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Lifetime Enhancement of Cluster Head Selection for MIMO Routing Algorithm Based On Weighted Sum Method for WSN

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Abstract
Energy-constrained wireless sensor network (WSN) has attained considerable research attention in recent years and requires robust and energy efficient routing protocols for communication in fading environments to minimise the energy consumption.To Mitigate the Fading Effect in Wireless Channel ,Multi- Input Multi Output(MIMO)Scheme is Utilized for Wireless Sensor Network. This Paper proposed a Cluster Head Selection for MIMO Routing Algorithm based on Weighted Sum Method for WSN. The Performance factor of Energy consumption depends on Battery life for WSN. In this Scheme Cluster head nodes Transmit Data to Master Cluster head nodes and that Transmit data to Cooperative nodes. Weighted Sum Method is used to Elect the Healthier Cluster Heads Having Battery Life and Sufficient Residual energy. Further Weighted Sum Method is used to select the Master Head Nodes and Cooperative Nodes for MIMO Communication.The outcome of the simulation results show that the Cluster Head Selection for MIMO Routing Algorithm based on Weighted Sum Method provides more than 40% increase in residual energy as compared to CH-C-TEEM.
Keywords- clustering, energy analysis, MIMO, weighted sum method, wireless sensor network,

I. Introduction

Wireless sensor network is an autonomous system of numerous tiny sensor nodes equipped with integrated sensing and data processing capabilities. Sensor networks are distinguished from other wireless networks by the fundamental constraints under which they operate, i.e., sensors have limited power resources making energy management a critical issue in wireless sensor networks. Therefore sensors must utilize their limited energy as efficiently as possible[1]. The sensors are deployed in large numbers, and either collecting them for recharging is expensive and time consuming, or is even infeasible in hostile environments. Therefore, improving the energy efficiency in WSNs is of prime importance. There are several approaches such as transmission power control, clustering, putting some nodes to sleep according to their duty cycles and exploiting the proximity between nodes and letting them to operate as a multi-input multi-output (MIMO) system, to achieve energy efficiency in WSNs. MIMO technology has the prospective to enhance channel capacity and decrease transmission energy consumption in fading channels. This is done by utilizing array gain, multiplexing gain and diversity gain [2].Multipath fading strongly impacts the communication and increases the possibility of signal cancellation which leads to higher packet loss and therefore resulting in more power consumption in wireless environments. MIMO technology has the potential to enhance channel capacity and reduce transmission energy consumption particularly in fading channels [3,4].Network security and node's trust evaluation is another vital issue in WSN. The nodes captured by opponents behave as malicious nodes, and attack the network by misreporting, modifying or dropping useful data packets. The trust based framework reduces the packet loss and routing overhead by eliminating the compromised nodes[5].The cluster head aggregates the data of its members and transmits it to the sink node or to other nodes for further relaying. The cluster heads role is energy consuming since it is always switched on and is responsible for the long-range transmissions. If a fixed node has this role, it would quickly drain its energy, and all its members would be "headless" and therefore useless. Therefore, this burden is rotated among the nodes. The protocol is round based, that is, all nodes make their decisions whether to become a cluster head at the same time and the non cluster head nodes have to associate to a cluster head subsequently. The non cluster heads choose their cluster head based on received signal strengths[6].Wireless sensor network requires robust and energy efficient routing protocols to minimise the energy consumption as much as possible [7-10].Due to the restricted physical dimension of a sensor node, direct application of multi-antennas to sensor nodes is not possible. If individual nodes cooperate for transmission and/or reception, a cooperative MIMO system can be build such that energy-efficient MIMO schemes can be employed in WSN. Cooperation among sensor nodes has the capability to reduce the total power consumed for data trans mission in the sensor network. However, the lifetime of sensor network reduces due to the adverse impacts caused by channel fading and interference. To maximise the network lifetime, Cluster Head Selection for MIMO Routing Algorithm based on Weighted Sum Method is suggested for wireless sensor networks in this paper. The performance of the proposed Cluster Head Selection for MIMO Routing Algorithm based on Weighted Sum Method is evaluated in terms of energy efficiency to improve the lifetime of sensor network and is compared with Cluster Head Cooperative Trustworthy Energy Efficient MIMO (CH-C-TEEM) & TEEM. In case of MIMO, there are always options to choose the cooperative nodes among the active sensors.In this Scheme Cluster head nodes Transmit Data to Master Cluster head nodes and that Transmit data to Cooperative nodes. Weighted Sum Method is used to Elect the Healthier Cluster Heads Having Better battery Life and Sufficient Residual energy. Further Weighted Sum Method is used to Select the Master Head Nodes and Cooperative Nodes for MIMO Communication. in this paper cooperative sensors are dynamically selected based on the residual energy, geographical location of the sensors and sensor distance in a cluster, to reduce the overall energy consumption by using weighted sum method.

The rest of the paper is organised as follows: The system model in section II, Proposed system in Section III, and results and discussion are provided in Section IV. Finally the conclusion of the paper is drawn in section V.

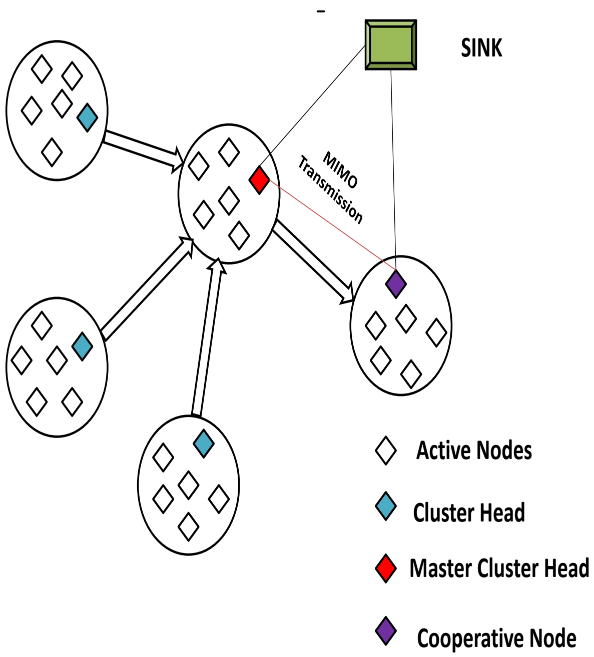
II. The system model

In this scheme the all cluster head (CH) nodes sends data to the master cluster head nodes and master cluster head transmit data to sink and cooperative nodes. then cooperative nodes transmit data to sink.

In system model Randomly uniform distribution of *N* sensor nodes evenly in a m*m rectangular sensor area, suppose WSN has the following properties:

a) The network has fixed BS (Sink node) which stays away from the sensor area. In the study, BS has enough energy supply and we would not consider BS energy consumption;
b) All the nodes in the network have limited energy and are homogeneous;
c) All the nodes in the network have the same initial energy;
d) All the nodes are still and uniformly distributed;
e) Node always have data to send;

the system model is shown in Fig 1.



fig"1-the system model

III. Proposed system

3.1.Cluster head selection

In the network based on clustering, a cluster head is responsible for coordinating operations among member nodes in the cluster, collecting and fusing data, and then sending the resulted data to the master cluster heads. The cluster head consumes more energy than other nodes in the round. Thus, the location and the residual energy of node are introduced during the generation of cluster head to balance the energy consumption of all nodes in every cluster for prolonging the lifetime of network.

all the cluster heads in first round are selected by minimum distance between sensor node to sink and their residual energy by using weighted sum method .In this method the maximum energy and distance are multiplied by weight parameter of residual energy and weight parameter of distance from the sink. The cluster head can be specified by following equation:

$$CH(i)=[Eres(i)*W1+D(i)*W2]max \quad (1)$$

where Eres(i) is its residual energy;D(i) is the distance from candidate node (i) to the sink, W1 is the weight parameter of residual energy and W2 is the weight parameter of distance from the sink.CH(i) is cluster heads for i number of rounds.

3.2. Cooperative node selection

the cooperative node are selected among cluster head nodes in the all clusters and then sending the resulted data to the sink .the cooperative cluster heads in each round are selected the max-1 energy of cluster head and minimum distance between cluster heads and sink are multiplied by weight parameter of residual energy and weight parameter of distance from the sink. The cooperative cluster head can be specified by following equation:

CO(i)=[Ech(i)*W1+Dch(i)*W2]max-1 (2)
where Ech(i) is its cluster head residual energy; D(i) is the distance from cluster head node (i) to the sink, W1 is the weight parameter of residual energy and W2 is the weight parameter of distance from the sink, CO(i) is the cooperative node for i number of rounds.

3.3 Master cluster head selection

the master cluster head are selected among cluster head nodes in the all clusters and then sending the resulted data to the sink .the master cluster heads in each round are selected by the maximum energy of cluster head and minimum distance between cluster heads and sink are multiplied by weight parameter of residual energy and weight parameter of distance from the sink. The cooperative cluster head can be specified by following equation:

MCH(i)=[Ech(i)*W1+Dch(i)*W2]max (3)
where Ech(i) is its cluster head residual energy; D(i) is the distance from cluster head node (i) to the sink, W1 is the weight parameter of residual energy and W2 is the weight parameter of distance from the sink.MCH(i) is the master cluster head node for i number of rounds.

3.4. Energy model

In this section, we describe our model for the energy consumed during transmission and reception. The nodes are assumed to have power control features so as to adjust their transmit power to the minimum level required for successful transmission .Now, different assumptions about the energy dissipation characteristics in the sending and receiving modes affect the performance of different protocols. To keep the model general, we assume that the dissipates Eelec J/bit to run the transmitter or receiver circuit and Eamp J/m2 for the transmitter amplifier to achieve an acceptable signal to noise ratio [11]. Assuming r2 energy loss due to channel transmission, to send a k bits message to a distance of d meters using this model, We assume all sensors have transmit-power control and can use just the minimum required energy to send information to the intended recipients. The sensors could turn off their transmitter and receiver to avoid receiving uninteresting information and save energy. This is motivated by the fact that receiving is also a high cost operation in the wireless communication systems in our aim. The equations used to model power consumption of a sensor node for communication are given below.

The power consumption for transmitting sensor:

Etx (k,d)= Eelec *k +ε amp *k* d 2 (4)

The power consumption for receiving sensor:

Rtx(K,d)=Eelec*k (5)

Here d is the distance between two sensors, k is the number of bits of information sent, and Eelec=50nJ/bit and εamp =100pJ/bit/m2are the constants as previously defined. The total power consumption cost is given by:

Etotal=Etx(k,d)+Rtx(K,d) (6)
= (2Eelec+εamp*d2*k) (7)

where Etx and Rtx denote the transmitter and receiver circuit energy consumption per bit, respectively; εamp accounts for the effect of amplifier, antenna and carrier frequency with a prescribed bit error rate (BER).

The power consumption is a second order function of distance. So the data routing with multiple shorter nearby hops will typically be more efficient than directly transmitting between two far sensor nodes. The power consumption is also a linear function of k which is bits of information transmitted through the sensor network. The energy of network is mainly consumed in:

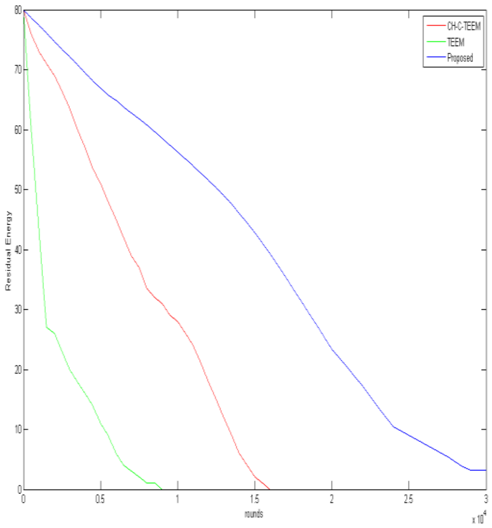
1) The data transmission from member nodes to the cluster head, from the cluster heads to the master cluster head nodes from the master cluster heads to the cooperative nodes, and from the cooperative nodes and master cluster head nodes to the sink;
2) The circuit operations corresponding to the above data transmission;
3) The data fusing in the cluster head. 4) The additional overheads in the operations of cluster head generation and cooperative node and master cluster head node selection.

IV. Results and discussion

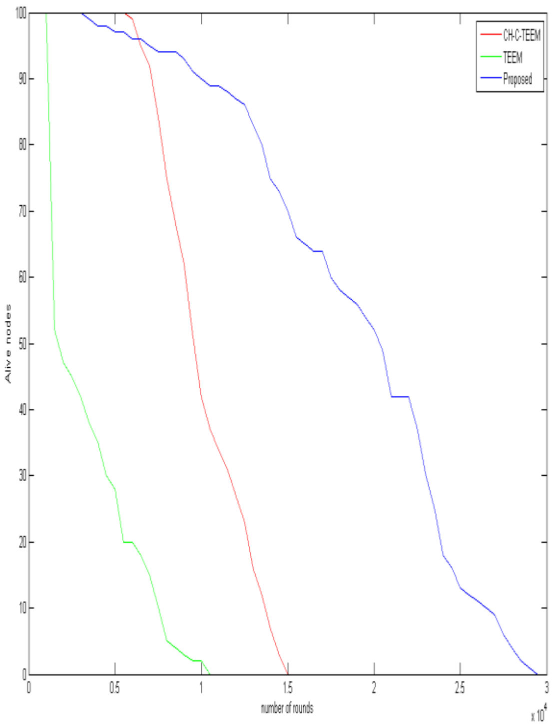
The analysis of the proposed system is carried out using MATLAB 1l.0 and the simulation parameters are listed in Table l. A sensing field with a population of N=100 nodes is considered for simulation sensors randomly deployed over the region, "Table"1.

Simulation parameters	**Description**
Network area	100*100 m2
Carrier frequency	2.5 GHZ
Channel Bandwidth	1MHZ
Number of Nodes	100
Number of frame per round	2
Path loss component	2
Transmission rate	0.75
Modulation techniques	QPSK
Packet size	2Kbits
Initial energy	0.8J
MIMO antenna configuration	2*2
Weight parameter of residual energy	0.99
Weight parameter of distance from the sink	0.01

The residual energy analysis for the proposed Algorithm and CH-C TEEM and TEEM is shown in Fig.2. It is inferred from the figure that the proposed Algorithm consumes lesser energy for data transmission. The residual energy of the proposed Routing Algorithm is around 40% more than the CH-C-TEEM and TEEM routing protocol.



"fig."2 energy comparison of proposed, CH-C-TEEM and TEEM



"fig".3.lifetime analysis comparison of proposed ,CH-C-TEEM ,and TEEM

The number of nodes alive for each round of data transmission for the proposed algorithm, TEEM and CH-C-TEEM is portrayed in Fig.3. It is vivid from the figure that 30% of nodes alive approximately in 5000 rounds in TEEM and 11000 rounds in CH-C-TEEM whereas the proposed algorithm scheme prolongs Lifetime by 23900 rounds. This is due to the trust based system which increases the path security thereby reducing the number of retransmissions.

V. Conclusion

In this paper, a Cluster Head Selection for MIMO Routing Algorithm based on Weighted Sum Method for WSN is proposed. where selected numbers of Cluster heads are used to form a MIMO structure. The performances of the proposed algorithm scheme are analysed in terms of energy consumption. Weighted Sum Method is used to elect cluster heads, Master cluster heads and select the cooperative nodes for MIMO communication. Simulation results show that the proposed algorithm performs better and extends 18900 rounds more than the TEEM and extends 12900 rounds more than cooperative MIMO CH-C-TEEM scheme for data transmission and saves more than 40% energy by the exploitation of the diversity gain of MIMO systems and by secured routing.

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