Assignment #5

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"A Cooperative Learning Scheme for Energy Efficient Routing in WSN" also "CEERA" researched by Dr Sami AlWakeel and Dr Najla AlNabhan is an excellent contribution to the development of energy-efficient WSNs that is crucial for sustainable and progressive growth and usability of the Internet of Things (IoT) in the real world.

The paper begins by introducing Wireless sensor networks. Then we are introduced to the primary problem, that is currently being actively researched that is, energy-efficiency in Wireless sensor networks.

Wireless sensor networks are gaining more interest in a variety of application. As the researchers rightly pointed out, Network lifetime and efficiency are the most considered issues in Wireless sensor networks (WSNs) based systems. The scarcest resource being energy.

It is common knowledge in the field of Wireless sensor communication that, the most energy spent on Communication is on two things in WSNs:

1. Route discovery: Route discovery is done to connect each node with the other. However it is still half of the work.
2. Data transmission: Data transmission can get complex as the network grows, and may have additional problems like network jitter, delay and duplicate transmissions. These activities consume a lot of energy.

This Paper presents a novel design of a cooperative nodes learning scheme called CEERA (Cooperative Energy-Efficient Routing Algorithm) in WSNs. We will discuss more about this later.

## Section 1 - INTRODUCTION:

In WSNs, a sensor node typically includes: A sensing unit, a microcontroller, a radio transceiver, battery, or power sources as sensor nodes are constrained by the amount of battery power available, it is necessary to conserve individual node energy to maximize system life.

Introducing CEERA, the research paper outlines its novel design for energy-efficient routing algorithm. The algorithm efficiently avoids the energy consumption problem as it does not require any prior configuration or routing discovery operations.

The paper then discusses the underlying network, deployment, traffic, and energy models in section 2. Section 3 explains the design of CEERA. Performance analysis and numerical results are discussed in Section 4. Section 5 concludes the paper also mentioning the future research scope.

**Section 2 - MODELS, ASSUMPTIONS, AND PERFORMANCE**

In this section, the paper describes the underlying network model and other related models, including: deployment, traffic, and energy models.

**A. Network Model**: In any WSN, data being sensed by the nodes in the network must be transmitted to a control centre or a Base Station (BS).

**B. Deployment Model**: Deployment is either random or deterministic.

In random deployment, sensor nodes are deployed by air-dropping them or throwing them randomly in a target area, this is most common. In the deterministic deployment sensors are placed at pre-determined locations.

**C. Traffic Model**: The inter-arrival time between messages is environment dependent.

**D. Energy Model**: An important consideration in sensor networks is the amount of energy required for sensing, computation, and communication.

**F. Performance Measures**:

Their Main performance measures are: Throughput, Delay, Delay time jitter, total energy dissipations, no of dead nodes, FND-First node to Die lifetime, Beta pf nodes to die lifetime, Half of the nodes Alive (HNA) LIFETIME. Last node to die lifetime (LND), duplicates.


**Section 3 - CEERA'S LEARNING SCHEME DESIGN:**

CEERA authors say, nodes cooperate in learning from each other in order to have an efficient delivery of data to the base station. Also, data message is flagged to be transmitted in either source-route mode or cooperative mode.

Based on its energy level, a node may not participate in data transmission if its current energy is less than a predefined energy threshold E_min.


**The CEERA Algorithm**:

The following is the researchers' algorithm design for CEERA

In Cooperative transmission, each transient node 't' that receives the packet will carry out the following steps:

      1) Calculates the ID difference

      2) Starts a timer counter

      3) Listens to BS's ACK, and periodically decrements its timer.

If the BS acknowledgment is not received within the timer value, the transient node retransmit message and appends its address to the address list of transient nodes. This process is repeated by every transient node until BS acknowledgement (ACK) is received.

Upon receiving the ACK, all nodes clear the call and reset their counters.

**Section 4 - PERFORMANCE RESULTS:**

The researchers implemented their own event-driven simulation written in C++, aimed at studying the impact of varying **the scalar factor, Dmax, buffer size, and duplication factor** over the collected performance measures

Researchers mention that these included Throughput delay, DTJ, memory occupation per node, energy dissipation, per initial energy, no. of died nodes, FND, BND, HNA, LND, Hop count, congestion/overhead, and duplicated arrivals.

The resultant analysis reiterated a significant improvement in energy usage in routing with CEERA. CEERA outperforms Flooding 15, 27, and 41 times. Also, CEERA achieves over a factor of 1.34 and 1.26 reduction in energy dissipation.


**Section 5 - CONCLUSION AND FUTURE WORK:**

Routing in sensor networks is a promising research area. Applications of WSNs show how it is important to design protocols and algorithms for wireless networks to be bandwidth and energy efficient.

The paper suggests future work that can optimize existing algorithm which includes:

- CEERA introducing zero scalar factor for key nodes (BS neighbours),
- finding a method for optimal factors selection and evaluation,
- incorporating data aggregation to minimize energy dissipation and allowing node mobility.


All in all, this paper concluded with future research topics which will help researchers interested in the field to carry on the idea and make further research contributions.


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