireless sensors in which instead of controlling the sensors. We are controlling the information instead of the sensor, we perform computations on the sensors and find out the value against the target with the help the sensor and since multiple sensors are involved the information [15] because more reliable and the readings are more accurate.

The sensors are placed in difficult positions in which, it would be too much difficult to collect the data manually so we have to make sure that the data being sent is accurate and the results are reliable. Many researches have been proposed to tackle the error results. The research will play a part in the improvement of wireless sensor accuracy to decrease the computational error, in turn improving the accuracy.

The Chapter 2 contains the introduction of the topic of wireless sensor networks and the sub section 1.1 contains all the domains that have the use of wireless sensor networks and in which they are applied practically. While the section 1.2 narrows downs the research topic and focuses on the target-tracking domain that is used in WSN. The section 1.2 covers the classification of the target tracking that is broadly associated in the wireless sensor domain.

1.1 Application of Wireless Sensor Networks

The applications use of wireless sensors are many. Some of the brief introduction are as follows:

- Military Application.

Wireless sensor firstly was used in the detection of targets and to check the monitor level and keep a check on fatigue level of the military personnel, they are used to check at where the soldier location is on the field, which helps in the tracking more efficient and reliable.

- Security and Surveillance:

  The use of tracking in wireless sensor network was restricted to military but in the recent era. I. It has now used in the civilian for security purpose and then now the range of civilian use them to put it on the vicinity of their property to prevent unauthorized personal from infiltration.

- Healthcare Application

  The sensor networks are now used in Healthcare application. The new evolution of the wireless networks. The introduction of the m-health [16]. This with the emergence of the 4G-health [17]. The new way of the integration enabled the sensor networks be opened to an entirely new domain. This domain keeps on widening and the new pros welcome new cons and new areas of research

- Fault Detection

  The wireless networks are used in automation and the vehicle [18], to find the detection of faults where the simple human touch is not possible. Sensor are placed like fluid detection so that once the fluid comes above the certain threshold the sensors becomes active and notifying the concerned authority before time so avoiding the major incident

- Detection of Ambient Conditions

  Soil monitoring is one of the common applications and is effective, the temperature humidity and other things are one of the most common observing that is done by the wireless sensor network.

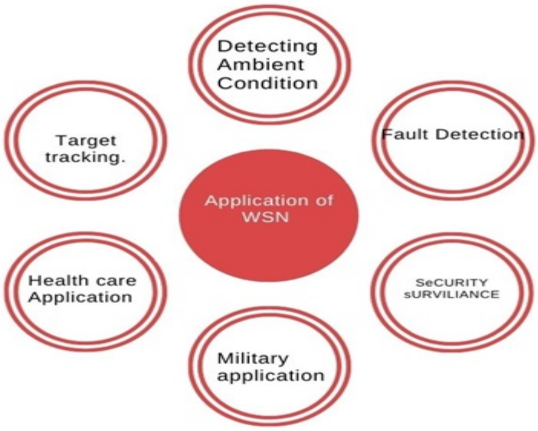

Figure 1.3: Application of Wireless Sensor Network

1.2 Target Tracking Using Wireless Sensor Networks.

There are various applications of wireless sensor networks and imminent is the target tracking applications in wireless sensor networks. Tracking can happen in terms of humans, objects, surveillance and many other things. Target tracking in terms of implementation can occur by single usage of sensor or by implementation of the complete web of sensors that can be uniformly or dynamically distributed. Target tracking depending upon the many factors and classification and communication overheads and several other things. The main thing is the tradeoff that we do, we sacrifice one for the other and the other thing is we have to balance the tradeoff in between.

One of the main reasons is that due to no standardization presently the classifications exist of wireless sensor network

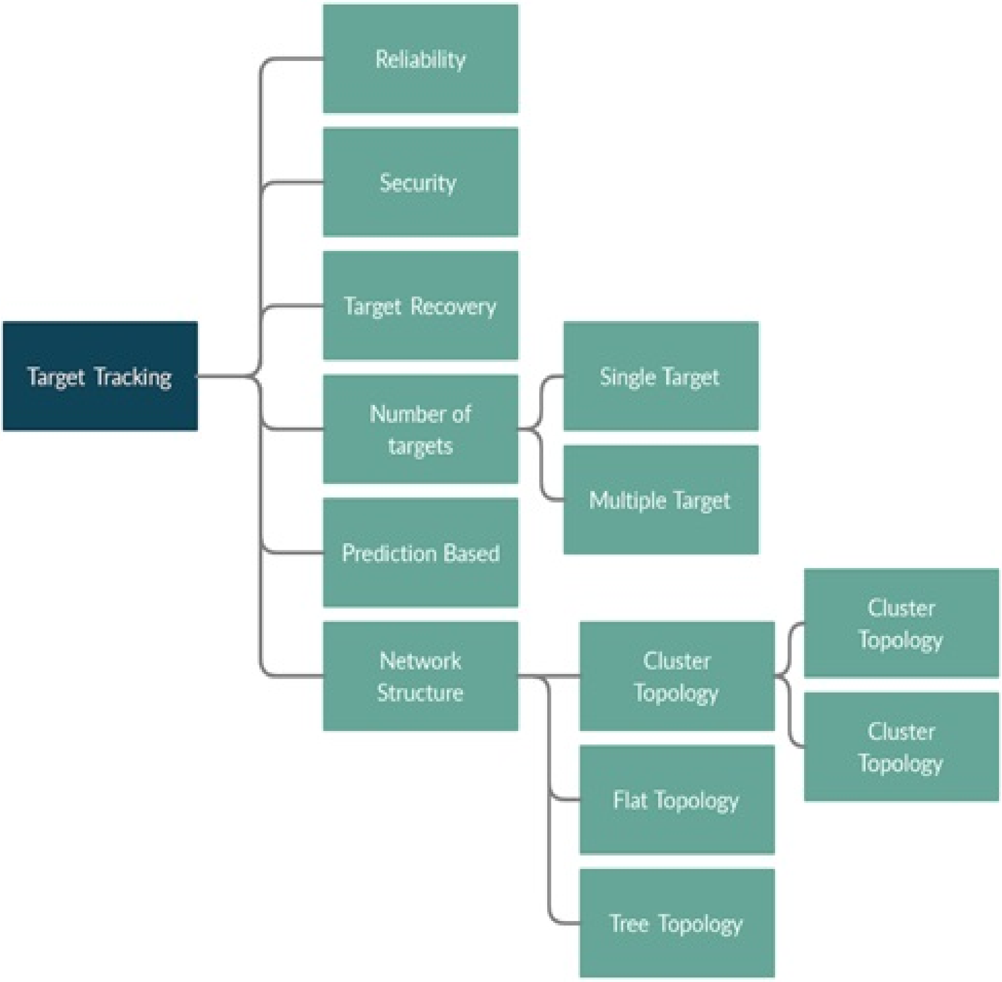

Figure 1.4: Classification of Wireless Sensor Networks

1.3 Target Tracking Based Classification.

Classification which is based upon target tracking in wireless sensor network has been explored and researched from different perspective, factors like how much is the numbers of target and the computational factors and different things. Following is the few of the classification that are as follows:

1.3.1 Network Structure

The network structure in the classification of wireless sensor networks has been distributed in three [1] main categories. One is the tree-based structure, the second is the cluster and the third is the leader-founded architecture. The distribution in to the sub categories is based upon the basis such that the target loss is then minimized and the accuracy is maximized. While another research in [19], distributes the network based structure in two classifications, one is the hierarchical and the other is the peer-to-peer. While the sub categories are as stated, one is the tree based the second is the hybrid based, third is the activation based, and lastly the cluster based. While the composition of the peer-to-peer's embedded filter is the Distributed, scalable Sigma-Point Kalman filter (DSPKF) and the (DKF) Distributed Kalman Filtering.

Now comes the differentiation of the network structure in further three sub types, firstly tree-based structure second is the flat structure, and cluster-based structure of the network.

- Tree Structure.

  The formation of the sensor network, the deployment of the sensor network, they form a logical structure. The data is then moved from the top to bottom and travelled down and from the root sensor to the leaf network.

- Flat Structure.

  This structure is almost like a no structure. You can safely assume that the distribution of the sensor network is almost works on the basis that each node has a equal and complete hand in the establishment and the network development. The sensor network will keep on broadcasting the gathered information; this will keep on happening and will stop at the destination.

- Cluster Structure.

  Cluster formation structure is one of the most common way of sensor structure deployment. This works on the basis that each and everything is defined, like the density of the sensors, area that is to be covered. Clustering is of the following two:

  * Static cluster

    The formation of the cluster, occurs at the network formation and also, during the life span of the whole network,

  * Dynamic Cluster

    In this formation, the formation of the cluster is dynamic and the formation of the cluster occurs as the target moves, the location changes and so does the cluster changes. As the target approaches, the cluster is then formed, while the other sensors in the non-surrounding area of the target remains sleep.

1.3.2 Predication Based Target Detection.

The prediction-based tracking is a technique in target detection where the target location is estimated or in other words predicted. The sensors are automatically turned on, where the target might move on to next position. This results in the firstly increasing the overall lifetime.

1.3.3 The Number of targets.

The tracking can then be further be sub categorized in to the number of targets, which are as follows:

* Single Target.

  The detection of the single target. The main edge in this that low communication overhead and the consumes less power.

* Multiple Targets.

  The target can either be one or can have multiple target depending upon the number of target and many other factor effecting the performance and at the same time detecting the target can be more challenging, because simultaneously you have to detect the target detection and other things and calculate each and everything. The main problem arises when both are moving and you have to calculate the position of the target, the data uncertainty is a common problem in multiple target tracking.

1.3.4 Target Recovery.

One of the main thing in target tracking is the target recovery, the main reason is that when we are dealing with a target, the speed of target may change excessively quickly, or there may be some sort of computational. There could be any error in the estimation of the target or any other reason where the localization of the target. So in order for the system to recoup the process of recovery should be fast and as well as resilient. Research has been done in order to tackle the problem.

1.3.5 Security.

The most important aspect in target tracking is the prediction and the other is the security, the reason is that most target applications needs to be correct and accurate and one should always keep in mind in such cases if the data is incorrect or wrong or some falsified data is sent it will lead to a disaster. Since the sensor networks having low computational capability can't have a high end security so the research is conducted by different researchers to tackle the problem such that no unauthorized or bogus information is sent over the network.

1.4 Overview of the Challenges and the Problems in Target Tracking

The wireless sensor network is a vast field and the application uses of the wireless sensor networks is almost limitless, a single idea itself can open an entirely new domain for research. In the same target tracking being an application of the wireless sensor network, the domain of target tracking now opens an entirely new path in which different research and problems arise. Research areas like the estimation error to inaccurate target reading, from overhead problems, to communication resolve the problems or in other words, we can say the domain itself is entirely new field in its own. As each passing moment, either the research is being done on the innovation or in simple words to create a solution to a problem to improve the solution presented by someone or to research as to what we can explore. The possibilities are limitless and so is the area of research. Some of the research, which can be done in this domain, are as follows:

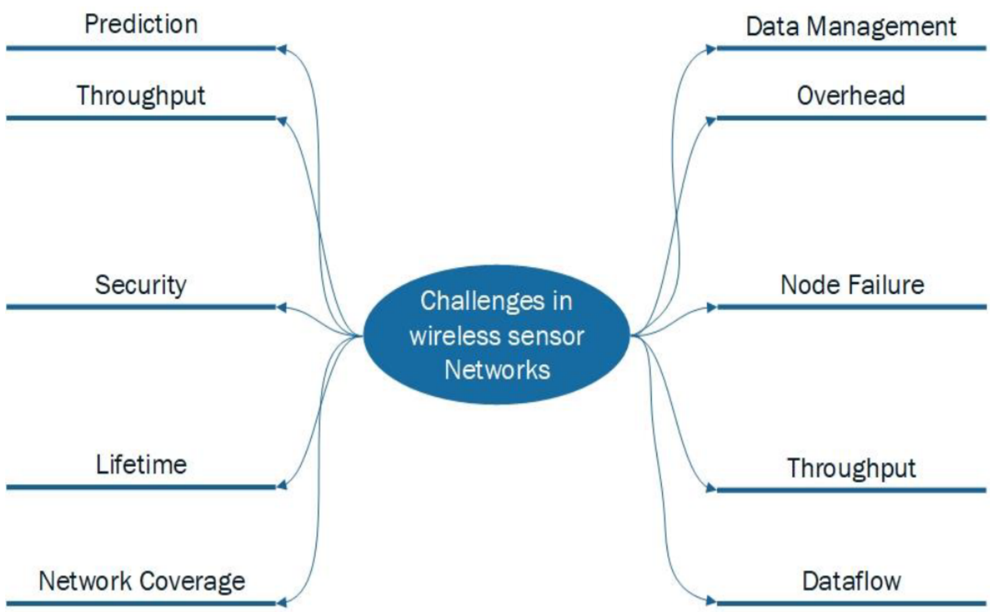

Figure 1.5: Challenges in Wireless Sensor Network.

1.4.1 Data management.

The tracking based on cluster management. When the rogue node enters, the data from the nodes are then transmitted to the cluster head after receiving the data removes the redundancy and repetition from the data and make the raw data into an organized fashion. While the data is being amalgamated, the latency of the data is kept to minimum.

1.4.2 Target Recovery.

When there is an uncertainty in the data, uncertainties include the target has deviated from the path, for the reason a robust and reliable algorithm is needed in order to deal with this problem.

1.4.3 Node Failure.

Node failure is one the most common challenge that is faced in the domain of the wireless sensor. This is caused by the natural events like catastrophe or any sort of occurrence of event that is not controlled leads to the node failure. This problem can be avoided by sensors that are implemented, should have some sort of periodic sharing which identifies the condition and state of the sensors.

1.4.4 Coverage Area.

The entire performance of the sensor networks depends upon the network's coverage area. This is mainly depending upon how much efficiently the sensor area is implemented and if the distribution is not done properly. If the area at one side is populated and the other side is not, performance degradation will occur. In order for the network to work properly performance the coverage should properly distributed.

1.4.5 lifetime

Since the area in which the sensors are implemented and the coverage is so large so it is impossible to replace. Therefore, the lifetime plays an important role. Therefore, we have to have an algorithm in which the performance is maximized and where the power consumption's are less.

1.4.6 Throughput

The throughput decrease when we observe the collision in the packets. Alternatively, when there is a loss of connectivity. This is now corrected by having traffic protocols and priorities set and having algorithm that makes scheduling more efficient and better.

1.4.7 Prediction and Precision

These two terms are interconnected, the more accurate the prediction the more will be the accurate will be the prediction. Optimization algorithm and approaches should be taken to make the accuracy results more accurate.

1.4.8 Flow for the Data

The flow of the data varies from condition to condition whether the flow of the data is in emergency condition or normal state of flow, implementation of such algorithms where the data flow remains uninterrupted even in the case of the emergency.

1.5 Challenged Area

In the above section, as you can see that there are vast area that can be taken in the field of target tracking. It is not possible to target all the area. The reason is that area defined in the Section 1.4 there exist many field that require complex and time taking research. So the area this research is based upon the Accuracy and Prediction of the target.
Since accuracy plays an important and crucial role in the tracking of target. The reason is that accuracy is always the first approach when we talk about tracking. Since we are calculating the position of the target, so the coordinates of the target needs to be accurate and the prediction of the target needs to be exact, If we don't get major results the consequences could be dire. This is the reason that this research carries importance and was selected as the area of research for this thesis

1.6 Problem Statement

It has been observed that when target tracking being done with the involvement of less density SN causes the results to be less accurate, which in turn increases the error rate. The error rate is further increased when there is a continuous path tracking for the rogue node in the surveillance node. Due to the complexity of the current schemes and the limited computational power of the wireless sensors, getting the accurate results for the rogue node more difficult. This lead to the development of the proposed scheme. The proposed scheme will detect the target's location within the area under observation. The evaluation parameter is based upon the accuracy, that how much efficient is our proposed system. Two models will be used in comparison with the existing triliteration technique to further strengthen the results of our scheme.

1.7 Contributions

Accuracy is one of the most crucial aspect in domain of target tracking In order to improve the localization of the target, since most of the application are time and result critical like tracking so this research carries utmost importance. As stated in 2.2, it is one of the most fundamental and crucial point. Following are the contributions that have been made in this thesis.

- The dynamic scheme is proposed to counter the accuracy issue that occurs in the target tracking. The proposed scheme with using the RSSI approach in the multiliteration. This hybrid scheme increases the accuracy and decreases the localization error.

- Lastly, present further challenges that are faced which can help in improvement of the domain target tracking.

The document is further divided in to the following section; Chapter 2 contains the Literature Review of all the present technique that are used in target tracking. While the comparison table of all the present techniques, their Limitations and all the results, the problem statement, and the research objective have been discussed in the following sub section 2.2.

CHAPTER 2

RELATED WORK

Target tracking not limited to the outdoor but also indoor. The author in the [20] discussed the issues in the indoor target tracking. To tackle the problem in the author proposed a mechanism based on the received signal strength indicator (RSSI). In order to select the most suitable algorithm that will have maximum efficiency for the adapted radio environment. The framework adapted by author is mixed maximum likelihood (ML)-Bayesian framework. This framework works on the prediction approach in which the radio environment is tried to be predicted. While the target tracking is achieved using the Particle Filtering scheme. The author then makes use of an algorithm to take all the RSSI measurements and then implement the technique of random linear network coding (RLNC) which will in-turn create packets. The results indicated that the obtained root mean square tracking error (RMSE) is slow as compared to other scheme in question, this comparison was done based on the localized aggregation. Furthermore, the RMSE had too much noise variance based on the connected network strength, under this technique, it was also reduced and the target tracking result was improved.

The target tracking application is one of the most used application of the wireless sensor networks among other applications. The Directional Sensors is a subfield of the WSN, improving the target tracking in this environment is a major challenge in this sub field. The author in [21], proposed a new algorithm using the DSN to tackle the target tracking issue. The first step was to select the boundary and afterwards the borderline sensor nodes that resulted in the customized coverage of the incoming target detection. In the second part the author both the dynamic and static node deployment, proposed a mechanism that will decide on which sensor in the interior node will be activated. This will result in better energy efficiency because of the smaller number of nodes being activated. Lastly, in order to take the data, he selected the geometric method. The target position was predicted using the Extended Kalman Filter (KEF). Afterwards the comparison between the proposed and the generic algorithm showed that the tracking efficiency of the proposed was much high.

The use of the WSN technology from detection to tracking has increased a lot. We can see many applications of terms of target tracking, whether the target entity. The author in [22] stated that When predicting an industrial motion, the normal assumption is that the movement is linear predictable state. With that basis, the implemented sensors are then taking the environmental data and gather all the required information to apply the mathematical equations. The nodes at times predicates the movement of the target object and calculates that whether the node selected is best suited to become the boundary node. While keeping the energy factory in check, the nodes have a sleep cycle set so that it helps with the saving of the energy. As soon as the object enters the vicinity of the node, it activates and predicts the position. The cluster formation-based scheme is implemented to calculate the location of the node at the boundary. The results after the technique implementation shows the target prediction efficiency as well the results were improved.

In [23], the author highlighted some of the major issues regarding wireless sensor networks. One of the major issues that the author explains is dealing while handling the wireless sensor networks, are Data association uncertainty. When we are collecting data from the sensors the data might not be relevant to us, it might have been corrupted, or any other reasons causing the results to be less accurate; to tackle this problem one search algorithm was developed. A way that is the minimum mean square error approach. However, this algorithm had an issue. When multiple sensors exist in the network, infrastructure this algorithm tends to fail because of the data transmission and control at the same perspective and time. The author designed a new distributed algorithm where the maximum numbers of sensors are accommodated. This algorithm has been tested in simulations and it exceeded all the results during the simulation testing the author finally concluded that the designed target tracking algorithm has taken account of the uncertainty is in the data which occur. They put in different comparison from the already available algorithm and find out that when multiple sensors are involved some of them give more data uncertainty as compared to others so they presented this algorithm, which will help in reducing the data uncertainty causing the efficiency to improve greatly.

In [24], the author in this paper explained the concept regarding the wireless sensor networks. He emphasized on the idea that monitoring and tracking are not limited to outdoor, but also in the tracking is now achieving its potential through indoor positioning. However, the author highlighted the fact that indoor Positioning is not as accurate as it should be. In the indoor tracking by wireless sensor networks because of the complex structures in the internal environment, it makes it quite difficult for the single sensor to adapt according to the environment in which it is implemented. In order to tackle this problem, the author proposed localization scheme. The second thing proposed is the tracking algorithm (CLTA). This algorithm works based on the grid. This algorithm is then divided into two phases. One is online phase and the other phase; offline face. Regarding the offline face are database consisting of fingerprints is maintained in that is based on the reliable nodes. Online phase consists of the overlapping mechanism, which minimizes the area of location. When is when one of these is selected, either it is offline and can be implemented online. Then a prediction algorithm is implemented that can predict the location of the target which greatly minimizes the area under consideration. This greatly increases the accuracy of the target tracking in the indoor environment.

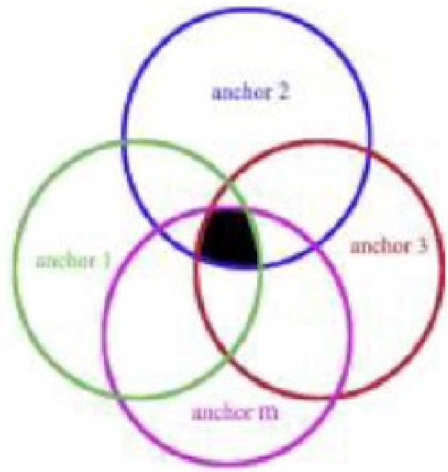

Figure 2.1: The Overlapping technique

A.Tripathi in [25], raised a concern regarding some network. He stated in his paper that during the tracking of the target we require some specified number of directional nodes in a multi wireless sensor environment. The author tried to solve the problem of the directions and the numbers of the nodes that are needed for the tracking of the target in populated WSN environment. In order to solve this problem, the author has taken the projection, the communicating ranges and the Field of Interest (FOI). The author has then divided the FOI in to different respective shape. After this finding, the optimal distance from the target making it easier to calculate and check the most optimize path.

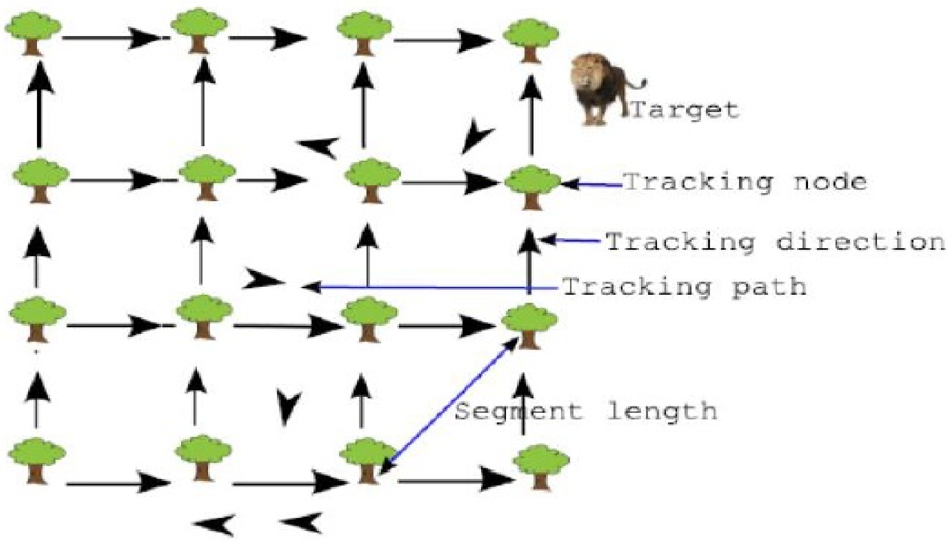

Figure 2.2: The Overlapping technique

The author proposed new algorithm in [26] based on using two approaches and combining it a single approach. One is Non-dominated Sorting Genetic Algorithm II (NSGA-II) and Generalized Extended Kalman Filter (GEKF) (NGEKF). GEKF in terms of target tracking achieves high target prediction results that has major drawbacks of high consumption, to tackle the issue the technique sensor scheduling was used. Through this we estimated the target's position. The author proposed the NSGA-II for the selection of the best-suited sensor group. The technique amalgamates the movement of the node through eight-sensor placement that is tracked. This is done with the help from taking their multiplicative movement models of noise. One is the high noise and the other is the low noise. The results derived from this technique showed that the target tracking was improved and the location error was greatly reduced.

In [27], V. Savie, explained that sensors are deployed in sensitive area to monitor the surrounding area for any unusual activity. These activities are monitored by the sensors. The author states that normally, we assume that the sensor is giving us the exact location. They when deployed the applied algorithm assumes that it is giving exact location. We do not know which sensors are working and whether they are giving us the exact position. This might have many reasons like damaging of the sensors or any other reason. The author proposed a refinement process for the sensors simultaneously. The area in question is divided in to finite portions of cube known as cells. When they are divided then he performs calculations to find out the marginal distribution. This calculation is performed for those sensors, which are not working according to the certainty principle. This Belief propagation checks in to account all the environmental factors. When the calculations were taken in to account, the author then proposed the ray-tracing simulation, which yielded the measurement data. The results yielded improved the low-density detection for target tracking. They afterwards concluded that even if the sensor was changed from its original position it gave us more robust and has more accuracy.

Target tracking is one of the most crucial application in the domain of wireless sensor networks; to accurately detect the location of the target is an ever-going research in the field of wireless sensor networks. Several researchers have proposed different schemes to lessen the error in the detection of the target tracking. The thing is that due to the limitation in the computing power of the wireless sensors, the need of a technique that can be used in localization of the target to detect the target with a minimum error. The author in [28] trying to solve the aspects of localization issues and decrease the target tracking error. They presented the trilateration and the multiliteration using the radio strength, by decreasing the density of the wireless sensor and gathering the information with RSS. The results showed that the implementation of the technique the results and the mean of the localization of the estimation error was low as compared to the technique without the implementation of the RSS. The numbers showed promising results such that different further research can be done in improving this technique and further decrease the error significantly.

The Wireless sensor application has long list in which one of the applications is the target trac/king, and since it needs to be as accurate as possible so main thing is that the when the target moves at a high speed so the results needs to be more accurate because the target is constantly changing its position. This action results in the location not being known properly due to the excess overhead. The reason is that when you have the sensor deployed in a difficult geographical environment, the sensors need to know the location of the neighboring sensor. The author proposed a scheme in [29] which is "Adaptive Signal Strength Based Localization Approach (ASSLA)". The approach they suggested increases the location accuracy of the target. The approach works on the principle of finding the shortest and the most stable path based on error bit rate and the radio strength and other things. Once the stable path is calculated, the cluster formation occurs with the help of multi-hop count to reach the target. Lastly using the vector concept alongside the trilateration, the value of the node location is calculated with least errors. This overall research improved the location efficiency and the target results were much more accurate.

The author in [30] explained that the location based services of the wireless sensor networks has increased a lot in the recent times. The computational power poses the biggest constraint while dealing with the wireless sensor networks is a major factor, and the results needed to be accurate and correct, so that the target gets recognized and the localization of the target. The constraints such as the power, communication overhead and other things that are the factor in the play. The author proposed a solution in light of all the problems that how we could solve the problems and try to increase the accuracy of the location of the target. He proposed a technique known as KickLoc. This algorithm works based on information that is gathered from the neighboring nodes. The information gathered in turn helps for better estimation of the target. In order to prove the results that are derived from this algorithm, the authors compared it with different localization schemes such as Cramér-Rao lower bound (CRLB). To further prove the evaluation parameters, they changed the range of the measurement setups on the sensor platform, which proved that the result is more valid and has less location error.

Localization has been an important factor when we unravel the domain of the wireless sensor networks. They are many factors to be considered when we talk about the tracking of objects, like indoor tracking, outdoor tracking, the visible and the non-visible line of sight. The author in [31] proposed a method through which the NLOS can be identified, that occurs in a sensor network. This is done firstly with the help of time difference and calculating the localized reflection points, this is done in a maximum likelihood framework. When it is calculated then with the help of the angles and the entire respective framework, this helps when the exact location of the sensor is known this helps in increasing the tracking efficiency of the nodes. After the simulations and experimentations have been performed, this will help in the increasing the tracking efficiency of the rogue entity and will help in the decreasing the error rate.

When we discuss about target tracking in wireless sensor networks, several researches are there to increase the accuracy of the target tracking some of which are the Kalman Filter, the Extended Kalman Filter and algorithm like Classical Least Square (CLS). Many researches have been done on them in order to get the results more precise and accurate. The author in [32] studied the base technique mentioned above and presented a hybrid approach. The author improved the CLS which has the basis of the Bayesian improved. The improved Bayesian is used to track the location of the target in the respective domain area. Using the Bayesian Technique firstly, the probability is found out for the range subset, this is done based on the target predicative location. In addition, when it done, we then get a range joint matrix, which has the probability. A matrix that is derived has an automatic updating, which happens only when the WSN testbed has a state of dormant. Then after this each weight and measurement are calculated based on the range of the matrix, after all the value has been taken accounted for by using the CLS method we calculate the position of the target through the derived results, we can calculate where the target will be on the given location coordinates. The results derived from this technique shows that when in comparison with the different schemes that are available for the accuracy finding, this technique showed better results 35%, 32% and up to 0.4% respectively.

The author in [33], emphasized, the importance of object tracking in the domain of WSN. In target tracking the wireless sensor networks are at the utmost importance, since they are implemented in the monitoring areas where normal reading the data is not possible. The author states that most of the tracking applications for the wireless sensors networks relies heavily on the signal processing applications and algorithm, but when designing the algorithms, things like accuracy and communication protocols must be kept in mind. Since the deployment of these sensors are in a domain with unreliable conditions so we have to make sure that the data we are receiving must be reliable since it is predicting a target and the target location should be exact and accurate. The proposed scheme by author takes the accuracy and as well as the reliability in to account. The sensors at first hand know the location of their respective neighboring node and then gather relevant information of the node. When the process is done the sensor then exchange the table information among each other. After this, a random node is selected as a CH and then it broadcast a message to the adjacent nodes. They exchange the values between 0 and 1 and if the values exceed the 1 threshold parameter a new CH is selected and the process goes on until all the value has been accounted for. This process records the value, this in turn makes every value known and when an unknown value enters the area then the rogue node will be identified, since the value will change, this in turn helps increase the accuracy of detecting the rogue nodes and identifying them.

Triliteration has always been an important application of wireless sensor network when we talk about target tracking. this technique has many uses and is also used in Global positioning Service. The paper [34] used the help of the RSSI and Trilit to solve the localization issues. this is done by adding first processing the raw data that is received from the RSSI. the preprocessing is done by the Gaussian Filter. this in turn reduces the noise measurement. Afterwards by using the least-squares curve fitting (LSCF) we calculate the estimation of the transmission power and the path loss exponent. And lastly, the author uses the triliteration technique which has been based upon the theory of extreme value, which calculates the node's position. By using the Taylor series the computational complexity is decreased. when all the above process is done the author selected the soothing process which will decrease the effects of the noise. The results showed that under the defined conditions the accuracy increased.

Keeping the hybrid approach in mind the localization algorithm and the time difference of arrival which is used for the asynchronous WSN, Here in the paper [34] the turning point is that the nodes position are uniform but their exact position are unknown. The sensor in the area after an interval broadcast a signal in which they send their location while using the TOA other senor record the nodes position, Using the triangulation the author calculates the clock parameter and using the maximum likelihood basin technique and the time of flight. The MLE is based for the localization. Results and simulations displayed that the technqiue is effective in accuracy for the indoor localization.

2.1 Existing Architecture

The domain of target tracking is so vast that we could not cover it all in one go. It would be impossible to address all the problems that arise in the respective field of the target tracking. This reason led us to further narrowing down the field and choosing the accuracy as the major point in the research. Since target, tracking results needs to be reliable because of its nature. The results should be accurate because the use of target tracking is mainly done for the detection of unauthorized entity that enters the vicinity. Since different research have been done in the field, this research focuses on the improvement of the technique that are as discussed below:

Trilateration as the name suggests that is combination of three circles. Using the three circles, we pinpoint the exact location of the target. The main concept of trilateration is that it uses the three nodes in question and compute the location of the target using the two dimension [x, y]. For this to work and find the location of the rogue node that is considered as the fourth node [35]. The working illustration principle on how the trilateration technique actually works is give in the form of diagram as follows:

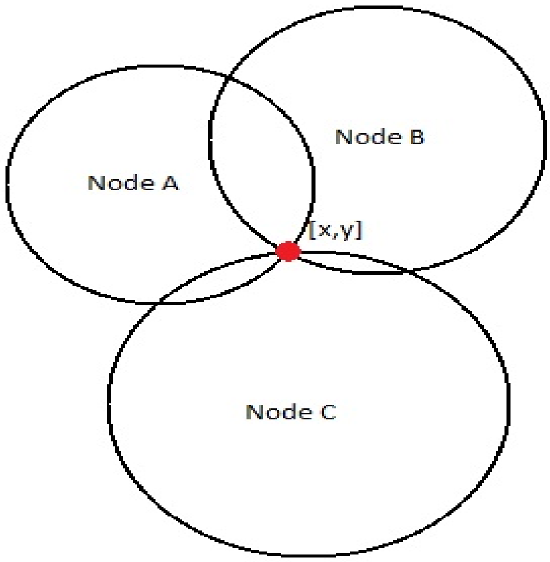

Figure 2.3: Triliteration Representation

It is to be kept in the problem that the trilateration does not check for the Angle of Arrival [36] in the whole process [37]. The trilateration has many applications; one of the most used service is the Global Positioning Service (GPS).

The existing architecture for the flowchart is given as below that how the current scheme calculates the position of the target. The following state 'Start' depicts that the sensors are in the state of sleep since unidentified node has not entered the proximity area. The state of theses sensors are zero.

As soon as the target enters the proximity area the sensors in the sensor nodes changes their initialization from zero to one, which means that they are now in the state of awake. The nodes than calculate the distance which is based on the target. The calculation on the distance will be based on the signal's receiving power. Once the distance is calculated from the node to the target, the information is than send to the respective cluster head, which will do the further processing. The cluster head after receiving all the information from the cluster head will predict the target's location based on the information provided by the node. Now once all the information is received and calculated, by using the distance formula the cluster head will now generate the respective coordinates of the target. The coordinates will then be displayed and the process will be repeated until the target is area of proximity. Otherwise if the target leaves the area, the flow will end and the sensor will go back to the state of zero i.e. which is sleep. The complete working for the existing architecture is shown as below:

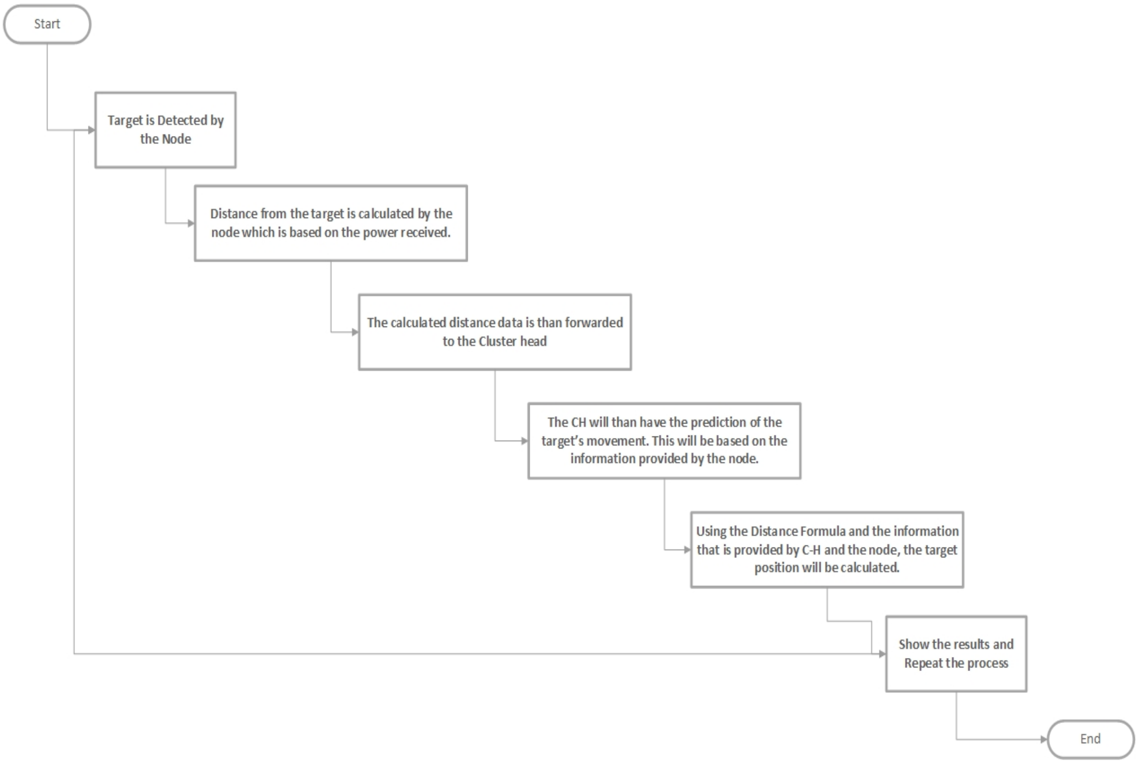

Figure 2.4: Existing Architecture

The trilateration technique though using widely but has major flaws when putting it to critical result oriented locations. Where the results even a meter can have major consequences if that are not give properly. Trilateration technique using the three circle using to calculate the position of the target. The main issues arises with the dissemination of the signal transmitting the data since the data conversion is a complex task and the we cannot depend solely on the inconsistent nature of the Received Signal Strength resulting in the decrease efficiency [37] and leading to tracking error.

2.1.1 Algorithm for the Random Walk Model

The following algorithm is based upon the Random walk model [38]. The author in [37] used the technique and derived the results for the localization technique. The Random Walk model Works on the basis that the generation of the node is entirely random and the entity has no knowledge of what is going to be next position of the sensor. The random walk is based on the Probability Distribution function(PDF). In PDF the point of appearance of the node is kept completely random. This appearance of the node makes one fact certain, that the target no matter how predictable be it be will not go above the PDF.

Algorithm 1 Random Walk Algorithm

Input: Numerical Data on the Sensor Network and Base Station.

Output: Target Coordinates After The Random Walk Model.

Initialization

- Current Point of Sensor Network.
  SenNet_{pi} =(X_S i,Y_S i)
- Current Point of Base Station.
  BaseStat_pi =(X_B i,Y_B i)

The Status of the Sensor Network is as follows 0 and 1, 0 implies for the Sensor are at the state of sleep and 1 for the Awake State.

$$\text{Status\_SenNet} = [0, 1]$$

while (Surveillance occurs for the Target) **do**
  if $(T_{int} == Stop)$ **then**
    $T_{position} = (TX_{position}, TY_{position})$
    for every $\text{SenNet}_i = 0$ to N **do**
      if $\text{Target}_{Position}$ near to the Sensor Network **then**
        Status_SenNet = 1;
      else
        Status_SenNet = 0;
      end if
      for every SenNet_i_Status $== 1$ **do**
        Sensor Network makes a formation of the cluster and based on the information the Cluster Head is selected.
        $\text{SenNet}_{Cluster} \longrightarrow$ ClusterHead
        After the information is send to the cluster head, it is responsibility of Cluster Head to calculate the position of the target.
        Every $\text{SenNet}_{cluster}$ calculates Dxi,yi
        $Target_{Position} \longrightarrow \text{BaseStat}_i$.
        SenNet_i_status = 0;
      end for
    end for
  end if
  $\text{Time}_{initialization}$ = Start;
end while
return $\text{Target}_{Position}$ = ($TX_{Position}$, $TY_{Position}$) = 0 =0

2.1.2 Existing Architecture B

Received Signal Strength index has always played an important role in the localization area as the signal transmission has always an important role in the development of the target tracking. While having another view of the architecture in [39] that uses RSSI to make a hybrid approach to make a better detection of the target. They uses the RSSI and the Angle of Arrival (AoA). By calculating the angle at which it is arrived and the strength it is arrived helps in the calculation. they further then have the integration of the Ghausian designed Radiation that is used as the pattern. They took the localization problem as a non convex problem and they coupled all the uncertain parameter as a single entity dealing with all the problems at the same time. They used the optimization technique such as the second cone relaxation. The proposed benchmark they selected was the Cramer-Rao lower Bounds (CRLB). This helped in the further calculation of the unknown node. The requirement for the sensors were to be that each sensor in the proximity area has to synchronization in time and each of them will have to be equipped with the extra hardware, which include the antenna arrays to intercept the angle at which the rogue entity arrives. The result per meter was lowest which is 3.58m, as compared to the existing schemes and the operating time for the RSSI was 1.26s and the AOA was 0.58s.
Though the scheme was similar approach, as it used the RSSI approach and had the integration of RSSI with AOA. While the approach seemed effective but there are too many limitations in the overall aspect of the scope. Firstly, when we are dealing with all the problems like overhead and throughput and other things as a single problem that leads to many issues arising what if the computational issues becomes the bottleneck and and limits the performance and it decreases the localization accuracy and secondary since the hardware is being as additional so that leads to extra performance and additional overhead leading to major performance degradation. Keeping in mind all the problems the proposed architecture is not using any additional requirement as it hardware while the algorithm since it's not increasing the additional requirement or the computational over head because the RSSI calculates the distance from the node and afterwards the calculation of the distance then Multiliteration calculate the position of the node

2.2 Comparison Table

The comparison table for the techniques that are used in the literature review and the pros and cons for the solution for their technique are as follows;

Paper	Problem Statement	Objective	Technique	Result	Limitation
[20]	Target tracking in terms of indoor based on RSSI causes accuracy errors.	To reduce the fluctuations in the radio environmental setup causing the target position estimates to be faulty	Mixed maximum likelihood (ML)-Bayesian framework. Random Linear Network Coding Framework (RLNCF)	Error Deficiency is reduced to [0.5-1]m while keeping the variance at 1db	The RMSC can't keep the variance constant at a weakly connected network making tracking the result less dependable.
[21]	The coverage area of the target tracking is concern in terms of uneven or large demographic area.	Improving the target prediction accuracy using the Directional sensor network	Improving the target prediction accuracy using the Directional sensor network	Results in a 100*100 was [3627.3–3789.3] m	Acceptable rate of sensor dimension of area needs to be calculated every time a target appears.
[22]	Unnecessary leak or object movement without timely response can have serious implication	To predict the boundary movement of the target object, if it makes any movement.	Back-off Timer Based Framework DEMOCO algorithm. PM-COT algorithm	Object detection in terms of number of cycle/no. of representative node of target detection was 27.5% in a dense setup.	Detection of tracking object in terms of diffusion was depending upon the boundary node being available at all time.

Paper	Problem Statement	Objective	Technique	Result	Limitation
[23]	The target tracking issues that arises in terms of data uncertainty leading to accuracy errors	To achieve that the sensor uncertainties are well calculated reducing the abnormality in the network.	Maximum a posteriori (MAP) approach framework	alpha=0.29m Where N=658	The difference in the value is always considered that it will be in the expected range.
[24]	Single positioning scheme makes the target detection in the indoor less accurate.	To develop a scheme such that it solves the complexity in target detection in the indoor	Cooperative localization and tracking algorithm.	Positioning error [0.5-0.6]m at an avg try of 30 simulation per round.	Number of sensors to be deployed must change according to the grid scheme.
[25]	The target should be detected by some certain number of nodes in order to have precise results.	To calculate the direction of the target node by using various points like (FoI)	K-Tracking Algorithm R-D Pattern Framework	Random walk for 5m at target speed of 3m/s is 0.48 while square pattern has 0.44.	This method is efficient as long as there is a grid like distribution and all the values are needed to find the result

Paper	Problem Statement	Objective	Technique	Result	Limitation
[26]	The densely applied nodes in the area affects the result of tracking making the results in accurate.	To improve the tracking precision results of the target	Non-dominated Sorting Genetic Algorithm II (NSGA-II) Generalized Extended Kalman Filter (GEKF) (NGEKF)	Tracking results per meter error reduced to 0.9% while keeping no of sensor avg. to 3.8105	All online adaptive algorithms used in this technique will be successful, when online algorithms are imposed.
[27]	SUneven uniform distribution of sensor causes the variance in the accuracy results	To check the state of the sensor and improve the target sensing.	Belief propagation scheme SLAT algorithm Ray tracing simulation	The target tracking was in between [2.5-3.2]m	The cell defined will only have a mine-like environment with pre-recoded uncertainty.
[28]	The localization error causes the target accuracy to decline.	Increase the accuracy of the localization of the target.	Multiliteration Triliteration	0.2 Every 10-sensor delay.	The node increment causes the whole error to be incremented proportionally

Paper	Problem Statement	Objective	Technique	Result	Limitation
[29]	Rogue node detection becomes difficult when object is moving at high speed.	To achieve location precision accuracy.	adaptive signal strength based localization approach (ASSLA)	End to end delay (0.2-0.05) ms.90% node detection is achieved by ASSLA as compared to traditional algorithms	The CRC check to each packet in the localization increases the overhead and degradation.
[30]	Localization accuracy issues due to constraints.	To present an algorithm that takes all the constraints in factor to increase the localization result.	KickLoc Algorithm Cramér-Rao lower bound (CRLB)	Path loss after implementing the proposed algorithm is 2.36 and the distance avg. is 0.27d	Continuous detection of the large object in the proximity will cause the algorithm to increase the distance value.
[31]	When uneven distribution of WSN occurs, they often put blind spots and causes the result of the accuracy to decline.	To localized and identify the NLOS and increase the tracking accuracy covering the blind spots	Maximum Likely hood Framework.	Localization error using proposed scheme is 0.2780m as compared to 1.2677	Avg. / result of the localization error is less than 0.35m

Paper	Problem Statement	Objective	Technique	Result	Limitation
[32]	Imprecise tracking values causes critical damage to the localization results	Increase the position accuracy of the localization.	Improved Bayesian Algorithm Enhanced Least-Squares Prediction position.	Positioning accuracy results, 35%, 32%, 18%, 9%, 0.4%	The Bayesian algorithm has the RMSC probability, which causes the continuous results to deviate.
[33]	Tracking reliability decrease in the results due to the falsification of the data.	Increase the tracking accuracy and reliability	Trust establishment model. (TEM). USM algorithm. SRPTT. Triliteration	Tracking reliability even in terms of compromised nodes showed [1.5-2.1]ms with an average of 1.7	The trilateration solely relies that the node be from a single entity and does not have multiple rogue node..

CHAPTER 3

ARCHITECTURE

This chapter explains in details the proposed architecture in detail along with the proposed workflow.

3.1 Proposed Architecture

The recent advancement in the technologies of Bluetooth, Wireless Fidelity and countless other wireless devices, The wireless technology like the RSSI has gained enough attention. This lead to several researches being conducted. This happened because this technology has low computational complexity, the cost is low, but the results have high rate of accuracy. The RSSI alone cannot tackle all the problems. The reason is that the RSSI with the obstruction of objects and environment make the results deviate. Even though the signals in the RSSI strength of signal remains constant, but the variance may increase and decrease, resulting in deviation from the actual results. This made several researches in order to tackle the problem at hand, many technologies were integrated with the RSSI to get better accurate results. Even though RSSI was compatible with different technologies but it did not yield good results as expected.

The main reason is that the RSSI depends on the environment and in order to get good results, we need find a mechanism that can constitute the Raw RSSI, before the data can be used in the target tracking process. Filtering can be done with either the soothing process using technologies like the Ghaussian Filtering or other technologies. The other way is using the RSSI classification. IT is divided in two categories; Literation base positioning and the other is Fingerprint based positioning. Triliteration and Multiliteration, is applied to positioning services. These technology individually achieve accuracy from near 3-5m, but in terms of comparison multiliteration produces more accurate results. Multiliteration otherwise known as hyperbolic positioning [40] . This technique calculates the difference of time for the arrival by using four or more

nodes in the process. This technique produces much more reliable results as compared to the existing architecture. Since we are focusing on the accuracy we will propose the approach using the multiliteration(MLAT) and RSSI. The MLAT approach is a simple,minimalist and dependent for accurate results. The RSSI will be based upon the two fundamentals steps; one is the mapping of the distance from the target while the other calculation of the position of the target. The first step is done by calculating the distance from the known nodes to the unknown node in the area under observation. This is done by the help of the RSSI. The results accuracy are dependent upon the Signal Transmission. Second steps include that once the results are obtained by the nodes and then forwarded to the Base Station by the cluster head. MLAT then imposes the Root Mean Square Method to calculate the location of the Target.
This research keeping in mind all the issues in the current research and the issues in the current technique. We proposed a hybrid technique using Multiliteration and Received Signal Strength Index (RSSI). Multiliteration is a one of the localization schemes in which works on the principle of measurement. This measurement is done based on the computing the time difference for the emitted signal. MLAT alone was not enough to help solve the problem, so we had to incorporate the RSSI factor. One of the basic advantage is that since there is no additional hardware will be included because most of the wireless sensor have already embedded in this and this does not have any effect on the computational processing. The RSSI's result is inversely proportional with the distance from the transmitter and receiver. Because of this reason, we use multiliteration and incorporate the RSSI resulting in a better technique. We have taken in account the overall accuracy of the scheme. The energy consumption is the trade-off. Since the accuracy and decreasing the error, enhances the application usage for the user. The results reflects that the outcomes in terms of accuracy are much better as compared to the triliteration technique.

MLAT alone was not enough to help solve the problem, so we had to incorporate the RSSI factor. One of the basic advantage is that since there is no additional hardware will be included because most of the wireless sensor have already embedded in this and this does not have any effect on the computational processing. The RSSI's result is inversely proportional with the distance from the transmitter and receiver. Because of this reason, we use multiliteration and incorporate the RSSI resulting in a better technique. Below is working of the proposed methodology in terms of flow chart.

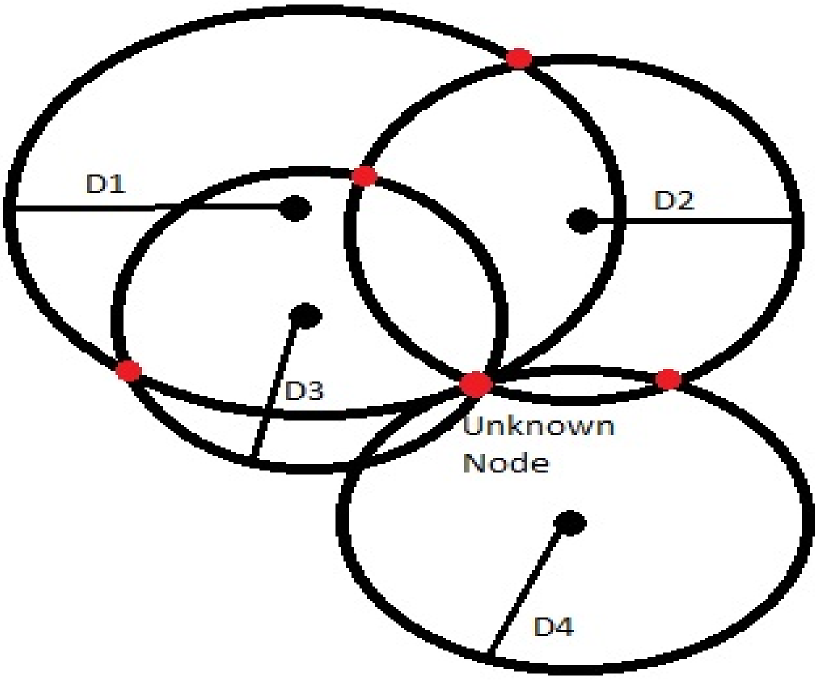

Figure 3.1: Multiliteration Representation

3.1.1 Proposed Algorithm

In this working of the algorithm 2, the nodes that had the value set as 0 have changed their state to 1 i.e. the state of awake or active state. They will be in the awake state, until the target is in the deployed area or you could say the area under observation.
The second is that since the target is in the area, now the cluster will be formed, based on where it is, the node closest to the base station will be selected as the cluster head. Every node in the formed cluster will analyze the situation and then calculate two things one is the location and the other is distance of the target. In addition, the result will then be forwarded to the base station.

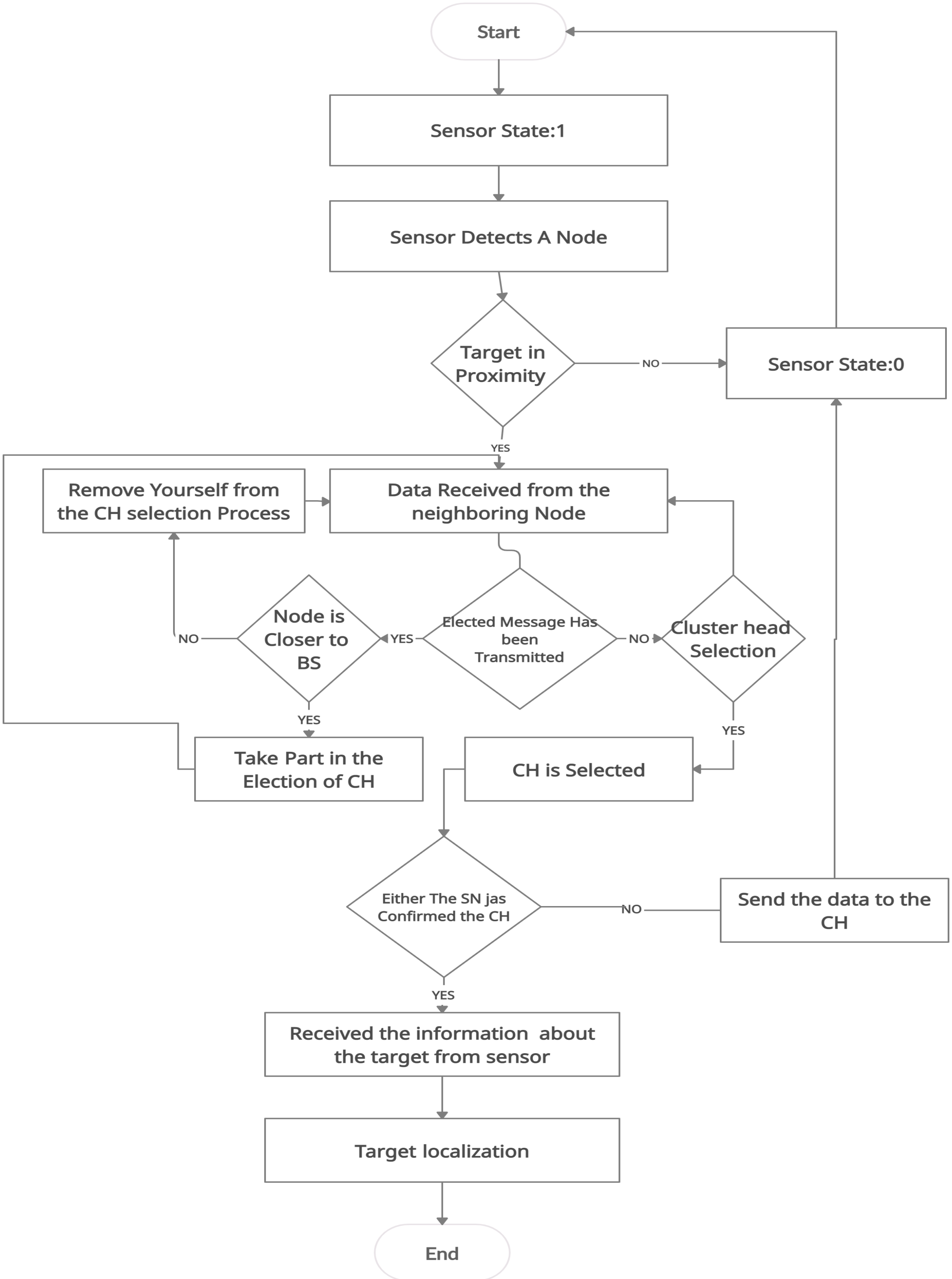

Figure 3.2: Proposed Flow Chart

Algorithm 2 Complete Path Tracking Algorithm

Input: Numerical Data on the Sensor Network and Base Station.

Output: Target Coordinates After The Random Walk Model.

Initialization

- Current Point of Sensor Network.
  SenNet_{pi} =(X_S i,Y_S i)
- Current Point of Base Station.
  BaseStat_pi =(X_B i,Y_B i)

The Status of the Sensor Network is as follows 0 and 1, 0 implies for the Sensor are at the state of sleep and 1 for the Awake State.

$$\text{Status\_SenNet} = [0, 1]$$

while (Surveillance occurs for the Target) **do**
  $T_{position}$ = ($TX_{position}$, $TY_{position}$)
  for every SenNet_i = 0 to N **do**
    Status_SenNet = 1;
    if ($\text{Target}_{position}$ Near to SenNet **then**
      There is a Creation of the cluster head; it's selection is from the sensor network.
      Every $\text{SenNet}_{cluster}$ calculates the Distance D(x_i, y_i)
      Every $\text{SenNet}_{cluster}$ calculates the Distance $D_{Trajectory}$
      $\text{SenNet}_{cluster} \longrightarrow$ ClusterHead.
      After the information is send to the cluster head, it is responsibility of Cluster Head to calculate the position of the target.
      $\text{Target}_{position} \longrightarrow \text{BaseStat}_i$
    end if
  end for
end while

$$\text{SenNet}_i\text{\_Status} = 0$$

return

$$\text{Target}_{Position} = (TX_{Position}, TY_{Position})$$

=0

CHAPTER 4

EXPERIMENTS AND RESULTS

The sensors that are deployed in the target tracking have a very limited computational capability. This makes the job of target tracking a very challenging work. From the Literature review, it is observed that most applied technique mentioned in the review has accuracy errors or some limitations to the scheme proposed. Since target, tracking has crucial importance. A scheme was needed that improves the target tracking more accurately and more efficient, because of this reason, a new scheme is designed, this scheme decreases the error, in turn improving the accuracy.

For the purpose of the evaluation, different scenario has been presented.

- Random Walk Model
- Complete Path model.

The results that are derived show that the proposed scheme results were way better as compared to the current schemes. There is a definite increase in the accuracy.

4.1 System Framework

At the initial level since we are strictly following the accuracy so following are the assumptions that we made in order to carry out the objectives. They are as follows:

1. The sensor in the sensor network knows the location of itself.
2. Along with location of self, the sensor also knows the neighbor's location.
3. The sensor networks have the Omni Directional antenna equipped in them.

Starting from the assumption 1, there we take an assumption that the sensor network is statically positioned and the link has no failure, and will not occur during the period of computation. The data that is compiled by the sensor nodes is sent to the cluster head. The cluster head after receiving all the information from the sensors then transmit all the relevant information to the base station.

Initially, we begin with the area under observation; we select 100x100m, under which all the all the sensors are deployed, the main thing is that the sensors are uniformly deployed. The base station or in other words known as sink are deployed at five different but uniform position. This position is shown below:

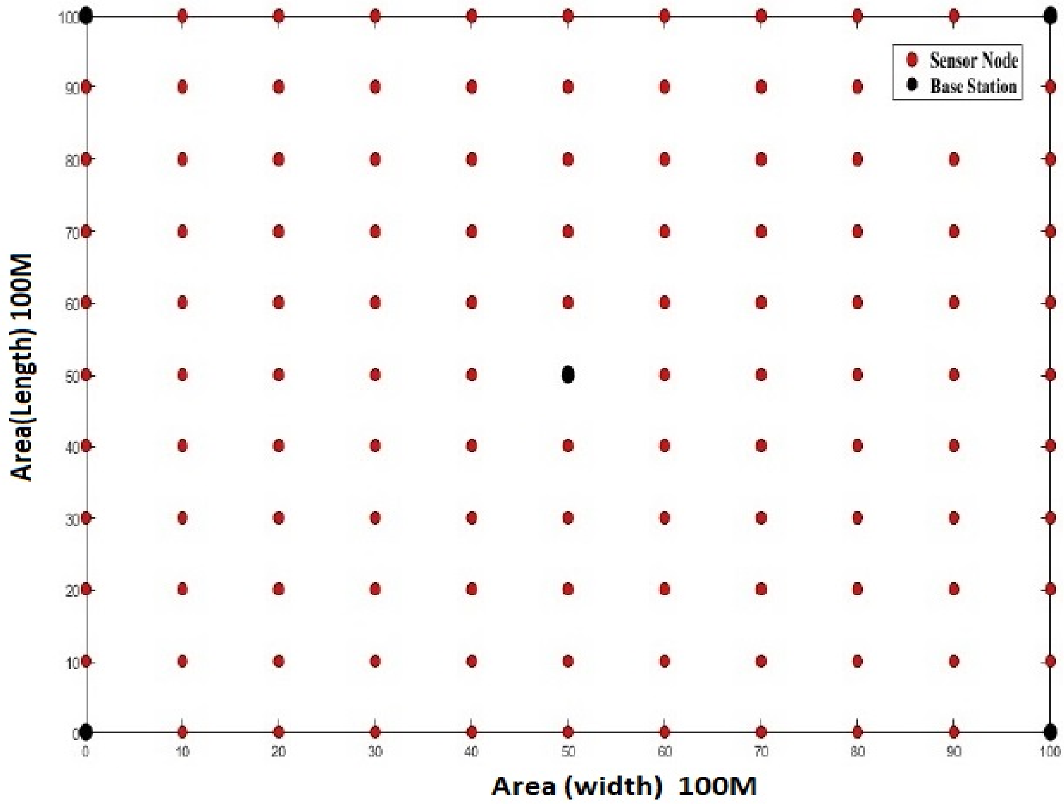

Figure 4.1: Area under Observation

In order to get the evaluation of the proposed algorithm, several simulations have been performed. The simulations have done in the MATLAB R2018b; the simulation took place under the following parameters:

Table 4.1: Parameters for the Experiment

Parameter	**Values**
Sensor Node	121
base Station	5
Channel	Wireless
Protocol MAC	IEEE 802.11.4
The Routing Protocol	Ad-hoc On-demand Distance Vector (AODV)
Antenna	Omni

4.2 Scenario 1: Target Tracking With Random Path Model.

The following section of the thesis, we now make assumptions that the target or the rogue node has entered the area that is under the surveillance. The location of the target by using random walk model [41] is calculated and the information that is gathered and then transmitted to the base station. By using the normal distribution, we generated the target's track. The function of normal distribution is denoted as follows:

$$X\tilde{}N(\mu,\sigma^2) \tag{4.1}$$

In the above 4.1. The variable in the above equatiion "X" is the random/irregular variable that is dispersed with having the mean μ along with second variable which is; the σ^2 used in order to calculate the exact points on the Axis Plan i.e Plane-X and Plane-Y.

Now Probability distribution also abbreviated as the PDF is of the normal distribution. The mathematical equation of the normal distribution [42] is as follows:

$$\varphi(X) = \frac{1}{\sqrt{2}} e^{-\frac{1}{2}x^2} \tag{4.2}$$

$$f(x|\mu,\sigma^2) = \frac{1}{\sigma}\varphi\left(\frac{x-\mu}{\sigma}\right) \tag{4.3}$$

The above condition defines that the sensor network when detects the rogue node or the unauthorized enters the vicinity. The sensors those who are in the range of the target will activate. While in order to decrease the communication overhead the rest of the sensor in the network will remain asleep.

After incorporating the RSSI, which is already observed in [43] target's location. Both of the existing and the proposed scheme are evaluated, as the avg. per meter, which is represented as D. Using the equation that is as follow:

$$D_i = \sqrt{(x_i - x_t)^2 + (y_i - y_t)^2} \tag{4.4}$$

4.3 Results.

The formation of the cluster head is from the already present sensor network, but the basis for the formation of the cluster head is that it is near to the base station. As shown in the following Figure 6.2. The sensor under the cluster will calculate the location of the target. After the position is calculated by the node and then the deliver the position information on to cluster head. As soon as data is gathered over to cluster head, the cluster head will amalgamate the information, once the position of the target is calculated it is then send to the organized information to the base station.

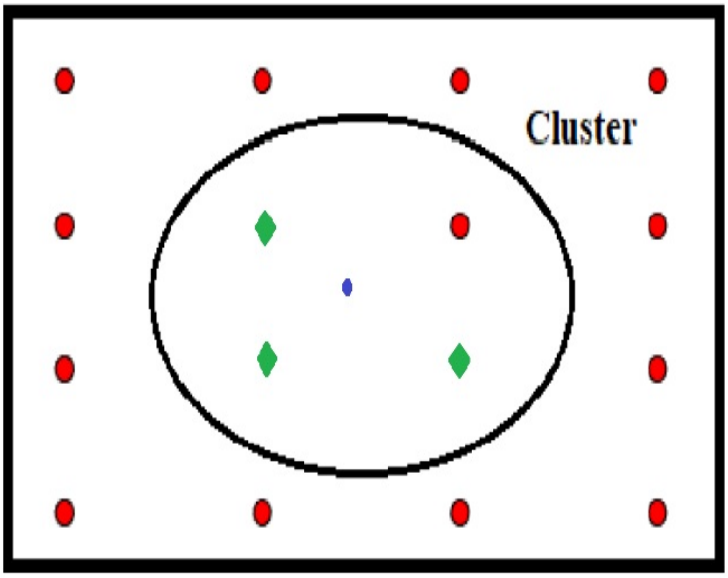

Figure 4.2: Cluster Formation

The following figure illustrates that the location of the target and at the regular conditions. The green point on the sensor area shows the target's location after regular interval of times.

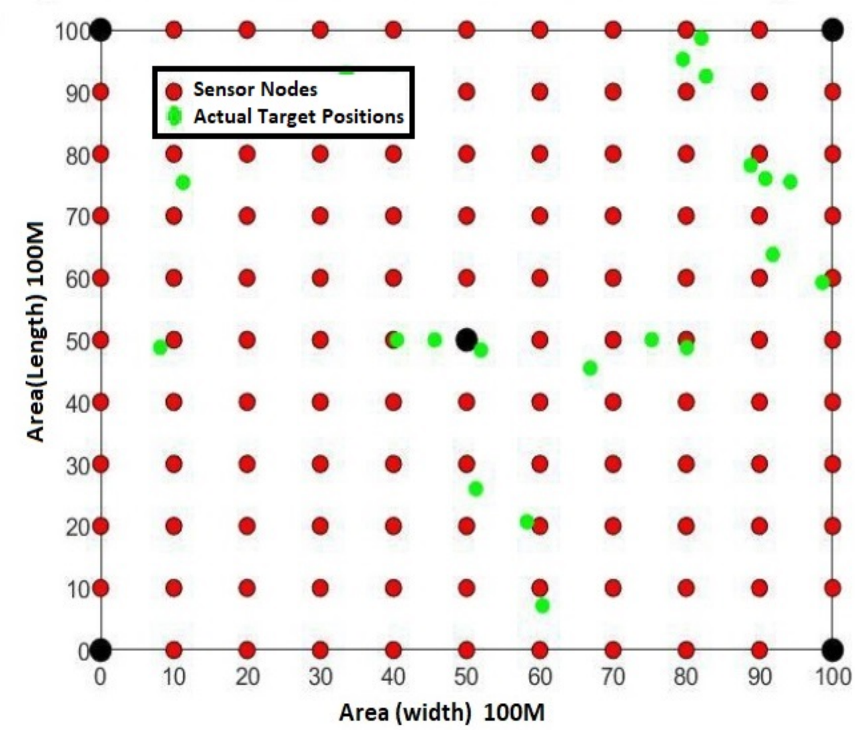

Figure 4.3: Target's Location at Regular Intervals.

During the simulations, under the normal conditions, we applied the same condition for 21 Times. This was done for the both of the technique i.e. the base [37] as well proposed technique.

The Figure 4.4 has the results derived by the base technique i.e. the trilateration technique

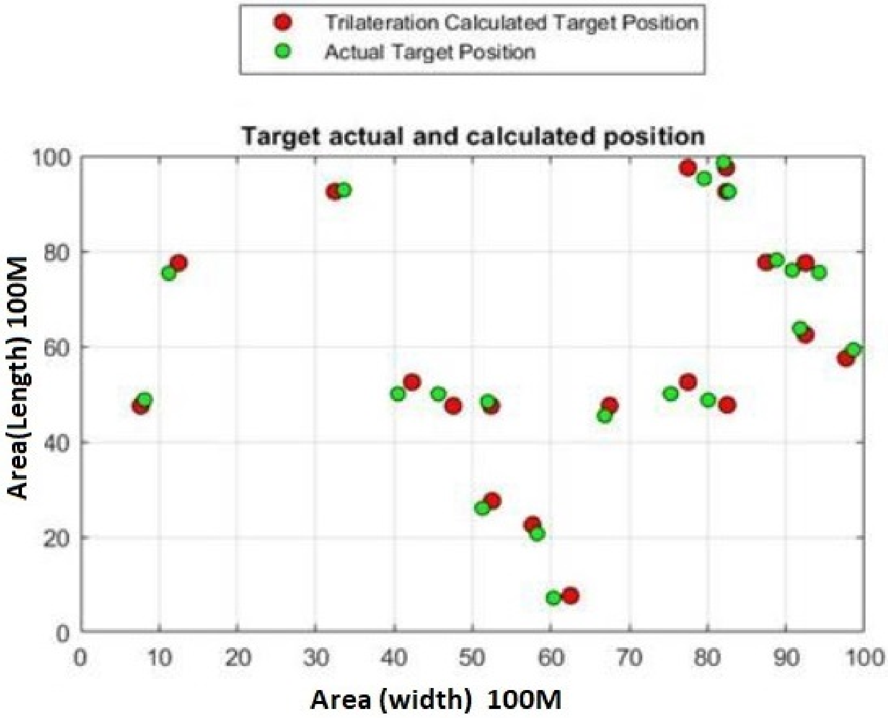

Figure 4.4: Existing Architecture (Triliteration) Result for Random Walk

The Figure 4.4 has the results derived by the base technique i.e. the trilateration technique.

After both the schemes have been performed and are under the same condition we now use the following equation while will help us in the error calculation.

$$E = \sqrt{(X^t_{pre} - X^1_{real})^2 + Y^t_{pre} - Y^1_{real})^2} \quad (4.5)$$

After implementation of the above technique, we can clearly see in the following image that the proposed technique performed well as compared to the base technique.

Comparison of the base technique and Proposed Technique is given below in the form of visual representation.

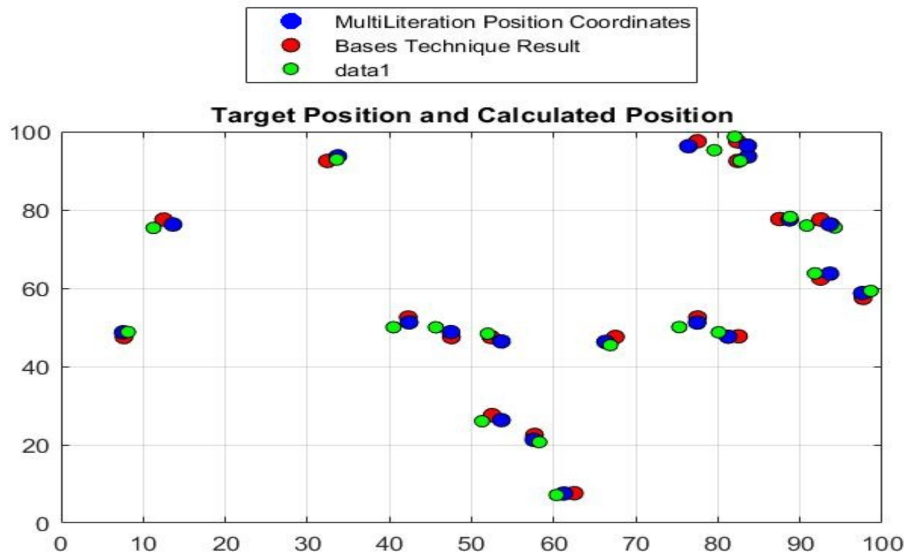

Figure 4.5: Graph Result for the Proposed Architecture(Multiliteration) VS Existing Architecture(Trilateration)

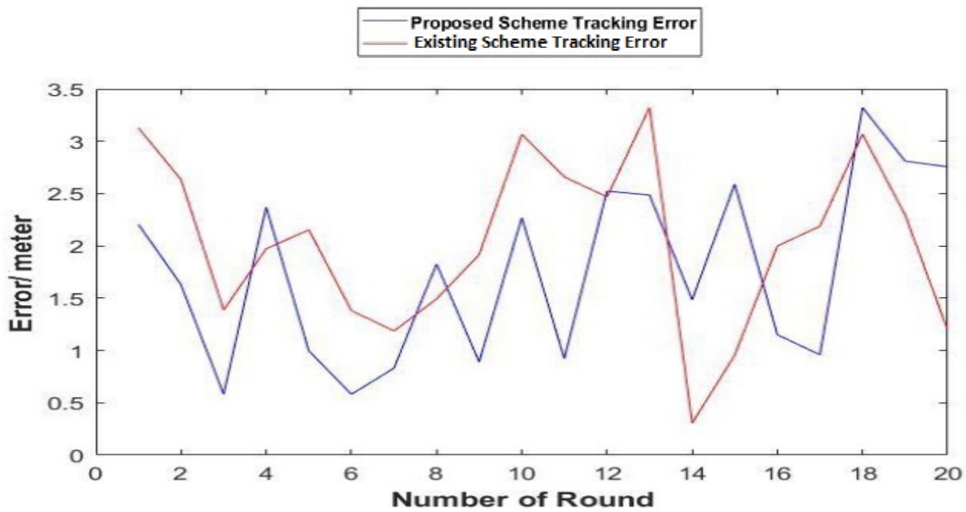

Figure 4.6: Graph Result for the Proposed Architecture(Multiliteration) VS Existing Architecture(Trilateration)

Table 4.2: Simulation Results

Technique	Lifetime(S)	Interval	RMSE
Base	100	4	2.0385
Proposed	100	4	1.7592

While in the next Figure is the Probability Graph for the Existing Technique in Comparison with Proposed Technique.

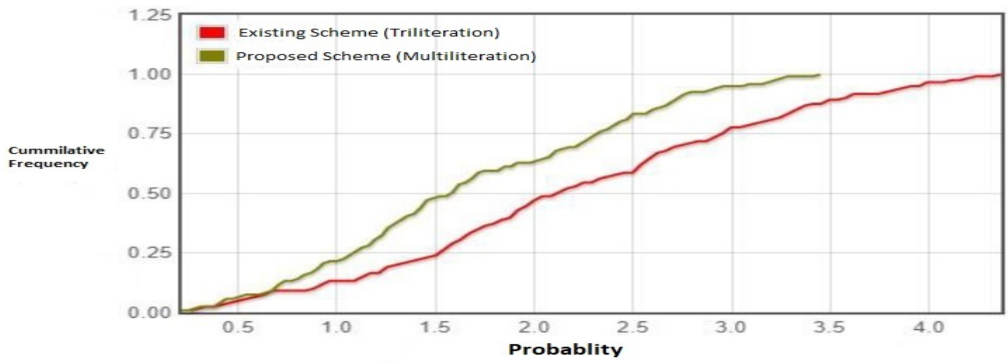

Figure 4.7: Probablity Graph for the ProposedArchitecture(Multiliteration) VS Existing Architecture(Trilateration)

4.4 Scenario 2: Complete path of the Target.

This section has a condition in which we are now assuming that the rogue node or the target has now entered the area under observation and is now being tracked, the situation has now emerged in which the sensors have a state of alert and the target from wherever will pass, the sensors will start and start gathering the information.

This scenario is again implemented with the same as before mentioned parameters Table 4.1. In this condition, the, the target's movement is found out using the Complete Path Model.

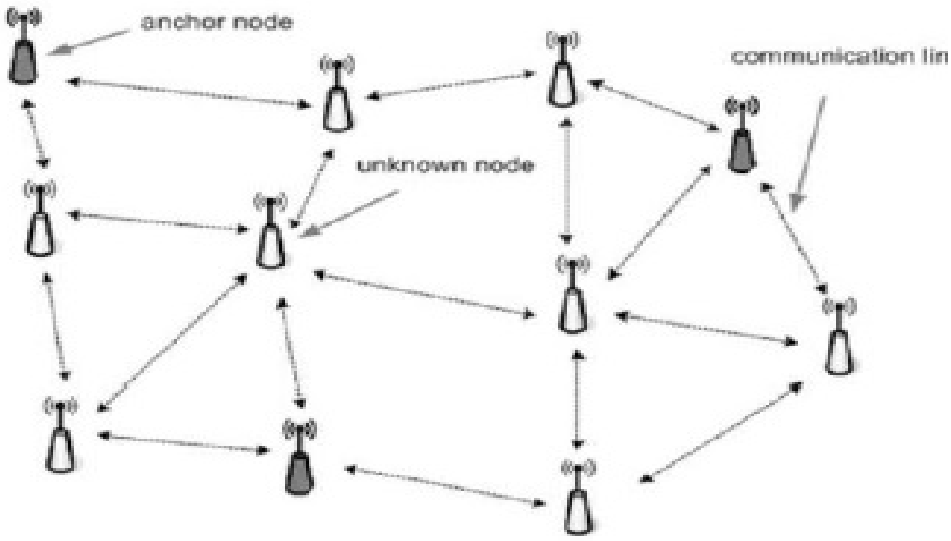

Figure 4.8: Target detection

The model is a classical and yet effective model that assumes that the every step that is taken goes further away from the previous step that is taken, while keeping the steps as independent steps and also as they are also kept as identically distributed.

4.4.1 Sub Scenario: Complete Path tracking using random path model.

Like previous scenario, we did this for the base [36] and the proposed scheme, the figure is shown below:

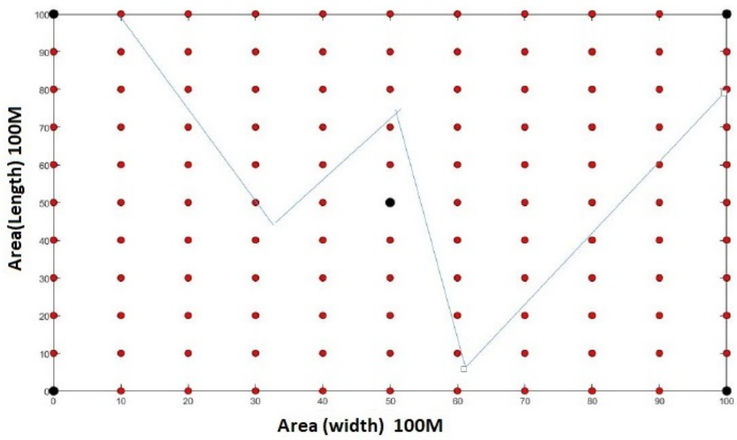

Figure 4.9: The target tracking in terms of Complete Path Model

The sensor networks localize the target's position and then forward those results to the respective cluster head. The cluster head afterwards then predict the location of the respective target and then send that analyzed information to the closest sink. In addition, since the packets are now travelling within the respective clusters it removes the communication overhead.

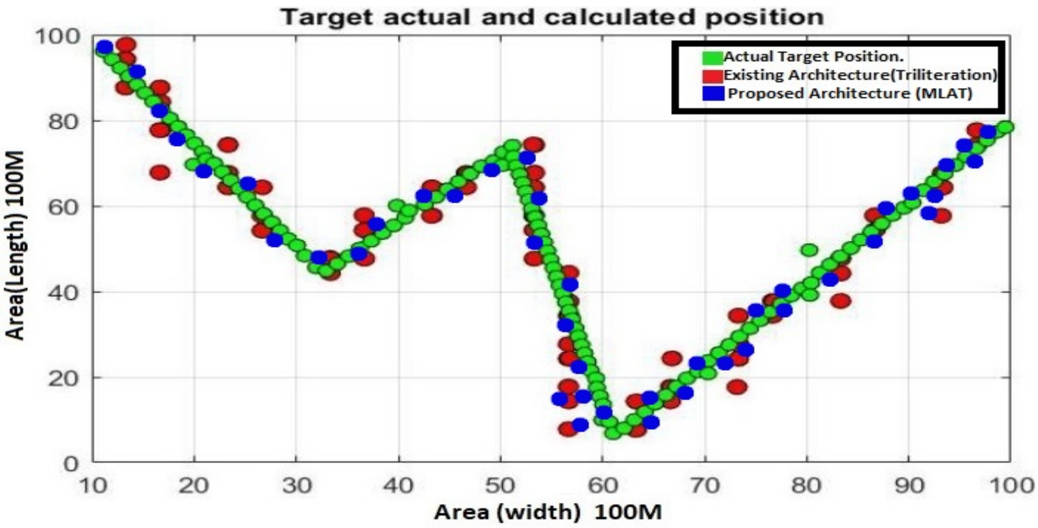

Figure 4.10: Existing Architecture (Triliteration) Vs Proposed Architecture (Hybrid MLAT) Target tracking Result for Complete Path Tracking

The simulations shows transparent results that the proposed methodology is much better as compared to the base technique results. The image is shown below:

While in the next Figure is the Probability Graph for the Existing Technique in Comparison with Proposed Technique

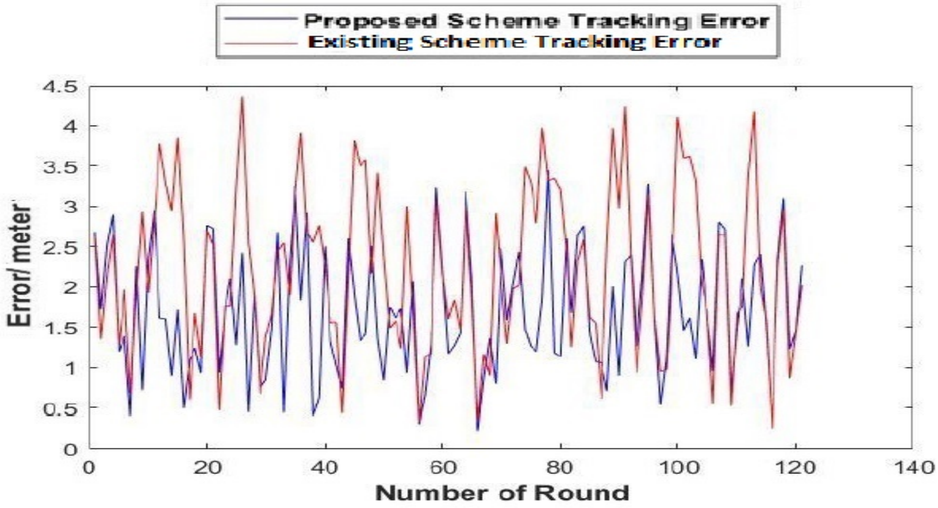

Figure 4.11: Graph Result for the Proposed Architecture(Multiliteration) VS Existing Architecture(Trilateration)

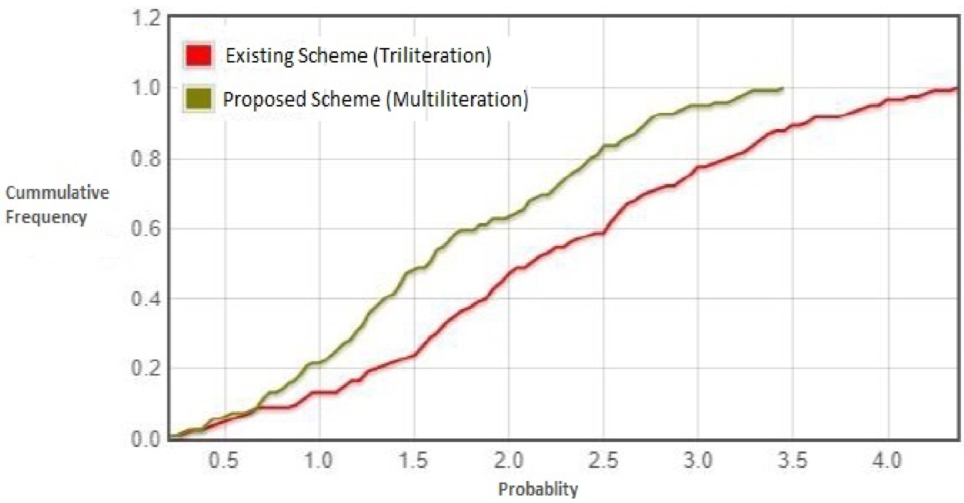

Figure 4.12: Probability Graph for the Proposed Architecture(Multiliteration) VS Existing Architecture(Trilateration)

The numerical form of the results are as follows:

Table 4.3: Probability for the Random Path model Results

Technique	Samples	Minimum	Maximum	RMSE
Base	121	0.257221	4.364021	2.212937
Proposed	121	0.213711	3.447480	1.682629

4.4.2 Sub Scenario: Complete Path tracking using Frequency Model.

We now use the frequency model to demonstrate that the proposed technique is better as compared to the base technique.

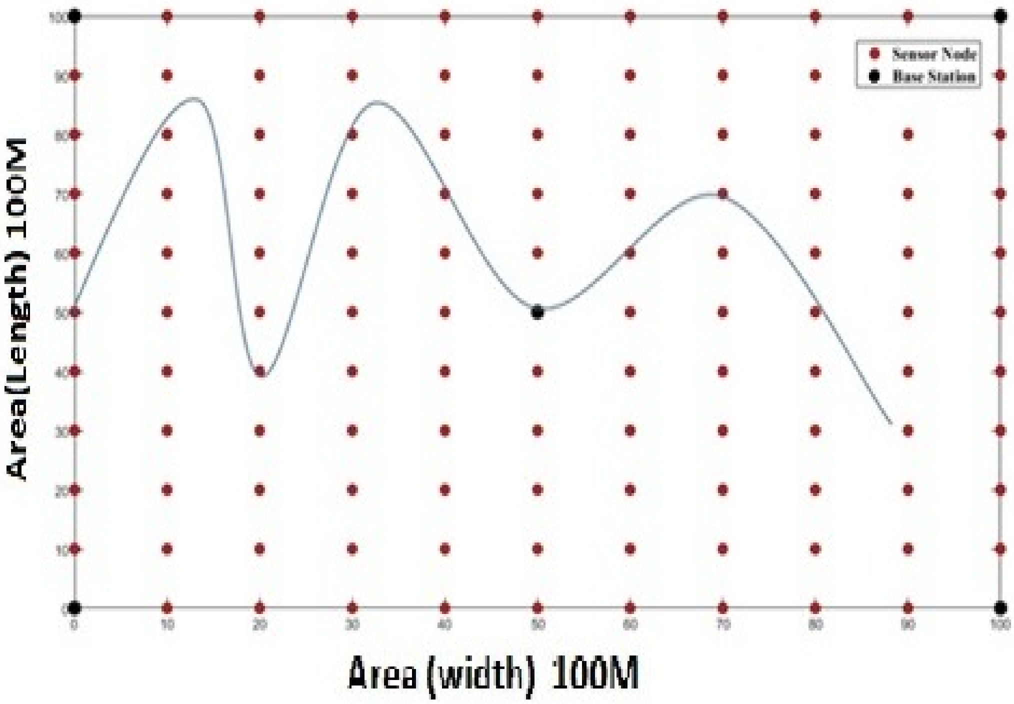

Figure 4.13: Complete Path in terms of Frequency Model

Now after performing the Frequency Model on the area under consideration and implementing the simulations on the model the trilateration and Hybrid MLAT results were as follows:

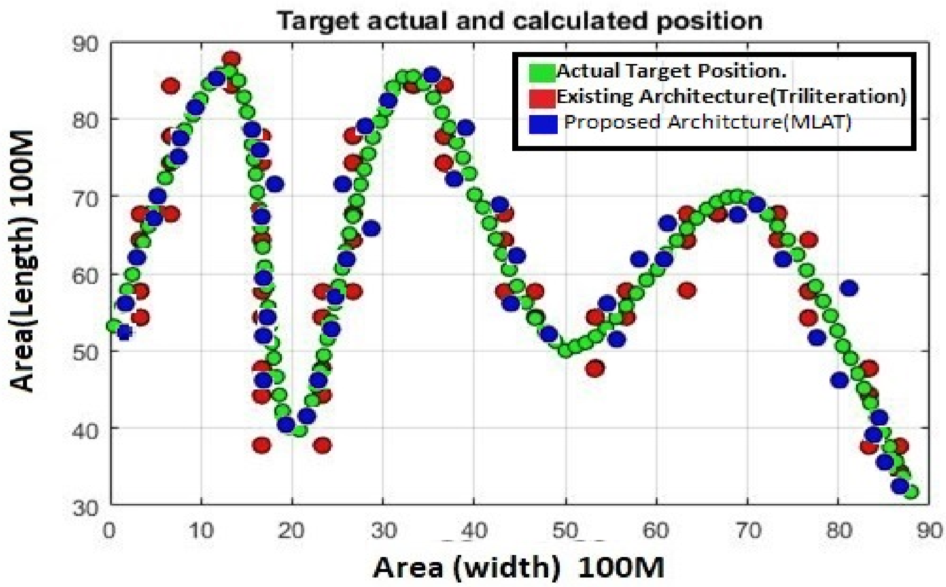

Figure 4.14: Existing Architecture (Triliteration) Vs Proposed Architecture (Hybrid MLAT) Target tracking Result for Frequency model

Comparing both results in terms of graph, we get,

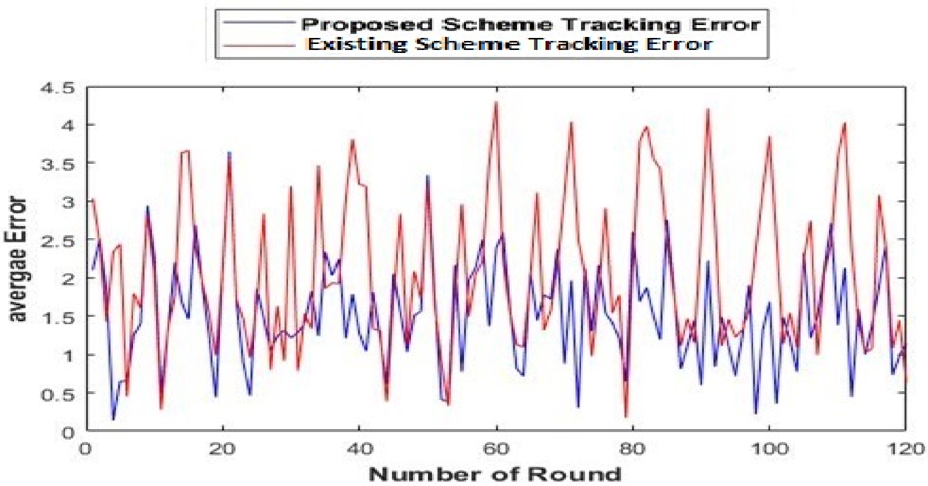

Figure 4.15: Graph Result for the Proposed Architecture(Multiliteration) VS Existing Architecture(Trilateration)

Figure 4.16: Probablity Graph for the Proposed Architecture(Multiliteration) VS Existing Architecture(Trilateration)

The numerical form of the results are as follows:

Table 4.4: Results for the Frequency Model

Technique	**Samples**	**Minimum**	**Maximum**	**RMSE**
Base	120	0.174155	4.302680	2.069952
Proposed	120	0.143515	3.642254	1.516586

4.4.3 Sub Scenario: Complete Path tracking using Spiral Model.

Now by using the spiral model we will now perform the simulations further verifying the results of the proposed mechanism as shown below:

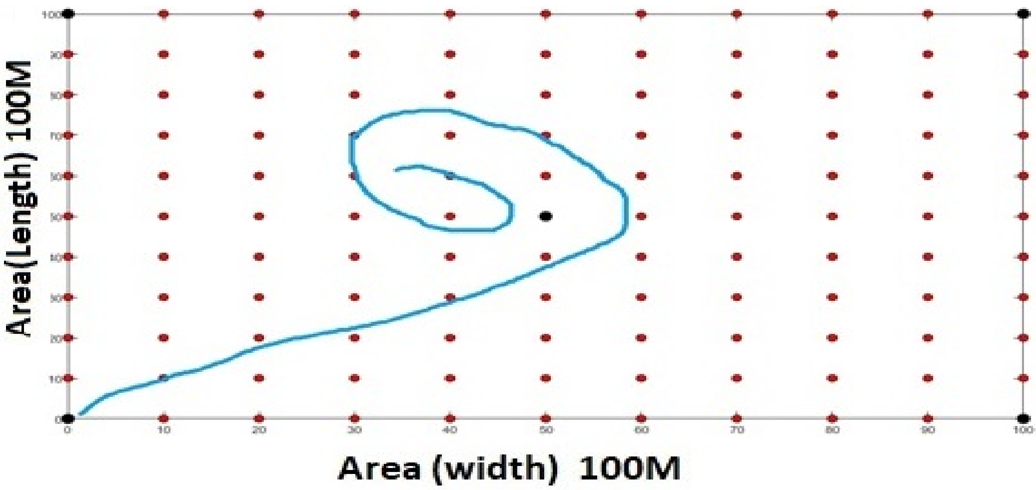

Figure 4.17: Complete Path in terms of Spiral Model

Now after performing the Spiral Model on the area under consideration and implementing the simulations on the model the triliteration results were as follows:

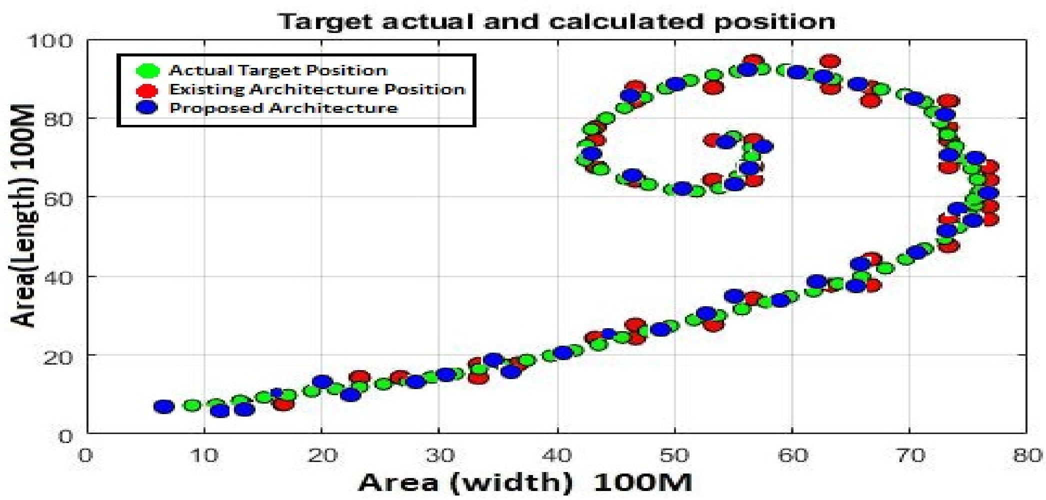

Figure 4.18: Existing Architecture (Triliteration) Vs Proposed Architecture (Hybrid MLAT) Target tracking Result for Spiral Model

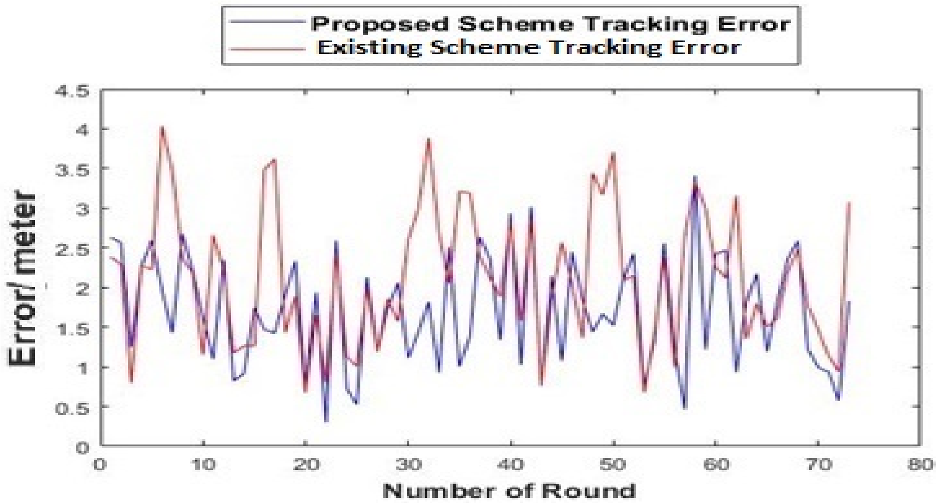

Figure 4.19: Graph Result for the Proposed Architecture(Multiliteration) VS Existing Architecture(Trilateration)

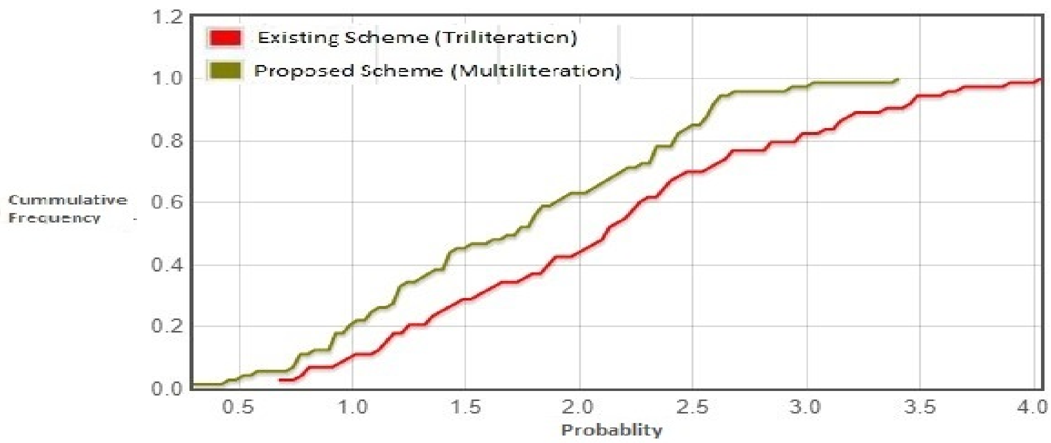

Figure 4.20: Probablity Graph for the Proposed Architecture(Multiliteration) VS Existing Architecture(Trilateration)

Table 4.5: Results for the Spiral Model

Technique	Samples	Minimum	Maximum	RMSE
Base	73	0.673907	4.030995	2.125513
Proposed	73	0.299064	3.406102	1.703091

CHAPTER 5

CONCLUSION AND FUTURE WORK.

In contrast to the proposed architecture the research emphasized on both, accuracy for the results because in terms of target tracking the accuracy and prediction matters a lot and the second thing is the signal transmission. The reason this research used RSSI as its hybrid approach was to overcome the signal transmission issue that arise and to depopulate the deployed sensor area while achieving high efficiency. The hybrid Multiliteration focused on first mapping of the node with using the transmission power of the nodes while having the location aware sensor they have the coordinates of the neighboring sensor. Afterwards the multiliteration technique solves the calculation of the rogue node in vicinity, when calculated the amalgam-ted information is sent to the base station for suitable action, each of the technique working side by side to increase the accuracy and reducing the error rate. The results showed that the proposed technique under rigorous testing performed much better as compared to the existing technique.

5.1 Limitations

Every research has different trade off to achieve different results and one cannot cover everything in the research. this Research focused on the accuracy by sacrificing the security of the wireless sensor network. Since limited computational capability of the sensor don't give us much room to work on the technique and as well as the energy parameter. so we assumed that the energy parameter is kept constant. Lastly we needed the multi object detection, because this research was focused on the single object detection while there could be multiple rogue identities that we need to detect.

5.1.1 Future Work

After the research has been successfully conducted, the important future work issues have been identified that are the future research problems and considered as the future work in the target tracking.

- Technique Optimization.

  This research has improved the results that are achieved in the process of target tracking. We can implement different hybrid technologies that can amalgamate the data and could prove much more efficient. Techniques like Kalman Filtering, The Ant-Farm and other techniques and we could embed the time of arrival signal, improving the results.

- Security.

  The security is still one of the crucial aspect in the wireless sensor networks. Since the Sensor, networks are vulnerable because of the low computational power. Without increasing the overhead, a security research is open to pursue in such a way, that it does not increase the overhead and as well, as keep the accuracy constant.

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