Improved Survivable Path Routing in WSN for IOT Applications

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Abstract

WSN is low power, scalable, fault tolerant network and the cost is very less as well as maintenance free. Nowadays, WSN are used for Internet of Things applications. Internet of Things scenario normally requires high reliability of data transmitted from source to destination node. During the broadcasting of the packets to find a route from source to destination node, congestion is inevitable in the network. This paper presents a routing scheme, which avoids the links with high congestion, which would result in lesser nodes opting for forwarding of packets. The proposed scheme shows improvement in terms of throughput, packet delivery ratio, and remaining energy.

Keywords: *Sensors, IOT, PCF, throughput*

I. INTRODUCTION

A WSN is a network of consists of low power devices known as sensor nodes (SN), which are distributed over the area to measure the atmospheric variations. One or more number of SNs among network will act as the sink that will bring the direct communication with users. The main component of WSN is sensor that collects information about the physical environmental conditions like sound, humidity, intensity, pressure etc., in different areas. The functionalities of SN include data processing,communication, leveraging the network with more SNs [10]. WSN is low power, scalable, fault tolerant network and the cost is very less as well as maintenance free [11].

The Internet of Things (IoT) is an arrangement of computing devices, mechanical and advanced machines, items, creatures or individuals and it has the capacity to exchange information over a network without involving human-to-human or human-to-PC collaboration. In Internet of Things, a thing [12] can be a man, a vehicle that has worked in sensors to caution the driver when tire weight is low or some other normal or man-made question that can give an IP address and furnished with the capacity to exchange information over a network. It has concocted a general of network gadgets to detect and amass information from our general surroundings. After the information spread, it shares the gathered information over the internet for additionally handling as per the client's wants. Fundamentally, Internet of Things is the network of physical articles prohibited and regulated over internet.

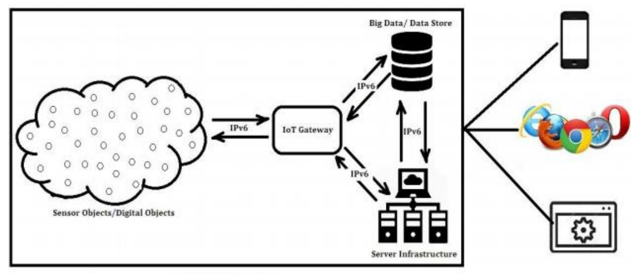

Figure 1.1: Internet of Things (IOT)

Internet of Things scenario normally requires high reliability of data transmitted from source to destination node. During the broadcasting of the packets to find a route from source to destination node, congestion is inevitable in the network. Thus, the problem, which exists here, is that if such nodes broadcast the packets to every neighbor for path formation, it would waste resources of the network. This paper presents a routing scheme, which avoids the links with high congestion, which would result in lesser nodes opting for forwarding of interest packets. This would eventually reduce packet drop and save more energy from the network.

Section II presents brief study about routing schemes in WSN, with proposed work presented in section III. Finally, the results are presented in section IV with the conclusion discussed at the last.

II. LITERATURE REVIEW

Glibertet. al.[1] This paper presents an overview of the various research issues in WSN based applications. The application of WSN in the areas of biomedical, intelligent parking, healthcare applications,

and environmental, industrial, and military applications have been briefed. These interesting applications are possible due to the flexibility, fault tolerance, low cost and rapid deployment characteristics of sensor networks. A review on the various research issues involved in the WSN applications has been outlined.
Ji et al. [2] presented the low power adaptive RP for WSN. To bring the energy efficiency and resolve the data aggregation issue, author has presented the adaptive routing algorithm for clustering. In this clustering, head was selected based on node density in the measuring area. The results of adaptive routing algorithm are compared with LEACH algorithm and it is concluded that the algorithm brings energy optimization & improved communication quality in distribution situation.

The work of Hu and Li [3] presented the geography region based clustering algorithm in WSN. In this, the every region chooses its respective cluster head. To reduce the energy usage and proper resource allocation, multi-hop and single hop combination is used. The simulation result of the geographic region algorithm satisfies the above requirement.

Ca and Yu [4] described a mechanism of load balance in WSN using compressive sensing. In this work, the energy consumption of SNs is considered. The load is balanced by using compressive sensing, and the performance is evaluated by Tiny OS and simulation results represent the significant results.

Chelbiet. al, [5] presented an energy efficient routing protocol for WSN. When the sensor field is far away from the BS, the CH is burdened with heavier relay traffic and tends to die much faster. To solve this problem, a Multi-hop Energy Efficient routing protocol based on Data Controlling (MEEDC) is proposed in this paper. This work focuses on (i) a heterogeneous network and (ii) a sensitive data controlling. The role of super nodes in the proposed heterogeneous network is to connect the CH and the BS. They are responsible for transmitting packets received from the CH to the BS, thus the CH can preserve some energy in data forwarding. The control of data transmission tries to reduce the number of transmissions and thus considerable energy conservation is achieved. Simulation results show that the MEEDC protocol significantly prolongs the etwork survival time.

Maizate and Kamoun[6] In this paper they propose a new approach called EPCDRE (Enhanced passive clustering algorithm based on distance and residual energy), which evenly distributes the energy dissipation among the sensor nodes to maximize the network lifetime. This is achieved by using residual energy and distance between nodes in the selection of nodes cluster heads and election of cluster head backup. Comparison with the existing schemes such as Passive Clustering, PCEEC and GRIDS (Geographically Repulsive Insomnious Distributed Sensors) reveals that the proposed algorithm approach significantly improves the network lifetime and it can further efficiently relay the cluster data. Simulation results show the effectiveness of the approach in reducing the amount of energy consumed by the network in comparison with three well known protocols, passive clustering, PCEEC and GRIDS PC.

Naregal and Gudnavar[7] In this work the classical cluster routing protocol LEACH and improvement of LEACH (LEACH-E) are analyzed and improved (LEACHEX). In LEACH-E energy depletion of nodes is balanced by two methods; first by considering the current energy of nodes when electing them as cluster heads, another is by limiting the number of nodes in each cluster. In LEACH-EX, the threshold formula for election of cluster heads is simplified and simulation results show the effectiveness of the formula (LEACH-EX) and prove that LEACH-EX is much better than LEACH and LEACH-E in energy consumption and lifetime of network.

RawyaRizaket. al, [8] proposed a Stable and energy efficient clustering protocol for heterogeneous WSNs. It depends on the network structure that is divided into clusters. Each cluster has a powerful advanced node (AN) and some of normal nodes (NNs). The NNs make the sensing operation; AN then aggregates all data coming from its cluster and transmits them to the base station. The optimum number of ANs and the required energy for them with respect to the NNs are analytically obtained in order to guarantee minimum energy consumption of the network. The performance of the proposed protocol is compared by the existing homogeneous and heterogeneous protocols. Simulation results show that the proposed protocol provides more energy efficiency and stability than the existing protocols.

Manu Elappilaet. al, [9] presented a congestion and interference aware energy efficient routing technique for WSN namely, Survivable Path Routing. This protocol is supposed to work in the networks with high traffic because multiple sources try to send their packets to a destination at the same time, which is a typical scenario in IoT applications for remote healthcare monitoring. For selecting the next hop node, the algorithm uses a criterion, which is a function of three factors: signal to interference and noise ratio of the link, the survivability factor the path from the next hop node to the destination, and the congestion level at the next hop node. Simulation results suggest that the proposed protocol works better concerning the network throughput, end-to-end delay, packet delivery ratio and the remaining energy level of the nodes. The rate of packet drops is also observed to be lesser in the congested topology scenarios.

III. RESEARCH METHODOLOGY

The proposed protocol works as following:

A. Route Discovery/Setup phase

Destination node initiates by broadcasting the interest packet (Route Discovery Packet) to all its neighbors that in turn rebroadcast it to all their neighbors and so on. During the process of rebroadcasting, many nodes will be involved in transfer of packets. This will lead to inevitable congestion, which degrades the quality of the links. Such kind of links would encounter packets being dropped from the network. Thus, at each hop, only those nodes will rebroadcast the packets for which packet delivery ratio would be more than 90 percent. At the end of this phase, multiple paths between source and destination are found out, i.e., it will find all the topologically possible paths from the source to the destination. This phase creates the routing table.

B. Data Communication/Forwarding Phase

During this phase, the source node sends the data to the next hop node that is selected from its routing table based on the defined Path Choosing Factor. PCF will be calculated considering survivability of the path and link quality (based on SINR value) only. Every intermediate node also selects their relay nodes from their respective routing tables based on this PCF.

C. Route Management/Maintenance phase

Each node would forward the data packets by checking whether its route purge credentials (i.e., remaining energy and components of PCF) are below a threshold. If so, it informs the sink node for starting the route purging. Each route purge makes a new round, starting from the route setup. When sink node receives a route purge packet, it will send the maintenance packet to its neighbors. And the process works in the same way as the Setup Phase.

IV. IMPLEMENTATION & RESULTS

In this work, we have simulated two techniques namely, “Survivable Path Routing in WSN for IoT applications”, and second was modification to it, which we named Modified-SPR. These techniques are simulated in Network Simulator 2.35. The following set of input parameters were considered while creating a wireless sensor network:

Parameter	Value
Channel	Wireless
Mac	802.15.4
Propagation Model	Shadowing
Antenna	Omni Directional
Number of nodes	50
Network Area	100 * 100 sq meters
Initial Energy	20 Joules
Queue	Drop Tail
Queue Length	500
Routing Protocol	AODV

Table 4.1: Simulation Parameters

The performance of the network was measured based on throughput, packet delivery ratio and energy remaining in the network.

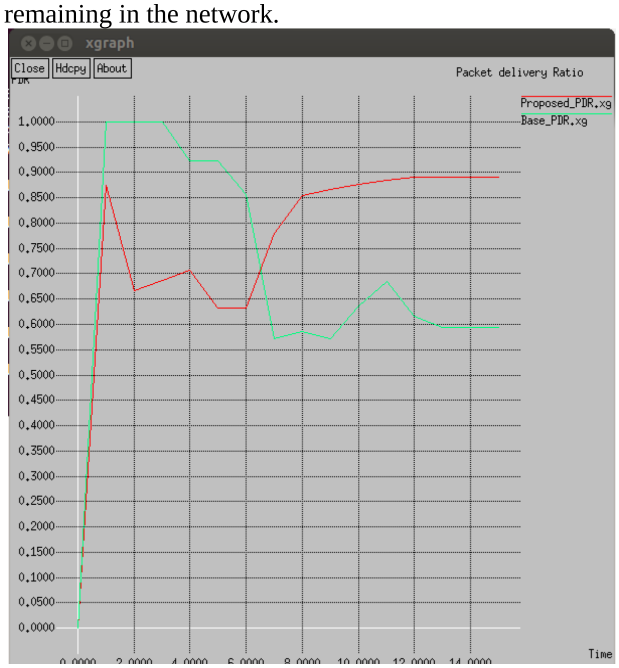

Figure 4.1: Comparison of PDR

This graph shows the comparison of Packet Delivery ratio in the network. The value of PDR for the proposed scheme (is around 90 percent) shows the increase as equated to the value for the existing scheme (is around 60 percent). This is because the proposed scheme does not allows the congested nodes to take part in the broadcasting process. The nodes with PDR less than 90 percent are do not rebroadcast the Interest packets. Consequently, these nodes are not selected in the path to deliver the data to the sink node, which drives values for PDR at higher levels.

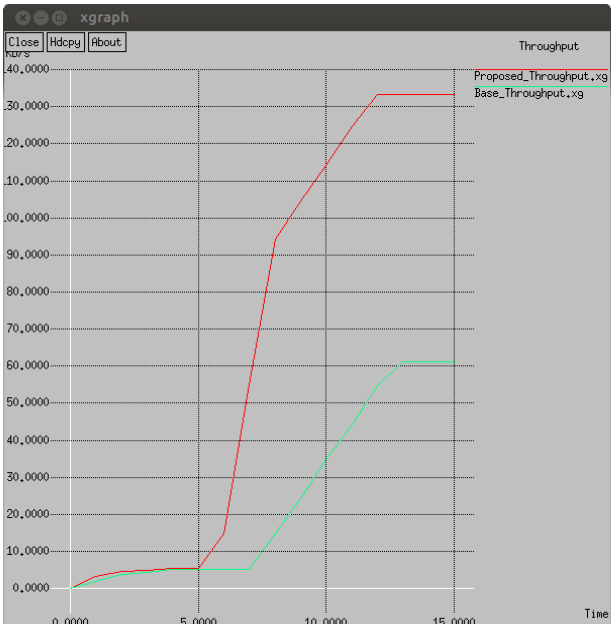

Figure 4.2: Comparison of Throughput

Throughput shows the amount of data received at the destination node. The value of throughput for proposed scheme was around 135 Kbps and for the existing scheme, it was around 62 Kbps.

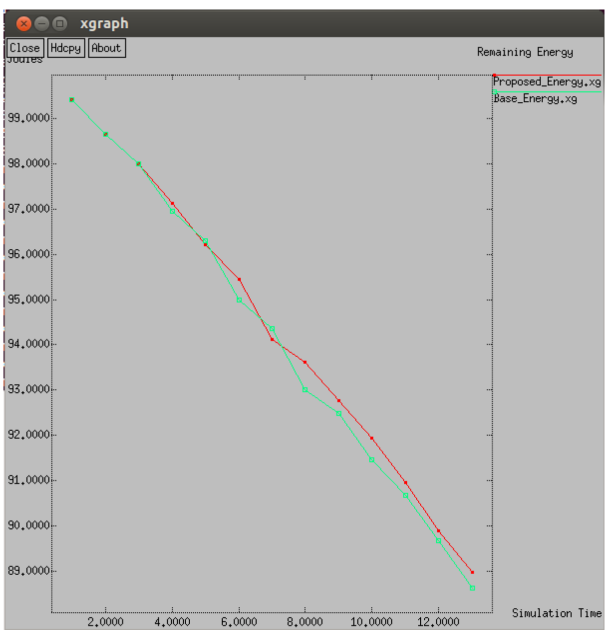

Figure 4.3: Comparison of Remaining Energy

This graph gives an estimate of lifetime of the network. All the nodes were provided with initial energy of 100 Joules. At the end of the simulation, the amount of energy remaining for the proposed scheme was 89 Joules and for the existing scheme was 88 Joules. This shows that proposed scheme provides with better network lifetime.

V. CONCLUSION AND FUTURE WORK

In this work, we have simulated two techniques namely, "Survivable Path Routing in WSN for IoT applications", and second was modification to it, which we named Modified-SPR. Since reliability of the data is most important in Internet of things scenario, thus it means the packet drops must be least in the network. Taking this point in mind, the proposed scheme was designed to not allow the congested nodes (or the nodes which are dropping the packets lesser than 90 percent) to take part in the broadcasting process. The value of PDR for the proposed scheme (is around 90 percent) shows the increase as equated to the value for the existing scheme (is around 60 percent). The nodes with PDR less than 90 percent are do not rebroadcast the Interest packets. Consequently, these nodes are not selected in the path to deliver the data to the sink node, which drives values for PDR as well as throughput at higher levels. The scheme also improves network lifetime as lesser number of nodes broadcast the packets in the route discovery phase in the network. In future, other parameters such as delay, jitter can be analyzed for better analysis of the proposed scheme. Also, this scheme can be analyzed for various other Internet of things scenarios, such as forest fire detection, military surveillance etc.

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