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Modified Gossiping Routing Protocol for Energy Conservation in Wireless Sensor Networks

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Abstract: The wireless sensor networks due to its invincible property finds its application in several areas. For all these applications, the energy utilization is the factor which determines the performance of the sensor networks. Routing of information and transmitting the same to the base station plays a vital role because the nodes are battery operated and the energy resources are scarce. The study proposes a novel protocol called Position Based Gossiping (PBG) for providing a solution for addressing the problems in gossiping technique. The proposed technique enhances the energy within the network and improves the lifetime of the network as compared to the conventional routing protocols. Moreover, the energy between the nodes are equalized which considerably enhances the lifetime of the network. As added the protocol minimizes the delay in transmission and loss of data packets.

Key words: Wireless sensor networks, routing, battery operated, lifetime, protocol

INTRODUCTION

The wireless sensor networks are a collection of small nodes called the sensor nodes consisting of sensors for monitoring the temperature, humidity, light along with microprocessor, memory capabilities and power. For understanding the conventional and application areas of wireless sensor networks an improved and energy efficient techniques for communication are needed (Riad and Mohamed, 2013). The sensor networks are purely dependent on the application areas they serve because the demand for designing the wireless sensor networks alters accordingly. The protocol requirements differ from one application to other i.e., the need of routing protocols for serving the environmental applications are not same for military and health scenarios in many cases (Alghamdi, 2015; Gong *et al*., 2015; Yadav and Rana, 2015). But, the primary goal of the routing protocols in wireless sensor networks are not subjected to particular application rather they must improve the lifetime of the network and reduce the energy utilization within the network. The energy utilization must be reduced for improving the network lifetime which is the major issue in sensor networks because for many applications it is not practically possible to replace or recharge (Kalpana and Bhuvaneshwari, 2011; Singh and Sharma, 2015). This makes it necessary for proposing a protocol for improving the network lifetime but it is not possible to examine the lifetime of the network due to the network framework and protocols, initiation of data gathering, defining lifetime of the network, medium characteristics and energy utilization (Kalpana and Bhuvaneshwari, 2011). Whatever may be the routing protocols the energy utilization during communication remains a major issue for energy exhaustion and the transmissions must be minimized for improving the lifetime of the network. The energy consumption remains at the top for several reasons in wireless sensor network (Singh and Sharma, 2015; Akyildiz and Vuran, 2010).

The study is focused on designing a novel protocol for routing which uses gossiping called the Position Based Gossiping (PBG) for enhancing the setbacks in gossiping. The position based gossiping works in three stages namely assumption, data collection and routing. In assumption phase, every node creates the rise to the sink. For data collection, the PBG gossiping forwards a RREQ to the other nodes for obtaining data about the adjacent nodes. Based on the hop count and residual energy information the PBG selects a couple of nodes in the last phase. The chosen nodes are present near the base station and based on the hop count of the chosen nodes with the target node for delivering the data packets to the

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destination. From the selected node couples only one node is chosen by the protocol for packet transfer. The node with high remaining energy is chosen for forwarding the message in order to broadcast it to the base station. The results of proposed technique produce best possible results by which the proposed technique provides best routing strategies.

Literature review: Riad and Mohamed (2013) described the role and applications of wireless sensor networks in industries, military and academics. The present focus is upon routing issues in wireless sensor networks without compromising security but the fullest concentration is not upon enforcing security while routing. The researchers focused on security aspects during routing for which artificial intelligence based techniques was focused in WSN routing protocols. Furthermore, the researchers also focused on security and threats with the protocol with an equal analysis on merits and demerits.

Alghamdi (2015) described wireless sensor networks as widely accepted networks for its application in multiple scenarios. The networks are a collection of small devices that are affordable and easy to setup based on the application. The wireless body area sensor networks play an unbeatable role in observing critical patients. Whatever may be the application area of sensor networks routing still remains a challenge for which the researcher focused on designing an effective routing protocol based on clusters for improving the energy utilization on comparison with conventional methods. The proposed on comparison with other conventional protocols like LEACH and WBNS was high and improved and employed in several other application areas.

Rahayu *et al.* (2015) focused on the secure and effective routing protocols in wireless sensor networks. In sensor networks routing and data combination is not much attended issue for which the authors focused on designing a secure data combination protocol. The role of security is dominant while designing data combination technique without which the technique appears useless. It makes it necessary for a secure protocol for fetching best possible results. Researchers designed an energy aware protocol based on the LEACH and ESPDA protocols with security during routing and data combination. The performance of the proposed protocol outperformed the conventional protocols in terms of security and energy conservation.

Gong *et al.* (2015) designed a novel protocol for routing called the secure and energy aware routing protocol considering the security and energy conservation factors in wireless sensor networks. The protocol is best suited for high operational environments. The routing protocol focuses on route discovery with a keen observation on energy conservation and trust between the routes because the protocol identifies and chooses the routes based on highest utility without any additional overheads as compared with AODV. The results were compared with the conventional routing protocols AODV-EHA and LTB-AODV where it achieves security with high energy conservation for delivering the data packets.

Yadav and Rana (2015) research were focused on analyzing the development and applications of wireless sensor networks. The network is an aggregation of many cheap and small devices called the sensor nodes which communicate with each other via several communication techniques which are under the control of routing protocols and these routing protocols are trusty for attaining performance in wireless sensor networks. The network framework splits the routing protocols into three different types for the purpose of routing. The researcher focused on surveying cluster based routing schemes in wireless sensor networks for analyzing their merits and demerits based for deriving a best solution for cluster based routing in wireless sensor networks.

Kalpana and Bhuvaneswari (2011) addressed wireless sensor networks as a growing technology due to micro-electro-mechanical system technology in recent years. These networks are capable enough to physically connect the real world with the virtual world through a collection of sensor nodes. These sensor nodes are operated through batteries for which energy conservation scheme appears highly challenging. The lifetime of the sensor nodes can be prolonged by reducing the energy utilization by all the network layers. The concentration of researchers is towards cluster based routing protocols which holds special nodes called the head which leads to the destination. The job of these cluster heads is to gather information from the sensors to its clusters and forwarding the same to the destination. For a heterogeneous cluster networks the head consists of high energy devices in contrast to homogeneous cluster networks where each and all the nodes contains equal and restricted energy resources. This makes it necessary to evade quick exhaustion of cluster heads. The cluster formation conserves considerable energy by selection of cluster heads and data combination for minimizing the redundancies in data and energy conservation.

Singh and Sharma (2015) described about the latest advancements and applications in wireless sensor network technology which are a collection of cheap and several small devices called the sensor nodes. The sensor nodes facilitate communication through several communication techniques which are monitored by

routing protocols. The performance of these wireless sensor nodes are entirely governed by these routing protocols. The researchres primary goal focused on routing protocols in wireless sensor networks from which cluster based routing is given the prime importance. Based on the analysis and by considering the limitations and merits a novel cluster based scheme was designed.

Solution to the problem: The studies from previous research clearly explain the differences between flat and hierarchical routing schemes (Akyildiz and Vuran, 2010; Verdone *et al*., 2010). The implementation of the proposed work is purely dependant on gossiping technique. The gossiping approach is a protocol which causes data delay and it is based on flooding protocol which does not require any table for maintaining routing information or necessities for maintenance (He *et al*., 2006). The protocol is an enhancement of flooding and its overcomes the problem with flooding where a node broadcasts its data to all the adjacent nodes even since the node contains that particular information already and this broadcasting is performed until the information is delivered to the destination (Alghamdi, 2015; Verdone *et al*., 2010; Bandyopadhyay and Coyle 2003). For gossiping a node arbitrarily selects an adjacent node to onward the packet and upon reception of this packet by the adjacent node, it selects another arbitrary node for forwarding the data packet. The process is repeated until the data packet reaches the destination or until exceeding the predefined number of hops for the data packet. This facilitates only the communication only through the chosen nodes until the target node (Norouzi and Sertbas, 2011). Gossiping is not like flooding it does not broadcast but it communicates in 1-1 manner (Yadav and Rana, 2015).

The gossiping approach does not consume huge amount of energy rather other issues like delay in data propagation, latency might arise. Unlike flooding technique gossiping can be used for particular functions despite of simplicity. The energy consumed by gossiping at each step is O (NH). Here, 'N' represents the nodes that are forwarding the packets and 'H' represents the halts occurring before packet forwarding. The gossiping technique possesses the ability to manage the power consumption by choosing appropriate 'N' and 'H'.

MATERIALS AND METHODS

Proposed routing protocol: The idea behind the proposed technique is modifying the gossiping protocol for minimizing the energy utilization and to maximize the lifetime of the network. The extended gossiping protocol aims to maximize the lifetime of the network by choosing a node with high residual energy and reducing the distance to the destination. The proposed technique achieves high delivery ratio and minimizing the delay in packet delivery. The proposed algorithm works in three phases as network assumption, data collection and routing.

Network assumption: The network assumption phase is initialized by arbitrary positioning of the sensor nodes where the base station transmits a 'HELLO' message to all its adjacent nodes. The base station message holds the address of the base station and number of hops. The hop number is used to setup a rise to the base station i.e., it determines the distance of the node from the base station. After the transmission of 'HELLO' message all the 1-hop adjacent nodes gathers this message and obtains the address of the base station and the number of hops. The hop counts are hoarded into the nodes memory and increases the hop count by 1 i.e., the older entries are replaced by new hop count. After gathering the 'HELLO' message, the same is transmitted to the nodes that remain farther.

After reception of 'HELLO' message by a node, it checks for a rise which is compared with the number of hops and replaces the hop count with that of message hop count if the later one are smaller it is increased to 1 for transmitting it. In case, the number of hops are smaller than or if it is equal to the message hop number the message is discarded. The condition arises because the message is transmitted earlier by different routes. But, the node rise will hold only through the best paths. This process is repeated until all the sensors obtains the 'HELLO' message during network assumption phase is completed. This process allows the nodes to know its distance from the base station.

Data collection: Based on the identification the source node influences a radius of 50 m for dealing with the adjacent nodes. Each and every sensor nodes holds a GPS device for traversing to any position within their transmission range. Furthermore, the source node generates a RREQ for obtaining the data from adjacent nodes within its range of transmission. The RREQ is there inside the hop cont of the adjacent nodes to the destination based on which the nodes transmit the RREQ to the source node.

Routing: As soon as the expiry of network assumption phase the routing phase is initiated. The routing phase holds the following assumptions:

- At the initial state all the nodes contains full energy and have same quantity of energy
- The nodes are aware about its residual energy at every state of its lifetime
- Each node has a transmission range of 50 m

All the adjacent nodes receiving this request reply based on its residual energy and the number of hops. Furthermore, two adjacent nodes are chosen by the source node within its range of transmission with less hop count to the destination.

RESULTS AND DISCUSSION

Performance analysis: The simulations were carried out based on the following parameters.

Radius: The sensor node is capable enough of covering about 50 m. The sensor nodes are capable enough of drawing its transmission range up to the number of nodes within its range of transmission.

Remaining energy: It provides the information about the remaining energy. Initially the energy level for all the sensor nodes is assumed to be equal.

Sensor position: Each and every sensor nodes are equipped with GPS and are capable enough to relocate themselves within their range of transmission. The proposed PBG routing protocol outperformed the other conventional routing protocols for which the performance evaluation was performed by estimating packet losses, delay in transmission, active nodes and the total energy conserved during each and every round.

Packet losses: Figure 1 depicts that the packet losses are less in PBG routing protocol as compared to the conventional gossiping, Lgossiping and ELgossiping protocols. But, it is noted that the packet loss rate are increased after the 450th iteration.

Active nodes: All the nodes in gossiping are almost dead after the 150th iteration. Figure 2 depicts that in the proposed routing protocol all the nodes exhaust after 700th iteration by equalizing and using the energy in a better way.

Delay in transmission: As compared to the other arbitrary selection of protocols for transmitting the packets to the next hop the proposed routing protocol the adjacent nodes to the base station are chosen as the next

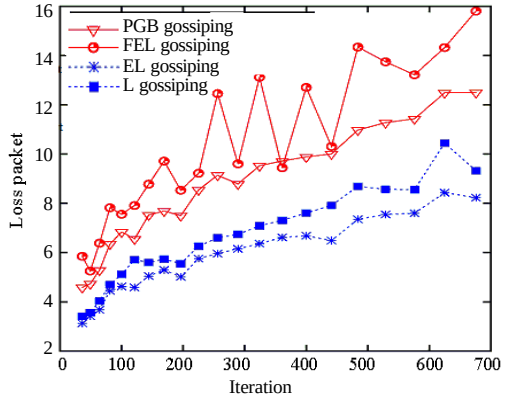

Fig. 1: Packet loss

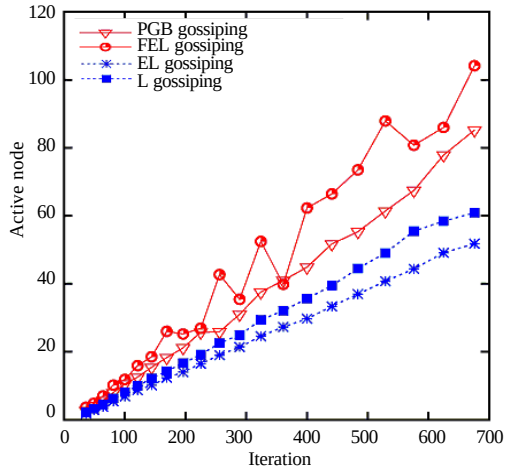

Fig. 2: Active node

hop and moreover, it uses GPS for finding the address of the base station in an effective manner. The comparison reveal that the delay is greatly reduced using the proposed routing protocol and from Fig. 3, it is clear that after 400th iteration the delay is approximately at 1 ms.

Energy utilization: The proposed routing protocol does not choose the nodes with remaining energy in a random manner as it is done in other conventional routing protocols. The energy is consumed considerably by each and every node during every transmission or reception made. The chance of selecting the same node as later hops is descended. It allows equalization of energy and better utilization. This all leads to conserve energy and extending the lifetime of the network as compared to the conventional routing protocols as depicted in Fig. 4.

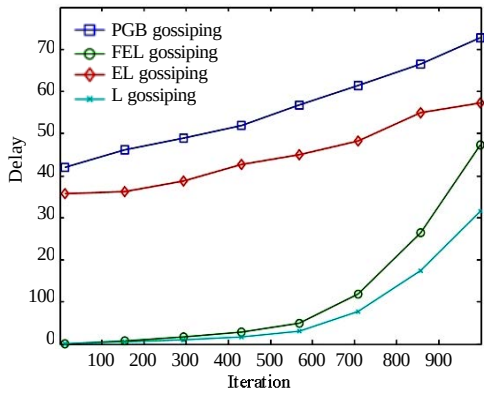

Fig. 3: Delay transmission

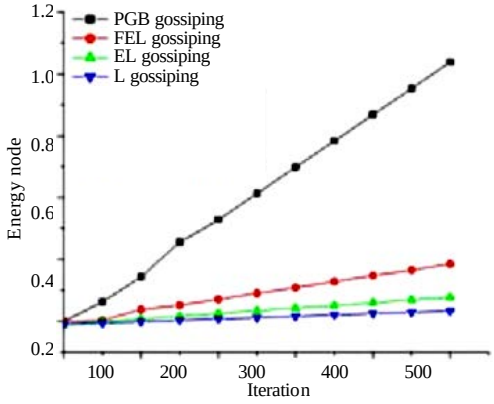

Fig. 4: Energy utilization

CONCLUSION

The wireless sensor networks are a collection of sensor nodes which are operated through batteries. Because of the energy restricted nature of these sensor nodes the topology of the network are subjected to change arbitrarily. Moreover, the fundamental characteristics of sensor nodes create added challenges to the protocols that facilitate communication. The study is focused in gossiping routing protocol with energy conservation and the factors essentially needed for conserving energy. In gossiping protocol based on a careful analysis it possible to extend the network lifetime by carefully selecting the next hop for transmission. Based on which in the proposed routing protocol initially the lifetime of the network are extended through brilliant utilization of energy by choosing nodes with high remaining energy and minimal distance to the target. Then, the protocol achieves high packet delivery and minimized the delays in delivering packets to the destination. Finally, the overheads in message are reduced and the energy utilization by nodes that facilitate data transmission to the base station by transmitting an acknowledgment message of successful packet reception.

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