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Performance analysis of energy-efficient routing protocol for wireless sensor networks

Palvinder Singh Mann[a] and Satvir Singh[b]

[a]Research Scholar, I. K. Gujral Punjab Technical University, Kapurthala, Punjab, India.

[b]Associate Professor, Department of ECE, SBS State Technical Campus, Ferozepur, Punjab, India.

Abstract: *Energy efficient routing in Wireless sensor networks (WSNs) require new paradigm for design and development of energy efficient protocols and can be applied for optimal routing of data, in an energy constraint WSNs environment. In this paper, we present BeeSwarm, an energy-efficient hierarchical routing protocol for WSNs. Our protocol integrate three phases for clustering, data routing and transmission, which is the key aspect of this proposed protocol, thus ultimately contributes to its robustness. Evaluation of simulation results show that BeeSwarm perform better in terms of packet delivery and energy consumption compared to other hierarchical routing protocols for WSNs.*

Keywords: *Wireless Sensor Networks, Energy-efficient Routing.*

I. Introduction

Advances in sensor networks have enabled distributed sensor networks (DSNs) to evolve from small cluster of sensors to large swarm of microsensors, from fixed sensor nodes to mobile nodes, from wired communication to wireless communication, from static network topology to dynamically changing topology. In such dynamic environment design and development of efficient routing protocol remains a challenge for researches around the world. Wireless Sensor Networks (WSNs) consist of large number of sensor nodes which sense, process and transmit the required collected data for a desired physical environment, collaboratively. Sensor nodes communicate not only with each other but also with a *Base Station* (BS) or *Sink* using their wireless radios, allowing them to disseminate their sensor data to remote processing, visualization and analysis [1]. Many researchers are currently engaged in developing architectures, routing protocols and schemes that fulfill the requirements of these key features. The main aim is to find ways for energy-efficient route setup and reliable relaying of data from the sensor nodes to the base station so that the lifetime of the network is maximized. There is always a trade off between computation and communication in each node when it makes the route decision and data aggregation. As the size of WSNs grows, so does the complexity of the data routing. Therefore a key area of WSNs research is in developing new routing algorithms to meet the strict low-power limitations [2].

II. BeeSwarm - Protocol Description

BeeSwarm is, energy-efficient hierarchical routing protocol for WSNs inspired from the natural behaviour of honey bees. Honey bees are eco-friendly species on our earth and helped researchers to solve critical optimization problems in the past. Our protocol is based on an integrated three phase layer structure namely 1) Setup Phase 2) Route Discovery Phase and finally 3) Data Transmission Phase. Below we discuss each phase of our proposed protocol in detail and provide an insight of its working.

III. Set up Phase

The proposed WSN model will consists of number of homogeneous sensor nodes randomly distributed over a geographical area with a BS. After cluster formation, which is based on our proposed clustering algorithm, all CHs prepare a TDMA schedule and transmit this schedule to sensor nodes register with them within their cluster. This ensures there will be no collisions among data events send by various nodes and also allows the radio components of each non- CH node to be turned off at all times except during their transmit time, thus further reducing the energy consumed by the individual sensors. After the TDMA schedule is known by all senor nodes, they will be ready to forward events to their respective CHs. Then each node will send data to its respective CH based on proposed routing algorithm using multi-hop communication and CHs forward it to BS after aggregation using single hop communication.

IV. Route Discovery Phase

After selection of CHs, the next phase *BeeSearch* will discover routes for event communication through scout bees. BeeSearch is a two way process 1) Forward Search and 2) Backward Search. Forward Search will explore the network

and Backward Search will establish and maintain paths between BS and various nodes. The first event communication is for registration of nodes with respective CHs. Each CH initiate J-ADV request for its neighbour nodes though scout bees, to join as zonal node under a specific CH. Further each node will forward the J-ADV request to other nodes in their communication range. If a particular node had already received a J-ADV message then it discard the message to eliminate duplicate frames. Now this process will be carried on until they cover all the surrounding nodes

V. Data Transmission Phase

Once all the nodes are registered to their respective CHs, scout pass the control to forager which carry the events from various nodes to their respective CHs with the help of RT in data transmission phase known as *BeeCarrier*. The CHs prepare a TDMA schedule and transmits this schedule to its registered nodes in the cluster.The complete Time Line schedule of *BeeSwarm*, which include time slots for all three phases viz. 1) Set-up phase 2) Route Discovery Phase and 3) Data Transmission Phase. This ensures that there are no collisions among data events send by various nodes and also allows the radio components of each non- CH node to be turned off at all times except during their transmission, thus reducing the energy consumed by the individual sensors.

VI. Results and Analysis

Our proposed protocol is simulated on *Nature Inspired Tool for Sensor Simulation* (NITSS), a java based platform specially developed to support WSNs environment. To evaluate its performance with other CI based hierarchal routing protocols *Leach* and *PSO the* following parameters are considered:

Table 1. Simulation Parameters

Parameter	Value
Channel Type	Wireless
MAC Protocol	802.11
Radio Propagation	Free Space
Node Deployment	Random
Packet Size	1000 bits
Message Size	300 bits

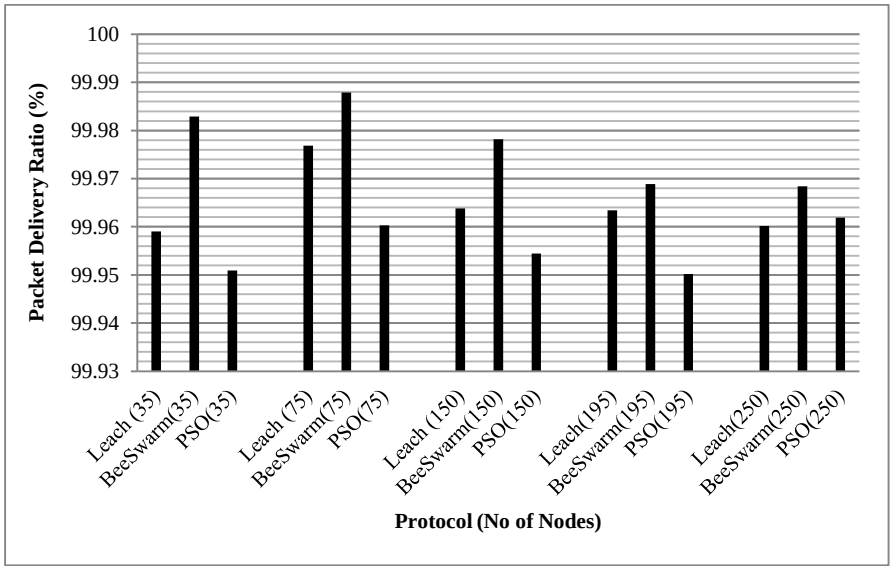

Fig 1. Packet Delivery Ratio (%)

Fig. [1] shows that our proposed protocol, *BeeSwarm* deliver the highest number of packets at BS compared to other protocols, even on high node density. Result shows that our proposed protocol deliver approximately 20% more packets. This shows the robust performance by our proposed protocol, which is very significant in case of data monitoring applications in WSNs.

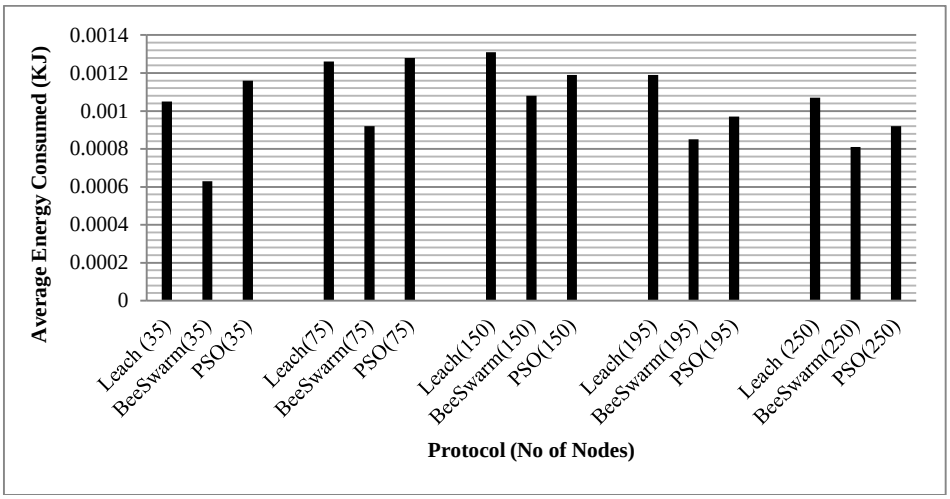

Fig 2. Average Energy Consumed (KJ)

Fig. [2] shows that *BeeSwarm* consumed lowest amount of energy as compared to *Leach* and PSO even at high density of nodes. On the other hand, *Leach* consumes less amount of energy as compared to *PSO* at low node density but as node density increases, *PSO* perform better in terms of energy consumption, but BeeSwarm consumes much less energy compared to *Leach* and *PSO*. The above result prove *BeeSwarm* as energy efficient protocol even for scalable networks.

V. Acknowledgement

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