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Effective Energy Aware Compressive Sensing in Wireless Sensor Network

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ABSTRACT: In wireless sensor network energy consumption plays major role. The main reason for designing an enhanced optimized energy efficient routing protocol is to reduce the scarcity of energy resource. The major intention of this protocol is to improve the data accuracy, packet delivery ratio and to reduce the retransmission delay, energy consumption using energy aware activity scheduling algorithm. The opportunistic routing makes use of a scheduler to co-ordinate transmission. The need for a scheduling algorithm to perform multitasking and multiplexing performance. The proposed E-OEERP reduces/eliminates such individual node formation and improves the overall network lifetime when compared with the existing protocols. It can be achieved by applying the concepts of energy aware activity scheduling algorithm for buffer node formation and routing respectively.

KEYWORDS: Compressive sensing (CS), wireless sensor network (WSN), activity scheduling.

I. INTRODUCTION

Wireless Sensor Network (WSN) has drawn many research works predominantly due to its plenty of applications in various fields. This includes environmental monitoring, health monitoring, military tracking, animal tracking and monitoring. WSN refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of an environment and organizing the collected data at a central location through wireless links. The physical conditions may include pressure, temperature, soil moisture, etc.

Each sensor node in Wireless Sensor Network is equipped with a radio transceiver, a microcontroller, an interfacing electronic circuit and an energy source, usually a battery. The energy source in WSN should be handled in an efficient way as it cannot be replaced or recharged if it is placed in a harsh or no-man environment. Transmitting the sensed data to the base station can be done using various methods which include: Single-hop transmission, multi-hop transmission, Cluster based transmission, Tree based and Chain based transmissions.

WSNs may consist of many different types of sensors such as seismic, magnetic, thermal, visual, infrared, and acoustic and radar, capable to monitor a wide variety of ambient conditions. Though each individual sensor may have severe resource constraint in terms of energy, memory, communication and computation capabilities; large number of them may collectively monitor the physical world, disseminate information upon critical environmental events and process the information on the fly. The issues of network lifetime and data availability are extremely important due to their deployment in hostile environment. The system should provide fault tolerant energy efficient real-time communication as well as automatic and effective action in crisis situations. A typical sensor network operates in five phases which are planning phase, deployment phase, post-deployment phase, operation phase and post-operation phase. The sensor nodes consist of sensing, data processing and communicating components. They can be used for continuous sensing, event detection as well as identification, location sensing and control of actuators. The nodes are deployed either inside the phenomenon or very close to it and can operate unattended. They can use their processing abilities to locally carry out simple computations and transmit only required and partially processed data. They may be



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organized into clusters or collaborate together to complete a task that is issued by the users. In addition, positions of these nodes do not need to be predefined.

These allow their random deployment in inaccessible terrains or disaster relief operations. The WSN provides an intelligent platform to gather and analyze data without human intervention. As a result, WSNs have a wide range of applications such as military applications, to detect and track hostile objects in a battle field or in environmental research applications, to monitor a disaster as seismic tremor, for industrial applications, to guide and diagnose robots or machines in a factory or for educational applications, to monitor developmental childhood or to create a problem solving environment. The wireless sensor nodes are generally battery driven and due to their deployment in harsh or hostile environment their battery is usually un-chargeable and un-replaceable. Moreover, since their sizes are too small to accommodate a large battery, they are constrained to operate using an extremely limited energy budget. The total stored energy in a smart dust mote, for instance is only 1. Since this small amount of energy is the only power supply to a sensor node, it plays a vital role in determining lifetime of the sensor networks. All the research works therefore have a common concern of minimizing energy consumption and it is a significant issue at all layers of the WSN. Other key issues are scalability to large number of nodes, design of data handling techniques, localization techniques, real time communication, data availability, fault tolerance etc.

II.BACKGROUND AND RELATED WORK

In this section we focused on system description of compressive sensing WSN and related work in scheduling process.

2.1.Compressive sensing

If a signal x is k -sparse in a basis then it is possible to fully recover x by a measurement y taken by $m \times n, M \ll N$ under some conditions;

$$\text{For } x = \sum_{i=1}^N v_i \psi_i$$

ψ_i are basis vectors of orthonormal Ψ , vector v has only K nonzero elements $K \ll N$, Measurement matrix ϕ satisfies Restricted Isometry Property (RIP)

$$M \geq cK \log(N/K) \ll N$$

Conventional coding methods compress/reconstruct the signals through discarding sufficiently small coefficients.

Compressive sensing theorems state that for signals that are sparse in some domains they can be fully reconstruct using only few designed measurements.

In order to recover the sparse signal the measurement should be taken from a measurement matrix whose product with the basis satisfies Restricted Isometry Property (RIP)

2.1.1.Optimized-EOERP based protocols

In this existing method optimized energy efficient routing protocol (EOERP) during formation of nodes. Such residual or individual nodes forward the sensed data directly to the base station or by finding the next best hop by sending many control messages hence reduces the network lifetime.

In this EOERP even though the individual nodes keep changing from one time slot to other which is an advantage mentioned there are some drawbacks too. The individual or residual nodes communicate directly to the base station or finding the next best hop by sending many control messages for transmitting the sensed data.

2.1.2. Data Gathering

The objective of the data gathering problem is to transmit the sensed data from each sensor node to a base station.

The goal of algorithm which implement data gathering is to maximize the network lifetime, to minimize energy consumption and reduce the retransmission delay. For a static sink uniform distributed WSN research has shown that sensors near a data sink deplete their battery power faster than those far apart due to their heavy overhead of relaying messages.



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2.1.3. Optimization and network coding

Lately, there is a trend towards incorporating network coding in optimization communications. The initial attempts for developing network coding-based optimization communications were focused on physical layer schemes. These approaches refer to the coding gain and optimal power allocation in simple cooperative topologies, usually considering one relay or cooperation among the users.

2.1.4. Network coding and energy efficiency

The impact of network coding in “green” communication has already started to be studied, especially in broad-cast and multicast scenarios. The recent research work that investigates the energy aspect of network coding applications, deals mostly with the network layer. OEERP by using a suboptimal scheduling algorithm that exploits network coding opportunities, thus achieving a significant power saving over pure routing. In proposed using enhanced optimized energy efficient routing protocol using energy aware scheduling algorithm in wireless sensor networks. Their proposed algorithm aims to reduce the network traffic and, consequently, the energy consumption, thus prolonging the net-work lifetime.

III. PROPOSED NETWORK CODING-ENHANCED OPTIMIZED ENERGY EFFICIENT ROUTING PROTOCOL (EOEERP)

3.1. Protocol description

In the proposed method sensor nodes are considered to be deployed randomly to monitor the environmental condition. Each sensor nodes are static except the buffer node. The buffer nodes are consider as a mobile nodes. Homogeneous networks have been considered all the sensor nodes have initial equal energy. The distance between the nodes and the base station can be computed based on received signal strength. In this project mobile node formation takes place using Particle Swarm Optimization in order to reduce the individual or residual node formation. PSO based energy efficient routing protocol called Enhanced-Optimized Energy Efficient Routing Protocol (E-OEERP) is proposed. In the existing method Optimized Energy Efficient Routing Protocol results in individual node formation. For eliminating such individual nodes the concept of Particle Swarm Optimization (PSO) are used for buffer node formation. Constructing the optimal routing path to transmit the sensed data is another challenging task in WSN. In the proposed system Gravitational Search Algorithm is also used for constructing an optimal routing path to transmit the sensed data to the base station.

3.2. Operational example

A simple network topology with four stations is considered, all of them in the transmission range of each other. A source station (S) transmits a data packet (A) to a destination station (D) that does also have a packet (B) destined to the source station. Furthermore, buffer nodes are used to store the retransmission packet. It also used to recover the lossed data packets.

1. To choose the source and sink nodes in the network.
2. To create the buffer nodes for storing the transmitted packets.
3. By using the energy aware activity scheduling algorithm to schedule the data packets.
4. To set the threshold value for each nodes.
5. By using this threshold value to identified the lossed data packets in the network.
6. Using the buffer node to regain the lossed data packets.
7. Using this algorithm to increase the throughput, packet delivery ratio.
8. To reduce the energy consumption and delay in the network.

3.3. Protocol analysis

3.3.1. Network Formation

Networks are formed with in the given range of sensor. Nodes are automatically grouped depends on their radiowave range. Simulation model network deploys 40 nodes in sensor field.



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Source and destination establishes TCP connection. By using of File Transfer Protocol randomly choose different source to destination connection.

3.3.2. Buffer Node Creation

Wireless propagation chooses two ray ground model. Using EOEERP is a simulation routing protocol. Mobile node gather communication data between source to destination nodes.

Buffer node is also used for storing data by using this nodes to regain the lossed data packets.

3.3.3. Particle Swarm Optimization

In general each and every node create position in simulation space. The position of each node is calculated by specific velocity. Nodes are created using two parameters namely position and velocity. The fitness value is calculated choosing nodes on the following three factors (i)Energy of the node (ii)Energy of the nodes or sensors within the radio range (iii)Distance of those nodes within the radio range.

3.3.4. Gravitational Search Algorithm

In proposed method uses GSA algorithm for constructing optimal path for transmitting data to the base station. Each node find the best hop to transmit data towards destination or base station. Route request message is sent to the neighbor node. This request message contain node position, velocity and energy. Until reaches the base station same process will be repeated.

3.4 Performance Analysis

3.4.1. Delay analysis

The network coding techniques in our proposed scheme imply the simultaneous transmission of more than one packet in the network. Therefore, we analytically estimate the expected time needed for two packets to be exchanged under the EOEERP protocol. The total time elapsed from the initial transmission until the correct reception at the destinations can be defined as:

$$E [T_{total}] = E [T_s] + E [T_{re}]$$

where $E [T_s]$ represents the average time for the direct transmission of a single data packet from the source to destination and $E [T_{re}]$ corresponds to the average time required for a retransmission via relays to be completed.

3.4.2. Throughput analysis

Throughput of the network can be defined as the number of useful bits per unit of time forwarded by the network from a certain source address to a certain destination, including protocol overhead, retransmission data packets.

3.4.3 Energy performance analysis

Having analyzed the operation of the proposed EOEERP protocol, we derive a closed-form expression that describes the average energy consumption in the network:

consumption during the retransmission from the source, respectively. We consider three different modes:

1. Transmission mode, when the node is transmitting data/control packets.
2. Reception mode, when the node is receiving data/control packets.
3. Idle mode, when the node is sensing the medium with-out performing any action.

IV. PERFORMANCE EVALUATION

In order to validate our analysis and further evaluate the performance of EOEERP we have developed a time-driven C++ simulator that executes the rules of the protocol. In the following subsections we present the simulation set up along with the results of our experiments



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Result Analysis

FIG 1:Packet Delivery Ratio Vs Nodes

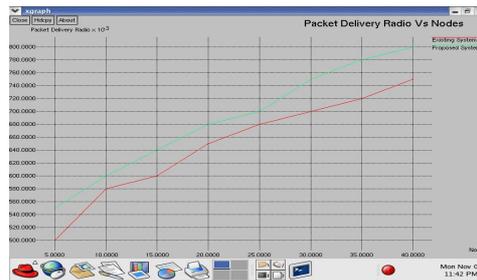


Fig. 1 presents the throughput performance in the threescenarios described above for various values of PER_{RID} . First, we can see that the theoretical and the simulation results are almost perfectly matched, thus verifying our analysis. Comparing with simple compressive sensing schemes which have only the advantage of spatial diversity without any network coding capabilities, we can achieve a throughput enhancement up to 80%.

FIG 2:Delay Vs Nodes



Fig. 2 presents the packet delay in both network coding-based and simple EOEERP protocols. In this point, we must recall that two packets are delivered to their respective destinations in each retransmission cycle . Hence, in order to be accurate, we compare the delay in EOEERP with the time required for two packets to be exchanged in EOEERP.As it can be observed, we can achieve significantly lower packet delay by applying network coding techniques.

FIG 3:Energy Consumption Vs Time

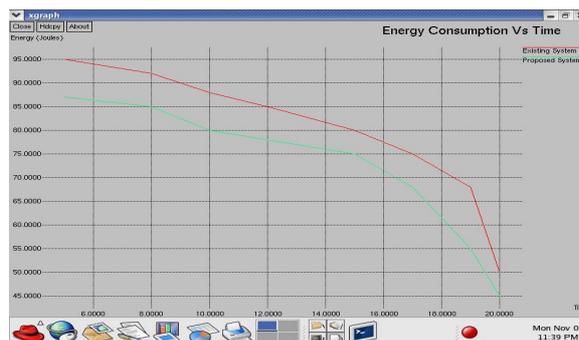


fig 3 shows that the simulation results verify our analysis regarding the energy performance. Comparing our



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proposed network coding-based scheme with simple cooperative protocols for different PER (and consequently different number of retransmissions) between the relays and the destination, we observe that our scheme is reduce energy consumption EOEERP

FIG 4:Throughput Vs Nodes

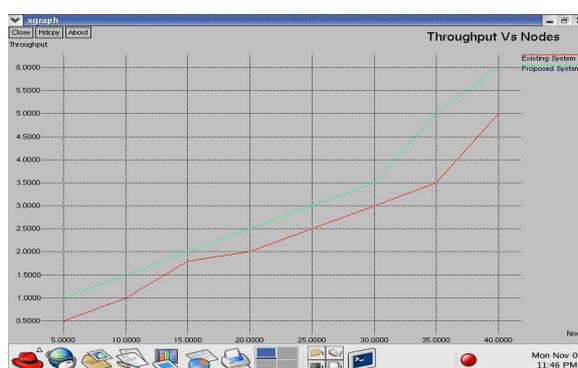


Fig 4 shows that the simulation results verify our analysis regarding the throughput. Comparing our proposed network coding based scheme improve the throughput in EOEERP.

V. CONCLUSION

We have proposed a enhanced optimization energy efficient routing protocol using optimization named PSO. The simulation experiments undertaken on several network topologies of wireless sensor networks showed the effectiveness of EOEERP protocol in terms of 60% improve throughput and reduce the delay. Other interesting characteristics of this protocol, that we can found in the majority of EOEERP protocols to energy saving, allow to mitigate some problems such as collision and idle listening which has been proved to be potential sources of energy wastage; and in addition support the scalability.

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