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An Energy-Efficient Routing Scheme Using Energy Density in Wireless Sensor Networks

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Abstract
Wireless sensor network is a wireless network consisting of widely distributer autonomous devices using sensors to monitor physical or environmental conditions. In WSN large number of node organized into a cooperative network. In WSN nodes are battery powered devices, they have limited transmission power, communication ability storage capacity. For effective transmission of data to receiver we go for design of routing protocol. Since energy conservation is a key issue in WSN, data aggregation is exploited to save the energy. This paper proposes energy efficient method using energy balanced routing protocol. This method is based on forward aware factor technique. In FAF, next hop node is selected based on forward energy density and link weight. Simulation results shows that the proposed method balances the energy consumption, increase the network lifetime and provide QoS.

Keywords
Wireless Sensor Networks (WSN) ,Network simulator ,Forward Aware Factor(FAF).

I. Introduction

Wireless Sensor Networks (WSN) contains many number of sensor nodes. It is well known that wireless sensor network consist of large number of sensor nodes.in industrial application. WSNs are an active research area over past few years. WSN used as an effective medium to integrate physical world and information world of industrial application. Each sensor node act as both sensor and router . It has limited energy and communication ability. So the design of routing protocol and network topology are required. Energy consumption is important factor in the design of WSN, there are two approaches to accomplish the data collection. They are direct communication and multi hop forwarding. Mainly these sensor nodes have some important functions. They involve sensing of data, processing of data, comprising of data, transmission of data etc.

In recent years, to balances the energy consumption, increase the communication and connectivity, several mechanism are designed for wireless sensor networks. Some mechanism deals with complex networks such as SCN and airport network

Sensor node can be used in a fixed or mobile manner. The sensor nodes have power units. Sensor nodes can be deployed in sensor fields corresponds to their application. They have a wide variety of applications. It is useful for industrial and military applications. It can also be used to find atmospheric parameters such as pressure, light intensity, amount of gases etc. The proper and effective transmission of data is very essential thing. But these sensors are micro tic sensor nodes. And they are energy and band width limited devices. Their communication abilities are poor. So energy aware routing protocol is used as a remedy. Without an efficient energy balanced routing method, networks are failed in data transmission. Cluster network is used. By using mobile sink the packet loss reduction is aimed.

It is well known that wireless sensor network consist of large number of sensor nodes.in industrial application. WSN is an active research area over past few years. WSN is used as an effective medium to integrate physical world and information world of industrial application. Each sensor node act as both sensor and router . It has limited energy and communication ability. so the design of routing protocol and network topology are required. Energy consumption is important factor in the design of WSN, there are two approaches to accomplish the data collection. They are direct communication and multi hop forwarding. In direct communication, the sensor node directly transmits the data to the sink, this method increase the communication distance and degrade the energy efficiency of the sensor nodes. In multi hop forwarding sensor node transmit the data to the sink through multiple relays and thus communication.

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The network simulator is going to be defined as a discrete event based packet level simulator. Whereas the network simulator protects a very large and different number of applications worldwide of and again change considering kind of protocols of different network types which are consisting of different network based elements and considering different traffic models. Network simulator consists of tools such that sometimes we call it as a package of tools which simulates behavior covering different networks, performing network related operations such as creating network topologies, and recording log events, and analyzing the events to check the operation and understand the network behavior. Here the main objective of our first experiment is learn network simulator, how to use it , getting familiar with simulated objects and making understand the functions of network simulation and here we also need to judge the behavior of the simulation object with help of network simulation.

II. Organization

This paper is organized as follows, section 1 discusses the introduction, and section 3 describes related work. Section 4 details the system design and implementation. Section 5, presents the performance evaluations of our system design. Finally, section 6 presents some concluding remark.

III. Related Work

"Scale-free networks: A decade and beyond," Science, A L. Barabási [1], has described the components of such mentioned complex systems as the cell present in the network, the society state, or technology considered

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here is the Internet are randomly connected together. Consider the function, and mainly about scope, combine into similar network architectures or topology to a universality system that permitted the researchers from different point of view to study the network theory as a common approach. **"Design and implementation of embedded un-interruptible power supply system (EUPSS) for web-based mobile application," D. G. Zhang and X. D. Zhang, [2],** has considered the study of embedded application systems, they describe it like with the growth of the proportion or amount of data calculated by these application systems called embedded applications,Then results collected from the experiments performed, the mobile end users going to monitor and also going to control the UPS system very easily in different places along the long distances **"An application-specific protocol architecture for wireless sensor networks," W. B. Heinzelman, A. P. Chandrakasan, and H. Balakrishnan [3],** has considered the study of networking involving hundreds or thousands of devices like cheap micro-sensor nodes, And hence such networks require or in need of a protocol called robust wireless communication protocols, which provides features such as energy efficiently and also latency with reduced value. .**"A modified DPWS protocol stack for 6LoWPAN-based wireless sensor networks,"I. K. Samaras and G. D. Hassapis,[4]** has modified the protocol stack of the device profile for web services (DPWS) is proposed which can be applied in wireless sensor networks (WSNs) that comply with the IPv6 over low-power wireless personal area networks (6LoWPAN) architecture. Simulation results have shown that the modified DPWS presents better performance than the DPWS and offers inferior results only when it is compared with the binary-based DPWS which, however, does not retain the WSs interoperability feature as it does not use XML documents.**"Anew approach and system for attentive mobile learning based on seamless migration," D.G. Zhang,[5]** has described the function of seamless mobility is suitable for mobile services such as mobile Web-based learning. The author proposes an approach that supports an attentive mobile learning paradigm. This suggested attentive mobile learning paradigm based on seamless migration is useful and convenient to mobile learners.**"Web-based seamless migration for task-oriented nomadic service," D. G. Zhang,[6]** has introduced a new approach that explores the use of Semantic Web language in building architecture for service mining in mobile environment in this paper. The author proposes a Web Ontology Language based ontology for service description, and for supporting logic-based service matchmaking. It improves the veracity of service process, and paves the way for fuzzy process and service composition.**"Analysis of per-node traffic load in multi-hop wireless sensor networks," Q. J. Chen, S. S. Kanhere, andM. Hassan[7],** has described the energy expended by sensor nodes in data communication makes up a significant quantum of their total energy consumption. The author proposes an analytical model for estimating the per-node traffic load in a multi-hop wireless sensor network. The results from our analysis are validated by extensive simulations.**"Handling inelastic traffic in wireless sensor networks,"J. Jin et al[8].** has developed the theory of utility proportional rate control for wired networks to a wireless setting, and combining it with a stochastic optimization framework that results in an elegant queue back pressure-based algorithm, author has designed the first-ever rate control protocol that can efficiently handle a mix of elastic and inelastic traffic in a wireless sensor network. In order to evaluate the real-world performance of this protocol through comprehensive experiments on 20 and 40-node sub networks of USC's 94-node Tutornet wireless sensor network tested.**A novel image de-noising method based on spherical coordinates system," D. G. Zhang and X. J. Kang,[9]** has proposed a novel image de-noising method .This method is based on spherical coordinates system. This article names the multi-scale product in spherical coordinates system as Multi-Scale Norm Product the results indicate that improved algorithm is simple and effective.**"A local-world evolving network model," X. Li and G. R. Chen,[10]** has proposed and studied a novel evolving network model with the new concept of local-world connectivity, which exists in many physical complex networks. The author found that this local-world evolving network model can maintain the robustness of scale-free networks and can improve the network reliance against intentional attacks, which is the inherent fragility of most scale-free networks.

IV. Methodology

The basic objective of the project is to implement a routing protocol for WSNs so that sensing data can be transmitted to the receiver effectively.

A. Proposed System

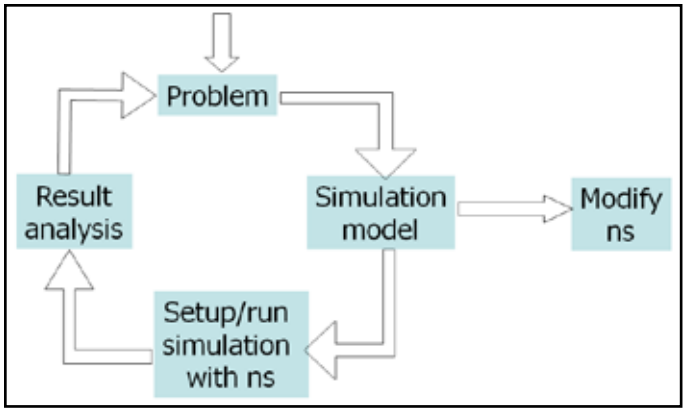

Fig. 1: Architecture of proposed system.

Here we proposed energy based routing algorithm popularly called as FAF-EBRM, which helps to optimize the level of energy consumption in network such as WSN.

In FAF-EBRM, here the next-hop node is going to be selected based on the knowledge of link weight value and another important parameter is forward energy density.

2. The routing algorithm can be divided as follows:

- Determine forward transmission area (FTA) all of the selected specific next-hop nodes of system.
- Determine the next-hop for each possible next-hop nodes and find the distance between the next-hop nodes and base station (SFTA).
- Calculate forward energy density (FED) of each possible next-hop node.
- Calculate the weight of edges between each node.
- Calculate the forward aware factor (FAF) of each possible transmit link using FED + the weight of edges.
- Choose the next-hop node which has maximum FAF.

B. Forward Aware Factor and Forward EnergyDensity

Forward Aware Factor is a mathematical derivation. And this Forward Aware Factor of communication link between node I and node j is derived by using FED (Forward EnergyDensity).

Algorithm of FED

Step1: To determine FTA (Forward Transmission Area)and possible next hop nodes.

Step2 : Then communication radius is considered.

Step3: To determine set of all nodes that have edges with node i.

Step4: To select the nodes that closer to destination node i does which contains the set of all of the possible next hop nodes and

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furthest node determines FTA(Forward Transmission Area)
Step5: To calculate FTA (j) and S(FTA j) of each possible network nodes.
Step6: FTA(j) is also determined as the same way of FTA(j).
Step7: Fix the furthest distance between node j and nodes in FTA is obtained.
Step8: And furthest distance between node j and destination node is obtained.

- S (FTA j) is obtained.
- FED (j) of each possible next hop is calculated.
- Fix the parameters into probability Pn and Weight between i and neighbor node in to FAF.

Step9:Then calculated FAF of each possible transmission link.

C. Generic Script Structure

Set ns [new Simulator]
[Turn on tracing]
create topology
Setup packet loss, link dynamics
Create routing agents
Create:
- multicast groups
- protocol agents
- application and/or setup traffic sources
Post -processing procs
Start simulation

D. LEACH implementation in Wireless Sensor Networks

In this module, a wireless sensor network is created. Sensor nodes are created along with base station nodes. All the sensor nodes are connected using wireless links. The sensor nodes send the sensed data details directly to the main base station node. LEACH protocol is applied in the network. The WSN in divided into clusters and each cluster have its own base station node. The data are transferred to base station through cluster head nodes

E. Implementation of FAF-EBRM

In this module, FAF-EBRM protocol is implemented in the network. In FAF-EBRM, the next-hop node is selected according to the knowledge of link weight and another value is forward energy density value. The distance from BS and weight for each and every node is determined and FAF is calculated. The node which is having highest FAF is selected as next-hop node.

F. System Design

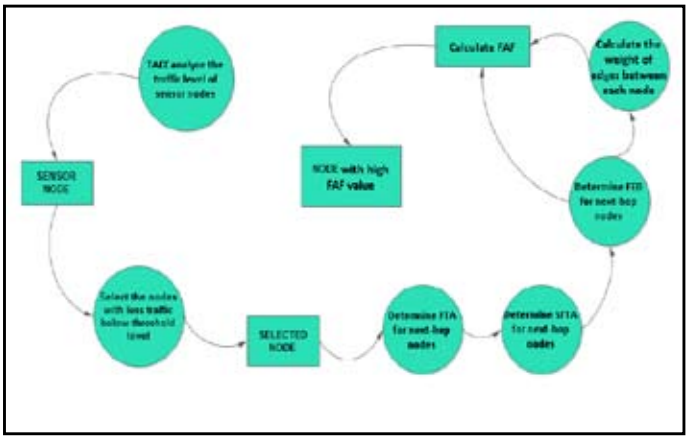

Fig. 2 : Data flow diagram

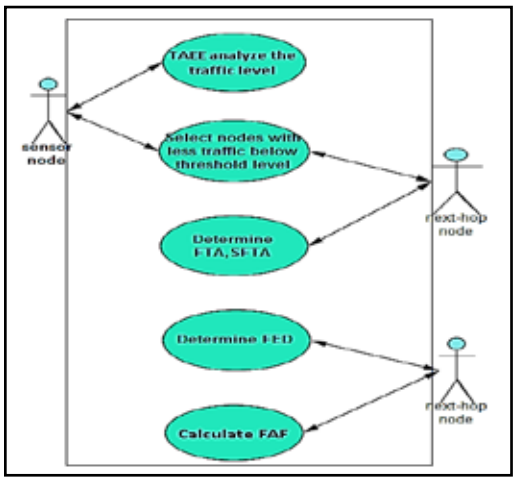

Fig. 3: Use case diagram

V. Results

1. Simulation

At present agent based modeling and simulation is the only pattern which allows the simulation of complex behavior in the environment of wireless sensor networks. Agent based simulation of WSN is new paradigm. It is based on social simulation. Network simulator like OPNET, netsim, and NS2 can be used to simulate wireless sensor networks. This project was done using NS2. Basically NS2 program contain four steps. They are 1). Create an event scheduler 2). Turn on tracing 3). Create a network 4). Monitor using network animator. Creating network contains computing the setup routing, creating transport connection, and creating traffic.

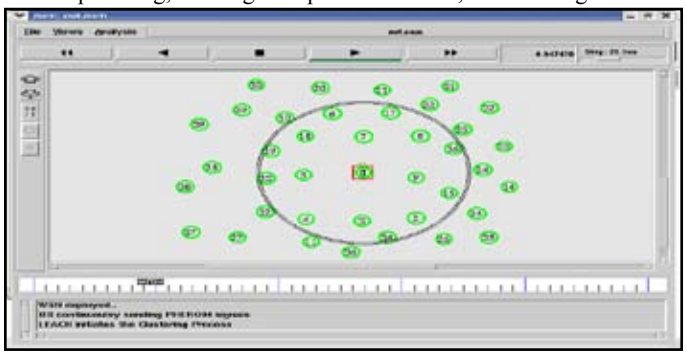

Fig. 4 : Existing System of WSN.

In fig 4, first the WSN is deployed, and then the base station (BS) continuously sends the PHENOM signals to all the nodes in the WSN. After this process the BS comes to know the locations of all the nodes, and then the BS initiates the clustering process.

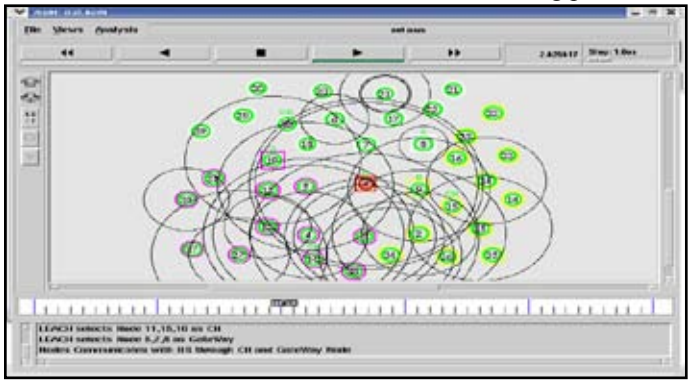

Fig. 5: Selection of LEACH and Cluster heads.

In fig 5 show LEACH selects the Cluster heads, here the CH are nodes

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11, 15 & 10.and LEACH selects the gateways also, these gateway nodes helps in communication between the two clusters of the network. All the nodes communicate with BS through the CH and gateway nodes.

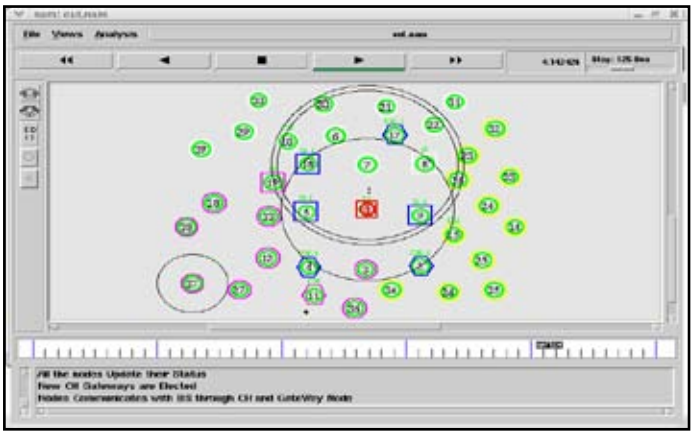

Fig. 6 : Re –clustering of nodes.

In fig6 shows, a re-clustering phase is done so that the other nodes can participate to become CH and gateway nodes. All the nodes update their status & new CH and gateway nodes are elected.

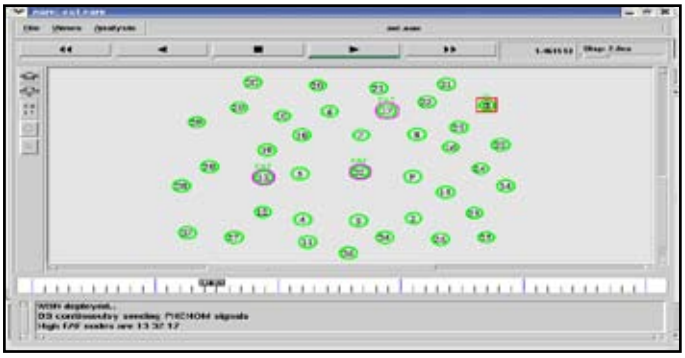

Fig. 7 : Formation of WSN

In fig7, the WSN is deployed. The Base-station (BS) sends the PHENOM signals so that it comes to know the location of all the nodes that are present in the network. The PHENOM signals are the type of broadcast signals that are received by every node in the network. Next the nodes with high FAF (forward aware factor) is selected, here the nodes 13, 32 & 17 have high FAF.

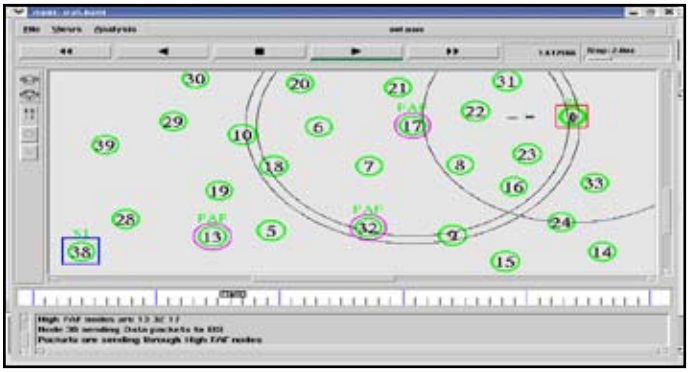

Fig. 8: Intermediate nodes are formed.

In fig 8 shows, node 38 sends the Data packets to the base station, this is done through the intermediate nodes that have high FAF i.e. nodes 13, 32, 17 these nodes act as the intermediate hops between the S1 and BS.

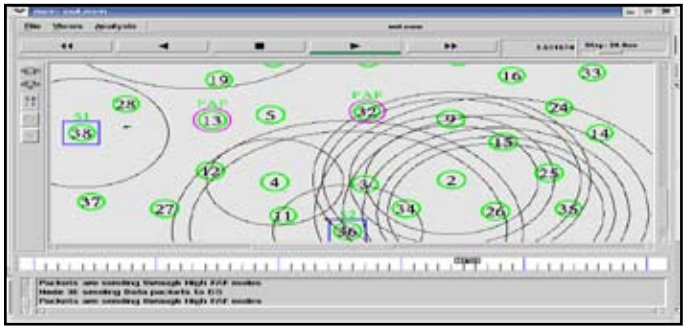

Fig. 9 : Energy transferring packets.

In fig9 shows, selection of the node 38 the next sources S2 from another cluster sends the packets through the high FAF nodes. The nodes maintain the energy while transferring the data packets to BS.

2. Graph showing throughput comparison

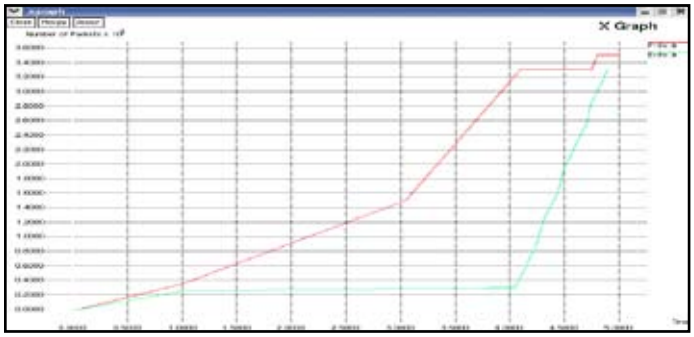

Fig. 10: Throughput Comparison

In fig10, shows the throughput of the proposed system (Red) is very high as compared to the existing system (Green).

3. Graph showing PDR(Packet Drop Ratio) comparison

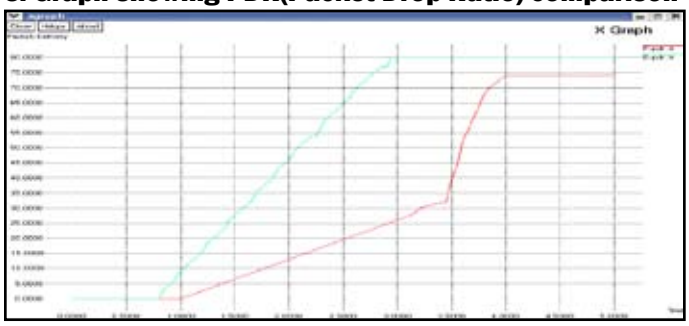

Fig. 11: PDR comparison.

In fig11, shows the packet drop ratio, as the graph displays the PDR of existing system is more than the PDR of the proposed system. As the packet drop ratio increases the throughput and the efficiency of the protocol.

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4. Graph showing energy consumption comparison

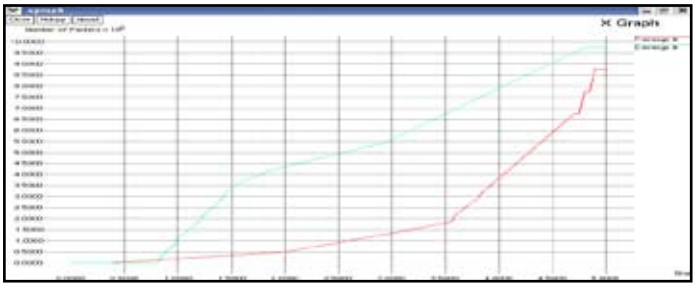

Fig. 12: Energy consumption Comparison

In fig12, shows the energy consumption of the nodes in the network. The proposed protocol (Red) or method (FAF-EBRP) reduces the energy consumption of the nodes as compared with existing protocol(Green)

VI. Conclusion and Future Work

The proposed method FAF-EBRM based on the parameter that is forward-aware factor is proposed or implemented in this work. In this method, the next-hop node in the network is chosen according to the knowledge of link weight value and also other value such as forward energy density value. And hence furthermore, a standard reconstruction mechanism for local architecture of topology is designed. Here in experiment which is performed, the protocol FAF-EBRM is compared with other techniques such as LEACH protocol and EEUC technique, and analysis results also show that proposed method FAF-EBRM perform well compared to LEACH and another one is EEUC, which is going to balance the energy consumption parameter, and prolongs or enlarge the function lifetime, and also guarantees quality service i.e. QoS of WSN.

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