

CHAPTER 2. LITERATURE SURVEY

The predominance of wireless sensor networks in the areas of military applications, disaster management, IoT (Internet of Things), healthcare, smart buildings, bridges, machine supervision, agriculture, emergency services, traffic monitoring is strongly dependent on localization technique. This research focusses on finding the issues in post disaster conditions and to design a hardware node which is based on state of the art localization algorithm for the sustainable development of the region. The scenario of post disaster for the first 72 hours is critical, as the trapped person is not able to make the rescue decision and the rescue operation teams are not able to reach out to trapped people due to communication failure.

Literature survey is organized as:

1. On categorical basis:
 - ▶ Role of Wireless Network in regional sustainable development
 - ▶ Algorithm for localization of nodes in wireless network
 - ▶ Hardware development of nodes for wireless network.
2. Survey has been done on sensor network for regional sustainable development especially for first 72 hours.
3. Localization techniques already available for use in wireless sensor networks are Trilateration, Location fingerprinting algorithms, Hop count algorithms.
4. Range based and range free techniques are used for localization which includes ToA, TDoA, AoA and RSSI etc.

5. Many optimization algorithms like PSO, GA, artificial bee colony (ABC), GSA, ACO, HS, and ANN, Fuzzy etc. have been designed, but there is a need to optimize it further.

In [33] author reported that people should have a communication with rescue operation team immediately post disaster. And also in [34] it has been discussed that there is a need of designing flexible and dynamic type of wireless sensor networks. In [35] the author has stressed that there should be an emergency link to be established using the existing or newly designed wireless sensor networks. The author has also explained about the use of cellular or satellite network. Some of the authors have claimed the use of robotics application in managing disaster scenarios. In [36] UAV (Unmanned Aerial Vehicle) are used for disaster management. In this research author claimed that UAV will detect the human existence in post disaster scenarios. The communication in post disaster situations become a vital thing to be in existence so that minimum casualties will happen as reported in [37]. To improve the throughput of the network author proposes the framework in MAC and also account the energy aware routing protocol for the network. For recovery in a disaster, a network has been proposed by author in [38]. In this paper author describes the internet establishment in disaster prone area. The network is also capable of handling the failure issues and node's mobility across the disaster prone area. Author in [39] discussed the TDRAN (Tree based disaster recovery access network). TDRAN provides the connectivity during the post disaster. The network based on TDRAN is on two operational modes. In one mode it will handle its own network connection and in other mode it will be useful to handle the other network connection. There is another network based on COMVIVOR (Communication for survivor) discussed by author in [40]. In COMVIVOR a smart node positioning is reported for fast propagation of information. Author in [41] discussed about the hybrid network based on ad-hoc and cellular network. In this hybrid network the node is by default connected to cellular network and once the cellular network fails then it will automatically connect to ad-hoc network. In [42], less infrastructural network has been

discussed to achieve the reliable communication. All these systems discussed above are focused on the designing of the framework in such a manner so that a quick communication link will be established. Also the research finds a gap in self-dependency of networks as mostly the networks are hybrid in nature. Either they are dependent upon cellular or broad band communication.

Sustainable development is another important aspect to consider for designing of wireless sensor network. The faster rescue and evacuation process in the disaster prone area is very challenging. The trapped person is not able to provide their location to rescuing authorities which adds to the further delay in the evacuation process. The famous Brundtland report in [43] discussed about the sustainable development strongly emphasizes on the life enhancement of the people. The report mentioned that it is very important to have a technology that will enrich the life of the people specially when in need. The aim of our research is to highlight the importance of communication in saving the lives and also to design the reliable communication network in the disaster prone area that will withstand also. Such network will automatically increase the quality of human life in terms of survival in such adverse conditions of disaster. A lot of discussion is also given in [44] for shifting to the heterogeneous topology from the macro cell strategy of traditional cellular network. By doing so, the channel capacity also increases which leads to the better transmission speeds and more number of users. This study shows the way the communication is happening and how the network is accommodating large number of users. But after the link failure condition, there will be no communication no matter how much is the data rate it is giving and how many users it is able to accommodate. The point is not to challenge the traditional cellular network but to highlight the capabilities of the heterogeneous network designed for disaster prone area for managements. Several researches have been carried out which shows the correlation in between sustainable development and technology. Author in [45] shows the hybrid energy system role in sustainable development. The technology is related to sustainable development. Also the author in [46] discussed about the use of clean energy in the cellular

network operation resulting into maximum network throughput. In the research paper [47] author stated the detail analysis of communication architecture of distributed energy systems. Author in [48] proposes the distributed energy system as a good alternative for sustainable development. The role of cheap and sustainable development to grid extension is discussed in research in [49]. In this work PV- biodiesel is studied in context to the sustainable development. The research work carried out in [50] shows the PV module study on environmental parameters so as to have a sustainable development. One study has been carried out on the interesting topic of sustainable urban neighborhoods in context to learning networks in [51]. In[52] detailed analysis is done in Barcelona city as a smart city for sustainable development. Here the main emphasis is laid upon the exchange of information. In [53] a detailed study has been carried out for technologies used in sustainable development. Similarly for food quality assessment, IoT (Internet of Things) technology has been used in[54] for promoting sustainable development thereby improving the human life quality.

Hence, technology plays an important role for sustainable development by means of designing network in post disaster management. However for post disaster management, many researches have been carried so far. The research carried out in[33] discuss the important issues of post disaster management in context to sustainable development. It is stated that people residing in the locality should have the chance to communicate with the rescue operation teams for immediate requirements. They should also participate in decision making for evacuation process. This point to the research gap as there is no technology for communication right after the disaster especially for the first 72 hours. Author in[55] stated that it is important to have a post disaster planning for sustainable hazard removal rather than the recovery. Whereas in[34] it is reported to have an improved resilience post disaster. In [56] author studied in detail the applications of remote sensing in disaster management. Some of the researches like in[57] stated that there should be stress on the need of adaptation of new methods for disaster management, including redundancy of the rescue systems and increased

communication amongst managers. Author in[58] stated that there is a urgent need of developing a communication system for managing post disaster scenarios.

Wireless sensor network in managing disaster is one of the most capable and encouraging technology and many hardware devices designed till date which provides an early indication of the disaster that result into saving human lives [59-61]. WSN technology is very promising[62, 63] in the remote locations to get a pre-indication. Some modern studies stated in the same areas as discussed in [64]. WSN has also been expansively applied and observed in environmental monitoring[65], vehicular ad-hoc network[66], body area network[67] and localization of target. Ad-hoc sensor network is well known for designing of network which are used for localization as discussed in[68]. Localization is of two types range free and range-based[69, 70]. The range free localization is cost effective but in this paper range based localization is used as these are based on real time measurement. Localization through GPS or TOF, TOA (time of flight)[15], TDOA (Time Difference of Arrival)[28], AOA (Angle of Arrival)[21, 29] can be done but all these methods are expensive, as lot of hardware is required. RSSI (Received Signal Strength Indicator)[30] is a key component that can be achieved through little or less hardware. Author has used RSSI based localization. Paper discusses the trilateral algorithm for outliers suppression. Performance is discussed with classical trilateral algorithm and modified trilateration algorithm. MinCD algorithm is also discussed. Results of the paper shows that MinCD is more stable. RSSI is inversely proportional to the distance and greatly affected by physical obstruction, trees[71] etc. So nodes cannot rely fully on the RSSI value but the RSSI based localization is very promising in terms of cost involved as it does not require any extra hardware.

Reliability is another important aspect as system is for disaster prone area. It is very important to design a reliable wireless sensor network. Post disaster scenarios involves more risks of human lives as the communication link in between the trapped people and rescue operation teams fails and all the communication links till date is traditional infrastructure dependent. GPS (Global

Positioning System) is one of the mature and old communication technology used for localization but it works mostly inefficiently in hilly regions and it also involves costly hardware[72]. Some robots participates in the application of localization in disaster prone area like UAV (Unmanned Aerial Vehicle) but the application of robotics needs high power supply[73] making it unreliable for search operation over a larger geographical region. Power consumption by nodes in wide wireless sensor network is a major issue these days [74-76]. To some extent, some operating systems along with their supportive hardware have been designed to control the power related issues like TinyOS[77] and Contiki[78]. In the network, nodes are programmed to go to the sleep mode[79] to save the power unit but when the nodes are triggered via software then they become active again. To support the wireless sensor network, nodes like IRIS[80], MicaZ[81], IMote2 [82], SunSpot[83], WaspMote[84] and WiS-Mote[85] have been design and easily available. The wireless sensor network is focused on the capability of the nodes to communicate with other nodes with optimized algorithms and it also depends upon the power consumes by the nodes. If the nodes consume minimal power, the life of nodes automatically increases. The performance examination of nodes is very much appreciated for nearby future to design sustainable network to increase the quality of human lives and it will also boost the confidence of the rescue operation teams.

Apart from sustainability and reliability localization technique and optimization algorithm in designing wireless sensor networks are very important. A detailed survey has been done on localization and its optimized algorithms. Many studies have been conducted for localization of wireless sensor node. Author in [72] discussed about the ingrained challenges and main issues they have encountered by the localization algorithms which are assisted by mobile anchor nodes in wireless sensor nodes. In research paper[86] author discussed APIT (Approximate Point in Triangulation) technique. APIT technique performs best when the placement of nodes is random in the geographical region; radio pattern is irregular and also when low communication overhead is desired. Author also discussed that range

free schemes is accurate and sufficient for all wireless sensor network applications. But for the whole system the performance may degrade. Author in[87] discussed the RSSI (Received signal strength indicator) localization algorithm based on MAP (Maximum a posterior) along with channel parameter estimation. The MAP takes into account the knowledge of priori location of the target node in wireless sensor networks. The experimental results of MAP show that the location estimation is 30 % to 40% more accurate than the conventional method of location estimation. The author in[15] discussed about the localization techniques used in coal mines and used TOA (Time of Arrival) for localization which is already discussed. In this research MATLAB as a simulation tool has been used but for TOA extra hardware is required which makes the system a bit costly. Author in[29] used RTT (Round Trip Time) and AoA (Angle of Arrival) technique for localization which also required hardware. The author used this hybrid localization technique for only indoor applications. The advantage of using such technique is that it avoids time synchronizations. The author has considered reflection by floors and ceiling as the application is for indoor platform. The results have been studied for 2D and 3D environments. Also the hybrid technique does not need any prior knowledge so as to correct any errors which are caused by multipath propagation ray tracing. The research carried out in[70] discussed two step algorithm for position estimation of the node. The first step is to estimate the parameters of time of arrival like signal from target node and RSSI values. And the second step is to find the parameters by statistical or geometric approaches for analysis. Instead of multiple observations for a single signal, author focused on specific observation of the signal. Many other position estimations and their theoretical limitations are also discussed. One of the research carried out in[20] investigated the distance between two nodes by two approaches. One approach is based on classical method and i.e. LNSM (Log Normal Shadowing Model) and second approach is based on hybrid PSO-ANN (Particle Swarm Optimization-Artificial Neural Network). LNSM is a classical approach for distance estimation and PSO-ANN was used to enhance the accuracy of distance estimation. The

proposed hybrid PSO-ANN technique shows better results for average localization. The author uses RSSI values for localization technique. As per the author in[17] the RSSI values are very unstable as these are highly affected by the environmental parameters. Therefore author uses HECOPS (Heuristic Environmental Consideration over Positioning System) approach. HECOPS is very accurate as compared to other technique. The author claims 100% efficiency in distance estimation when the average of last n estimates are used instead of using RSSI values to measure the distance between the two nodes. Author in[88] discussed AFL(Anchor Free distributed localization) for real time applications. In[18] author used ZigBee based beacon known as Zig BEACON for indoor localization. The ZigBee based beacon uses Ambient Light Intelligent (AmL) environment. AmL computing refers to environments in electronics which is sensitive and responds to people presence. The results show that localization error reduces significantly for indoor application. Algorithm proposed in[89] based on Bayesian probability and determine the position of object. Results shows that the proposed algorithm gives an accuracy of 1.5 meters which is better than RSSI based systems. In[90] authors evaluated some RSSI based algorithms and shows the better results than RFID system based localization. RFID based systems are also used for localization purposes. Author in[21] discusses the measurement techniques in terms of localization. Author uses one-hop localization algorithm and also presented multi-hop distance & connectivity based algorithms. The paper also discusses the problems & issues related to distance estimation algorithms along with the solutions. The author has done exhaustive experiments for distance estimation. Author in[91] uses TDoA (Time Difference of Arrival) technique that is based on localization of source by using decentralized method. Author proposed decentralized method as in centralized method there is an issue of bandwidth and power required. The results show that the both the methods have similar performance but the decentralized method is less costly than centralized one. Author in[69] presented the localization algorithm classifications i.e. range based and range free based. However difficulty is to classify hybrid solutions into

the same range-based and range-free. This paper simplifies this difficulty by dividing the mentioned schemes into two types: Fully-range based, fully range-free and hybrid range-based and hybrid range-free. The comparative study in this paper is mainly on three parameters viz., Network Assumptions, Localization Process and Design Goals. Sensor nodes described in[92] are self-discoverable by receiving signals from some fixed transmitters known as beacons. Position estimation is done with AoA (Angle of Arrival). Major cost of the system is because of antenna design. As the nodes are self-discoverable, the numbers of nodes are not affecting the system performance. The article in[93] which also has advanced in time present location estimation technique for Ad-hoc sensor networks using distributed iterative algorithms which is very unique. Using the testbed prototype, authors were able to achieve an accuracy of a few cm. Simulation is used to study the performance and scalability. It is shown that ToA (Time-of-Arrival) is a good parameter for fine-grained location estimate, whereas RF signal strength (RSSI) is not suitable for pin-point localization. Each localization technique presented above in the survey needs some accuracy to localize the node. Many researchers have tried to reduce the localization error and have shown the improvement in terms of error distance in the result obtained either by simulation or by practical approach but still the results are not satisfactory. Author in[94] investigates the possibility of implementing node positioning in the ZigBee wireless sensor network . The author uses Received Signal Strength Indicator (RSSI) as a measuring tool. The main key finding of the research is that the author uses distance to RSSI relation in the grid based network. For this purpose, localization is done using trilateration technique and finally mapped with google map. Author in[95] present a detailed study on the RSS-based location techniques in wireless sensor networks. Author has proposed the modeling of channel through loss model. Gaussian fitting is used to find the estimated distance and uses quadrilateral technique to localize the node. Novel localization algorithms are proposed by author in[96] to find out possible location information. The main key findings are the use of hop counts (HCs) algorithm.

Author has estimated the distance between the anchor node and unknown node and proves that the accuracy depends on the hop density. Author in[97] presented an Kalman filter-based hybrid indoor position estimation technique. It is an integration of fingerprinting and trilateration approach. Author in[98] uses Particle swarm optimization algorithm for localization of the nodes. Using PSO, the fitness function is designed which use trilateration technique and 100 particles have been used to localize node. Author in[99] uses RSSI as a tool for node localization. Author has used Back propagation algorithm to localize the node. The MATLAB simulation environment has been used for 100 X 100 sq. mtrs area. Author in[16] used average RSSI is first adopted for reducing the noise interference of LQI (Link Quality Indicator) and then the object to be detected is trained by radial basis function network. It uses LQI for localization for indoor study of 7.26 m X 16.5 sq. m. Author in[100] emphasize that the sensor node position estimation method and its optimization to reduce the error from multipath propagation. Offline training using neural networks have been proposed. Author in[101] uses neural network for localization and its optimization for 100 X 100 sq. m area. Author in research[102] proposes a method to localize a mobile station in an indoor environment using wavelet based features (WBF). The research is for Indoor study and mainly focused on finding distance as well as location error of target node. In research[103] has proposed novel technique to localize the node. The author also compared their algorithm with classical approaches of RSSI based localization. Its Indoor based study with 20 X 20 sq. m. In[104] the author proposes hop-count-based localization which is a cost-effective alternative to range based localization algorithms. In this research hop count is used for localization and it uses MDS localization algorithm. MDS using real number hop-count is better than the other localization algorithms.

These above are the localization techniques and algorithm surveyed. Hence it is concluded that

1. There is lack of communication network in disaster prone areas where human/ lives tracking has to be necessary for sustainable development
2. Also, in order to develop such networks, specific algorithms are not explored so far.