RESEARCH PAPER | Engineering | Volume : 4 | Issue : 8 | August 2014 | ISSN - 2249-555X

Circularly Polarized Adaptive Beam Scanning Antenna in a Cluster Grouping to Avoid Hidden Node Collision in Wireless Sensor Network

KEYWORDS: Wireless sensor Network, Hidden Node collision, Adaptive Beam scanning Antenna

Ms.M.Sujatha
Research Scholar&Assistant Professor, Sathyabama University & Prathyusha Institute of Technology and Management.

Dr.R.S.Bhuvaneswaran
Associate Professor, Anna university.

ABSTRACT *Hidden Node Collision is a common problem in Wireless Sensor Networks which makes it difficult to provide the network lifetime extension and the required Quality of Service. To avoid these problems a directional antennas with adaptive Beam scanning have been extensively used in designing MAC protocols for wireless sensor network. A design limitation is projected and overcome by circularly polarized adaptive Beam scanning antenna in a wireless sensor Network. A randomized distributed algorithm, which forms a autonomous Clustering via Directional Antenna (ACDA) has been proposed to mitigate hidden node collision in a wireless sensor Network .When a new node tries to join a group , a beam scanning process is initiated in the new node to determine a cluster Head of a communication sector using circularly polarized adaptive Beam scanning antenna .Simulation and analysis using the ADS proves that the directivity and Gain is further increased by these mechanisms and provides proof of concept for their efficiency.*

I.Introduction

Wireless sensor networks(WSN) consist of small, low powered sensors deployed over an area of interest to monitor their environment and deliver sensory data to a user. In a WSN, collisions may happen when a receiver is within the transmission range of two transmitters that are transmitting simultaneously, so that the receiver captures neither frame [1]. As each collision represents unnecessary energy dissipation, reducing collisions should be the main design objective in any method. Characteristics of the physical environment lead to a major source of QoS degradation in WSNs—the "hidden node problem." This problem greatly impacts network throughput, energy-efficiency and message transfer delays, and the problem dramatically increases with the number of nodes.

Therefore, energy efficiency in the wireless sensor networks is critical and a number of approaches have been proposed to prolong the network lifetime; most of them focus on reducing sensor node's energy consumption [1].

A lot of research has been done to avoid hidden node collision problems and many schemes have emerged. Many research works have proposed the solutions for eliminating or reducing the impact of the hidden-node problem in wireless networks, roughly categorized as: 1) Request-To-Send/Clear-To-Send (RTS/CTS) mechanisms; and 2) node grouping mechanisms [6].

This paper introduces a novel means of prolonging the network lifetime, employing a adaptive beam scanning directional antenna to determine a cluster head of a communication sector in a wireless sensor network.

II. Related Works

As WSN are deployed without infrastructure, which requires them to be self-organized distributed system with reliability and centralized control. Because of hardware restrictions such as limited power, direct transmission may not be established across the complete network. In order to share information between sensors which cannot communicate directly, communication may occur via intermediaries in a multi-hop fashion. Which in turn causes unfair channel allocation and wastage of channels between each node can be happened, which is directly affects throughput performance with wastage of energy. The various problems associated with classical antennas are listed as,

1. Hidden terminal problem

Hidden terminal interference is caused by the simultaneous transmission of two node stations that cannot hear each other, but are both received by the same destination station [7]. Hidden terminal problem is solved using RTS/CTS

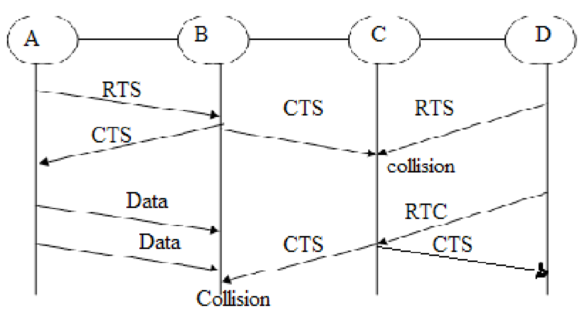


Fig1: Illustration of the situation where RTS/CTS fail to avoid collision.

As depicted in Fig 1, let us assume that there are four sensor nodes A, B, C, D as shown and links between nodes denote their communication ranges. Let us assume that A wants to communicate to B. So, it sends RTS to B and in turn, B broadcasts CTS. At the same time, let us suppose that D transmits RTS to C resulting in a RTS CTS collision at C. Node D timeouts and sends its RTS after the timeout interval. Once C gets RTS from D, it broadcasts CTS. This results in a collision with data from A at B. This occurs due to lack of proper decoding of CTS at C. Thus, RTS/CTS cannot avoid collisions in such a scenario and leads to low system throughput and increased average packet latency. We approach this problem using sensor MAC by using directional antennas so that, all the above problems can be solved with less energy consuming and high throughput.

Volume : 4 | Issue : 8 | August 2014 | ISSN - 2249-555X

2.Exposed Terminal problem

The exposed node problem occurs when a node is prevented from sending packets to other nodes due to a neighboring transmitter. Consider the below fig 2, an example of nodes labeled A, B, C, and D, where the two receivers are out of range of each other, yet the two transmitters in the middle are in range of each other. Here, if a transmission between A and B is taking place, node C is prevented from transmitting to D as it concludes after carrier sense that it will interfere with the transmission by its neighbor node B. However note that node D could still receive the transmission of C without interference because it is out of range from B. Therefore, implementing directional antenna at a physical layer in each node could reduce the probability of signal interference, because the signal is propagated in a narrow band.

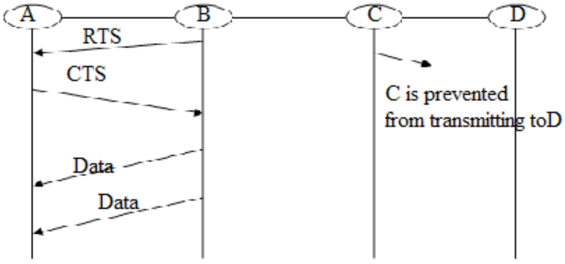


Fig 2: Illustration of the situation where RTS/CTS causes exposed terminal problem

Unlike Omni-directional antennas, the directional antennas are capable of dynamically conveying the radiated power along given directions[1] ,[2].They can alleviate wireless contention by not involving nodes other than the destination, and increase communication range essentially at no additional energy cost. Directional antennas have been extensively used in designing MAC protocols for wireless ad hoc networks in recent years. Directional antennas provide many advantages over the classical antennas which are Omni directional. These advantages include spatial reuse and increase in coverage area. The MAC protocol conserves energy at the nodes by calculating a scheduling strategy at individual nodes and by avoiding packet collisions almost completely.

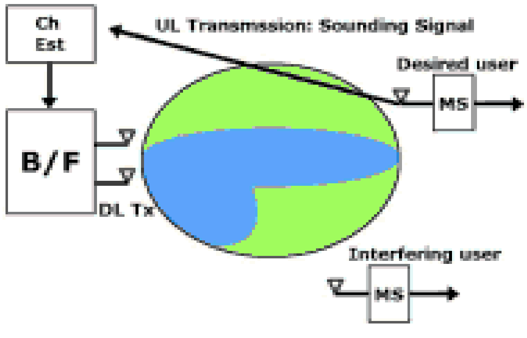


Fig 3: Beamforming

Beam forming is a ubiquitous technology for wave propagation and it is a signal processing technique for direct transmission and reception [3]. Fig 3, represents the beam forming which is obtained by combining elements in the array in a way where the signals at particular angle experiences constructive interference and others destructive interference. If the complex weights are selected from a library of weights that form beams in specific, predetermined directions this process is called switched beam forming. On the other hand if the weights are computed and adaptively updated in real time ,this process is known as adaptive beam forming. By which, the base stations can form narrow beams towards the desired user and nulls towards the interfering users.

III. Proposed Work

In this paper a novel method is proposed to mitigate the hidden Node collision in wireless sensor network by circularly polarized adaptive beam scanning directional antenna for any new node that wants to join the cluster. Several clustering algorithms have been proposed in recent years. A randomized distributed algorithm, which forms a autonomous Clustering via Directional Antenna (ACDA) that forms clusters automatically in three phases:

Phase I: Determining the Active Sensing Sectors; Phase II: Choosing the Communication Sectors and Cluster heads .Phase III: Group access period allocation. The main assumptions are: (1) All sensors are homogeneous with the same transmission range; (2) The sensors are in fixed but unknown locations; (3) The network topology does not change; (4) The sensors have directional sensing and communication capability. Note that there are no base stations to coordinate or supervise activities among sensors.

Phase I: Determining Active Sensing Sectors

In Phase I, each sector of a sensor broadcasts a *Hello* message at a random sector waiting time (SWT), which allows each sector to estimate how many neighboring sectors it has. A *Hello* message consists of: (1) the sensor ID of the sending sensor, (2) the sector ID of the sending sensor, and (3) the cluster ID of the sending sensor. At the beginning, the cluster ID of each sensor is zero. Sectors update their neighbor information (i.e. a counter specifying how many neighbors it has detected) and decrease the random SWT based on each 'new' *Hello* message received.

Phase II: Choosing Communication Sectors and Cluster heads

When completing the operation of Phase I, each sensor initiates a cluster waiting timer (CWT) for being a cluster head. Note that in Phase I, random SWTs are used to decide the active sectors. In Phase II, each sensor sets a random CWT and update the timer based on the total number of message receptions and transmissions in its sectors during the operation in Phase I. The sensors that hear many neighbors are good candidates for initiating new clusters; those with new neighbors should choose to wait.

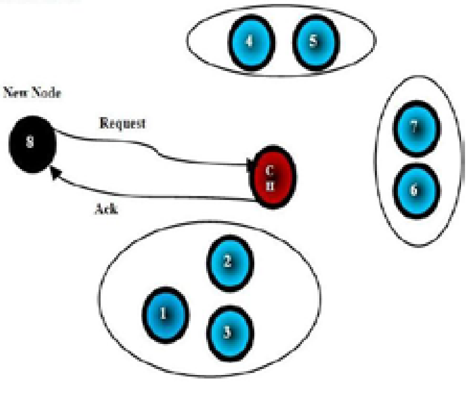


Fig 4: An example scenario where node 8 is the new node and CH is the coordinator

Volume : 4 | Issue : 8 | August 2014 | ISSN - 2249-555X

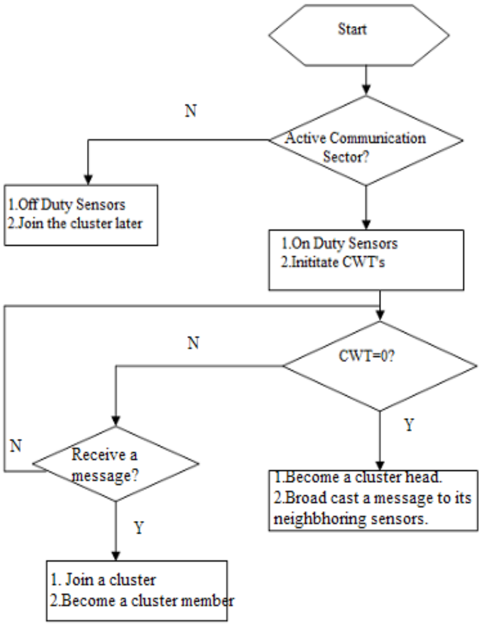


Fig 5: The procedure of the clustering phase.

***Phase III:* Group access period allocation.** The group access period allocation has to be determined for the efficient functioning .

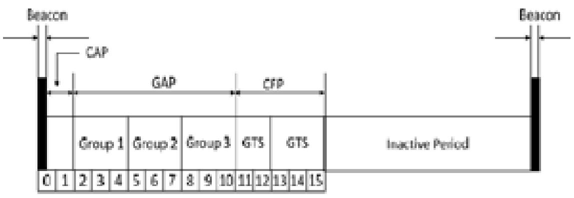


Fig 6: Group slots in the communication sector

In this phase new node is informed about its group by the coordinator. Therefore, new node can contend to transmit its data in a particular group access period. This is the final phase and the node is admitted as part of the WSN under a particular coordinator in a suitable group.

As clusters and cluster heads are formed in the network as new node approach the network ,it has to join the cluster , hence the node does the above procedure to join the grouping .Here the node has to send signals to the neighboring cluster ,instead of sending the signals only in fixed direction, an adaptive beam forming technique is used where by the beam forming is done in different directions such as 30 degrees, 45 degrees and so on by doing such different degree of beam forming it provides energy efficient , reduced delay for the node to join the cluster. This is done by using a circularly polarized directional antenna which is developed using a patch antenna. This antenna provides a better directivity and improved gain.

IV.Simulation and Analysis of the Proposed Work

The proposed patch antenna is simulated and analyzed .In this various angle of beam forming is simulated which are shown below .

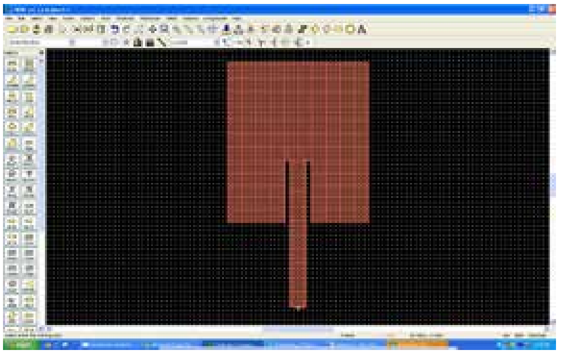
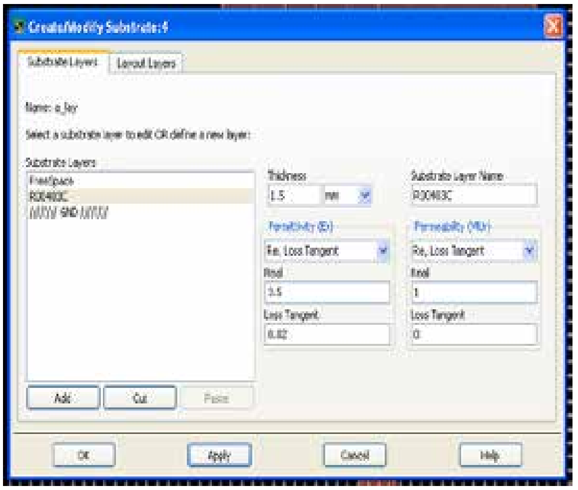
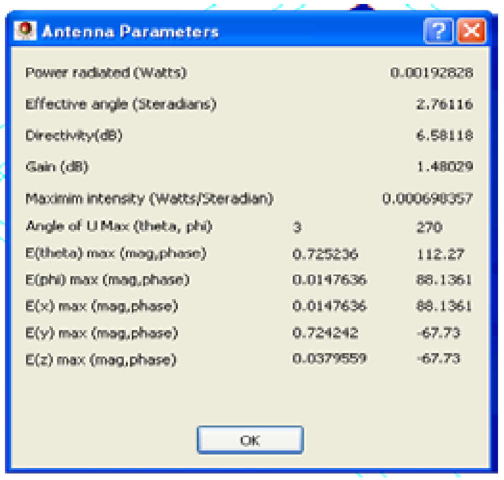


Fig 7: Proposed patch antenna.





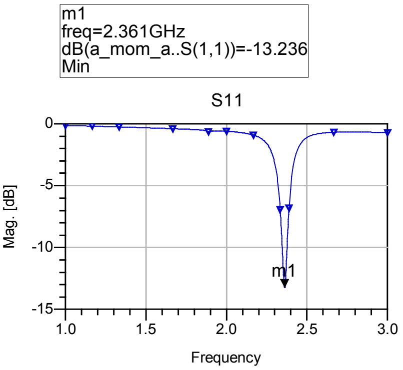


Fig 8: Return Loss of Patch Antenna

Volume : 4 | Issue : 8 | August 2014 | ISSN - 2249-555X

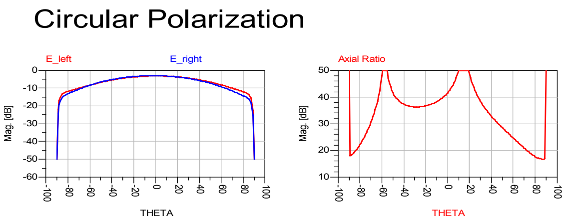


Fig 9: Circular Ploarization for 30 degree

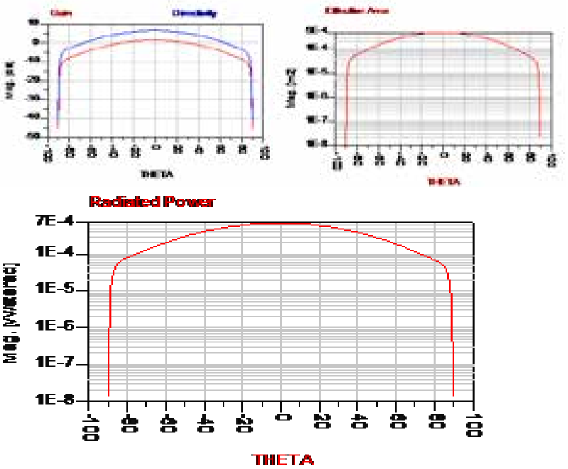


Fig 9a:Power radiated for 30 degree

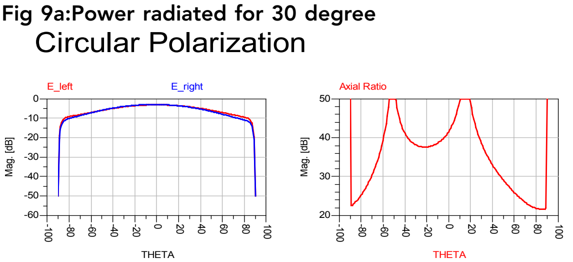


Fig 9b:Circular Ploarization for 45 degree

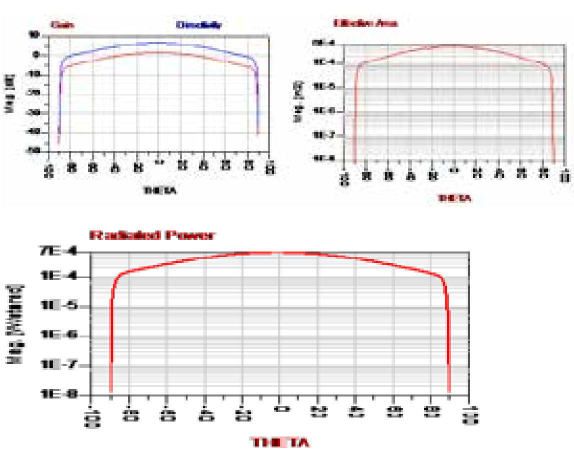


Fig 9c:Power ratdiated for 45 degree

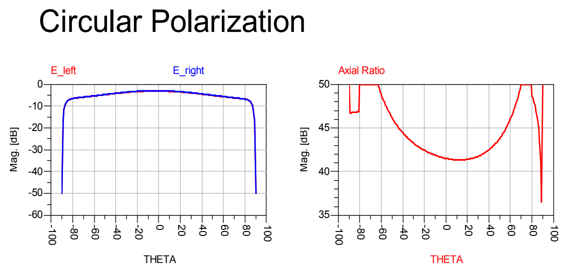


Fig 9d: Circular Ploarization for 90 degree

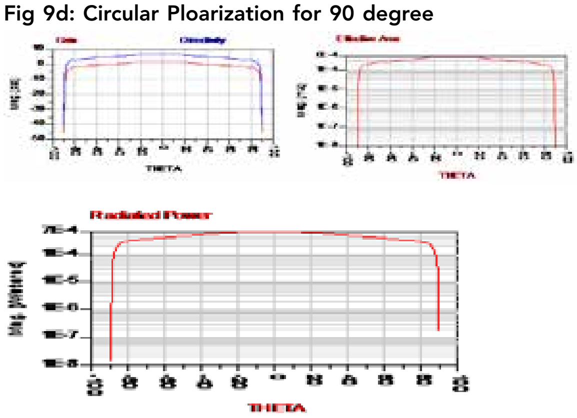


Fig 9e:Power radiated for 90 degree

REFERENCE [1] Luca Mottola, Thiemo Voigt, Gian Pietro Picco_, "Electronically-switched Directional Antennas for Wireless Sensor Networks:A Full-stack Evaluation". | [2] Jasmine K.S, Sumithradevi K.A, " Beam forming in Wireless Sensor Networks"in IJSER Volume 3 Issue 4 April 2012 | [3] Ying-Chih Chen, Pei-Lun Chung, and Chih-Yu Wen, "On Autonomous Clustering in Wireless Sensor Networks With Directional Antennas" Department of Electrical Engineering/GICE National Chung Hsing University. | [4] Ketema Adere, Garimella Rama Murthy, "Solving the Hidden and Exposed Terminal problems Using Directional-Antenna Based MAC Protocol for Wireless Sensor Networks, International Institute of Information Technology Hyderabad, India. | [5] Ritu Patidar and Prof. Dinesh Chandra Jain, "Solving the Hidden Terminal problems Using Directional-Antenna Based MAC Protocol for Wireless Adhoc Networks " in IJARCSSE Vol.2 Issue5 May 2012. | [6] Anis Koubâa, Ricardo Severino, Mário Alves, and Eduardo Tovar, "Improving Quality-of-Service in Wireless Sensor Networks by Mitigating "Hidden-Node Collisions",IEEE Transactions On Industrial Informatics, Vol. 5, No. 3, August 2009 | [7] K. Xu, M. Gerla, and S. Bae, "How effective is the IEEE 802.11 RTS/CTS handshake in ad hoc networks", in Proc. Global Telecomm. Conf. (GLOBECOM'02), 2002, vol. 1, pp. 72–76 | [8] Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, ISO/IEC IEEE-802-11, IEEE Standard for Information Technology, 1999 | [9]C. L. Fullmer and J. J. Garcia-Luna-Aceves, "Solutions to hidden terminal problems in wireless networks," in Proc. ACM SIGCOMM, Cannes, France, Sep. 1997, pp. 39–49 | [10] Lain-Jinn Hwang, Shiann-Tsong Sheu, Yun-Yen Shih and Yen-Chieh Cheng,"Grouping Strategy for Solving Hidden Node Problem in IEEE 802.15.4 LR-WPAN", IEEE, Proc. of the First International Conference on Wireless Internet (WICON'05), 2005. | |