CHAPTER 2

LITERATURE REVIEW

Most of the energy aware routing approaches for unattended wireless sensor networks pursue multi-hop paths in order to minimize the total transmission power. Since almost in all sensor networks data are routed towards a single sink (base-station), hops close to that sink become heavily involved in packet forwarding and thus their batteries get depleted rather quickly. In this chapter the entire survey study is classified into three different sections.

In our first section, the details study about the different sink repositioning and relocation techniques, in section 2, the detailed information about the localization are explained and in section 3, different mobile node tracking methodologies are explained with proposed algorithms.

2.1 Existing Works on Sink Repositioning and Relocation

Mohamed Younis et al [45] have investigated the potential of base-station repositioning for enhanced network performance. We address issues related to when should the base-station be relocated, where it would be moved to and how to handle its motion without any effect on data traffic. Their approach tracks the distance from the closest hops to the base-station and the traffic density through these hops. When a hop that forward high traffic is further than a threshold the base-station qualifies the impact of the relocation on the network performance and moves if the overhead is justified. The presented approach is validated in a simulated environment. Relocating the gateway during regular network operation is very challenging. The basic issues are when it would make sense for the gateway to be relocated, where the gateway should go and how it will be moved. The relocation of the gateway first has to be motivated by odd pattern of energy depletion or data route setup, even if it is the most efficient network operation given the traffic distribution and network state at that time. Once the gateway detects such odd pattern it identifies the best location to be placed at in order to enhance network performance. While the gateway is on the move, it must ensure that no data is lost during that period. The gateway performs a trade-off analysis between the gain achieved by going to a new location and the
overhead in terms of additional energy consumption that the relocation imposes on sensors. If the relocation is justified, the gateway moves towards that location. In their paper, they have studied the three issues of when, where and how to relocate the gateway node. Repositioning the gateway is a very complex problem, NP hard in nature, given the infinite number of locations that the gateway can move to.

Therefore, they pursue a heuristic search that is based on the current network topology and traffic pattern. They used the traffic density times the transmission power as metric for monitoring network performance and searching for the best gateway location. Their approach tracks the changes in the nodes that act as the closest hop to the gateway and the traffic density going through these hops. If the distance between the gateway and some of the nodes that are in direct communication is larger than a threshold value, the gateway will qualify the impact of these nodes on the overall network lifetime by considering the number of packets routed through them. If the transmission power times the traffic density is large enough the gateway will consider relocating to a new position. The gain for the potential relocation is further qualified against the overhead imposed by the relocation on sensor nodes.

Kemal Akkaya et al [31] have investigated the potential of gateway repositioning for enhanced network performance in terms of energy, delay and throughput. They addressed issues related to when should the gateway be relocated, where it would be moved to and how to handle its motion without negative effect on data traffic. They presented two approaches that factor in the traffic pattern for determining a new location of the gateway for optimized communication energy and timeliness, respectively. The gateway movement is carefully managed in order to avoid packet losses. In their paper, they studied the three issues of when, where and how to relocate the gateway node. They pursue a heuristic search that is based on the current network topology and traffic pattern. They first consider relocating the gateway under unconstrained traffic. They used the traffic density times the transmission power as a metric for monitoring the network operation and searching for the best gateway location. Their approach tracks the changes in the nodes that act as the closest hop to the gateway and the traffic density going through these hops. If the distance between the gateway and some of the nodes that are in direct communication is larger than a threshold value, the gateway will qualify the impact of these nodes on the overall network lifetime by considering the number of packets
routed through them. If the transmission power times the traffic density is large enough, the gateway will consider relocating to a new position. Such consideration does not mean that the gateway will certainly move. The gain for the potential relocation is further qualified against the overhead imposed on sensor nodes by the gateways relocation.

Secondly, they considered relocation of the gateway in the presence of real-time traffic. They presented a novel relocation mechanism for enhanced on-time data delivery in sensor networks. When the average rate of deadline misses for real-time packets starts to increase, their approach pursues moving the gateway to a better position in order to maintain the same or even better level of timeliness. To determine the new gateways position, we identify locations on or close to the most heavily loaded last-hop node and try to split the incoming traffic passing through that node without extending the delay experienced by real-time packets over other routes. As long as the gateway they maintain the same routes that were set initially. If it is expected that the new location will put the gateway out of the transmission range of some of the last hop nodes in the current routes, new forwarder nodes that are not involved in any routing activity are selected. Such unused nodes will introduce very little queuing delay, which is desirable for on-time delivery of all real-time packets that use these nodes as relays. If suitable forwarder nodes cannot be found, relocation is either not considered or a new network topology is set at the new location depending on the overhead that rerouting will introduce relative to the gain in timeliness.

**Jesse English et al** [23] have argued that changing the position of a gateway cannot be pursued without the consideration of the impact on inter-gateway connectivity. They presented an efficient algorithm for Coordinated Relocation of gateways (CORE). CORE strives to maintain communication paths among gateways while repositioning individual gateways to better manage the sensors in their vicinity. In their research they presented CORE; an algorithm for Coordinated Relocation of gateway nodes. CORE considers the inter-cluster implications of a gateway repositioning and derives the necessary conditions for approving a gateway move. Even if the motive for a gateway’s relocation may be local to its cluster, the global effect of such a change in position is categorized and the appropriate actions are performed. In case a strongly connected inter-gateway topology can be achieved,
CORE allows the repositioning. To handle the possibility of creating a partitioned inter gateway topology, CORE pursues novel heuristics that trigger the relocation of multiple gateways in order improve the operation within individual clusters.

To the best of their knowledge, the problem of coordinated repositioning of multiple gateway nodes in WSNs has not been addressed in their research. At the functional level, the CORE algorithm consists of five parts. The outer CORE function, Evaluate And Move() is responsible for initializing the recursion, maintaining the critical section, i.e. the mutex, and deciding to send the movement message. Inside Evaluate And Move(), CORE needs access to the Find New Location() function.

This function is responsible for identifying a desired location inside the gateway's cluster to move to. Following this, the Move To Location() recursive function is called. This function trickles down through the network of connected gateways, recalling itself for each subsequent link break and updating CORE's view of the virtual network via the Update Virtual Network(). The recursion also needs one other function, Find Help Location(), which calculates the closest location for a gateway to move to establish communication with a given location subject to intra-cluster constraints. When the recursion returns, G will compare the view of the network with the view presented in the virtual network. Only if the virtual network performs better in simulation based on recent network activity, G will actually move.

Zoltan Vincze et al [83] have proposed a novel iterative algorithm called 1hop that carries out the sink deployment based only on the location information of the neighboring nodes while the location of the distant nodes is being approximated. They compared the two algorithms and show that 1hop approaches the performance of global very closely. Another important issue is that the neighboring nodes of the sinks have a high traffic load, thus the lifetime of the network can be elongated by relocating the sinks from time to time. Based on the 1hop algorithm they proposed the 1hop relocation algorithm for the coordinated relocation of multiple sinks. One of the most important issues to be aware of when handling wireless sensors is their energy consumption.

Sensor batteries are usually impossible or impractical to replace or recharge; therefore, energy should be spared, so as to be able to perform, for the longest
possible period, the role they were deployed for. Energy is consumed by several tasks, but the most important energy consumer is the communication module. In small networks sensors can send data directly to the sink node; in larger setups multi-hop communication is needed, i.e., sensors forward each other’s data toward the sink. In both cases the energy consumption depends on the communication distance.

Reducing this communication distance can be done in many ways. One solution would be to have a mobile sink that moves inside the monitored region and collects the data from the sensors it passes by. This approach, however, could not fit real-time applications, where data has to reach immediately the sink. Another possibility is to deploy multiple sinks; this would decrease the average number of hops a message has to pass through before being received and processed by a sink, as data will always be sent to the closest sink. In their research they presented a solution that builds on this idea.

They proposed a multiple sink placement solution that uses only local information. After deploying the sink nodes, certain sensors will get rapidly depleted: those near the sink(s) in case of multi-hop communication, and those far from the sink(s) in case of direct sensor-sink exchanges. Thus, we provide a solution not only to deploy those multiple sink nodes, but also to reposition them if needed.

Waleed Alsalih et al [70] have proposed a mobile base station placement scheme for extending the lifetime of the network. In their scheme the life of the network is divided into rounds and base stations are moved to new locations at the beginning of each round. While previous work has focused on placing the base stations at predefined spots or at the boundary of the network, they defined and solved a more general problem in which a base station can be placed anywhere in the sensing field. They formulated the problem as an Integer Linear Program (ILP) and use an ILP solver (with a constant time limit) to find a near-optimal placement of the base stations and to find routing patterns to deliver collected data to base stations.

A sensor node has a wireless communication interface through which it can communicate with other devices in its vicinity. Due to the scarcity of the energy reservoir and due to the fact that communication is the dominant power consumer in a sensor node, the transmission range of these nodes is limited for energy-efficiency purposes. Sensor nodes which are spatially distant from the base station use multi-hop
communication to deliver data to the base station. The multi-hop communication results in an unbalanced energy expenditure over different parts of the network; nodes around the base station deplete their energy reserve much faster than distant nodes. This will not only stop those nodes around the base station from functioning, but will also make the base station unreachable by other nodes.

In their research, they argued for using multiple mobile base stations and proposed a scheme for placing these base stations in a way that balances the energy expenditure and increases the lifetime of the network. Their scheme divides the lifetime of the network into fixed length rounds (e.g., hours, days, or weeks) and moves the base stations, which can be Autonomous Unmanned Vehicles (AUVs), to new locations at the beginning of each round. Some recently proposed schemes have addressed the issue of mobile base stations. However, they are either limited to a given set of base station locations, or incur high complexity. To this end, the novel contribution of this paper is two fold:

1) They defined and solved the general placement problem in which a base station can be placed anywhere in the sensing field. Previous work has focused on placing the base stations at predefined spots, or placing them at the boundaries of the field.

2) They devised an algorithm to construct a finite set of relatively small number of points, and they proved the existence of an optimal placement in which each base station is placed at a point in that set. Since the problem is modeled as an ILP, making the cardinality of this set as small as possible would significantly improve the efficiency and the solution quality. This makes their approach more efficient than earlier schemes, which is based on solving a number of linear programming instances which is exponential in the number of base stations. By formulating the problem as an ILP, an optimal solution could be found.

Bin Wang et al [6] have proposed a solution that is significantly different from all the other approaches. They assumed in an event-driven scenario, there exist multiple mobile sinks in the network. When a sensor node detects an event occurring, it sends data to the nearest sink via multi-hop routing. Their goal is to find a suitable deploying manner of multiple mobile sinks so as to shorten the delay of data delivery and prolong the network lifetime.
Information gathering in sensor networks can follow different patterns, depending mostly on the specific needs of the applications. In a time-driven scenario all sensors send data periodically to the sink. As opposed to this, in the event-driven case sensors start communicating with the sink only if sensing an event, i.e., a situation that is worth reporting. Finally, in a query-driven scenario a sensor transmits its data only if the sink asks for it.

Most of the research works in the area address the time-driven scenario, and provide energy-efficient solutions for homogeneous networks, with sensors having constant and equal amounts of data to send in all parts of the covered region. However, there are a large number of applications (e.g., intrusion detection, seismic activity monitoring, animal movement tracking) where an event-driven approach is more appropriate. Hence, their research address only this scenario.

Jun Luo et al [27] have built a unified framework for investigating the joint sink mobility and routing problem. They formally proved the NP-hardness of the problem. They also investigated the induced sub-problems. In particular, they developed an efficient interior point algorithm to solve the sub-problem involving a single sink, then they generalize this algorithm to approximate the original problem.

In their research, they investigated the problem of maximum lifetime data collection in WSNs by jointly considering sink mobility and routing. They consider a type of continuously monitoring WSNs whose data generation rates of sensors can be estimated accurately. They focus on the slow mobility approach. They built a unified framework to cover most of the joint sink mobility and routing strategies. Their investigation of the maximizing network lifetime (MNL) problem is based on a graph model.

They have shown that the MNL problem involving multiple mobile sinks is NP-hard, but that certain induced sub-problems having a practical significance are tractable. Moreover, they showed that the MNL problem involving only a single mobile sink can be solved by an efficient interior point algorithm; they further generalized the algorithm to approximate the general MNL problem. Finally, they illustrate the benefit of using a mobile sink by applying their algorithm to a set of typical topological graphs.
Their main contributions are:

- They provided a constructive proof of the NP-hardness of the MNL problem involving multiple mobile sinks.
- They identified the sub-problem that has a potential to guide routing protocol designs in practice.
- They developed an efficient interior point algorithm for the sub-problem involving a single sink; it is then generalized to approximate the general MNL problem.
- They formally proved the superiority of moving the sinks over keeping them static.

Yimin Chen et al [80] have proposed energy efficient and real-time solution for an application scenario inspired by the recent research on WSNs applied in the area of Intelligent Transportation Systems (ITS). Recently, researchers have proposed WSNs with mobile sinks (mWSN). One of the most remarkable contribution of mWSN is that it balances the energy dissipation, thus to eliminate the “energy hole” nearby the fixed sinks due to the heavy data flow. The mobility of sink can be categorized as random, predictable or controllable. A lot of research has been conducted on the mobile sinks with predictable or controllable mobility.

However, in real world scenarios, mobile sinks are more likely to be integrated into mobile devices with random mobility, such as cellular phones and portable computers. For real-time applications, requested data should be delivered towards the MS as quickly as possible. For example, the prevention on fire relies on the timely temperature updates; or a surveillance system needs to report the intruders as soon as possible. Thus multihop communication needs to be used. The major challenge of such query-based WSNs is that the sensor nodes are not able to know the real-time information on the sink position in an energy efficient way.

Thus, the relaying sensor nodes need to employ certain estimation strategy for the routing destination at each hop. ITS refers to the utilization of information and communications technology to develop and improve the transport infrastructure and vehicles. Some researchers have brought forward another dynamic scenario, where
mobile users query a WSN based on the existing ITS infrastructure for information from the physical world. In this application scenario, sensor nodes are densely deployed in the sensing field, and collecting data such as temperature, sound, vibration, pressure, motion or pollutants. The data packets are delivered from the source node to the mobile sink moving along a straight path, via multi-hop communication.

**Rajeev Paulus et al [54]** have proposed Particle swarm optimization (PSO) based algorithm for sink repositioning. It includes two phases clustering and Scheduling. In the first phase, all nodes are grouped into several clusters based on their overflow time and location. In the second phase, multiple sinks are deployed with mobility. To schedule the sink mobility, within a single cluster, the scheduling algorithm generates node movement schedules for the sink based on the PSO technique. Finally, the scheduling solutions of all the clusters are aggregated to form the global sink movement path.

The authors in their research have propose to develop a Particle swarm optimization (PSO) based scheduling algorithm for sink repositioning. It includes two phases clustering and Scheduling. First, all nodes are grouped into several clusters based on their data generation rate and location. Second, multiple sinks are deployed with mobility. To schedule the sink mobility, within a single cluster, the scheduling algorithm generates node visiting schedules for the sink by minimizing the overhead of moving back and forth across far-away nodes. Finally, the scheduling solutions of all the clusters are aggregated to form the global sink movement path.

The proposed scheduling algorithm has the following advantages:

- Minimizing the energy of sensor nodes
- Increasing the sink coverage for sensor nodes
- Reducing the buffer overflow or data loss of the sensor nodes
- Recovery of sink failures

**Amir Mollanejad et al [2]** have presented a dynamic optimum method for base station replacement so that can save energy in sensors and increases network lifetime. Because positioning problem is a NP hard problem, therefore they have used genetic algorithm to solve positioning problem. They have considered energy and distance
parameters for finding BS optimized position. In their represented algorithm base station position is fixed just during each round and its positioning is done at the start of next round then it will be placed in optimized position. In their research they have found optimized position of Base Station toward the available node in network, they have tried the node can gather data and send it to BS with the least possible energy usage. Finding BS optimized position; they have considered energy and distance parameters. BS optimized positioning is a NP-hard problem. Therefore they have used genetic algorithm to solve positioning problem in their proposed DBSR algorithm the primal population consists of n chromosomes which show the position of BS. Each chromosome includes two parts; X (length of network environment) & Y (width of network environment). They have encoded by binary encoding scheme. Each chromosome is evaluated by fitness function. They have applied modified 2-point crossover and random point flip for mutation operation. In additional, for new population replacement, they have replaced the selected population with next population. The condition of genetic algorithm expiry is based on the number of generations they have supposed.

2.2 Existing Works on Mobile Sink Positioning

**Suraj Sharma et al** [65] have proposed a tree-based energy efficient data dissemination protocol. In this protocol, any sensor node can disseminate the data to the sink via tree which generates a tree T from the sensor network. It can be represented as a graph G (V,E) where V are the sensor nodes and E are the links between them. The tree construction is independent of the sink position. This method reduces the traffic and prolongs the lifetime of the network.

**Djuraev Mamurjon et al** [9] have proposed a novel data collection method for large wireless sensor networks and ubiquitous applications. A typical data collection tour using a mobile sink starts from a sensor node nearby a base station, travels all nodes of wireless sensor network by visiting and each node spends battery power quickly. A novel data collection method is proposed to increase energy efficiency using a mobile sink.

**Abdullah I. Alhasanat et al** [1] have presented a new data gathering algorithm called Connectivity-Based Data Collection (CBDC). The CBDC algorithm utilizes the connectivity between sensor nodes so as to determine the trajectory of the
mobile sink whilst satisfying its path constraint and minimizing the number of multi-hop communications. The presented results show that CBDC, in comparison with the LEACH-C algorithm, prolongs the network lifetime at different connectivity levels of sensor networks, varying number of sensor nodes and at different path constraints of the mobile sink.

Xinxin Liu et al [73] have proposed two energy efficient proactive data reporting protocols, SinkTrail and SinkTrail-S, for mobile sink-based data collection. The proposed protocols feature low-complexity and reduced control overheads. Two unique aspects distinguish our approach from previous ones: 1) we allow sufficient flexibility in the movement of mobile sinks to dynamically adapt to various terrestrial changes; and 2) without requirements of GPS devices or predefined landmarks, SinkTrail establishes a logical coordinate system for routing and forwarding data packets, making it suitable for diverse application scenarios. We systematically analyze the impact of several design factors in the proposed algorithms.

Junzhao Du et al [29] have introduced to optimize the energy consumption on gathering the global data named In-network communication cost. By doing so, the Mobile Element is able to efficiently collect network wide data within a given delay bound meanwhile the network eliminates the energy bottleneck to prolong its lifetime. For case study, they considered the trajectory planning for both Mobile Relay and Mobile Sink on a tree-shaped network.

In the Mobile Relay case where the ME’s trajectory must pass through a given point to upload sensory data, an O(nlgn) algorithm named RP-MR is proposed to approach 1: the optimal Rendezvous Points (RPs) to collect global sensory data; 2: the optimal data collection trajectory for the Mobile Relay to gather the cached data from RPs and upload to a fixed point for further processing, i.e., the sink. In the Mobile Sink case where the Mobile Element can processing the sensory on its motion, they have developed an O(nlg²n) algorithm named RP-MS to recursively investigate the optimal solution.

Huan Zhaoa et al [16] have proposed a heuristic topology control algorithm with time complexity O(n(m + n log n)), where n and m are the number of nodes and edges in the network, respectively, and further discuss how to refine our algorithm to
satisfy practical requirements such as distributed computing and transmission timeliness.

Saim Ghafoor et al [61] have proposed a novel approach for mobile sink trajectory in wireless sensor networks. Their proposed approach is based on Hilbert Space Filling Curve, however, the proposed approach is different from their previous work in a sense that the curve order changes according to node density. In their research, they investigated the mobile sink trajectory based on Hilbert Curve Order which depends upon the size of the network. Second, they calculated the Hilbert Curve Order based on node density to redimension the mobile sink trajectory.

Marwa M.Hassana et al [38] have introduced the optimal location solution through utilizing the Mixed Integer Linear Programming (MILP) solution to the problem in small scale WSNs. Consequently, maximum reliability of a path may lead to the minimum energy consumed for retransmission along the routing path. However, in large-scale networks, their paper introduced the Genetic Algorithm (GA) as one of the heuristics solution. The Fitness function of the GA calculates the negative value of the log of the reliability of a path and the GA tries to find the sink position with the minimum fitness value to minimize the energy spent by each sensor in the routing towards the sink.

Miao Zhao and Yuanyuan Yang [40] proposed to utilize mobility for joint energy replenishment and data gathering. A multi-functional mobile entity, called SenCar was employed, not only as a mobile data collector roaming over the field to gather data via short-range communication but also as an energy transporter that charges static sensors on its migration tour via wireless energy transmissions. Taking advantages of SenCar’s controlled mobility, the joint optimization of effective energy charging and high-performance data collections were performed. The locations of a subset of sensors were periodically selected as anchor points, where the SenCar will be sequentially visited to charge the sensors at these locations and gathered data from nearby sensors in a multi-hop fashion. A selection algorithm was provided to search for a maximum number of anchor points where sensors hold the least battery energy, and by visiting them, the tour length of the SenCar was no more than a threshold to achieve a desirable balance between energy replenishment amount and data gathering latency.
Then data gathering performance was performed when the SenCar migrates among these anchor points. The problem was formulated into a network utility maximization problem and proposed a distributed algorithm to adjust data rates at which sensors send buffered data to the SenCar, link scheduling and flow routing so as to adapt to the up-to-date energy replenishing status of sensors.

2.3 Existing Works on Localization

Lingxuan Hu et al [35] have introduced the sequential Monte Carlo Localization method and argue that it can exploit mobility to improve the accuracy and precision of localization. Their approach does not require additional hardware on the nodes and works even when the movement of seeds and nodes is uncontrollable. The authors are interested in performing localization in a more general network environment where no special hardware for ranging is available, the prior deployment of seed nodes is unknown, the seed density is low, the node distribution is irregular, and where nodes and seeds can move uncontrollably. Although mobility makes other localization techniques increasingly less accurate, our technique takes advantage of mobility to improve accuracy and reduce the number of seeds required.

They considered a network composed of nodes with unknown locations and seeds that know their locations. They are interested in three kinds of scenarios:

1. Nodes are static, seeds are moving. For example, a military application where nodes are dropped from a plane onto land, and transmitters attached to soldiers or animals in the area are used as moving seeds. Each nodes location estimate should become more accurate as time passes and it receives information from more seeds.

2. Nodes are moving, seeds are static. One example would be nodes floating in currents along a river and seeds at fixed locations on the river banks. A more concrete, but less worldly, example is NASAs Mars Tumbleweed project. It proposes a low cost way to explore large areas on Mars by having rovers with sensors that are blown over the surface by the wind, with minimal or no control over their movement. Of course, GPS does not work on Mars, but it
may be possible to establish fixed landmark seeds or positioning from orbiters. For these scenarios, each node's location estimate will fluctuate around its current actual location: as time passes, old location information becomes inaccurate since the node has moved, but as new seed information is received the location estimate is revised.

3. Both nodes and seeds are moving. This is the most general situation. It applies to any application where the nodes and seeds are both deployed in an ad hoc way, and move either because of the environment they are in (wind, currents, etc.) or because they have actuators for motion.

**Huang Lee et al** [17] have introduced a novel localization technique that can jointly estimate the locations of a moving target and the sensor nodes in a wireless image sensor network. The proposed method is based on in-node image processing and can be implemented in a decentralized or clustered fashion. In their approach, two image sensors are used to define a relative coordinate system. In order to synchronize the observations, the node defined as the origin broadcasts packets that trigger image capture at other nodes. In the decentralized version of the technique, each one of the two reference nodes broadcasts its image plane position of the moving target at a few time instances. Each of the other nodes in the network that can detect the target in its image plane upon receiving a number of triggering broadcasts, calculates its own relative coordinates and orientation as well as the coordinates of the observed target. In the clustered version of the proposed technique, observations gathered by the nodes within a neighbourhood cluster are sent to a cluster-head, which can be the reference node at the origin.

The cluster-head combines the data and calculates the coordinates of the target and all the nodes that contributed observations. Most applications in sensor networks rely on the knowledge of sensor positions. However, manual location entry results in high deployment cost and is unrealistic in large networks. Node localization therefore is a fundamental problem in sensor networks. Recently, research on image sensor networks has received large interest; however, only limited study of the localization problem has been reported for these networks. In image sensor networks, each node may be equipped with a low-resolution camera because of the complexity and cost limitations. Furthermore, calibration in multi-camera systems is impractical in large
networks. Hence, a localization algorithm that can utilize low-resolution images and requires low computational power and minor sensor calibration is very much desired.

They assumed that there is a moving target in the network and want to jointly estimate the locations and orientations of sensor nodes and the position of the moving target. In the proposed approach, they selected two image sensors as reference nodes to define a relative coordinate system. In order to synchronize the observations of all image sensors, a low complexity synchronization protocol is implemented in the network. The synchronized sensor nodes acquire images simultaneously and locate the moving target in their image planes. Based on the requirements, these sensor nodes can exchange information in different ways. In the decentralized version of the proposed technique, the two reference nodes broadcast their observations so that each of the other sensors can estimate its location and orientation. Each node only uses its own observations and the information sent by the reference nodes. In the cluster-based version, all observed data are sent to the reference node at the origin (cluster-head), which then calculates the coordinates of the target and locations and orientations of all the other sensor nodes.

Cesare Alippi et al [8] have presented a multi-hop localization technique for WSNs exploiting acquired received signal strength indications. The proposed system aims at providing an effective solution for the self localization of nodes in static/semistatic wireless sensor networks without requiring previous deployment information. In their research they have proposed a practical approach for units localization in a typical scenario where some nodes, e.g., the ones at the network border, are used as anchors (i.e. they are placed in known positions). All the RSSI (Received Signal Strength Indicator) values of the packets exchanged among nodes at different power levels are collected (RF mapping phase) and processed both to build the ranging model to be fed into a centralized Minimum Least Square (MLS) algorithm. The ranging model is calibrated from the online collected values, by selecting the optimal approximation family on the specific environment and normalizing the intensity of the received power. Although in static WSNs the RSSI distributions are practically constant in absence of external perturbations, they proposed a system that can be easily extended to update the position estimates every time a node notifies that the received RSSI has varied beyond a fixed threshold (i.e.,
the environment has changed). This enhancement allows the target network to tolerate slow movements of the nodes (semi-static network).

Their contribution can be summarized as

- A practical self localization system which does not need the development of costly deployments of the nodes;
- A ranging model derived from calibrated RSSI information.

**Min Ding et al** [41] have proposed fault-tolerant algorithms to detect the region containing targets and to identify possible targets within the target region. Here only the same kinds of targets are considered. To avoid the disturbance of extreme measurements at faulty sensors, each sensor collects neighbouring readings and computes the median, representing its local observation on the targets. Median is proved to be an effective robust nonparametric operator that requires no strong mathematical assumptions. A median exceeding some threshold indicates the occurrence of a possible target. Whether a real target exists or not must be jointly determined by neighboring sensors at the same time. To localize a target within the target region, a sensor whose observation is a local maximum computes the geometric centre of neighboring sensors with similar observations. They also explored time dimension to reduce the false alarm rate. Results from multiple epoches are combined to refine the target position estimates. Their algorithms have low computation overhead because only simple numerical operations (maximum, median, and mean) are involved at each sensor. The protocol has a low communication overhead too, since only sensors in charge of the location estimation report to the base station.

**Yifeng Zhou et al** [79] have presented an optimal local map registration algorithm for constructing global maps from local relative maps for wireless sensor network localization applications. In the algorithm, local maps are transformed into a global map using a set of affine transforms with each consisting of a rotation, a reflection and a translation for each individual local map. The optimal transform is found by minimizing the discrepancies, in the global map, of the common sensor nodes shared by different local maps. A computationally efficient gradient projection algorithm is developed for finding the optimal transforms. The local map registration approach can solve many of the problems encountered by pair wise map merging based approaches and is able to achieve global optimal performance.
It provides a systematic approach for constructing global maps from local maps. In their research, they have proposed an optimal local map registration algorithm for merging local relative maps for wireless sensor localization problems. A set of affine transforms are used to map the local maps to a global map. Each affine transform is applied to an individual local map and consists of a rotation, a reflection and a translation transformation. The optimal transforms are found by minimizing the discrepancies of the locations of common sensor nodes in the global map shared by all local maps that are available. The discrepancy is represented by the sum of the squared distances of all nodes to their respective geometric centers in the global map. Since the proposed local map registration algorithm minimizes the overall discrepancies of the locations of the common nodes, it is able to achieve the global optimal performance and counter the problems associated with approaches based on pair wise map merging. A computationally efficient gradient projection algorithm is developed for finding the optimal transform. The approach provides a systematic approach for constructing global maps from local maps.

Sadegh Zainalie et al [60] have proposed a clustering algorithm called CFL (Clustering for Localization). CFL is designed in such a way to consider principle of designing a clustering algorithm, in addition to providing an environment for designing a localization algorithm based on clustering. The proposed algorithm uses a combined weight function and tries to classify the sensor nodes so that minimum number of clusters with maximum number of nodes in each cluster could be achieved. In their research they presented a new distributed clustering algorithm called CFL (Cluster for Localization), that can be used for localization algorithms in future. The proposed algorithm uses a weight function at each sensor node, which is a combination of different parameters including: reminding energy, transmission power and number of neighbors. Using the weight function the proposed algorithm tries to classify the sensor nodes so that minimum number of clusters with maximum number of nodes in each cluster could be achieved.

Vibha Yadav et al [69] have discussed about a range free localization mechanism for WSN that operate in a three dimensional space. in this scheme, the sensor network is supposed to be comprised of mobile and static sensor nodes. Mobile sensor nodes are assumed to be equipped with GPS enabled devices and are expected to be aware of their position at any instance. These mobile nodes move in the network
space and periodically broadcast beacon messages about their location. Static sensor nodes receive these messages as soon as they enter the communication range of any mobile node. On receiving such messages the static nodes calculate their individual position based on the equation of sphere. The proposed scheme gains in terms of computational and memory overhead as compared to existing approaches. The authors in their research have discussed a range free localization technique. It works on the above discussed second approach. They used the basic principle of three-dimensional geometry, that is "if any point is at the surface of sphere then it will satisfy the sphere equation". Suppose they have a few GPS enabled mobile wireless sensor nodes in the vicinity and they continuously broadcast their location. The static nodes on receiving such a broadcast message will record it. Then they can compute their locations with the help of four more such messages, assuming that these satisfy the sphere equation representing the transmission range of individual mobile node. Here they have assumed that, all the mobile sensor nodes deployed in a field have same the radio communication range.

Hongyang Chen et al [14] have proposed a cooperative localization algorithm that considers the existence of obstacles in mobility assisted wireless sensor networks (WSNs). In this scheme, a mobile anchor (MA) node cooperates with static sensor nodes and moves actively to refine location performance. The localization accuracy of the proposed algorithm can be improved further by changing the transmission range of mobile anchor node. The algorithm takes advantage of cooperation between MAs and static sensors while, at the same time, taking into account the relay node availability to make the best use of beacon signals.

For achieving high localization accuracy and coverage, a novel convex position estimation algorithm is proposed, which can effectively solve the localization problem when infeasible points occur because of the effects of radio irregularity and obstacles. This method is the only range-free based convex method to solve the localization problem when the feasible set of localization inequalities is empty. In their research, they focused on the investigation of range free localization algorithms for mobility-assisted WSNs. An obstacle can be dynamically formed due to unbalanced deployment, failure or power exhaustion of sensor nodes, animus interference, or physical obstacles such as mountains or buildings. In their paper, they considered only physical obstacles.
Most previous algorithms cannot work well in anisotropic networks, where obstacles appear among sensor nodes. However, anisotropic networks with obstacles are more likely to exist in practice for several reasons. Firstly, a uniform node distribution cannot always be achieved because of random deployment of sensor nodes, which may cause some regions to not contain any sensor node. Secondly, unbalanced power consumption among nodes results in some regions without functionality of sensing and communication. Thirdly, physical obstacles such as mountains or buildings will naturally exist in many networks. In their work, they have proposed a multi-power level mobile anchor assisted range-free algorithm for WSNs with obstacles. By using a relay node, their scheme can effectively reduce the effects of obstacles on node localization.

**Yun Wang et al** [81] have proposed a novel range-free localization algorithm using expected hop progress (LAEP) to predict the location of any sensor in a WSN is proposed. This algorithm is based on an accurate analysis of hop progress in a WSN with randomly deployed sensors and arbitrary node density. By deriving the expected hop progress from a network model for WSNs in terms of network parameters, the distance between any pair of sensors can be accurately computed. Since the distance estimation is a key issue in localization systems for WSNs, the proposed range-free LAEP achieves better performance and less communication overhead as compared to some existent schemes like DV-Hop and RAW.

In their research paper, they have introduced a hop progress analytical model, to estimate the optimal path distance between any pair of sensors in a WSN. More specifically, they derive the distance estimation between any two sensors in terms of expected hop progress and hop counts from a network model with arbitrary node density and sensor transmission range. Based on the analytical results, a range-free localization algorithm using expected hop progress (LAEP) is proposed and validated. The algorithm leads to a good position determination and reduced communication overhead for WSNs, as compared to some existent positioning schemes. The main contributions of this paper are as follows:

- They characterized the distribution of hop progress for a WSN with arbitrary network parameters, and prove that the expected hop progress is a function of node density, node connectivity, and transmission range. They also showed
that the distance estimation based on the expected hop progress provides satisfactory accuracy.

- They have proposed a novel range-free localization algorithm, called LAEP, with enhanced performance, reduced communication overhead, and decreased computing complexity as compared to existing range-free localization schemes, such as RAW and DV-Hop in realistic network settings.

- They studied the impact of anchor placement on the system performance of the proposed LAEP algorithm, and they showed that a triangle-pattern-based anchor placement leads to better performance than square pattern placement, with fewer numbers of required anchors.

**Huseyin Akcan et al** [19] have proposed two distributed algorithms based on directional localization that facilitate the collaborative movement of nodes in a sensor network without the need for global positioning systems, seed nodes or a pre-existing infrastructure such as anchors with known positions. Their first algorithm, GPS-free Directed Localization (GDL) assumes the availability of a simple digital compass on each sensor node. They relax this requirement in their second algorithm termed GPS and Compass-free Directed Localization (GCDL)

Their main contributions are distributed algorithms for solving the problem of directional localization in sensor networks with mobile GPS-free nodes. They introduced novel, motion-based algorithms for node position and direction calculation with respect to each individual node's local coordinate system in mobile ad-hoc sensor networks, without global positioning information. Their first algorithm, GPS-free Directed Localization (GDL), assumes the availability of a digital compass on each node, and calculates a node's directional localization from a single-step movement. In their second algorithm, GPS and Compass fre Directed Localization (GCDL), they relax the compass requirement and compute directional localization with a 2-step motion algorithm. Their algorithms perform localization in a few steps of movement and are memory less; in addition, they are not affected by cumulative position errors. More specifically, their proposed algorithms:

- provide directional neighbour localization in a network-wide coordinate system,
• can function under fairly large motion and distance measurement errors,
• are unaffected by the speed of nodes,
• support a stable network in mobility problems,
• help organize the sensor network in any polygonal shape of our choice.

Engin Massazad et al [10] have proposed an energy efficient iterative source localization scheme where the algorithm begins with a coarse location estimate obtained from measurement data from a set of anchor sensors. Based on the available data at each iteration, the posterior probability density function (pdf) of the source location is approximated using an importance sampling based Monte Carlo method and this information is utilized to activate a number of non-anchor sensors. Two sensor selection metrics namely the mutual information and the posterior Cramer-Rao lower bound (PCRLB) are employed and their performance compared.

Further, the approximate posterior pdf of the source location is used to compress the quantized data of each activated sensor using distributed data compression techniques. In their research paper, they first extend the mutual information based sensor selection scheme presented for quantized sensor measurements. Then, they defined another metric for sensor selection based on the PCRLB. Note that the recursive approach is utilized to calculate the PCRLB. In their work, they re-formulate the PCRLB-based sensor selection metric for static source location estimation.

They approximate the posterior pdf of the source location using an importance sampling based Monte Carlo method and by using this approximate posterior pdf, a number of non-anchor sensors are selected in an iterative manner. For sensor selection at each iteration, they compare the PCRLB based sensor selection metric with the state-of-the-art mutual information based sensor selection metric in terms of estimation accuracy and computational complexity. The proposed iterative algorithm is expected to provide large energy savings. When sensors are densely deployed in a region of interest (ROI), the sensor measurements are likely to be spatially correlated and this correlation can be utilized to compress the quantized measurements of each sensor prior to transmission to further reduce energy consumption.
Given the multi-bit data received during previous iterations and the posterior pdf of the source location, the fusion center calculates the conditional entropy of the sensors to be activated during an iteration and it requests a compressed version of sensor’s multi-bit data. After the most informative sensors about the source location have been selected, the conditional entropy for each activated sensor becomes very small and only a small number of bits are requested by the fusion center. Hence, data compression yields further energy savings.

**Hongyang Chen et al** [15] have proposed a cooperative localization algorithm that considers the existence of obstacles in mobility assisted wireless sensor networks (WSNs). An optimal movement scheduling method with mobile elements (MEs) is proposed to address limitations of static WSNs in node localization. In this scheme, a mobile anchor node cooperates with static sensor nodes and moves actively to refine location performance. It takes advantage of cooperation between MEs and static sensors while, at the same time, taking into account the relay node availability to make the best use of beacon signals. For achieving high localization accuracy and coverage, a novel convex position estimation algorithm is proposed, which can effectively solve the problem when infeasible points occur because of the effects of radio irregularity and obstacles.

This method is the only range free based convex method to solve the localization problem when the feasible set of localization inequalities is empty. In their research they have proposed a multi-power-level mobile anchor assisted range-free algorithm for WSNs with obstacles, in which the node localization problem is formulated as a convex optimization problem. By using a relay node, their scheme can effectively reduce the effects of obstacles on node localization. Furthermore, their scheme can calculate the positions of infeasible points caused by a complex radio transmission environment, which is recognized as a problem when the feasible set for localization inequalities is empty. Based on the derived localization error bound, an optimal movement scheduling method is proposed to reduce the total moving distance of the mobile element (ME) while assuring high localization performance, which can efficiently extend the lifetime of the ME.

**Jasper Gnana Chandran et al** [46] have proposed a Particle Swarm Optimization (PSO) based energy efficient localization method. The localization is
performed by learning movement patterns and their parameters such as Received Signal Strength (RSS) and angle of arrival (AoA) to guide LA nodes for locating target(s). Only a small number of sensors are activated to track and localize the target; while others are turned into sleep mode thus minimizing the energy consumption. Particle swarm optimization (PSO) based energy efficient localization technique (EELT) is based on various mobility models, the proposed method is evaluated.

The localization is performed by learning movement patterns and their parameters such as velocity and acceleration. Based on a combined measurement including information utility, communication cost, and residual energy, the energy conservation and the subset of sensor nodes are activated. Only a small number of sensors are activated to track and localize the target; while others are turned into sleep mode, in order to reduce the energy consumption. In order to analyze the set of localization algorithms and to optimize the proposed localization algorithm, the Particle Swarm Optimization (PSO) technique is utilized.

A population based stochastic optimization technique which shares many similarities with evolutionary computation techniques such as Genetic Algorithms (GA) is called as Particle Swarm Optimization. By updating the generations, the system is initialized with a population of random solutions and recursively searches for maximum. PSO has been successfully applied in many research and application areas for the past several years. When compared with other methods, the PSO attains better results in faster and in cheaper way.

B. Paul et al [5] have proposed a new sink location estimating method that combines multi-hop inter-cluster routing with single-hop intra-cluster routing where the death of first cluster head counts as network lifetime. For doing this, the authors proposed a geometrical solution for locating the optimum sink placement using an algorithm outlining the novel approach that has been demonstrated to be superior to other methods for its convergence and many other practical features such as data rates and cluster heads. Application-specific requirements of networking sensors result in a great variety of network architectures for which the lifetime, coverage, connectivity, response time and temporal accuracy are some of the metrics used for network design evaluation.
The network architecture presented in their paper mostly suits real-time applications such as a fire alarm system or a camera sensor network for security monitoring. For some applications (e.g. a fire alarm system) to maintain quality of service (QoS) a typical response time of 20 mm is required and the network architecture has to ensure such a prompt response. For an application where the response time is relaxed, a dynamic network is a better choice. Based on their topological differences, they have two basic types of WSN: homogeneous networks where all the SN are of the same type and heterogeneous networks where the node type varies. In a typical heterogeneous network, clusters are formed around some more capable nodes, usually selected as CH, which are responsible for communicating with the sink and the low-capability nodes that perform the data collection task, are only responsible for forwarding data to the CH.

2.4 Existing Works on Tracking

Mohamed K. Watfa et al [43] have developed tracking algorithms using reduced set of sensor nodes. The tradeoffs involved in the energy efficient tracking of the target are studied and the performance of the distributed tracking algorithms is compared with well known strategies. It is shown that the gain in energy savings comes at the expense of reduced quality of tracking. The algorithms guarantee the robustness and accuracy of tracking as well as the extension of the overall system lifetime. In their research paper, it is demonstrated that substantial savings can be obtained by using a reduced number of nodes at each instant for tracking the target. Further, it is also demonstrated that this savings comes at the expense of the quality of tracking. The techniques presented are computationally simple and can be implemented in a distributed fashion.

Peng Zeng et al [50] have proposed a novel model to formally define the lifetime of target tracking sensor network by establishing the relationship between individual sensors and the whole sensor network. In this model, they derived the key factor in routing that determines the lifetime bound. In their paper, they first proposed a novel model to formally define the lifetime of target tracking sensor network that explicitly considers the end-to-end delay constraint, from which they can see the key factors that determine the lifetime. Then, with the reference of this model, they suggested an ant based routing algorithm to achieve the bound.
Informally, their ant-based routing algorithm can be described as follows:

- When a sensor node detects the target, it begins data transmission. A forward ant is launched from this source node toward the base station.
- Each forward ant searches for the destination by selecting the next hop node according to the link probability distribution. Initially all the links have equal probability.
- While moving forward, each forward ant remembers the list of nodes it has visited and tries to avoid traversing the same node.
- Once a forward ant finds the destination, a backward ant is created, which moves back along the links that the forward ant had traversed.
- During the backward travel, the pheromone is distributed to each node in the path.
- In the next data transmission, the link probability distribution of each intermediate node will be updated according to the pheromone.

Xue Wang et al [76] have proposed a practical target tracking system based on the auto regressive moving average (ARMA) model in a distributed peer-to-peer (P2P) signal processing framework. In the proposed framework, wireless sensor nodes act as peers that perform target detection, feature extraction, classification and tracking, whereas target localization requires the collaboration between wireless sensor nodes for improving the accuracy and robustness. For carrying out target tracking under the constraints imposed by the limited capabilities of the wireless sensor nodes, some practically feasible algorithms, such as the ARMA model and the 2-D integer lifting wavelet transform, are adopted in single wireless sensor nodes due to their outstanding performance and light computational burden. Furthermore, a progressive multi-view localization algorithm is proposed in distributed P2P signal processing framework considering the tradeoff between the accuracy and energy consumption.

In their research paper, distributed signal processing is combined with a P2P architecture. P2P is another kind of novel architecture which has the advantages of robustness and dynamic. Thus architecture can increase the performance and prolong the lifetime of WSNs because it can reduce the congestion and energy consumption.
Furthermore, a target tracking system for strictly constrained WSNs is designed, which consists of several specific signal processing algorithms for target detection, classification and tracking. In the proposed system, background subtraction based target detection, 2-D integer lifting wavelet transform (ILWT) based feature extraction, support vector machine (SVM) based target classification and autoregressive moving average (ARMA) model based target tracking are carried out in each sensor node, while multi-view localization algorithm is implemented with the collaboration between wireless sensor nodes in a distributed P2P signal processing framework.

**Khin Thanda Soe et al** [32] have proposed a model to identify the lifetime of target tracking wireless sensor network. The model is a static cluster based architecture and aims to provide two factors. First, it is to increase the lifetime of target tracking wireless sensor network. Secondly, it is to enable good localization result with low energy consumption for each sensor in the network. The model consists of heterogeneous sensors and each sensing member node in a cluster uses two operation modes—active mode and sleep mode. In their research paper, the system design and implementation architecture is proposed to increase sensor network lifetime for target tracking. The purpose of the system is to support the ability to track the position of moving targets in an energy efficient manner with low energy consumption for the sensing nodes in the network and to extend the lifetime of a sensor network. Their system is the designed architecture of an energy efficient target tracking system using acoustic sensors and photoelectric sensors. It also uses sleep mode and active mode for each acoustic sensor to make these acoustic sensor nodes save their important energy.

**Xue Wang et al** [75] have proposed an energy-efficient organization method. The organization of wireless sensor networks is formulated for target tracking. Target localization is achieved by collaborative sensing with multi-sensor fusion. The historical localization results are utilized for adaptive target trajectory forecasting. Combining autoregressive moving average (ARMA) model and radial basis function networks (RBFNs), robust target position forecasting is performed. Moreover, an energy efficient organization method is presented to enhance the energy efficiency of wireless sensor networks. The sensor nodes implement sensing tasks are awakened in a distributed manner. When the sensor nodes transfer their observations to achieve
data fusion, the routing scheme is obtained by ant colony optimization. Thus, both the operation and communication energy consumption can be minimized.

In their research, their paper proposed an energy-efficient organization method for WSNs. Equipped with multi sensors; sensor nodes can produce range and bearing measurements. As the target is often detected by a number of sensor nodes, a Fisher information matrix (FIM) is adopted to evaluate the target localization error. With the known target trajectory, adaptive target position forecasting is implemented by a novel algorithm. It is a combination of ARMA model and RBFN, which is called ARMARBF. The target position estimation of the next sensing instant is available. The energy-efficient organization approach includes sensor node awakening and dynamic routing. A distributed awakening approach is presented to save and scale the operation energy consumption. Ant colony optimization (ACO) is introduced to optimize the routing scheme, where transmission energy consumption is concerned.

Muhammad Taqi Raza et al [47] have presented Dead Reckoning (DR) based target tracking protocol. DR determines target’s present position by projecting its past positions and speed over elapsed time and known target's path. Moreover, it inherits the functionality of error correction and error avoidance using a position fix technique.

In their research the authors have proposed Dead Reckoning (DR) based target tracking in WSN. Their approach is inspired by the well known navigation protocol, i.e. DR, described as the process of estimating object's current position based upon a previously determined position, or fix, and advancing that position based upon known speed, elapsed time, and course. They assumed triangulation based localization technique, where three sensors take part to localize the target. Then the location information is sent to the cluster head.

The cluster head runs DR based tracking algorithm and, if required, it sends tracking information to the base station. Based on this information, the base station plots the tracking path in order to get the overall picture of the target course, so that the appropriate measures could be adopted accordingly. The error correction and error avoidance phase starts when the cluster head receives the fix, also known as position fix. Fix is the known position within the sensor field, against which target’s current position is measured. Using position fix the cluster head observes an accurate target
location and verifies it too. At the other hand, the base station adjusts the location errors on every position fix. Significant tracking accuracy is achieved with error correction and error avoidance phase of DR.

Rui Tan et al [56] have exploited reactive mobility to improve the target detection performance of wireless sensor networks. In their approach, mobile sensors collaborate with static sensors and move reactively to achieve the required detection performance. Specifically, mobile sensors initially remain stationary and are directed to move toward a possible target only when a detection consensus is reached by a group of sensors. The accuracy of final detection result is then improved as the measurements of mobile sensors have higher Signal-to-Noise Ratios after the movement. We develop a sensor movement scheduling algorithm that achieves near-optimal system detection performance under a given detection delay bound.

In their work, they attempted to address the aforementioned challenges and demonstrate the advantages of reactive mobility in target-detection WSNs. Their paper makes the following major contributions:

- They presented a new formulation for the problem of target detection based on a novel two-phase detection approach. Their formulation accounts for stringent performance requirements imposed by mission-critical detection application including high detection probability, low false alarm rate and bounded detection delay. In the two-phase detection approach, mobile sensors initially remain stationary and are directed to move toward a possible target only when a detection consensus is reached by all nearby sensors. Such a strategy allows mobile sensors to avoid unnecessary movement through the collaboration with static sensors.

- They developed a near-optimal movement scheduling algorithm based on dynamic programming that minimizes the expected moving distance of mobile sensors. Their scheduling algorithm also enables mobile sensors to locally control their movement and sensing, thus both coordination overhead and detection delay are reduced significantly. Although the algorithm is mainly designed for stationary target detection at fixed locations, they also discussed the extensions to more general cases such as detecting moving targets.
They conducted extensive simulations using real data traces collected by 23 sensors in a real vehicle detection experiment. Their results provide several important insights into the design of target-detection systems with mobile sensors. First, they showed that a small number of mobile sensors can significantly boost the detection performance of a network. Second, tight detection delays can be achieved by efficiently scheduling slow-moving mobile sensors.

Jianzhong Li et al [25] have proposed a data compressing based target tracking protocol. It first incorporates a clustering based data gather method to group sensor nodes into clusters. Then a novel threshold technique with bounded error is proposed to exploit the spatial correlation of sensed data and compress the data in the same cluster. Finally, the compact data presentations are transmitted to the base-station for targets localization.

In their paper, they presented a data compressing based target tracking protocol, which incorporates data approximation algorithm in the procedure of targets tracking. The characteristic of sensed data over sensor nodes surrounding interested targets is exploited, replaced as a series of approximate values. Compact descriptions of these readings are transmitted to the base-station, where targets location is implemented on the compact descriptions directly. Given an error bound, they tried to compress readings for the same target maximally by grouping the original data and approximating them falls within the error bound around estimated values.

The proposed approach can release the traffic load and reduce energy consumption for data transmission efficiently. However, this often comes at the price of loss in tracking quality, which is equivalent to a loss in data precision and localization accuracy. They analyzed the error of tracking results and discuss the determinations of parameters in their paper. In addition, the proposed compressing provides a low overhead, which makes it practical for overhead sensitive applications with WSNs.

The contributions of this paper are as follows:

- They introduced a new approximation scheme that makes full use of correlations among data of multiple sensor nodes. It exploited the spatial correlation of targets information to implement data reduction.
• They incorporated the idea of data reduction into target tracking, which shrinks the volume of transmitted data efficiently with guarantee of tracking quality. It is an efficient solution for prolonged network lifetime.

• They explored the trade-off between energy savings and tracking quality. They aim to design a tracking system in an energy-efficient manner at the price of allowable accuracy sacrificing.

**Zhibin Xue et al** [82] have elaborated that introducing the target tracking control and global asymptotic stability respectively of the two kinds of different swarm systems with aggregation functions, the study of multi-agent systems is start with two aspects: one hand is starting off from formation coverage search, but on the other hand, researching the character of high noise inhibiting ability and stability. By use of the swarm dynamical models, meanwhile, considering the interactions among agents, based on the artificial potential functions (APFs) and Newton-Raphson iteration updating behaviour rules, theoretical analysis.

**Samer Samarah et al** [62] have proposed a prediction based tracking technique using sequential patterns (PTSPs) designed to achieve significant reductions in the energy dissipated by the OTSNs while maintaining acceptable missing rate levels. PTSP is tested against basic tracking techniques to determine the appropriateness of PTSP under various circumstances.

In their paper, they proposed the prediction-based tracking technique using sequential pattern (PTSP), which is an object tracking technique that revolves around the ability to predict the objects’ future movements to track it with the minimum number of sensor nodes while keeping the other sensor nodes in the network in sleep mode. This would achieve their goals while significantly reducing the network’s energy consumption. The PTSP is based on the inherited patterns of the objects’ movements in the network and the utilization of sequential patterns (a data-mining technique) to predict to which sensor node that the moving object will be heading next. Since the PTSP totally depends on prediction, it is possible to have some missing objects during the tracking process. In addition to the main prediction technique, they proposed several mechanisms to locate missed objects.
2.5 Existing Works on Clustering

Pu Wang et. al., [53] has been proposed a distributed clustering protocol called minimum-energy clustering (MCCP) protocol. It selects a set of non-overlapping clusters from all potential clusters based on the cost metric assigned to each potential cluster and attempts to minimize the overall cost of the selected clusters. Here a Centralized Minimum-Cost Clustering Algorithm (MCCA) is implemented and then MCCP is presented which implements MCCA in a distributed manner. The total energy consumption of the cluster members for sending data to the cluster head, the residual energy of the cluster head and its cluster members and the relative location between the cluster head and the underwater sink are discussed here.

B. Elbhiri et al., [4] have been proposed a scheme for heterogeneous wireless sensor networks named Stochastic Distributed Energy-Efficient Clustering (SDEEC). This technique is based on DEEC scheme in which all nodes use the initial and residual energy level to define the cluster heads. It estimates the ideal value of network lifetime to compute the reference energy that each node should consume during each round. It balances the cluster head selection over all network nodes following their residual energy. It also reduces the intra-clusters transmission when the objective is to collect the maximum or minimum data values in a region.

Malathi and Gnanamurthy [34] have proposed a clustering algorithm to construct the routing tree for efficient data transmission and consume less energy, while distributing energy consumption equally among all nodes. It finally extends the network lifetime. Simulation result shows that this protocol consumes the energy of the node efficiently and improves the life time of the Network. For set of 100 nodes, this algorithm gives 31% better performance than LEACH, 18% better performance than LEACH-C, and 15% better performance than LEACH-C in terms of network life time.

Mao Song et al., [37] have proposed a novel energy efficient unequal clustering algorithm for large scale wireless sensor network (WSN) which aims to balance the node power consumption and prolong the network lifetime as long as possible. This approach focuses on energy efficient unequal clustering scheme and inter-cluster routing protocol. On the one hand, considering each node’s local information such as energy level, distance to base station and local density, they use
fuzzy logic system to determine one node’s chance of becoming cluster head and estimate the corresponding competence radius.

On the other hand, adaptive max-min ant colony optimization is used to construct energy-aware inter-cluster routing between cluster heads and base station (BS), which balances the energy consumption of cluster heads and alleviates the hot spots problem that occurs in multi-hop WSN routing protocol to a large extent. The confirmation experiment results have indicated the proposed clustering algorithm has more superior performance than other methods such as low energy adaptive clustering hierarchy (LEACH) and energy efficient unequal clustering (EEUC).

Md. Abdul Alim et al. [39] have proposed a fuzzy logic based energy-aware dynamic clustering technique, which increases the network lifetime in terms of LND. Here, two inputs are given in the fuzzy inference system and a node is selected as a cluster head according to the fuzzy cost (output). The main advantage of this protocol is that the optimum number of cluster is formed in every round, which is almost impossible in LEACH (low-energy adaptive clustering hierarchy). Moreover, this protocol has less computational load and complexity.

Jalil Jabari Lotf et al. [20] have made an attempt to present a model based on Hopfield–fuzzy CMeans clustering algorithm. Firstly, it is capable of identifying the reasons behind the emergence of the present status. Secondly, the suggested model must represent the clustering of the WSN in different levels. Finally, it tests the validity of the suggested model with comparing by other models (Hopfield–K-Means, K-Means, and fuzzy C-means).

The clustering algorithm in an iterative process tries to find a policy that determines a cluster-head set with the minimum cardinality for the network. This approach eliminates the randomness of the initial solution provided by fuzzy C-means based algorithms and it moves closer to the global optimum.

Rogaia Mhemed et al., [55] have been proposed a novel scheme called the Fuzzy Logic Cluster Formation Protocol (FLCFP). This scheme uses Fuzzy Logic Inference System (FIS) in the cluster formation process. Using multiple parameters in cluster formation minimizes energy consumption. This technique considers three parameters such as energy level of the CH, distance of the CH to the BS and the
distance between the CH and the node in cluster formation, as opposed to LEACH, which uses only one parameter.

FLCFP technique is compared with the well-known LEACH protocol using FND metrics and Paired T-Test in MINITAB. This shows that using a multi parameter, FIS improves the network lifetime. Simulation results show that this approach prolongs the network lifetime as compared to the LEACH protocol.

Proposed methodologies explain Sink repositioning and relocation, clustering, localization of mobile nodes and different tracking methods. From the above literature we can find some of the major drawback. The above discussion leads to the following findings:

1. In Sink repositioning and relocation approaches is not considering the factor about the time limit to find the solution.
2. In existing case the sink mobility in the network dynamics is not analysed.
3. The Existing works which are explained about localization are not explained about the transmission range of the mobile nodes.
4. In all the existing papers which are explained about tracking is not an energy-efficient one. Most of the proposed protocols are energy constrained only. So we need a optimal energy based tracking methodology.