CHAPTER 1

INTRODUCTION

1.1 BASIC CONCEPTS OF WIRELESS SENSOR NETWORKS (WSN)

A Wireless Sensor Network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations. For large-scale WSNs with a minority of anchor nodes, multi-hop localization is a popular scheme for determining the geographical positions of the normal nodes. However, in practice existing multi-hop localization methods suffer from various kinds of problems, such as poor adaptability to irregular topology, high computational complexity, low positioning accuracy.

The signal position is the major factor of the sensor network. The accuracy of signal position can be described by the various parameters. A typical wireless sensor network consists of a base station and several nodes distributed or positioned in the environment of interest. Each node is expected to detect events of interest and estimate parameters that characterize these events. The resulting information at a node needs to be transmitted to the base station either directly or in multi-hop fashion involving automatic routing through several other nodes in the network [Rong Peng, 2006]. Implementation of such a network requires hardware
components and corresponding software modules to program these components in a cooperative manner. Wireless Sensor Networks can be applied to a range of application monitoring of space which includes environmental and habitat monitoring, indoor climate control, surveillance etc.

1.2 NETWORK ARCHITECTURE

The architecture of Wireless sensor network implies that how the signal can be transferred through communication channel and how the frequency is allotted to the particular location. The sink node is defined for specifying the authentication between source and destination [Soochang Park, 2013]. The figure 1.2 shows the architecture of sensor node with all relay nodes.

![Wireless Sensor Network Architecture](image)

**Figure: 1.2. Wireless Sensor Network Architecture**
In the present scenarios, WSN plays a vital role in many Engineering and Scientific applications. A WSN is composed of plenty of sensor nodes. These nodes have the ability of sensing computation, and wireless communication. Owing to its powerful function and low energy cost, the WSN has been widely used. The Localization concept is one of the major important factors in WSN. In WSN, identify the signal position is crucial. When an abnormal event occurs, the sensor node detecting the event needs the position information to locate the abnormal event and report to the base station.

1.3 LOCALIZATION IN WSN

In WSN, the localization is defined as identifying the physical coordinates of a group of sensor nodes. The coverage control technology is the one of the basic technologies of wireless sensor network, and is mainly concerned about, how to prolong the network lifetime on the basis of meeting a user’s perception demand. Among this technology, the localized area coverage algorithm in the study of area coverage technology is gradually attracting wide attention, for its less traffic and lower single-node computation [S. Zhong, 2008].

In general, almost all the sensor network localization algorithms share three main phases

1. Distance estimation
2. Position computation
3. Localization algorithm
Many Localization algorithms have been demonstrated in the earlier work. Each algorithm has defined the signal position for transferring the information between the nodes. The data is communicated from one node to another node by various schemes such as Location based scheme, neighbor based scheme, Energy saving scheme and Receiver signal strength scheme. From these schemes, finding the exact position of the signal with appropriate bandwidth and also producing the Quality of Services is the present challenges in WSN [R. Peng, 2006]. Each scheme can be explained one by one in the following session.

**Location Based Scheme:** In the LB scheme, each beacon reports its observed signal strengths, which are used by the BMD Module to compute each beacon’s current location.

**Neighbor Based Scheme:** In the NB scheme, each beacon locally decides if some neighboring beacons have moved into or out of their communication coverage range and reports its binary observations to the BMD Module.

**Receiver Signal Strength:** An RSS-based localization scheme- The measuring distances in the path-loss equation can be computed more precisely by the calibration process.

Based on these schemes the localization accuracy is identified for finding the exact signal position [Sheng-Po, 2009].
1.3.1 LOCALIZATION ACCURACY

Localization accuracy is the parameter that defines the signal strength variations of all the coverage of nodes. Normally the signals passed through several times before reaching the command center. Identifying the localization accuracy, finding errors and bandwidth accuracy will improve the localization [Zhao ju-Min, 2014].

1.4 MULTIPLE ACCESS TECHNIQUES

Medium Access Control (MAC) refers to controlling user access to the communication channel, i.e., sharing the bandwidth amongst the users. Ideally, the bandwidth would be shared fairly with some quality of service considerations. When communication is used for real time information, there needs to be a bound on the delay that a user experiences before it can successfully access the channel [El-Hoiyi, 2004].

The exact frequency levels could not be specified and positions with authentication are not defined in the early research work. In WSN, finding the frequency and bandwidth are difficult task for node to node communication. The RSS algorithm is used to find the improved level of transferring information between nodes, but in the case of signal position, frequency and scheduling the communication is a major problem in the localized environment. In order to avoid such problems, the multiple access technique need to be implemented in the communication channel and the
various channels are analyzed and implemented with localization algorithm for producing the best frequencies in the localized environment. The Space Division Multiple Access (SDMA), Frequency Division Multiple Access (FDMA) and Orthogonal Frequency Division Multiple Access (OFDMA) techniques have been implemented in the communication channel. All the multiple access techniques have been implemented and measure the performance of bandwidth in the communication channel.

The basic issue in communication networks is the transmission of messages to achieve a prescribed message throughput (Quantity of Service) and Quality of Service (QoS). The QoS can be specified in terms of message delay, message due dates, bit error rates, packet loss, and economic cost of transmission. The primary responsibility of a MAC protocol in WSN is the distributed arbitration for the shared channel for transmission of data [Umesh B.N, 2013]. Each multiple access techniques have been discussed in the following scenario.

1.4.1 **Space Division Multiple Access Technique (SDMA)**

SDMA relies on user position information and that provides users access to the communication channel based on their spatial locations. The SDMA divides the geographical space, where the users are located, in a smaller space. The key element of the design is a one-to-one mapping between the space divisions and the bandwidth divisions of time slots, frequency divisions, etc. Therefore, SDMA is compatible with any multiple access schemes such as TDMA and FDMA [Soheila V. Bana, 2001].
SDMA Method has used for representing the voice over data. The frequency is duplicated and new frequency is assigned for every transmission. The fixed time slot is not measured for all transmission channels using SDMA technique.

1.4.2 Frequency Division Multiple Access Technique (FDMA)

FDMA divides the shared medium bandwidth into an individual channel. Subcarriers modulated by the information to be transmitted to occupy each sub channel. FDMA is the traditional way of separating radio signals from different transmitters. It is a networking technique in which, multiple data signal is combined for simultaneous transmission via a shared communication medium. The frequency spectrum is divided into several non-overlapping frequency bands. The advantage of the FDMA is the senders can send signals continuously. In this case no dynamic coordination is necessary. A Channel gets a certain frequency band for a certain amount of time and also FDMA is not vulnerable to the timing problems. FDMA gives users an individual allocation of one or several frequency bands or channels [T. Frank, 2005].

1.4.3 Orthogonal Frequency Division Multiple Access Techniques (OFDMA)

To increase the data rate, one can use architecture that simultaneously transmitting multiple signals over a single transmission path. Each signal travels within its own unique frequency range, which is modulated by the
data. Orthogonal frequency division multiplexing (OFDM) systems break the bandwidth into narrower orthogonal subcarriers and transmit a data as parallel streams. Using OFDMA, the bandwidth is used in a narrow beam without any subdivisions during the communications of data. We assume that wireless channels between nodes in the cellular are frequency selective fading channels [Guoqing Li, 2006]. OFDM technology divides the whole channel into many subcarriers so that each subcarrier experiences frequency flat fading. We assume a slow fading environment so that the channel remains unchanged during the resource allocation period.

1.4.3.1 Comparison of OFDMA

The OFDMA technique is the best way of finding the more frequency in the communication channel. The bandwidth can be increased in this technique for establishing the data transmission quickly. The purpose of WSN node localization is to determine the appropriate positions of a sensor node without knowing the initial location information. The scenario of a various multiplexing technique defined under the multipath environment with same frequencies and bandwidth, but in the case of all techniques of multiplexing in the MAC protocol such as FDMA, CDMA and SDMA are used in a narrow beam. In this case every technique divides the frequencies and produces the lower bandwidth. The OFDMA is the best solution, even if we do not use any statistical techniques to identify the errors. The OFDMA should not divide the frequencies and produces the higher bandwidth [Tijs van Dam, 2003].
OFDMA spread spectrum technique distributes the data over a large number of carriers that are spaced apart at precise frequencies. This spacing provides the orthogonally. In this technique which prevents the demodulators from seeing frequencies other than their own.

1.4.3.2. Efficiency of OFDMA in WSN

A clustered network topology and cooperation protocol is proposed to realize multi-hop long haul signal transmission. The effect of the cluster scale is studied thoroughly to obtain the optimal size of clusters, subject to the cooperation overhead [Riaz Ahmed Shaikh, 2009]. Simulation results show that the proposed cooperation scheme can consistently reduce the transmission power with the increase of cooperation scale. OFDM systems offer some of the overwhelming features as below

1. The bandwidth is very less compare to all other multiplexing techniques.
2. Robustness that against the multipath channel, flexible resource allocations and high spectral efficiency, the OFDM scheme is being gradually applied in WSNs.
3. Due to the difference of channel conditions, distinct energy consumptions are occurring within sensor nodes.
4. Unfair energy usage can result in that excessive energy are consumed by some advantageous sensor nodes that minimize transmit power for OFDM under a WSN.
1.4.3.2 Errors in WSN

The properties of errors can be divided into two categories

The permanent faults include,
1. Due to unavailability of energy resource.
2. Calibration errors after prolonged use.
3. Loss of wireless coverage.

Soft failures occur,
1. Wireless channels as transient errors.
2. Noise from various sources.

The errors occur during the communication and it also occurred for a finding of signal in the localization. The coverage area is normally defined by coordinating the position of localization. If the signal measurement is accurate, then data can be transferred frequently without any interference. The signal position is weak in the particular location; the lack of coverage area can be measured. The errors can be measured with the help of statistical procedure for finding the accurate result of localization error. The Minimum variance Unbiased Estimator (MVUE) technique is used to find the average error rate for distributing the data. While distributing the data using with multiple access technique like SDMA, FDMA and OFDMA, the errors are calculated based on the bandwidth can access in the communication channel [Ghobadzadeh, 2012]. So the statistical structure of error calculating measurement is to be taken in the next session.
1.5 STATISTICAL APPROACH

The statistical approach can be used to calculate the error rate in the communication channel as well as in the localization environment. The errors are identified by the various techniques. One of the techniques which are used to calculate the error rate is a MVUE.

There may be many unbiased estimators of $\mu$. Given two unbiased estimators are on $\hat{\theta}_1$ and $\hat{\theta}_2$ of $\theta$. We choose the one that gives less variance. If $V(\hat{\theta}_1) \leq V(\hat{\theta}_2)$, $\hat{\theta}_1$ is called more efficient than $\hat{\theta}_2$. An efficient estimator has less variability so these are more likely to make an estimate close to the true parameter value. Among all unbiased estimators, we choose the most efficient estimator called the Minimum Variance Unbiased Estimator (MVUE). The MVUE is an unbiased estimator with the smallest variance. MVUE is the most efficient estimator. An efficient estimator $\hat{\theta}$ will produce an estimate closer to the true parameter $\theta$ [Ashok Shanubhogue, 2012].

**Lemma:** Assuming the Sensor nodes $X_1, X_2... X_n$, are traveling on the same communication channel, the frequency can be measured in the localization with linear estimator of parameter $\theta$ is an estimator of form

$$\hat{\theta} = \sum_{i=1}^{n} c_i X_i \quad (1.1)$$

Then it can be shown that $\bar{x}$ is the MVUE for all sensing nodes for minimizing the error in the mean $\mu$ among all possible linear estimators.
**Proof**

Let we take two nodes where $n=2$ will be proved that the MVUE estimator is the most efficient estimator in the localization for transferring the data in the communication channels. Consider linear estimators

$$\hat{\mu} = c_1 X_1 + c_2 X_2 \quad (1.2)$$

To be unbiased, $c_1 + c_2 = 1$. To be most efficient among all unbiased linear estimators, the variance has to be minimized. The variance is

$$C_1^2 V \hat{\mu} = C_1^2 V X_1 + C_2^2 V X_2 = [C_1^2 + (1 - C_1)^2] \sigma^2 \quad (1.3)$$

The quadratic term in the bracket $2 - 2C_1 + 1$ is minimized the error in the variance when $c_1 = 1/2$.

In this case, the error rates are calculated in less than 0.5 for minimizing the errors. In the localization, the signal strength is accurate in the particular location.

1.6 **PARTICLE SWARM OPTIMIZATION**

Particle Swarm Optimization is an algorithm capable of optimizing a non-linear and multidimensional problem which usually reaches good solutions efficiently while requiring minimal parameterization. Particle Swarm Optimization (PSO) is used to find the position of localization. The coordinating position is identified by finding the signal positions where it is available in the localized environment. The PSO provides accurate source location estimation for both known and unknown propagation speed and also gives an efficient speed estimate in the latter case. The PSO algorithm cannot be used to find the time limitations for allocating the bandwidth in the communication channel for positioning the signal [Mansoor-ul-Haque,
In this case, the exact frequency level and time is not mentioned in the location [Kenneth W. K., 2007]. To overcome this scenario, the improved particle Swarm Optimization algorithm is used to allocate the time limitations and measuring the bandwidth in the communication channel. Particle Swarm Optimization is an algorithm capable of optimizing a non-linear and multidimensional problem which usually reaches a good solution efficiently while requiring minimal parameterization.

The basic concept of the PSO is to create a swarm of particles which move in the space around them searching for their goal, the place which best suits their needs is given by a fitness function. A nature analogy with birds is the following: a bird flock flies in its environment looking for the best place to rest. Based on this simple concept, there are two main ideas behind its optimization properties

1. A single particle can determine how good its current position is. It benefits not only from its problem space exploration, knowledge but also from the knowledge obtained and shared by the other particles.
2. A stochastic factor in each particle's velocity makes them to move through the unknown problem space regions. This property combined with a good initial distribution of the swarm enable an extensive exploration of the problem space and gives a very high chance of finding the best.
Regarding position, all the particles in the swarm positioned in the n-dimensional space by distributing them as desired within the search space, two common ways to do it are randomly or uniformly position them. The velocity is usually set to a random value. The lower ones are usually more adequate to avoid a large initial offset. The social and cognitive component scale values are also determined at initialization time since they are constant throughout the optimization process.

The improved particle swarm optimization algorithm and Sink nodes are implemented in OFDMA technique for producing an efficient way of communication. The signal positions are allocated in the particular environment by the IPSO (Improved Particle Swarm Optimization) algorithm in the certain coordinates. The position is taken and analyzed in the particular location. In every particle, the signal is measured. Then Swarm the optimized position of the nodes.

Once the positions are assigned, nodes are clustered with a sink node for authentication. Then the nodes are transferring the information without any interference to the destination node. Each node is scheduled with the particular time for establishing the transmission. In this way each communication is analyzed and measuring the efficient bandwidth in the localized environment.
1.7 SECURITY IN WIRELESS SENSOR NETWORK

A number of procedures have been included to define the problem of Initial secure key deployment in Wireless Sensor networks. The security is the major aspects of protecting the environment of localization in wireless sensor networks. The various security mechanisms can be included and protecting against unauthorized access. The authentication is one of the control protections by providing a secure way of transmission. The nature of the wireless sensor medium leaves it vulnerable to intentional interference attacks, typically referred to as Jamming. This intentional interference with wireless transmissions can be launched for mounting Denial of Service attacks [Rajeev Paulus, 2012].

The clustering of nodes in wireless medium is difficult to understand about the attacks. This type of attack will be classified in the transmission channel for identifying the indented node to communicate with the destination.

The mobile sink is the mechanism, which is used to cluster all the nodes in a place and identify the suspicious nodes in the source place. It is used to provide the authentication for controlling the duplicate nodes.
1.7.1 Mobile Sink

There are two sinks can be classified in the mobile sink named as, static sink and dynamic sink. The static sink is used to identify all the nodes in single path communication. In such an environment, the main energy consumption is the communication module of each node. In the way of practice, multihop communication is required for sending a data from sources to sink nodes. Alternatively, the energy consumption depends on the communication distance [Liang song, 2007].

The reduction of communication distance is to deploy with multiple static sinks. The problem of multiple sink is lacking of identifying positions to deploy the data in the localized environment. If the positions of the static sinks are given, then the solution of this problem can be used for finding the optimal partitioning of the field. Such a partitioning can be either static or dynamic, and it can be predetermined or self-organized within the network cluster heads that tend to have higher capacity than regular nodes and are responsible for forwarding collected data to the sink over a single or multiple hops. Both the cluster formation and the selection of the cluster head is done, in such a way that the energy dissipation during the routing can be minimized.
1.8 APPLICATION OF WIRELESS SENSOR NETWORK

The WSN is widely used in the large number of applications in the real time environment. Using WSN different organizations is using different type’s applications for the purpose of reducing the manpower. The Military organization is used for Wireless sensor network for attacking the enemies in the forest area. In the Home environment, Media people can use for the purpose of protecting the things in the house using WSN and Patient tracking system in the hospital is also used by WSN. The various sensor devices are used in the different applications for finding their satisfactory activities [Aminian, 2013].

In the recent world, one of the applications like cancers tracking system in the human body is analyzed and proposed to implement in the hospital. This system is used to measure how the drug can be inserted into the human body and how it can be finding the cancer biopsy inside the body. Once the drug is delivered into the human body, the nature of the system is intimated to the doctor by using an alarm in WSN.

This method can be implemented with the proposed algorithm for intimating the alarm system when the drug is spread out in the body. This can be helpful in reducing the scan and X-ray procedure and also can be used in smaller hospitals without diagnosing the scanning system.
1.9 ORGANIZATION OF THESIS

A detailed discussion about Literature survey on the proposed algorithm is explained in the chapter 2.

Designing of the system and implementation is described about proposed dynamically addressed the source in WSN using SDMA technique in chapter 3.

The proposed analysis of the signal strength localization of FDMA Technique using with FDMASS algorithm is explained in chapter 4.

Improving the Quality of Service of OFDMA technique in WSN and also improving the security between sink nodes in WSN using IPSO is explained in chapter 5.

The application of IPSO is explained in chapter 6

The finalization of the conclusion and future work of the thesis is defined in chapter 7

The references, list of publications and biography are added at the end of the thesis.