Turkish Online Journal of Qualitative Inquiry (TOJQI)
Volume 12, Issue 3, June 2021: 5058 – 5069

Research Article

Two-Level Hierarchal Protocol to Improve Lifetime of Internet of Things

Divya sharma[1], Dr. Dinesh Javalkar[2]

Abstract

Internet of things (IoT) is an innovative area in the field of technology. This network has potential for accessing the entire information whose collection is done from other things and integrating this information into smaller pieces. The IoT network has a major issue of energy consumption which can be solved with the approach of clustering. The gateway nodes are introduced in the network which can increase the level of hierarchy and reduce energy consumed in the network. In a network, sensor nodes are responsible to transmit data to cluster head which transmit information to the gateway node. Afterward, the information is sent to the sink by the gateway node. MATLAB is applied to execute the suggested model and results are compared between LEACH, LEACH-C and proposed LEACH in terms of the number of dead nodes, the number of alive nodes and the number of packets whose transmission is done in the network.

Keywords: LEACH, LEACH-C, Gateway Node, Cluster Head, Data Aggregation

1. Introduction

Internet of things (IoT) is the group of things, especially the objects that are employed every day and can be read, recognized, located and addressed with the implementation of sensing devices. Internet services are applied to control these things concerning their communication means. The electronic devices as well as the products having higher technical development such as vehicles and other appliances are comprised in these objects. Some objects which are not electronic including food, clothing, chair, animal, trees and water are also contained in this. IoT is a newly developed technology.

[1,2]Department of computer science, Lingayas's vidyapeeth Universiy,Faridabad, India
[1]divya2957@gmail.com, [2]Dineshjavalkar@lingayasuniversity.edu.in

This network is capable of accessing the information captured from other things and integrating this information into smaller pieces. This information is related to the CC and unlimited addressing tendency.

The significant properties of Internet of Things are defined as:

1. Interconnectivity: On the basis of IoT, global communication and communication infrastructure are assisted in establishing connection among everything.

2. Things-related services: The services related to things are offered in the constraints of services such as to protect the data services and synchronized consistent services amid physical and virtual [1] things. The IoT is adopted to acquire the things-related services in the constraints of things in the world of technology and real time.

3. Heterogeneity: Internet of Things makes the utilization of a variety of devices on the basis of several hardware platforms and networks available in applications. These devices help in deploying several networks as intermediates to interact with other service platforms

4. Dynamic changes: This network also offers dynamic changes in services or in location and speed. Therefore, the change in number of appliances becomes easy.

5. Enormous scale: A number of devices are available in which services to manage and communicate with each other are needed as compared to devices associated with internet.

6. Safety: The safety becomes a major concern as the advantages of internet of Things are developed rapidly. Thus, the formation of devices of IoT is done considering the safety issues. The personal data as well as physical well-being must be protected and the endpoints, the network and the data stored in the network must also be kept secure while deploying these divices.

7. Connectivity: It is network accessible and compatible. The network can be accessed with the help of accessibility. The compatibility assists in utilizing and generating the data.

1.1. Data Aggregation

The data aggregation is implemented to gather the data from the sensor nodes and transmit it to BS with lower redundancy. The working of data aggregation is described in the figure 1 along with the proposed techniques. The sensor node provides the data which is necessitated in this approach. Some aggregation methods are employed to gather the data. The adequate and relevant data is selected to transmit this gathered data to the BS. This major goal of this technique is to eliminate and remove all the data, which is not relevant, from the network and to enhance the duration of power. The data is transmitted in a multi-hop way. The data is transmitted to its nearby node through each node. Thus, the nearby node obtains potential to sense the data [6]. Another technique, using which every node can send its data to CH, is suggested for dealing with above mentioned issue. The cluster head (CH) is responsible for aggregating the data that is further transmitted to the BS in order to perform the processing. The energy is wasted and the CH becomes unable to perform for long time in WSN due to this. Consequently, the entire processing is carried out again because of which much time and energy is consumed. Several data aggregation schemes have been developed over the years. Following is the list of some commonly used aggregation techniques:

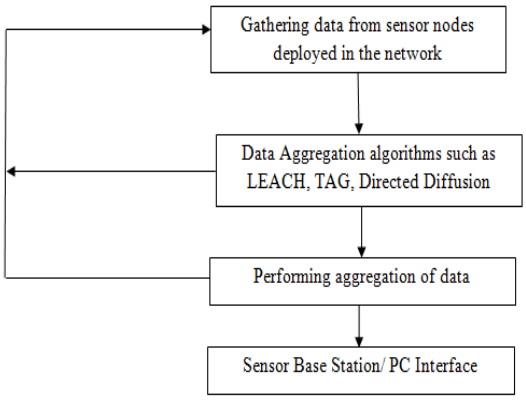

Fig 1: Basic data aggregation process

1. Centralized Approach:

This approach is an address centralized technique which allows nodes to transmit the data to the central node using the shortest possible path. Sensor node is the powerful node and plays a role of leader of all the nodes and assists in transmitting the data packets in order to perform the further processing. This approach is valuable for aggregating the stored data of network. Every node, which lies in the path, is forced to transmit their data packets to the sensor node. Thus, the transmission of enormous amount of data and messages is done for a query.

2. Tree-Based Approach:

This technique is implemented to aggregate the data in the form of tree that may be a mitigated spanning tree with the roots which act [7] like a BS and its leaves play a role of a source node. A parent node is comprised in every node for sending its entire data to complete the processing. The data is passed through the leaves and base station and then aggregated at the parent node.

i. 3.Cluster-Based Approach:

This technique is implemented to generate the clusters by dividing the complete network. The selection of CH is done at individual level for each cluster among all nodes. This CH is responsible for gathering and aggregating the data from other nodes in the cluster. Thus, it is called aggregator. The final processing is performed with the transmission of this aggregated data to the BS.

ii. 4.In-Network Aggregation:

In this, the multi-hop network is deployed to collect and route the information. This approach has potential for alleviating the resource usage that leads to prolong the duration of network. Two methods are included in this approach. The initial one focuses on decreasing the size and the latter do not diminish the size. The initial method is exploited to integrate and compress the data packets from the nodes. In addition, these nodes are utilized to mitigate the packet length whose transmission is done to the BS. In the latter technique, of collaboration of all the data packets received from all the neighboring nodes are integrated and processed without the value of data.

2. Literature Review

Emma Fitzgerald [8] presented mixed-integer programming designs and algorithmic approaches to provide a solution to the issue of energy efficiency along with multiple-sink and combined aggregation and distribution for computing sensed data in IoT edge systems. This considered network optimization for both minima consumed energy and minimum-maximum energy used by each node. This work also designed an algorithm to schedule the best throughput of transmission in a physically interfering model for data aggregation. In this work, mathematical comparative analysis was conducted based on the requirement of energy for the two real-time cases, as well as the time to resolve them, in-network conditions made with different topologies with the varying number of nodes. The obtained depicted that the use of direct path flow from sensing nodes to actuators increased the energy consumption by 13-fold in a network consisting of 40 sensing nodes than the presented approaches.

Ali Kadhum Idrees et al. [9] introduced DiDAMoK) which was a distributed data aggregation based modified K-means (DiDAMoK) approach to extend the service time of PWSNs. This working of this approach was divided into periods. Each period was made up of 3 stages. First, sensor readings are collected and saved in the sensor node. Initially, the readings of sensorswere collected and stored in the sensor node. Next,this work applied modified k-means on these readings to arrange them into sets of readings. The final stage was to transfer a typical reading of every cluster to the base station. This work used OMNeT++ network as the simulation tool. Simulation results suggested that the new method couldsuccessfully the reduce the energy used by the entire PWSN.

Heng Chuan Tan et al. [10] presented an end-to-end integrity protocol by employing chameleon hashing based on elliptic curve to ensure the integrity and validity of data. The MDMS (Meter Data Management System) validated a chameleon hash value of the collected readings which was generated and forwarded by the concentrator. The smart meter with the trapdoor key sent a commit value to the MDMS following the computation. The main aim here was to make obtained chameleon hash value equal to the earlier hash value transferred by the concentrator. MDMS could compare the two hash values to verify the data integrity and data validity. In comparison to the discrete logarithm application, the ECC application reduced the computing cost of MDMS by36.8%, concentrator by 80%and smart meter by 99% in approximation. This work conducted informal review of security to depict the security robustness of the presented protocol.

Shilpa Rao et al. [11] took into account a multi-hop IIoT system, wherein IoT devices transmitted their uplink data to the sink using UE in the form of a relay. This work analyzed end-to-end breakdown probability on IoT devices when devices linked themselves with UEs through different ways (e.g., random, fixed and greedy). This work accentuated the intricacy of association methods and their aptness in the IIoTenvironment. This work performed the comparison of the end-to-end breakdown probabilities at the IoT devices for every connectivity approach. According to the results, the greedy association approach had the least end-to-end breakdown probability on IoT gadgets. It was seen that increasing the number of IoT devices or increasing the probability of data onset on the devices increases the breakdown possibility on the

IoT gadgets. In addition, the probability of a breakdown was autonomous of the changes in the uplink data transition value of the UE.

Lijun Dong et al. [12]proposed theINADS(InnetworkAggregation and Distribution of conditional loT subscription)approach ICN (Information Centric Networking). It was considered as an optimistic candidate for deploying loT in nearby future. The new scheme significantly reduced the average number of reports in both single as well as multiple generator scenarios. This resulted in the reduction of power consumed by loTdevices' to a great extent. Put it another way, the consumption of bandwidth in the transmission of the subscription messages and superfluous message notificationswas reduced intensely.

Sabin Bhandari et al. [13] presented a priority-based channel access and data aggregation algorithm at the CH (Cluster Head) in order to decrease channel access and queuelatency in a clustered IIoT system.

First of all, based oninformation delivered by a cloud center for certain applications, packets arriving from two kind of IoT nodes, called high and lowpriority nodes, were assigned by specifying different Medium Access Control (MAC) layer features to develop aranked channel access mechanism. Next, before transferring aggregated data to the Cloud, this work used independent high- and low-ranking nodes to apply a preemptive m/g/1 queuing model is employed. According to the results, the new approach considerably reduced system delay and improved reliability in comparison to its rival approaches.

Tianqi Yu [14]used R-PCA (Recursive Principal Component Analysis) to present a cluster-based data analysis model. This model could be used for the aggregation ofunnecessary dataand to discover the outliers at the sametime.More explicitly, the principal components (PCs) were extracted to aggregate the spatially correlated sensor data gathered from the members of clusters at the CH. This work used irregular SPE scores to determine the probable data outliers. These scores by defined by the square of the remaining value once PCs were extracted. It was possible to recursively maintain the metrics of the PCA model using R-PCA to made them adaptable to the variations in IoT models. In addition, the cluster-based data analysis model released the computing and processing load on the sensing devices. The simulations conducted on real-time database had established that the new model successfully aggregated theinterrelated sensor data with improved accuracy of retrieval. The new scheme also increased the accuracy of data outlier detection than its counterparts.

Firas Al-Doghman et al. [15] presented a study related to several data aggregation techniques proposed for IoT by several researchers. This paper also discussed about the novel class of reliable data aggregation algorithm. The algorithmic approach of new type employed consensus-specific aggregation as well as fault tolerating schemein fog computing. The adaptive behavior is promoted and the aggregation outcomes are delivered to ascendant nodes efficiently using this novel technique. The node reliability issues are handled and the fault tolerance ability is provided through the proposed approach.

Raja Jitendra Nayaka et al. [16] proposed a novel protocol which uses certain statistical models and protocols such that efficient data aggregation and routing mechanism can be achieved. To improve the efficiency of public utility and improve the duration of combined smart utility grid,

this approach is applied. WSN is used to provide smart public utilities services in this paper such that an energy competent data aggregation and routing approach can be achieved. Therefore, the data computation and transmission latency are minimized and the working duration of the networkis improved here. For recognizing the utility network failures, the failure points or stolen utility service network, the data analytics is performed on gathered data.
H. Rahman et al. [17] put forward a fresh hybrid scheme name as QoS-Aware Data Aggregation (QADA). This approach combined tree-based data aggregation schemes along with the traits of cluster. With respect to the power consumed, period of network and traffic load bearing capacity, the performance of proposed approach is known to be better. The amount of sensed information selected for transmission is minimized at huge level. Through the rotation of CH nodes after each round, the lifetime of network increases by applying cluster-based approach.By implementing a tree-based approach, the distance between nodes was reduced resulting in the transmission cost of the network to be minimum.

Abrar Alkhamisi et al. [18] discussed that an efficient framework is required for IoT applications such that the data can be utilized efficiently. It is easy to search the appropriate sensor and use appropriately using this framework. The available techniques and search schemes were based on the assumption that the registries of sensing nodes could be figured out. However, for retrieving the sensor data efficiently and making it available in such format that the registers can be searched in required format; enough research has not been done. Thus, a distributed CLCP approach for aggregating data and its flexibility for query-based search have been analyzed in this research.

Zhikun Deng et al. [19] presented a study related to the utilization of mobile apps and wearable devices which are used to gather and forward the life-logging data. The existing personal health data collection solutions are compared in this study. Within the IoT scenarios, the need to design a life-logging data aggregator is recognized here. This paper further proposed ancombined data gatheringapproach by means of highlysafe standard. The five different life-logging resources are integrated here in order to generate a novel healthcare platform named as MHA. It is seen through the experimental results that the personal health information of patients is recorded, stored and reutilized in future securely.

EvangelosZimos et al. [20] put forward a fresh scheme which aims to enhance the quality of data reconstruction even when the noise is present during the transmission of data, which was not possible within traditional approaches. The large-scale IoT-based applications used this novel approach is a well-suited manner. The new model successfully used the intra- and inter-source relationships existing amongstnumerous associated sources. It was seen that in comparison to existing techniques, the MSE was improved when the proposed technique was applied in EPA dataset.
Haneul Ko et a [21] proposed a novel approach to provide efficient data aggregation which was named as CG-E2S2. The Markov decision process (MDP) was applied in this proposed technique to determine the optimal sleep duration and amount of data aggregated through this proposed approach. The data traffic, consistency and energy efficiency were considered during this study. The results achieved after evaluations and comparisons showed that with respect to the previously mentioned parameters, the optimal policy outperformed other existing techniques.

3. Research Methodology

The amount of energy consumed by the network defines its reliability. A clustering approach is applied to make IOT more energy effcient depending upon the similarities, sensor nodes are grouped together when clusters are formed. The leftover energy in nodes was the basis for selecting aCH (cluster head). The cluster head to normal ratio is calculated as adopted for improving the lifetime of IOT. The LEACH protocol helps in selecting cluster heads depending on the distance and remaining node energy. Depending on the residual energy, a cluster is elected directly for every round. However, the LEACH protocol efficiency gets reduced due to the existence of the energy hole problem. To solve this problem, the gateway nodes are deployed optimally near to the base station in our proposed model with a finite number of sensingmotes. The branching of the deployed network is carried out into a fixed number of clusters by means of location-based clustering. In each cluster, CHs are chosen according to the energy and distance. The sensor nodes which have the least energy and minimum distance to the sink is chosen as the CH while the second level of nodes is the leader nodes. The nodes which have the maximum energy but does not have least distance to the sink is considered as leader nodes while the third level of nodes are the gateway nodes. The gateway nodes are the nodes which are deployed at one hop near to the sink. The gateway nodes do not sense any information, it will just forward information which is already sensed like a hub, while the CH forwards information to the leader node. The leader node passes the collected data to the gateway node which later passes this information to the sink.

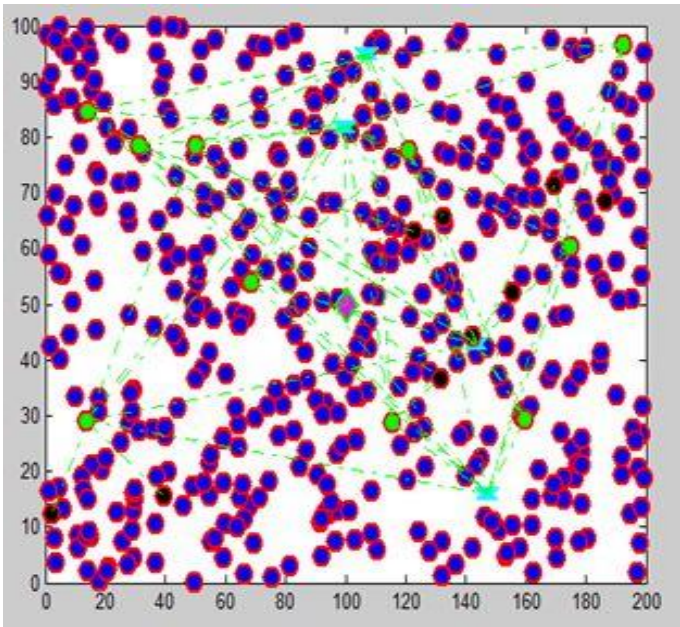

Figure 2: Diagram of proposed model

As illustrated in the Figure 2, the sensor nodes are shown in the blue color. The CHs are shown with the green color while the leader nodes are marked with black shade. The nodes shaded by magenta are the gateway nodes and in the centre of the network, base station is presented.

Algorithm of the Proposed/Improved Scheme

1. Initialize
2. B=Base station
3. S_{alive}=Set of alive nodes in the network
4. K: Number of cluster heads
5. N_{alive}=The number of alive nodes in the network
6. S_{CH} =The set of cluster heads
7. S_{NCH}=The set of non-cluster head nodes
8. S_{NCH2}=The set of non-cluster nodes assigned to cluster
9. S_{NC}=The set of non-clustered nodes
10. S_{LN}= The set of leader nodes
11. S_{GN}=The set of gateway nodes
12. Start
13. Process:
14. Input
15. For every node in S_{alive}do
16. Send energy level to Base station
17. k= N_{alive}*0.05
18. For every node in S_{NCH} do
19. For every node in S_{CH}do
20. If Distance (Node1,Node2)< Minimum-distance
21. Minimum distance=Distance (Node1,Node2)
22. Cluster-head(Node1)=Node2
23. End if
24. End For
25. End For
26. For every node in S_{NC}do
27. If Distance(Node1,BS) <Minimum-distance
28. Minimum distance=Distance (Node1,BS)
29. Leader-Node(BS)=Node1
30. End if
31. End For
32. S_{NCH} send data to S_{CH}
33. S_{CH} send data to S_{LN}
34. S_{LH} send data to S_{GN}

4. Result And Discussion

In our simulation, the performance analysis will be based on the energy consumption of IOT versus other scheme from literature. The simulation parameters which are considered have 200 nodes, an Omni-directional antenna, the number of channels is 5 and on each sensingdevice priority queue is employed for the data forwarding. The initial energy of each sensor node is about 0.5 joules, the energy consumed by every sensor node depends upon the distance between

the nodes for the data communication. The sensor nodes are arbitrarily deployed in the fixed zone and all the nodes are static. The nodes cannot change its location and a base station is deployed in the network of the network. The mathematic toolbox of the matlab is used for the simulation. To test the performance of the proposed model the simulation is executed on various set of rounds which is 1500.The performance metrics like the number of dead nodes, number of alive nodes, energy consumption, and packets transmitted to the base station are considered Table 1 (simulation parameter) below.

Table 1: Simulation Parameters

Metric/Indices	**Values**
Number of nodes	200
Area (m^2)	800m x 800m
Antenna type	Omni-directional
Queue	Priority Queue
Queue size	50
Channel	Wireless channel
No. of Channel Used	5
Physical medium	Wireless medium
Frequency Bands	2.4 GHz, 5 GHz
MAC Standard/Protocol	802.11

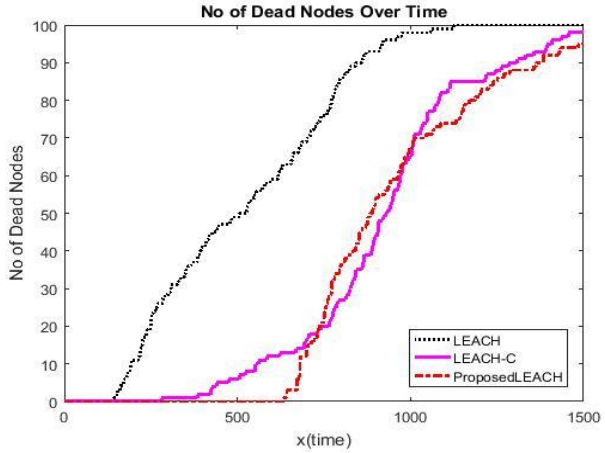

Figure 3: No of Dead Node Comparison

As shown in fig. 3, the number of inactive nodes correspond to number of rounds are compared between LEACH, LEACH-C and proposed LEACH model. It is discovered that in the proposed LEACH due to use of gateway nodes,reduces the no. of inactive nodes in the network.

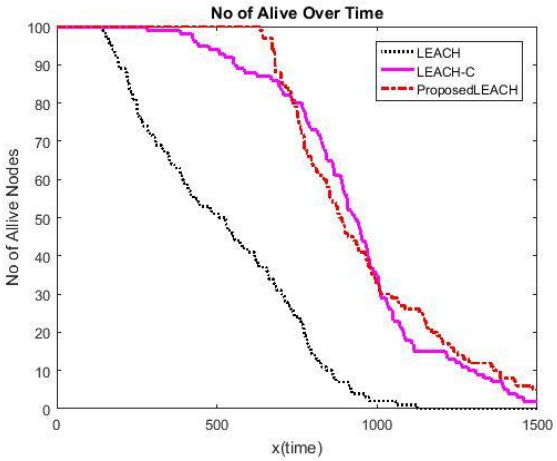

Figure 4: Number of Alive Nodes

Figure 4 exhibits that the no. of active nodes correspond to no. of rounds. These are compared between LEACH, LEACH-C and proposed LEACH. As per analysis, the proposed LEACH protocol has maximal number of alive nodes in comparison to other protocols due to use of gateway nodes in the network.

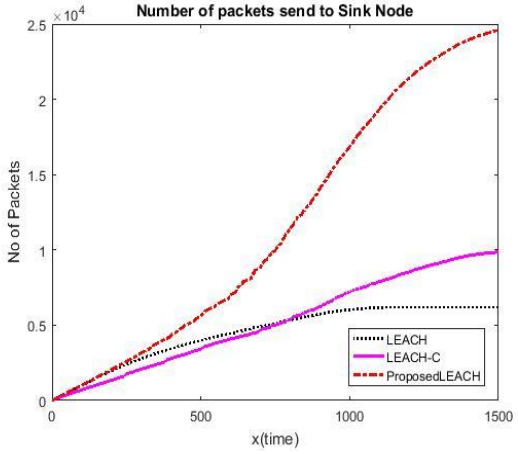

Figure 5: Number of Packet Transmitted

Figure 5 illustrates that no of packets transferred in the network correspond to no. of rounds are compared between LEACH, LEACH-C and proposed LEACH. The proposed LEACH transmits high number of packets as compared LEACH and LEACH-C

Conclusion

The internet of things is a decentralizednetwork. Inadequate energy efficiency is one of the main issues

In this network. To improve the service time of IoT, cluster analysis is anefficient approach. The cluster analysis is to split the entire network into different clustering zones. In each cluster, cluster head will be selected for the data transmission. Distance and energy are the two main parameters of CH (cluster head) selection. This work introduces the gateway nodes within IoT

framework to increase one level hierarchy and to make IoT energy efficient. This work implements new model in MATLAB software. This work considers several metrics such as total no. of inactive nodes, total no. of active nodes and total no. of packets forwarded in the network. The proposed results shows improvements in the result and results are improved by10 percent.

References

[1] Dr. Ovidiu Vermesan SINTEF, Norway, Dr. Peter FriessEU, Belgium, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", river publishers' series in communications, 2013.
[2] Dr. Ovidiu Vermesan SINTEF, Norway, Dr. Peter FriessEU, Belgium, "Internet of Things– From Research and Innovation to Market Deployment", River publishers' series in communications, 2014.
[3] G. Kortuem, F. Kawsar, V. Sundramoorthy, and D. Fitton, "Smart objects as building blocks for the internet of things," IEEE Internet Computing, Volume: 14 , Issue: 1, pp. 30–37, 2010.
[4] Martin Serrano, Insight Centre for Data Analytics, Ireland ,OmarElloumi, Alcatel Lucent, France, Paul Murdock, Landis+Gyr, Switzerland, "Alliance for Internet of Things Innovation", Semantic Interoperability", Release 2.0, AIOTI WG03 – loT Standardisation,2015.
[5] C. Liu, K. Wu, and J. Pei, "An energy-efficient data collection framework for wireless sensor networks by exploiting spatiotemporal correlation," IEEE Trans. Parallel and Distributed Syst., vol. 18, no. 7, pp. 1010–1023, 2007.
[6] V. Stankovic, L. Stankovi ´ c, S. Wang, and S. Cheng, "Distributed ´ compression for condition monitoring of wind farms," IEEE Trans. Sustainable Energy, vol. 4, no. 1, pp. 174–181, 2013.
[7] N. Deligiannis, E. Zimos, D. Ofrim, Y. Andreopoulos, and A. Munteanu, "Distributed joint source-channel coding with copulafunction-based correlation modeling for wireless sensors measuring temperature," IEEE Sensor J., vol. 15, no. 8, pp. 4496–4507, 2015.
[8] Emma Fitzgerald, "Energy-Optimal Data Aggregation and Dissemination for the Internet of Things," IEEE Internet of Things Journal, Volume: 5, Issue: 2, 2018.
[9] Ali KadhumIdreesa, WathiqLaftah Al-Yaseenb, Mohamad Abou Taamc and Oussama Zahwe, "Distributed Data Aggregation based Modified K-means Technique for Energy Conservation in Periodic Wireless Sensor Networks", 2018 IEEE Middle East and North Africa Communications Conference (MENACOMM)
[10] Heng Chuan Tan, Kelvin Lim, Sye Loong Keoh, Zhaohui Tang, David Leong, Chin Sean Sum, "Chameleon: A Blind Double Trapdoor Hash Function for Securing AMI Data Aggregation", IEEE 4th World Forum on Internet of Things, 2018.
[11] Shilpa Rao and Rajeev Shorey, "Efficient Device-to-Device Association and Data Aggregation in Industrial IoT Systems", 9th International Conference on Communication Systems and Networks (COMSNETS), 2017.
[12] Lijun Dong and Guoqiang Wang, "INADS: In-Network Aggregation and Distribution of IoT Data Subscription in ICN", IEEE International Conference on Multimedia & Expo Workshops (ICMEW), 2017.
[13] Sabin Bhandari, Shree Krishna Sharma, Xianbin Wang, "Latency Minimization in Wireless IoT Using Prioritized Channel Access and Data Aggregation", GLOBECOM 2017 - 2017 IEEE Global Communications Conference

[14] Tianqi Yu, "Recursive Principal Component Analysis based Data Outlier Detection and Sensor Data Aggregation in IoT Systems", IEEE Internet of Things Journal, Volume: 4, Issue: 6, 2017.
[15] Firas Al-Doghman, Zenon Chaczko and Jianming Jiang, "A Review of Aggregation Algorithms for the Internet of Things", 25th International Conference on Systems Engineering (ICSEng), 2017.
[16] Raja Jitendra Nayaka and Rajashekhar.C.Biradar, "Data Aggregation and Routing Scheme for Smart City Public Utility Services Using WSN", Second International Conference on Electrical, Computer and Communication Technologies (ICECCT), 2017.
[17] H. RahmanI, N. Ahmed1, and Md. I. Hussain, "A hybrid data aggregation scheme for provisioning Quality of Service (QoS) in Internet of Things (loT)", Cloudification of the Internet of Things (CIoT), 2016.
[18] Abrar Alkhamisi, Mohamed Saleem Haja and Seyed M. Buhari, "A Cross-Layer Framework for Sensor Data Aggregation for IoT Applications in Smart Cities", IEEE International Smart Cities Conference (ISC2), 2016.
[19] Zhikun Deng, Po Yang, Youbing Zhao, Xia Zhao, Feng Dong, "Life-Logging Data Aggregation Solution for Interdisciplinary Healthcare Research and Collaboration", 2015 IEEE International Conference on Computer and Information Technology; Ubiquitous Computing and Communications, 2015.
[20] EvangelosZimos, Joao F. C. Mota , Miguel R. D. Rodrigues, and Nikos Deligiannis, "Internet-of-Things Data Aggregation Using Compressed Sensing with Side Information", 23rd International Conference on Telecommunications (ICT), 2016.
[21] Haneul Ko, Jaewook Lee, and Sangheon Pack, "Consistency-Guaranteed and Energy Efficient Sleep Scheduling Algorithm with Data Aggregation for IoT", Future Generation Computer Systems, Volume 92, Pages 1093-1102, 2019.