Mobile WSN with Directional Antennas And Routing Protocol Methods: Review

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Abstract— Mobile wireless sensor networks have a great impact on the technology and it is supportive to the wider range of the applications and it ranged from weather information to the industrial major projects even in the military area. The current research is obtained for representing the description of mobile wireless sensor networks with the use of reconfigurable directional antennas. Usually, the directional antennas are utilized for the communication purposes in the mobile networks due to its vast features as the enhanced transmission range, reduced interferences, and so on. The complete description of directional antennas is given with the description of various routing protocols used in the directional antennas. RDA (re-configurable directional antennas) bring opportunities to optimize the data collision in WSN(Wireless Sensor Network). The protocols used in directional antennas are different as compared to the basic routing protocols utilized in the other antennas and in the mobile networks. MAC (Medium Access Control) protocols are carried out for the secured sharing of wireless resources. The main survey of the various papers MAC protocols used for WSN sensor node devices with switched antennas. A less-complexity and energy-efficiency scanning procedure is embedded in directional antenna to verify the direction giving the higher received signal strength between two nodes.

Keywords— *WSN (Wireless Sensor Networks); MIMO (Multiple Input Multiple Output); MAC (Medium Access Control); RAM (Random Access Mechanism); SM (Scheduling Mechanism).*

I. INTRODUCTION

At the present time, the wireless sensor networks (WSN) are utilized enormously. It has vast applications in every field. Generally, a wireless sensor network is an infrastructure less network which was not connected by using wires. The data communication was occurred using wireless signals. The wireless systems are representing the new form of embedded systems that has different communication ways and it is differ from the traditional networks [1].

Fig. 1:Wireless Sensor Networks [3]

It's composed of the sensor devices which are distributed in the environment, even indoor or outdoor. The aim of the wireless sensor network is to collect the information and to transfer to other devices. The main topologies of WSN are mesh and star topologies [2].

In fig.1 the blue mobile nodes are the sensor nodes and the red colored mobile node is the target node which initialized the data transmission or a source node. The most challenging concepts in the field of WSN are the energy consumption, location of sensor nodes, robustness, efficiency and the routing protocols [2]. The major applications of mobile wireless sensor networks are seen in the industrial area, automatic and smart homes, surveillance systems, traffic monitoring system, medical field, robotics and pollution monitoring devices [4].

An antenna is a conductor that mainly used in the networking. Its major role is to transmit the data from source to destination. The data are transferred into signals and the signals are varied in different type, for instance radio, microwave or satellite. The reason behind the use of antennas in the network is to strengthen the network and to expel the limitations of WSN such as the limited storage of sensor nodes, consumption of energy, routing issues, efficiency and so on. Therefore, antennas are utilized mainly for the communication in the most secure way and to enhance the performance of the network.

A. Classification of Antennas

The antenna is classified into two categories as the omnidirectional and directional antennas.

1) *Omnidirectional Antenna:* The internal procedure of communication of nodes in the network access the omnidirectional antenna. It simply broadcasts the radio signal in all the directions. These are generally small sized, low cost, easy to implement.

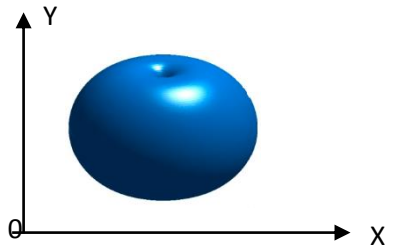
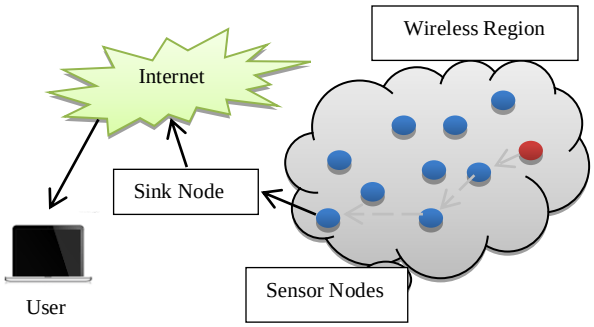


Fig.2: Omni directional Radiation Pattern [5]



2) *Directional Antenna*: The use of the directional antenna is to alleviate the issues in the wireless sensor networks. It is applied in two ways as in directly and indirectly which relies on the node position. The other name of the directional antenna is the beam antenna. Its main objective is to emit and receives, the more power in some specific direction. In this way, it declined the interferences and the collision that later increased the security against the harmful attacks like jamming, eavesdropping and so on [5].

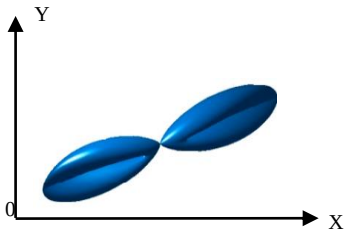


Fig.3: Directional Radiation Pattern [5]

The review study is represented in the different sections and these sections have corresponding data. The first section composed of the basic information of the mobile wireless sensor networks, wireless sensor networks, antenna description and the basic classification of the antenna. Second Section is the overall description of the directional antennas in the field of mobile wireless sensor network. The third section is the discussion about the previous researches done in the reconfigurable directional antenna with WSN (Wireless Sensor Networks). In the last section, the routing protocols are described that come under the area of the directional antenna. At last, the conclusion is given from the entire review paper.

II. OVERVIEW OF THE DIRECTIONAL ANTENNA

The directional antenna is the best category [6] as compared to the other antenna's classification. Generally, it is categorized into two types as the traditional antenna and the smart antenna.

A. Traditional Antenna

In this simple directional antenna, the beams are obtained from the antennas are fixed and managed by using some specific mechanical rotation procedures. The common traditional antennas are pyramidal, conical horns, reflectors and the patch antennas.

B. Smart Antenna

Usually, the smart antennas are composed of the antenna elements as the linear and the circular array with the ability of the signal processing mainly to send and receive the data. The performance of the smart antennas is better as compared to the traditional antenna in terms of the beam formation, diversity and the adaptive reusing abilities. It is not just the collection of the elements, but also contains a control unit which was executed by using the digital processor and it is also considered as the brain of the antenna. Furthermore, the smart antennas are also classified into four types. Smart antennas can be categorized as the following types:

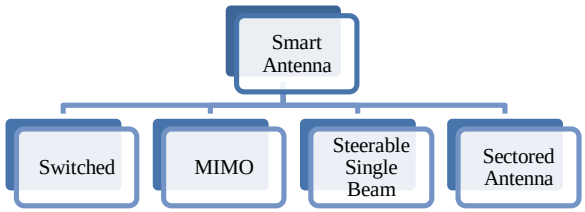


Fig.4:Classification of Smart Antennas [6]

1) *Switched Beam Antenna:* This kind of the antenna is mainly evaluated via shifting the elements in the signal phase. For the better formation of the beam patterns. These patterns are saved in the memory and switched.
2) *MIMO Adaptive Array:* MIMO (Multiple Input Multiple Output) adaptive array is also the category of the smart antennas. For the multi-path signals that are required to be acquired by radiation patterns are obtained by applying the space diversity schemas. The main reason behind the creation of adaptive array is to utilize the antenna at the both sides as the transmitter and the receiver. These are called as a MIMO beam formation. Later, it enhanced the performance of the signals in the multipath [6] [7].
3) *Steerable Single Beam:* These are generally known as the dynamic phase array and these are obtained on the fly. The radiation patterns are managed according to the directions to set it at null. The goal of using steerable beams is to increase the signal interference and the noise ratio.
4) *Sectored Antenna:* The main use of the sectored antenna is seen in the cellular networks. It simply partitions the region that covered by the omnidirectional antenna. The each partition group referred as sector and contains the different cell. These cells are mainly utilized for giving

the widest range as compared to the omnidirectional antennas. It chooses the one and more sectors, specifically for the transmission of data at a time. Commonly, it referred as the switched beam [6].

C. Characteristics of Directional Antennas

There are generally countless characteristics are seen in the directional antenna rather than the omnidirectional antennas. Some of the major characteristics of the directional antenna are mentioned below-

1) The interface in the directional antennas is lower as compared with omnidirectional antennas.
2) The reusability in the directional antenna is enhanced and it gives access for the better concurrent transmission of the data on both sides as the transmitter and the receiver.
3) The transmission range is wider in this antenna. The focus is in one direction that makes it reliable for being covered.
4) The needs of the power consumption are reduced because it has more gaining capability
5) The routing performance is better as compared to the other antennas.
6) The capacity of the directional antenna is more.
7) It enhanced the throughput of the wireless network [6] [8].

D. Routing Protocols in Directional Anteenas

Most of the effort on the study of directional antennas for ad hoc networks has concentrated on the MAC protocols [20]. Until now, however, there is no comprehensive study of routing protocols using directional antennas. We now discuss existing work on routing for directional antennas.

1) Directional Routing Protocols

Directional Routing Protocol (DRP) Directional Routing Protocol (DRP) [17] is a cross layered routing protocol which is specifically tuned to the underlying directional antennas. DRP attempts to alleviate some of the inherent drawbacks involved in directional communications while exploiting the potential benefits such as increased coverage range and directionality. DRP has a substantial decrease in route discovery latency as well as directional broadcasting overhead as compared to DDSR. The efficient route recovery mechanisms in DRP prevent any throughput degradation due to frequent movements of intermediate nodes. However, it is worthwhile to note that throughput gain in case of directional antenna systems depends on the topology under consideration. Mobile nodes that are in the restricted signal broadcast edge will broadcast while another node which are out of this edge will ignore the request of route packet. [21]

2) Directional Dynamic Source Routing (DDSR)

As the name implies, Directional Dynamic Source Routing (DDSR) [18] is the original DSR over directional antennas. The best route from the source node to the destination node is selected according to hop count, power budget and overlap count. In order to calculate the overlap count in a specific route, positional information of the current node will be inserted into the RREQ and RREP of the DDSR routing protocol.

In DDSR, instead of discarding every duplicate RREQ, intermediate nodes will forward the RREQs whose hop counts are not bigger than that of the previously received RREQs; even if they have the same ID. Therefore the source node may receive multiple RREPs and obtain all possible routes to the destination. DDSR avoids interference from nodes hops away by exploiting the directionality of the beams.

The conclusion of this protocol (DDSR) routing protocol i.e deliver number of data packets with less hop count and minimum end-to-end delay as compared to the DSR routing protocol. It also faces a minimum energy loss. [22]

3) Directional AODV Protocol

In DAODV [20], positional information about the current node will be inserted into the RREQ and RREP. As shown in Figure 1, the source node A initiates the route discovery process to destination node J by broadcasting the RREQ to its neighbor nodes. In this RREQ the positional information of node A is inserted. Once a node B receives the RREQ from node A, it adds its own positional information to the RREQ and forwards it to the neighboring nodes. After receiving the RREQ from node B, node D creates a backward route to node A in its routing table entries. According to the positional information of node A and B in the received RREQ, node D calculates the DOAs of A →B, A→D and D→B. Here the overlap count is one and is added on to the route to node A. Once the next hop becomes unreachable because of the link break caused by mobility and packet collision, the node upstream of the break empties its buffer and propagates a route error (RERR) packet to all active upstream neighbors. Similarly, these nodes, fresh out of their buffer, delete all the related routes and relay the RERR to their upstream neighbors and so on until the source node is reached. A new route discovery procedure will be initiated by the source if the route to the destination is still needed. DAODV avoids interference from nodes hops away by exploiting the directionality of the beams. However, DDSR routing protocol achieves a better performance than the DAODV routing protocol because of its capability of learning multiple routes to the destination in a single request cycle.

In D-AODV protocol reduces the number of signal broadcasting route request (RREQ) data packets by using

A restricted directional flooding methods (DDoS, Syn and IP Spooing). Its results showed that D-AODV is importantly minimum routing overhead by route request packets and improve overall throughput performance.[23]

Table.1: Comparison of the Directional Anteena

	Anteena Models	**Mac protocols**	**Max. Anteena Gain**
DRP	Switched	MDA	4db, 23.31 db,

	Beam Anteena		55.71 db
DDSR	Switched Beam Anteena	DMAC	15.56 db
DAODV	Switched Beam Anteena	DMAC	15.56 db

We compare the state-of-the-art routing protocols proposed so far in the literature. The main motive of the comparison routing protocol, which protocol results are better and give the high precise values.We evaluate the routing protocols over directional antennas in terms of various characteristics including important performance metrics. Antenna models, MAC protocols, maximum antenna gain, number of directional antenna beams, directional neighborhood, multipath support, network throughput, end-to-end delay, and routing overhead is studied in the comparative analysis. Table 1 summarizes the comparison results of these routing protocols.

III. PRIOR WORK

In this section, the previous research works are discussed with the description of the used techniques and the outcomes of the results are explained. The motive of study these researches are to acquire more knowledge from the previous research that are being important phase for the further researches.

Le, T.N., et al., (2016) [12] proposed the enhanced energy efficiency in the mobile wireless sensor networks (WSN) by accessing the reconfigurable directional antennas (RDA). WSN was a wireless network, which was infrastructure less and transmits the data through wireless links. Some when nodes were transmitting the data to the base station, collision was occurring and impacts on the network performance (Throughput and E2E Delay). Therefore, RDA was considered that was mainly declined the collision. The current research was introduced a new RDA, which was concatenated with RICER (Receiver Initiated Cycled Receiver) and known as RDA-RICER. Additionally, medium access control (MAC) protocols [24] were also utilized in the wireless network and these were associated with the switched antennas. The main motive of the current approach was to enhance the energy efficiency and to decline the consumption of energy with reduced collision.

Kumari, N., et al., (2017) [13] researched to enhance the energy efficiency in the MANET (Mobile Ad Hoc Networks) via using RDA (Reconfigurable Directional Antenna). A few decades ago, the demand of mobile networks was gaining a lot of attention in both areas as academics and the industrial sector. Usually, MANET (Mobile Ad Hoc Networks) was associated with the system that worked without using infrastructure and the nodes in the network were in small size as well as the cost is low. However, these nodes were not capable to store the data. Therefore, certain kinds of issues were occurring related to the collision, complexity, strength, delay, consumption of energy and so on [25]. The present research was given a radiation pattern which was relied on the directional antenna specifically to determine the energy consumption and for the scanning purposes. It implements the optimized genetic for the evaluation of the consumption of energy and to determine the loss of packets in all directions. It also checked out the strength of the wireless signals. The experiment results were acquired by performing a comparison between the existing approach and the proposed approach. The performance parameters were Collision Rate (CR) at 11%, energy consumption (EC) was 1700m J and the latency rate (LR) was recorded in 0.19. It otherwise the performance of the existing approach.

Rinkle, et al., (2018) [14] recommended the framework of an energy efficient method in the field of mobile ad hoc networks with the use of reconfigurable directional antenna approach. The mobile ad hoc networks (MANET) was the category of Ad hoc networks, which were infrastructure less and self-configured networks. It was more fascinating for the researchers for easy setup and small sized structure with the enhanced abilities for the communication purposes. Therefore, several kinds of issues were occurring. The objective of the research was to give an approach for ensuring the more saving of energy by the RDA (Reconfigurable Directional Antennas) [25]. Its main motive was to discover the location, focal point and the power of the signals. RDA was better if used it intelligently and gives better performance. The performance parameters in the research were the energy consumption and the latency rate. The performance of the current approach was rather better than previously used routing methods (DAODV and DDSR).

Dihissou, A., et al., (2018) [15] depicted the directions and the reconfigurable antenna arrays for WSN. Data communication was raised rapidly, mainly because of the use of mobile devices. These were specifically rooted in the WSN. The current research was utilized for SBA (Switchable beam Antennas) with wireless nodes, ISM band. Ordinarily, it's composed of two things as the fed monopolies and the loaded parasitic. The load value was acquired via using uzkov equations and it evaluated the weight coefficients in the antennas. Its major goal was to increase the gain and the directivity in a specific direction. The term re-configurability was determined via using rastor and the director elements (DE) particularly to diminish the radiation at the back sides and to focus on the particular direction.

Yadav, S. K., et al., (2017) [16] characterized the power aware medium access control protocols (MAC) by using MANET (Mobile Ad Hoc Networks). The main thing to keep in mind while designing a mobile ad hoc network was to use the low energy and to enhance the overall throughput of the network. The directional antennas were proven to be more enhanced and better technique that easily inclined the throughput. Subsequently, the channels were also efficient and better. These were associated with the enhanced coverage and the reduced consumption of power. There were various protocols

that flourished the energy to transform the data. In the present research, the power control approach was utilized with the directional antenna. It accesses the various power levels, but the current power levels were as RTS-CTS, DATA, ACK. The usage of the antenna simply increased the reusability and increased the throughput. Therefore, the energy consumption automatically decreased. The results of the current approach were compared with the previous used approaches like IEEE 802.11, DMAC and D basic. Throughput was recorded at 19%, which was 10 times more than the previously used approaches. The overall performance of the current research was rather better than other approaches [26].

Table. I:Technique's Comparison in Literature Survey

Authors name & Year	Title of Paper	Technique Used	Features
Le, T.N., et al., (2016)	Improving energy efficiency of mobile WSN using reconfigurable directional antennas	RDA-RICER (Reconfigurable Directional Antennas-Receiver Initiated Cycled Receiver)	Reduced the data collation Declined the consumption of energy
Kumari, N., et al., (2017)	Improving energy efficiency in MANET using reconfigurable directional antennas.	The Radiation Patterns with Directional Antennas	Saves Energy More adaptive method Improves the lifetime of the network
Rinkle, et al., (2018)	Designing an Energy Efficient Scheme in MANET using Reconfigurable Directional (RDA) Algorithm	RDA (Reconfigurable Directional Antennas)	Significant enhancements in network More energy efficiency Applicable for intelligent networks
Dihissou, A., et al., (2018)	Directive and Reconfigurable Loaded Antenna Array for Wireless Sensor Networks	SBA (Switchable Beam Antenna)	Enhancements in the arrays High reconfigurable capability. Covers the similar directions
Yadav, S. K., et al., (2017)	Power Aware MAC Protocol for Mobile Ad Hoc Networks Using Directional Antennas	Power Control Approach	Increased spatial re-use Declined consumption of energy Increased throughput

In some other authors, concluded that the proposed protocol as namely as RDA RICER is the most suitable [13] for autonomous and mobile WSN. In this way, the collision declined therefore, the energy consumption also reduced. They [13] gives the summary about MANET and gives a deeper discussion on the directional antennas and it gives the huge saving in the consumption of energy and enhanced the lifetime of the network. The authors [14] summarized the comparison of omnidirectional antenna and directional antenna. Further, the genetic algorithm is trained to make the system smarter and more energy efficient.

IV. ROUTING PROTOCOLS IN MOBILE WSN

In the mobile wireless sensor networks, the routing protocols are utilized for the better communication purposes while data is transmitted from one place to the other. There are various routing protocols are used, but in the case of the directional antenna, some protocols are supported because the protocols which are accessible in the omnidirectional antenna are not performed well in the directional antenna. The routing methods trained for directional are composed of other features. The different routing protocols in the directional antenna are the proactive, reactive and the hybrid.

A. Proactive Routing

The proactive routing protocols manage the entire network. The common direction routing is DLSRP which stands for the directional link state routing protocol. Direct LSRP (Link State Routing Protocol) is the other version of the link state routing method that is similar performed as DLSRP.

B. Reactive Routing

The other form of the routing in the directional antenna is the reactive routing protocols. ORDA is the on demand routing method using the directional antenna. It is the basic routing method in directional procedure. It composes the route request for a particular angle mainly to alleviate the message flooding in the network. The data is transmitted when the route reply occurred when the destination source got the request from the sender (Source). The common reactive routing protocols are ORDA, ARC-AODV, DDSR, MDDSR, DRP, etc.

C. Hybrid Routing

The routing protocols which simply concatenated the proactive and reactive protocols are considered in the category of the hybrid protocols. The common hybrid protocol is DHSLS. It stands for directional hazy sighted link state. It's commonly used in the large scale network and it generates the route path effectively with lesser number of the messages [6] [9].

D. MAC Protocols

MAC protocols are the medium access control protocols. These are mainly utilized to enhance the performance of the directional antennas in the wireless sensor network. It enhanced the reusability and declined the interferences via using radio beam. These days, MAC protocols with directional antennas are being more fascinating for the developers.

The basic MAC protocols via using directional antennas are RAM (Random Access Mechanism) and SM (Scheduling Mechanism).

1) *RAM (Random Access Mechanism):* It relies on the approaches which are mainly trained for the collision avoidance. It is a group of three other routing protocols. The first is RTS/CTS. It assumed that the nodes in the network are considered with multiple directions. It is generally followed up the principles of IEEE 802.11. In the process of RTS/CTS, the direction of the sensor node is blocked when the data packets are received. Second protocol is turn based. While RTS/CTS are performing a small tone is assisted to avoid the collision in the data messages. These nodes are enhancing the capability of the mobile network. At last, other routing protocols are used to expel the issues occurred in the wireless sensor networks by applying the synchronization of the data packets. For this purpose, a receiver initialized technique is used to get the best time synchronization for the receptions.
2) *SM (Scheduling Mechanism):* This mechanism is considered to manage and to organize the nodes in the network. Every node in the network is synchronized. The number of nodes in the network is equally partitioned into transmitters and the receivers. At the end, these nodes are collaborating to increase the throughput of the mobile wireless sensor network. Various kinds of methods are approached such as ROMA (Distributed Oriented Multiple Access) and MBAA (Multi Beam Adaptive Array) [10] [11].

V. CONCLUSION AND FUTURE SCOPE

In this conclusion, the new advancement in the technology innovates the small sized sensors that are gaining a lot of attention in every field. MAC protocol named re-configureable directional antenna suitable for autonomous and mobile nodes had been studied. Here, the mobile wireless sensor networks are the networks that fully rely on the structuring and processing of sensors. There are various kinds of shortcomings are arrived, which are managed by using different approaches and systems. Directional antennas are commonly used for the better communication of the different nodes in the network. It has a collection of vast features that specifically enhanced the performance of the network. It changed the traditional networks in the most advanced wireless networks, which covered wider area. Therefore, various papers or studying on the mobile wireless sensor networks with the use of reconfigurable directional antennas. They utilized the four switched beam antenna. In this review paper, describe the work various routing protocols, and comparison described which one is better than others. Some MAC protocol explained in this paper using directional antennas like as a RAM (Random Access Mechanism) and SM (Scheduling Mechanism).

The future scope of research work will, to motivate the researchers to share the findings and increase the use of re-configurable directional antennas. In the upcoming time period, there are many opportunities are seen in the use of directional antennas.

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