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Improved Hybrid Energy Aware Clustered Protocol for IoT Heterogeneous Network for WSN using Fuzzy Logic

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ABSTRACT

Abstract:The wireless sensor networks consist of numerous small battery-powered nodes. These networks provide a support to IoT applications related to agriculture, healthcare etc. Increasing the lifetime of the sensor nodes is a major issue. To increase the lifespan of the nodes in WSN, in the proposed protocol, clustering protocol have been presented where the cluster heads are selected according to fitness value of the nodes. The performance was evaluated based on number of dead nodes and throughput of the network. The better values of these parameters indicate the proposed protocol outperformed the existing one.

Keywords: *WSN, IOT, Clustering, fitness function, throughput*

I. INTRODUCTION

Wireless sensor network is a collection of undersized power-constrained nodes that logic data as well as correspond it to the base station. These nodes wrap an enormous region of interest (ROI) for some purposes according to the application requirements [1]. The sensor node, sink node, the user node comprise the three fundamentals of sensor networks. Sensor node is the basis of the whole network, they are responsible for the perception of data, processing data, store data and transmit data. The sensor node can sense much environmental information, including temperature and humidity, pressure, light condition, vehicle movement, mechanical pressure strength, the speed of the airflow direction as well as other characteristics. The main technologies of wireless sensor networks are power management plus security administration, network protocol, time-synchronization, localization, data aggregation [2].

The many applications of the sensor network are being used as backbone to Internet of things[13]. The word Internet of Things was first coined by Kevin Ashton in 1999 in the background of supply chain management. Internet of Things (IoT) word explains a universal idea for the capability of network strategy to sense as well as gather information from around the world, in addition to

then distribute that data across the Internet where it can be processed and utilized for various interesting purposes. The IoT is comprised of smart machines interacting and communicating with other machines, objects, environments plus infrastructures.

From educational organization perspective, the difficulty is that it needs some staff that has up to date data about the institute as well as the current activities in the institute. The second problem is that a person needs to go in the institute at the information desk in order to get data from them. The description of this is to utilize a technology and make technology accountable to respond all the queries asked by people. Some authors intended a device that has all the information stored in its database, whenever someone needs information they have to use that device plus get related data from through that device. For this to work, the device must be available to user who requires any help or support [3].

Since WSN provide a support to IoT applications, increasing the lifetime of the sensor nodes becomes a major issue. To increase the lifespan of the nodes in WSN, the researchers in the past have adopted for the clustering based approaches. These approaches allows the nodes to work for longer duration of time thus leading to lesser node failures occurring because of battery drainage.

This paper proposes a modification to existing clustering protocol to increase the network lifetime. Section II of this paper provides an overview of the existing techniques related to IoT. Section III describes the motivation behind this work and section IV explains the proposed protocol. Finally, section V explains the results and conclusion has been shown in the last section of this paper.

II. REVIEW OF LITERATURE

Authors in [4] outlined an original internet of things enabled multi adaptive clustering (MAC) energy efficient routing protocol for wireless sensor networks to reduce energy dissipation as well as to increase the network performance. This recent technique holds the hybrid cluster formation algorithm in which the network topology is separated in two regions where the first region is centralised and the second region is distributed. Both regions contain homogeneous plus heterogeneous nodes while the sink is static as well as situated in the centre of both networks. Purposely, planned IoT enabled MAC routing protocol holds the main three properties: allows of resources to sensor nodes through IoT, hybrid cluster pattern to split out the network load consistently among sensor nodes as well as a new mechanism to decrease the energy consumption in extended range data transmission. In all of the experiments MAC attains better performance than state-of-the-art routing protocols. Furthermore, performance evaluation proofs that MAC outperforms in critical network environment.

In [5], different applications such as smart transportation, smart grid, plus smart cities, are shared to set up that functioning of dynamic clustering computing-based IoT can support real-world applications in a well-organized way. In the proposed approach, the dynamic clustering-based methodology as well as frame relay nodes (RN) are enhanced to choose the most preferred sensor node (SN) amidst the nodes in cluster. For this purpose, a Genetic Analysis approach is utilized. The simulations states that the proposed system overcomes the dynamic clustering relay node (DCRN) clustering algorithm in terms of slot utilization, throughput in addition to standard deviation in transmission of information.

In [6], an original energy efficient k- centroid Lion optimization based routing protocol (kEE-LOP) to improve network performance. Anticipated kEE-LOP comprises three essential factors: distributed behaviour of lion based cluster formation technique to facilitate nodes organization, novel algorithm for constructing adaptive clusters based on lion migration and k-nodes centroid based cluster head rotation to distribute load to all sensor nodes eventually, thereby a novel mechanism for reducing energy utilization for distance communications. In specific, residual energy of nodes is measured with kEE-LOP for long distance communication. Specifically, nodes' residual energy is measured as kEE-LOP for computing CH centroid's position. Simulation results specifies kEE-LOP outperforms superior than LEACH, LEACH-C. As well as, kEE-LOP is more suitable for networks that is necessary for longer lifetime.

For integration of security services, an expansion of the 'Low-Energy Adaptive Clustering Hierarchy' ('LEACH') network routing protocol called, the 'Security Enabled - Low-Energy Adaptive Clustering Hierarchy' ('SE-LEACH') is proposed in [7]. This proposed protocol provides security services, like data integrity data confidentiality, key management, as well as data freshness in the figure of a flexible along with extendable form

thereby overcoming the security work of already existing Wireless sensor network protocols.

In [8], researchers suggested a multi sensor data fusion (MDF) scheme which plays fusion on serene network values for the selection of a suitable path with partnership of Fuzzy-based cluster head selection (FBCHS). Mutually, authors named the strategy as the MDF-FBCHS scheme for IoT-oriented WSN. Extensive simulations were made, and related results showed that the presented algorithm has improved performance compared with other schemes in the simulated cases.

In [9], authors take into explanation protocols that incorporate various IoT devices such as RFID and with energy-harvesting capability. Authors explained that the novel Rotating Energy-Efficient Clustering for Heterogeneous Devices (REECHD). This is a novel clustering protocol for heterogeneous WSNs. REECHD is compared with the state-of-the-art clustering by with the help of simulation.

In [10], the presented system considers a closely distributed WSN system model connected to Internet-of-Things as well as tree based cluster formation depending upon sensor node consumption density. For each tree based cluster having one cluster head node to accomplish energy efficient data meeting, a reinforcement learning based fuzzy inference system (RL-FIS) will useful to conclude the data gathering node for every cluster present in the densely distributed WSNs based on three metrics: neighbourhood overlap, bi-partivity index and algebraic connectivity. Authors compare the presented scheme with the other schemes. Simulation results designate that the presented scheme outperform the other schemes in overall energy consumption saving plus prolong the network lifetime.

In [11], authors outlined that the present day state of IoT is thickly deployed sensor nodes over a large area. In this work, clustering protocols for scalability is designed to cut the appropriateness with respect to IoT applications. The study of progressive algorithms gives a feature description of mathematical models utilized as well their effect on WSN. It also intended to show a judgment of performance metrics for particular as well as multiple hop clustering protocols.

This paper [12] proposes a new hybrid heterogeneous energy- aware IoT protocol for complex IoT network with multiple level of heterogeneity located in different regions. The paper introduces an efficient hybrid protocol; Hy-IoT that is suitable for the mixed heterogeneous dominating zones and the homogenous dominating zones in IoT environment. A new real cyber IoT architecture deployment is also proposed in this paper instead of simple random distribution of node to overcome the gap between the physical wireless sensor network environment and the real Cyber IoT. The proposed protocol comparison with the commonly used protocols has extensively examined in the new deployed architecture. The IoT proposed architecture provides two main features; ability to have zones based on the dominant level of heterogeneity and also having interaction among multiple levels of heterogeneity.

III. MOTIVATION

To increase the lifespan of the nodes in WSN, the researchers in the past have adopted for the clustering based approaches. These approaches allows the nodes to work for longer duration of time thus leading to lesser node failures occurring because of battery drainage.

The authors in Hy-IOT [12] have described the clustering approach in internet of things scenario driven by traditional LEACH protocol in the super region and SEP protocol in the normal region. In this scheme, the cluster heads are selected randomly in the super region. In such scenario, the nodes having the lesser energy can be elected as cluster head. This will lead to loss of data from the network when the cluster head depletes its battery. Furthermore, in the normal region the cluster heads are selected based on the remaining energy of the nodes. The nodes have higher energy can be far away from the base station, this will again consume more energy of the network. Thus, there is a need to modify the cluster head selection phase in the network.

IV. PROPOSED PROTOCOL

The cluster formation phase in the proposed work will follow the existing approach.

Every node will generate a random number and compare it with respective threshold value. Each node is eligible to become a CH only if the random number is less than threshold value. This phase will be same for the super region as well as normal region.

In the super region SEP will be used to select the cluster heads and in the normal region LEACH will be used to select the cluster heads. In the proposed scheme, the threshold value for each node will be modified according to fitness value of the nodes.

The fitness value is computed as:

Fitness = alpha * Remaining energy of the node / Average energy + beta * Threshold distance / Distance of the node to the base station

The node that has highest remaining energy and minimum distance to the base station will be considered fit to become cluster head.

Once the cluster heads have been elected, each cluster head will broadcast the ADV packet in its communication range. The nodes which receive ADV packets from multiple cluster heads will join the cluster head to which the distance is least. This marks the end of clustering setup phase.

Each node will compress the data before it is forwarded to the cluster head. This will again help in saving the energy of the nodes. When all the cluster heads have aggregated the data from the cluster members, they will send the data to the base station directly.

V. RESULTS AND DISCUSSION

The proposed work as well as existing work were simulated in MATLAB. The simulation was conducted in network area of 100 sq meters and a total of 100 nodes were randomly deployed in the network. The various simulation parameters used for the simulation are given in the table below:

Parameter	Value
Channel	Wireless
Number of Nodes	100
Network area	100 * 100 sq meters
Base station location	(50,80)
E_{elec}	50 nJ/bit
E_{da}	5 nJ/bit/message
E_{amp}	0.0013 pJ/bit/m^4
E_{fs}	10 pJ/bit/m^2
Packet Size	4000 bits
Initial energy of normal nodes	0.15 Joules
Energy factor of super advanced nodes	10
Energy factor of advanced nodes	3
P_{opt}	0.1

Table 4.1: Simulation Parameters

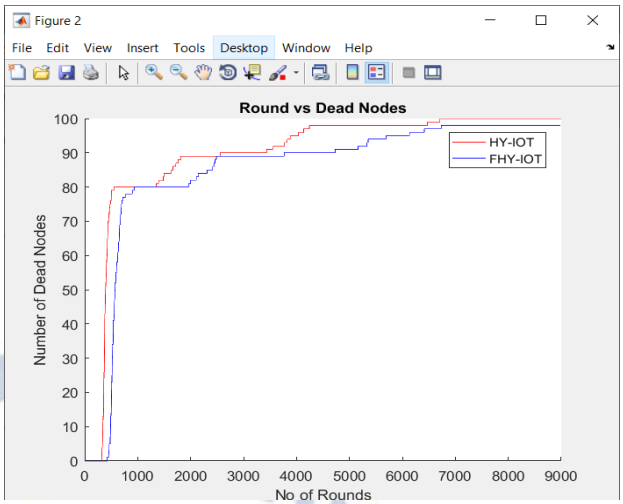

Figure 4.1 Comparison of Number of Dead nodes against number of rounds

This graph shows the number of nodes dead in the network against number of rounds for both the schemes. The network under the proposed scheme had 2 nodes alive at the end of 9000 rounds whereas with the existing scheme, the network went completely dead at 6712 rounds. This indicates better network lifetime with the proposed scheme.

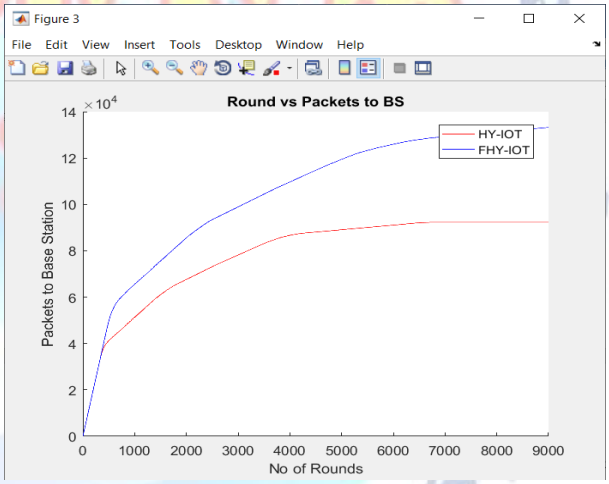

Figure 4.2 Comparison of Throughput against number of rounds

This graph shows the throughput of the network under both the schemes. Since the network with the existing scheme went dead at around 6712 rounds, the value of throughput goes constant after that. The proposed scheme has higher value of throughput since the network was alive for more number of rounds, so more number of packets were transmitted to the base station. The number of packets sent to base station was 92262 with the existing scheme and 132236 with the proposed scheme.

VI. CONCLUSION

This study presents a modification to the existing scheme to increase the network lifetime. In the proposed scheme, the cluster heads are selected

based on the fitness function. This leads to decreasing the distance of communication for cluster heads with the base station and correspondingly reduces the energy consumption too. Therefore, the energy gets saved and nodes do not die earlier. Since the nodes remain alive for more number of rounds in the network for the proposed scheme, they can send more packets to the base station also. This leads to higher values of throughput for the proposed scheme. Therefore, the better values of these parameters help us to conclude that the proposed scheme outperforms the existing scheme.

The wireless sensor networks provide a support to the internet of things networks these days. This clustering protocol can be applied for some IoT application in the future. The application can be agriculture oriented or disaster management application. Furthermore, the concept of mobile sinks can also be used in the future to enhance the network lifetime.

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