Energy Efficient Data Routing in Internet of Things

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Abstract: The network across which the information is sensed by the sensor devices and then forwarded to the sink is known as Internet of Things (IoT). Even though this system is deployed in several applications, there are certain issues faced in it due to its dynamic nature. The internet of things is derived from the wireless sensor networks. In this research work, the multilevel clustering will be improved so that lifetime of the network can be enhanced. In the proposed approach, the gateway nodes will be deployed in the network for the data aggregation. The cluster heads will transmit information to the gateway nodes which later transmit that information to base station. The proposed approach will be implemented in MATLAB and it will be compared with the existing approach of multilevel clustering in terms of throughput, packet loss and number of dead nodes. It is found that throughput of the network is increased; packet loss and number of dead nodes are reduced as compared to existing approach.

Keywords: Clustering, IoT, Energy Dissipation, Gateways.

1. INTRODUCTION

A technology that gives the access of deep analysis, integration and automation within the system to its customers is called Internet of Things. The information from the environment is sensed by the sensor nodes in this technology. The sensor nodes forward the sensed information to the base station. Further, the collected information is uploaded to the key server. The handoff system is set up after the change of the locations of the servers. The modification in the system can be done using this accuracy and reach to the area [1]. A number of technologies are developed for network sensing and automation. It demonstrates the new advancement in the software technology and hardware as well. The novel development in the area of product delivery, goods and services, economic and social sector have caused main transformations in the exiting components. In the present scenario, internet over public or private Internet Protocol (IP) networks has connected everybody [2]. Using internet, the people can sense the environment. Also, they can contact and share information with each other. The data from the environment is gathered by the entire interlinked objects. These objects analyze the gathered information to start the act for providing management and decision making.

Data aggregation refers to the mechanism of collecting and merging large amount of data by using aggregation techniques and passed to base station with least redundancy [3]. It requires sensor data which is extracted from the sensor node and then collects the data with the help of some aggregation techniques [4]. This collected data is further forwarded to the sink node by choosing and selecting the appropriate and relevant data. The elimination and removal of all the irrelevant and redundant data from the network and then improving the lifetime of energy are the important tasks of this approach. Data transmission is performed in multi-hop manner in which every node transfers its data to its nearby node. So, the nearby node will easily sense the data [5]. In order to overcome this limitation, another approach was introduced in which every node will transfer its data to the cluster-head which will perform the function of data aggregation and finally send the data to the sink for further processing. This will cause wastage of energy and in wireless sensor network the cluster head will not work much longer [6]. Due to this all the processing has to perform again which will waste time as well as energy. Data aggregation increases the lifespan of the network and reduces the energy consumption. However, every node can receive data from the neighboring nodes or generate data by itself for particular time duration [7]. These nodes combined this data and give out the combined outcome. As a result, the communication cost decreases and raw data becomes non-redundant. The nodes normally have limited resources and limited battery within the IoT. The data have to be combined to maintain resources and power.

Data aggregation is identified as the process of few nodes (or only one node) [8]. These nodes congregate the combined results from other nodes. The node must handle the collected data to decrease the transferring. This is the base station or frequently an external consumer who can have the access to communicate with the network. The collected data is transmitted to the sink by selecting the efficient path. The information is gathered and expressed in a compacted form in the data aggregation for various objectives like statistical analysis [9]. A general objective of aggregation is to obtain more information regarding specific set on the basis of particular variables. For example unprocessed data can be aggregated over a known period of time for providing statistics like average, minimum, maximum, sum and count [10]. The aggregated data can be analyzed after its aggregation and written to a view or report for gaining ideas regarding specific resources or resource clusters. Mainly two kinds of data aggregation are available. These are called time aggregation and spatial aggregation. Time Aggregation denotes all data points for an individual resource over a particular period of time. Spatial Aggregation represents all data points for a resource group over a particular period of time.

2. LITERATURE REVIEW

Emma Fitzgerald, et.al (2018) presented a study which was related to the different algorithms and formulations of mixed-inter programming [11]. The issues of energy-optimal routing and multiple-sink aggregation within IoT edge networks were solved by this approach. Due to the least and highest utilization of energy, it is important to consider optimization of network. In case of pure aggregation, the throughput optimal scheduling of transmissions is done using physical inference model. Substantial amount of energy is saved through this approach. It is seen that by utilizing the direct and shortest-path flows from sensors to actuators around 13 times higher energy is utilized by the 40-node networks.

Ali Kadhum Idrees et al. (2018) proposed a novel approach through which the lifetime of PWSNs which is named as DiDAMoK. Within the sensor nodes, this lifetime is distributed uniformly and it works in a periodic manner [12]. There are three stages amongst which these periods are setup. All the collected and saved data within the sensor nodes is read by the sensor node in the initial stage. These readings are then transformed into a set and there are dynamic clusters generated which relay on the nature of aggregated readings. For transmitting the cluster to sink, one reading is chosen as the representative reading in the final stage.

Shilpa Rao et al. (2017) presented a study in which the data is transmitted by the IoT devices to the base station using the User Equipments (UEs), otherwise known as uplink transmission [13]. In order to perform further processing, the data is transmitted from the base station to the cloud. Very minimal amount of energy is required when using the user equipments in IoT as per this study. The cases where IoT devices are associated with UEs using either the random, greedy or fixed approaches are studied here. For each of these three approaches, the end-to-end outage probability at the devices is evaluated. Least outage probability at the IoT devices is achieved as per the conclusion achieved while applying the proposed technique.

Lijun Dong et al. (2017) proposed a novel technique which acted as a solution to the problems arising in Information Centric Networking (ICN) [14]. The average number of notifications being received in single and multiple producer scenarios are minimized using this mechanism. The subscription and redundant notification messages are transmitted across the network using the least possible bandwidth through this research. The subscription condition is gathered successfully and then allocated into disjoint sets of proper transmission using the proposed technique. Thus, the duplicate notifications which carry the similar updated information from multiple producers are removed by this proposed technique.
Sabin Bhandari et al. (2017) proposed a novel mechanism through which the channel access and queuing delays of the clustered industrial IoT networks are minimized [15]. The packets which are being received are assigned with different MAC layer attributes by the proposed prioritized channel access approach. Further, before sensing the aggregated data to cloud, the separate low-priority and high-priority queues are utilized. It is seen through the comparative analysis that the system latency and reliability are improved by applying the proposed technique.

Tianqi Yu, et.al (2017) proposed a novel technique that includes a cluster-based data analysis. In this proposed technique, the redundant data is gathered and cluster head is identified using the recursive PCA applied here [16]. The members of clusters gather and aggregate the data at cluster head. The proposed technique is used to extract the data. For adapting to the changes in IoT systems, the parameters of PCA model are updated recursively using R-PCA. It is seen that the correlated sensor data is aggregated with high recovery accuracy when the proposed technique is applied within practical databases based simulations. Any kinds of computing and processing issues being faced by the sensor nodes are solved by applying cluster-based data analysis technique. It is seen that the correlated sensor data is aggregated efficiently with high recovery accuracy by applying proposed technique on practical datasets.

3. RESEARCH METHODOLOGY

The energy consumption and data aggregation is the major issue of IoT due to network deployment in far places. The clustering is the effective approach which can improve lifetime of internet of things. In the approach of clustering, whole network will be divided into clusters based on the location. The sensor nodes aggregate data to cluster head which forward data to base station. In this research work, the gateway nodes will be deployed in between the cluster head and base station. The gateway node will receive the data from cluster heads and forward is to the base station or sink. The proposed technique will lead to minimize energy consumption and improve lifetime of WSNs.

Energy Consumption is a major issue of IoT. The clustering is the efficient approach which improve lifetime of wireless sensor networks. The three-level hierarchal routing technique is proposed in this work which improve lifetime of IoT.

Level 1: Choosing the Cluster Head:- In this phase, the network is divided into certain clusters and process of cluster head selection is initiated by the base station. The message is passed all across the network which states that an efficient cluster head can be chosen. The distance of one node from the base station is calculated mathematically. The sensor nodes also present their residual energy which play important role in being chosen as cluster head. The radius of each cluster is calculated and the sensor nodes which lie within the radius of the cluster represent that cluster. The number of nodes represent the cluster should be 3 or more than 3. The nodes which are within the cluster should select their cluster head on the basis of residual energy.

Level 2: Choosing the Gateway Node:- The gateway selection is the last phase of proposed protocol. Gateway nodes are the extra nodes which are deployed for improving the lifetime of networks. The size of network is considered as an important factor for defining the number of gateway nodes. The data is transmitted to the leader nodes by the cluster heads which further transmit it to the gateways. Then the data is forwarded to sink by the gateways. The base station takes data from the nearest

gateway node and leader node transmits the data gateway node which is the nearest. The Euclidean distance is used to calculate the distance amongst the nodes.

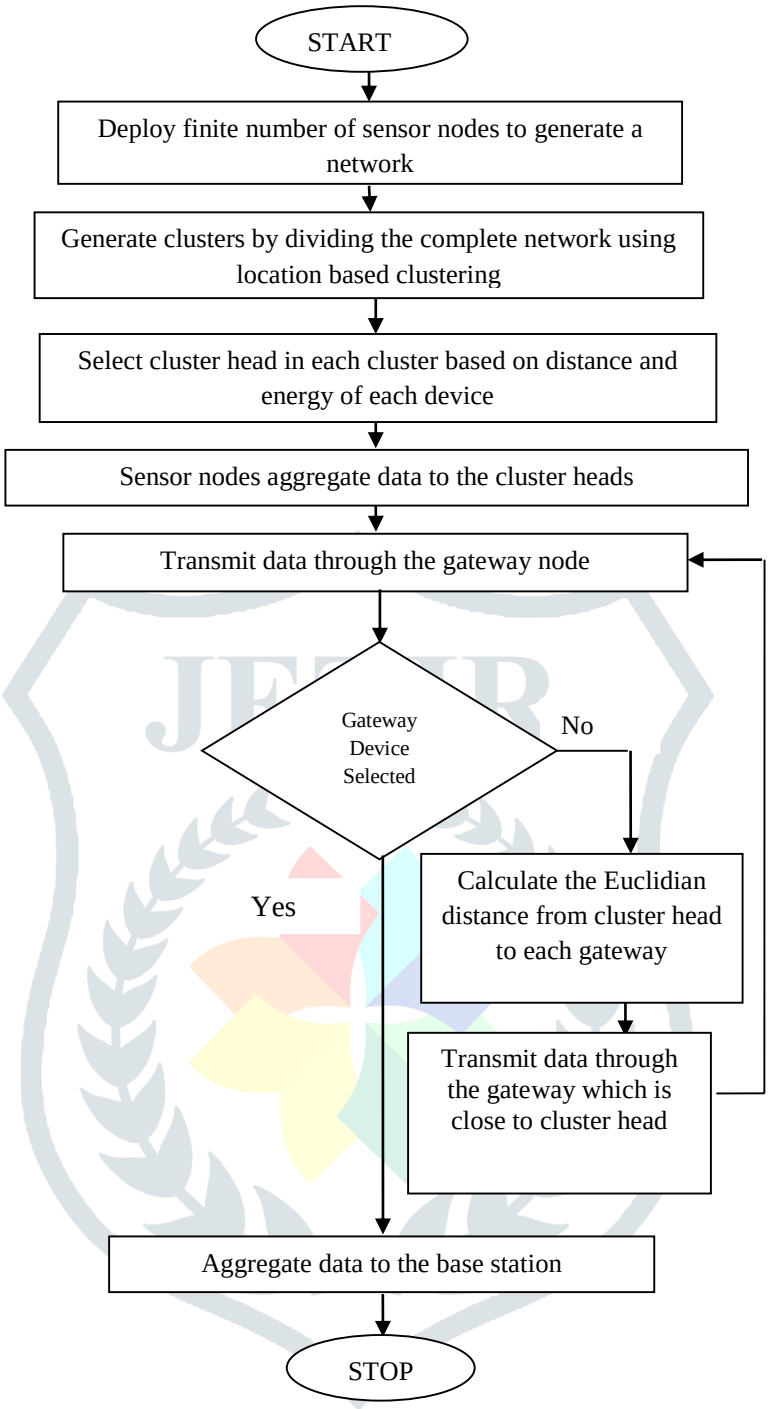

Fig 1: Proposed Flowchart

4. EXPERIMENTAL RESULTS

The proposed methodology is implemented in MATLAB and the results are evaluated by comparing proposed and existing techniques in terms of various parameters.

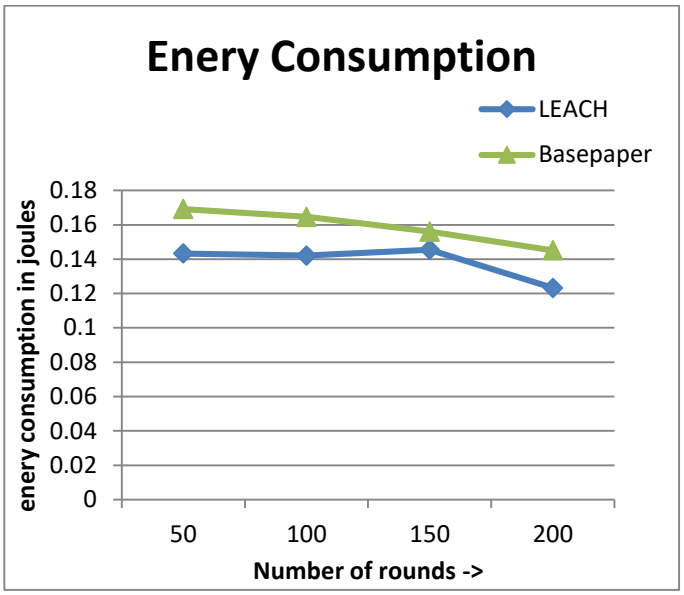

Fig 2: Energy Consumption

Figure 2, represents the comparison of base paper and proposed technique. It results that the proposed protocol has minimum amount of energy consumption in comparison to the other techniques.

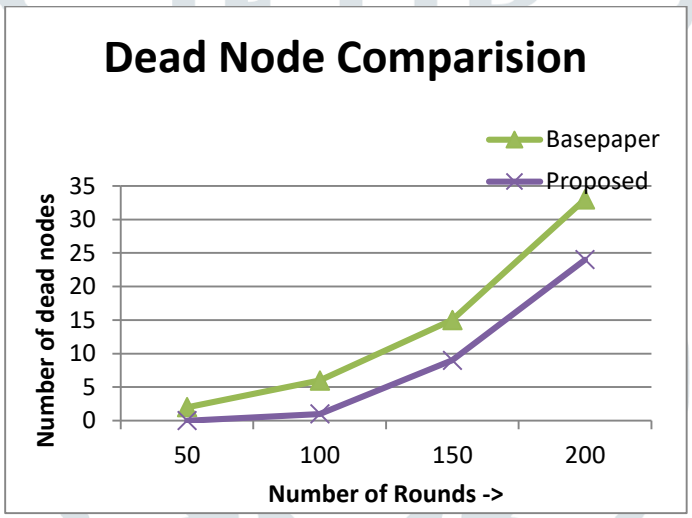

Fig 3: Number of dead Node Comparison

Figure 3, demonstrates the comparison between two level hierarchal protocol and cache technique in terms of the dead nodes. The proposed technique has fewer amounts of dead nodes in the give amount of rounds.

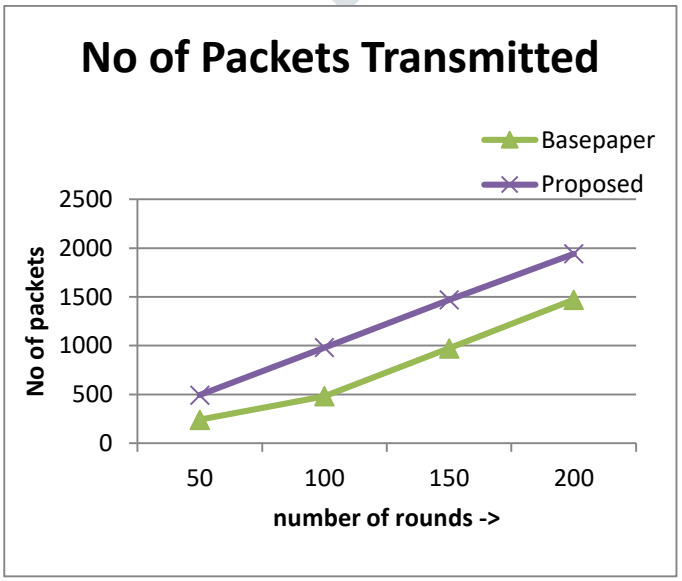

Fig 4: No of Packets Transmitted

Figure 4 show the comparison between the numbers of packet transmitted to the base station, proposed technique, two level hierarchal protocol and cache technique. The proposed technique transmits the large number of packet in comparison to the other techniques.

5. CONCLUSIONS AND FUTURE SCOPE

The IoT is the popular technology in which devices can sense the information and transmit it to base station. The major problems being faced in IoT are energy consumption and data aggregation because of the dynamic nature of the networks. The lifetime of WSNs can be enhanced by applying the clustering approach. Depending upon the distance and energy of nodes, cluster heads are chosen for each cluster. The data that is collected from the nodes is forwarded to the sink by these cluster heads. In this research work, the gateway nodes will be deployed. The proposed technique is implemented in MATLAB by considering various simulation parameters. The proposed three level hierarchal routing protocol is compared with existing two level hierarchal routing protocol and it is analyzed that number of dead nodes are reduced and number of packet transmission is increased. It is analyzed that results are improved upto 5 percent.

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