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Review Article

A Review: Trending Clustering Protocols in WSN with Analyzing their Complexity and Disadvantages

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Abstract: Wireless Sensor Networks are generally consists of various static or mobile sensor nodes that create a self-organized system in a multi-hop manner. Wireless Sensor Networks are considered as the main component to analyze the surroundings so as to utilize the sensor data for further processing such as weather prediction, health related predictions of a patient, traffic control and so forth. In these conditions, the network's sensor nodes are estimated to perform individually in the field for a long time, as it is not possible to recharge or replace the battery of the sensor nodes. Therefore, the depletion of a single sensor node may affect the processing of the entire network. Due to early energy depletion of the nodes, the concept of Cluster Head (CH) selection has included. This concept has a major impact on energy utilization of the network. Several clustering protocols, and optimization techniques are used for maintaining the energy efficiency in wireless sensor network and few of them are discussed in this work. This paper offers an overview of the work that has been done by many authors.

Keywords: Wireless Sensor Network, Cluster formation, Cluster Head, LEACH, Fuzzy.

INTRODUCTION

The Wireless Sensor Network is taken as real time embedded mechanism in an account, installed in a specific domain to sense several sorts of conditional parameters like humidity, pressure, temperature, gas and so forth. Recently, with the research community a lot of interest has been generated by the large applications of WSN such as forest fire detection, transport monitoring, habitant monitoring, surveillances and so forth [1]. Generally, the wireless sensor networks are heavily installed in dangerous locations in which battery recharge or replacement is not possible and human monitoring mechanism is very hazardous.

There are several general problems like restricted computing capacity, radio connectivity, power constraints; open environment makes the sensor nodes defective various times. After the setup of the network, the data is sensed by the nodes and the power of the battery goes exponentially. If the node finds an event then this information is transmitted to all other nodes including sink node. Every so often, the base station receives the same information as achieved with the neighbor nodes by which the network will become non-effective.

The data aggregation and sensor fusion have been accentuated in the previous research in order to evade this data redundancy and to prepare the system to be more effective to the energy [2]. In order to make the network energy efficient, several routing protocols among various distinctive ideas have been projected by various authors in the previous research [3]. One of the effective concepts is the cluster based routing protocol in which the sensor nodes are alienated into numerous groups and every group is known as a cluster. There is a cluster head in every cluster that is chosen as a group leader. Data aggregation is attained at the cluster head. The information is transmitted to the sink node from the cluster head. The basic model for clustering based WSN is shown in Figure 1.

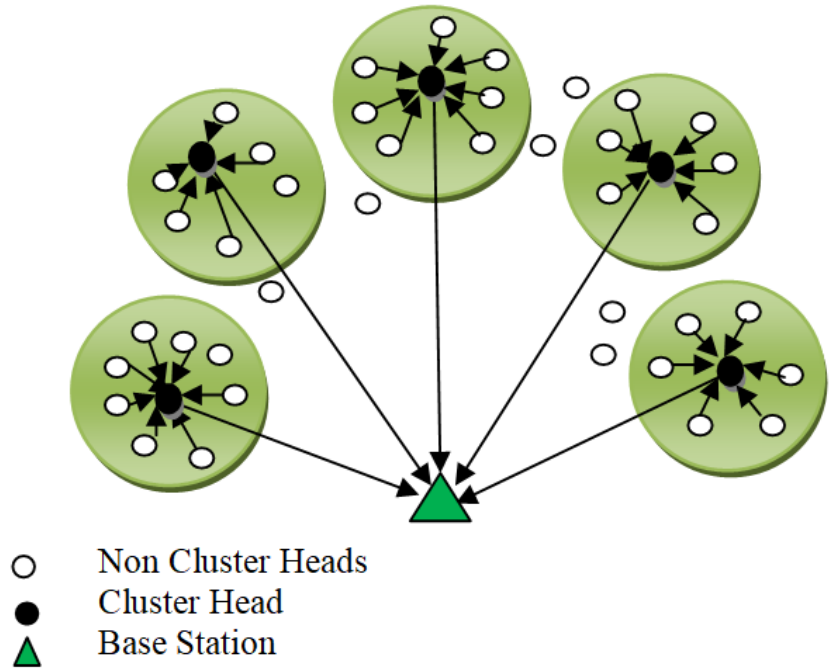

Figure 1: General System Model for clustered WSN [1]

1.1 WSN Features

Various features related to WSN are illustrated below as:

- **Sensor auto-configuration:** Auto-configuration is very important feature as the sensors are generally installed in a random way or by a human [4]. However, every node can self-configure as well as collaborate with other nodes in the network. A transmitting/receiving unit is inbuilt in the sensors by which the data can be exchanged in the nodes.
- **Scalability:** In order to attain a common objective, the sensor network should be scalable as it is capable to accept multiple sensors to work together.
- **Fault tolerance:** If there should arise an occurrence of a sensor malfunction or if new sensors are added to the system, the conventional sensor nodes in the WSN should work normally with no interference. This clarifies the way that a WSN does not embrace a fixed yet rather dynamic topology.
- **Communication ability:** For WSN, multi-hop communication is the minimum energy intensive and remains the most sought-after type of communication which needs a minimum energy utilization.

1.2 Sensor-Node Features

Some of the features of sensor nodes are demonstrated as follows [5]:

- **Energy consumption:** It is impossible to recharge or replace the batteries; however, to manage energy-consumption, is a main restraint in WSN.
- **Transmission scope:** For the deployment of wireless sensor network, it is a significant criterion. It is restricted via the radiation capability of the antennas utilized and the signal strength included.
- **Storage and processing power:** As the sensors have minimum storage as well as the minimum processing power they cannot operate on huge operations.

DIFFERENT PROTOCOLS USED IN WSN FOR ENERGY EFFICIENCY

In wireless sensor network various techniques are used for energy efficiency. Various clustering protocols are projected with fuzzy or without fuzzy that are illustrated as follows [1]:

2.1 Hierarchical Routing Protocols based on clustering

2.1.1 LEACH

LEACH [1] is a hierarchical routing protocol that chooses Cluster heads on the basis of a probabilistic model and every sensor node has the same possibility to become a cluster head. LEACH protocol works in a couple of phases that are set up phase and steady state phase. On every cluster head the load is distributed equally by LEACH protocol, but still there are some flaws which required to be tackled that are:

- In every round, it is not sure that the favored number of cluster heads is chosen.
- If a couple of close cluster heads are selected as probabilistic model used, then the entire energy is depleted in the network.

- As one random number is created and the threshold value is computed, therefore, the more CPU cycles are utilized in every round.
- In order to send the message to cluster head more energy could be utilized by the other nodes only if the selected node is situated close to the boundary of the system.

2.1.2 LEACH –C

With the help of a centralized paradigm, a cluster head is selected through the base station in LEACH-C [1]. The information on location and also the energy of every node is known by the base station. Therefore, it can generate improved clusters with the help of dispersing CH nodes all over the network. The major demerit of this protocol is that the location of every node is unidentified.

2.2 Fuzzy Logic based Clustering Protocol

Various Fuzzy Logic based clustering protocols are illustrated below as:

2.2.1 CHEF

On the basis of a couple of parameters such as distance and energy, the cluster head is selected in CHEF. A node having higher energy and less distance to the sink node is selected as the cluster head by using fuzzy based mechanism. However, CHEF is more effective compared to the LEACH protocol. The major demerit of this protocol is that somewhere local data is not offered as GPS receivers are not equipped in every node.

2.2.2 F-MCHEL

F-MCHEL is an advanced version of CHEF in which on the basis of energy and distance, the cluster head is selected by using fuzzy rules. The node with highest remaining energy than cluster heads is selected as a Master cluster head, which transmits the aggregated information to the sink node. Comparative to LEACH, as well as CHEF, more network stability is offered by this protocol. The main demerit of this protocol is that network lifespan remains constant with the increase or decrease in mobility [1].

2.3 Clustering approach to resolve energy consumption in the network

In order to resolve the issue of energy utilization, the clustering approaches are illustrated below as:

2.3.1 EECS (Energy Efficient Clustering scheme)

The working of the Energy Efficient Clustering Scheme is identical to the LEACH protocol. In this protocol the whole network is alienated into clusters, each having a cluster head. On the basis of a single hop, the communication occurs in cluster head and base station. To start the communication the nodes transmit an initial message to the cluster to verify the power level and once the information is attained the nodes are allocated with the workload and cluster arrangement in the system [6].

2.3.2 HEED: Hybrid energy efficient distributed

The main concept of HEED is that every node is homogeneous such as initially all the nodes have the same amount of energy. After that residual energy and the network topology are the main features in this protocol [6].

2.4 Introducing cloud to optimize the operation and storage in sensors

For energy consumption, there is another feasible mechanism that is to integrate sensor networks among cloud [6]. The following concept is discussed in the plan and optimization of Traffic Balance Broker for Cloud–Based Tele health Platform. In this structural design the requests are arranged by the cloud broker from the server and in addition the memory allocation is also arranged.

2.5 Energy optimization using nature inspired algorithms

In wireless sensor networks the optimization of energy utilization is occurring on the basis of Nature Inspired paradigms that are PSO (Particle Swarm Optimization), BCO (Bee colony optimization), and ACO (Ant colony optimization) paradigms [6]. By using these advanced paradigms over conventional paradigms, the efficiency of energy is increased.

2.6 Hybrid algorithms

In WSNs some hybrid algorithms are used to decrease the energy utilization which takes the following points into an account to do so [6]:

- Mobile base stations,
- Data mules, and
- Mobile relays.

The information is collected by the base station, whereas multiple hop transmission is necessitated in order to stabilize the transmission load. The information is computed by the sink node from the visited nodes and the battery gets exhausted very rapidly.

2.7 Energy Reduction using Miscellaneous Methods

Data Mules are the ad hoc form of mobile stations that gathers information from the nodes and transmit it to the sink node. The data mules are operated as polling officers to verify whether any information is accessible. Hereafter a route is generated by them in order to sense the mobility of the information and thus optimize on the similarities.

2.8 Wireless Energy Transfer

The Wireless energy transfer is an emerging manner for energy optimization. In WSNs the far-field wireless energy transfer provides the power-restricted appliances [1]. WET refers to the utilization of radioactive electromagnetic (EM) wave generated from a power transmitter to transfer energy to a power receiver. The electromagnetic frequency refuses quickly over spaces, in order to know WET in exercise, the EM energy requires to be focused into a thin ray in order to obtain effectual broadcast of power, additionally referred to as an energy beam forming.

2.9 Genetic Algorithms

The Utilization of genetic algorithms has likewise been actually to provide the need of energy optimization in WSN. One such genetic calculation motivated an energy optimization protocol is GAEEP [6]. The sensor nodes are grouped in order to create clusters so as to accomplish the system adaptability and to enhance the system lifetime.

RELATED WORK

Kajol Mohanty, Sawitri Shaw [7], had illustrated that the wireless sensor network was emerging gradually as it had several real-time applications. In order to enhance the network lifetime and its effectiveness a method called as clustering was utilized. The network was sub-alienated into several clusters in the procedure of clustering. There were various sensor nodes contained in every cluster that had a leader called as the Cluster Head (CH). In order to choose a cluster head there were several procedures. The energy of the network was utilized effectively with the help of clustering, therefore improving presentation as well as lifespan. Based on several parameters, various clustering protocols had been examined and contrasted in this work.

Sounak Paul and Tapan Kumar Dey [8], had illustrated that the wireless sensor network was strictly energy restrained. For that network choosing an energy effective routing was very crucial. In order to decrease the energy utilization to enhance the active lifespan of the network a method for routing in wireless sensor network was proposed in this work. In order to send information from a node to a fixed base station by a cluster head the projected mechanism had taken the minimum energy route. Through utilizing Hausdorff distance the distance between neighboring clusters had been estimated. In order to send a `k' bit message to the entire neighbors from source cluster the utilized energy was estimated. In order to send the information to the sink node the minimum energy route was chosen by comparing all the routes. The simulation results had demonstrated that the projected mechanism had obtained effective enhancement in cases of energy effectiveness while comparable with any of the established routing protocols in the similar category.

Alka Singh, Shubhangi Rathkanthiwar [9], had demonstrated that on the basis of the Particle Swarm Optimization mechanism as well as V-LEACH protocol the cluster head as well as vice cluster head election was conferred and a mechanism of energy effective routing was proposed in this work. The simulation results had demonstrated that the projected mechanism had offered better performance comparative to the traditional mechanisms in order to decrease energy dissipation in the transmission as well as the lifespan of the network had enhanced of the wireless sensor networks, additionally other relative performance metrics such as End to End delay, sent information as well as entire utilized energy had illustrated that the projected protocol had offered improved performance comparative to the traditional leach protocol.

H. V. Chaitra, G. K. Ravikuma [10], had illustrated that the industry of communication the wireless sensor based communication mechanism was an emerging technique. The communication in several appliances connected by an infrastructure protocol was enabled by a network that was wireless infrastructure. The network performance like security and appliance lifetime would get decreased because of the energy restrained that was at the time when the energy of the wireless sensor node (WSN's) was exhausted, recharging and offering safety of the sensor nodes in unattended environment was tougher. The battery was generally utilized to power the WSN appliances, the significant as well as nearly all perilous factors was how to make simple the energy intake through taking the safety of WSN appliances into an account, in order that the lifespan of the system could be improved to a point. In order to transfer the information to the sink node, routing the data in sensor nodes plays a crucial role. Several sorts of routing paradigm had been utilized like multi-hopping, hierarchical based, grid based and clustering based like HEED, LEACH etc. In the traditional LEACH protocol was deliberated in which security was not taken as a problem into an account. The author had centered on

incorporating clustering mechanism based on hierarchy named as EEHC-ECC cluster optimization in order to offer safety and enhance the lifespan of the sensor nodes. The simulation results of the proposed model had offered better efficiency compared to the traditional protocols.

L. Nirmala Devi, A. Nageswar Rao [12], had demonstrated that WSN Consists of the huge number of sensor nodes, which were associated through wireless medium, has developed as a groundbreaking innovation that offered the capacity to quantify the physical world parameters precisely. Right now there were some extraordinary sort of routing protocols were intended for sensor systems. All of these directing conventions have considered the vitality proficiency as the goal so as to amplify the existence time of the entire sensor arranges. So far the current routing protocols accessible in WSN were information driven, progressive, location based and on demand routing protocols. As WSN comprised of a gathering of application specific sensors, the powerful utilization of energy necessitated effective routing protocols. The cluster based protocol were Deterministic energy-efficient clustering (DEC), SEP-E were most reasonable as far as energy productivity. Therefore, in this work execution estimation of clustering improvement of SEP (stable decision convention improvement) was contrasted with DEC and SEP, and the experimental parameters were estimated for no of nodes Vs remaining energy. It had been seen that the normal remaining energy in SEP-E have more energy accessible compared to the DEC and SEP protocol. The Simulation results had demonstrated that the execution of the SEP improvement protocol was superior to other existing protocols.

Sreya Ghosh, Iti Saha Misr [13], had illustrated that the pertinence of WSNs had grown immensely in the most recent decade. Sensor nodes were energy imperatives gadgets. For the suitability of sensor system's energy advancement was the major challenges for scientists which can be accomplished by proficient deliberation of clustering routing protocols. LEACH was a standout amongst the most renowned hierarchical routing protocols which set up the fields for some, other routing protocols for WSN. An improved edition of LEACH was the EEEAC protocol, which was a versatile clustering dependent on the remaining energy of every node and created uniform cluster heads over the system. Not at all like EEEAC that taken unique recognition of Subarea code into an account, for situating the nodes located in this work the author had utilized the threshold level of mean connection quality of sensor node for sub-zone division. This procedure lessens the cost unpredictability and size of sensor nodes and non-working of GPS inside indoor condition for territory division. The critical commitment of this work lies in the genuine proving ground execution of both LEACH and our proposed model under SENSEnuts. System security and battery utilization were assessed for all intents and purposes which demonstrates that the altered EEEAC (M-EEEAC) was the more energy proficient improving system lifetime.

Sudhir Kumar [14], had proposed the compartmental model-based cluster size optimization utilizing opportunistic signals in WSNs. The opportunistic signals, to be specific, Wi-Fi, acoustic, or potentially visible light, can be used relying on the great accessibility of the signs in the given zone of intrigue. The compartmental model, which was an attenuation model, portrayed the variety of opportunistic signal power among promulgating separation. So as to limit the energy utilization, the ideal number of clusters was registered for various requests of the Taylor arrangement extension of the compartmental model. The author had outlined that the second-arrange Taylor arrangement development approximates well enough the correct execution of the compartmental model. A hypothetical investigation of the compartmental model execution had been performed with parameters generated from experimental estimations.

Rimpy Sharma, Shivani Sharma [15], had demonstrated that the WSNs were excellent system contained system gadgets in vast numbers and spatial course. They have distinctive sensing limits and take an interest to complete basic assignment. The density grid based clustering in WSN that had improved the execution of the WSNs through using the gathering based data total. Regardless, no upgrade technique was taken into an account for the route selection in density grid-based clustering. This work had projected a couple of new methodologies i.e. artificial bee colony was a swarm based improvement strategy for energy proficient routing calculation and the compressive detecting was likewise used to enhance the energy rate or execution. The proposed technique has appeared noteworthy enhancement over accessible ones.

Here in this section the Table 1 shows the overview of the literature with the complexity and disadvantages of different techniques used in WSN.

Table 1: Comparative Analysis of Survey and Observations on Energy Efficient Protocols in WSN

Author (Year)	Title	Parameters	Complexity	Disadvantages
Harneet Kour *et al.*, (2010) [16]	Hybrid Energy Efficient Distributed Protocol for Heterogeneous Wireless Sensor Network	• Load • Energy • Dissipation • Delay • Throughput	Moderate	Needs improvement in scheduling and prioritizing packet transaction

Author (Year)	Title	Parameters	Complexity	Disadvantages
Jihe Wang *et al.*, (2013) [17]	Design and Optimization of Traffic Balance Broker for Cloud–Based Telehealth Platform	• Memory • Energy • Throughput	High	Does not solve the energy problem, but only subsides the issue
Daniel Sebastião *et al., (*2009) [18]	Towards an Optimization of Parameters Setting in WLANs	• Packet size • Packet delivery ratio • Energy • Delay	Low	Stereotyped and over exploited method.
MihaelaCardei *et al.*, (2005) [19]	Energy -Efficient Target Coverage in Wireless Sensor Networks	• Energy Dissipation • Load • Throughput	Low	No scalability to higher range of networks
Nizar Hadi Abbas *et al.*, (2013)[20]	Optimization of Energy Consumption in Wireless Sensor Networks based on Nature-Inspired Algorithms	• Energy Dissipation • Load • Throughput • Delay	High	Complex methods and cost ineffective
G. Ravi Chandra Reddy *et al.*, (2015) [21]	Minimizes the Energy Consumption in Wireless Sensor Networks	• Energy Dissipation • Load • Throughput • Delay	High	Complex methods and cost ineffective
Chin Keong Ho *et al.*, (2015) [22]	Throughput Optimization for Massive MIMO Systems Powered by Wireless Energy Transfer	• Energy Dissipation • Load • Throughput • Delay	Moderate	No energy localization is done
Mohammed Abo-Zahhad *et al.*, (2014) [23]	Energy-Efficient Adaptive Clustering Protocol Based on Genetic Algorithm for Improving the Lifetime and the Stable Period of Wireless Sensor Networks	• Energy Dissipation • Load • Throughput • Delay	High	Complex methods and cost ineffective

CONCLUSION

Presently, the energy efficiency has become a major issue in WSNs. The Sensor nodes operate on battery due to which the lifetime of these sensor nodes is very short or in other words the sensor nodes can perform for a specific interval of time. The energy plays an important role in operating the sensor networks. The working of the entire network is occurring on the basis of energy which is allocated to the nodes in starting. It is necessary to deal with the energy utilization of the network to improve the lifespan of the network. Several clustering protocols or optimization techniques can be used to improve the energy efficiency, surveyed by the author of the literature.

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General Terms: Protocols, Algorithms, Clustering, Optimization, Energy Efficiency.

REFERENCES

1. Padmalaya, N., & Anurag, D. (2016). A Fuzzy Logic Based Clustering Algorithm for WSN to Extend the Network Lifetime. *IEEE*, 6(1), 137-144.
2. Heinzelman, W. R., Chandrakasan, A., & Balakrishnan, H. (2000). Energy-efficient Communication Protocol for Wireless Microsensor Networks. In *IEEE Computer Society Proceedings of the Thirty Third Hawaii International Conference on System Sciences (HICSS '00)*, Washington, DC: IEEE, pp. 1-10.
3. Kemal, A., & Mohamed, Y. (2005). A survey on routing protocols for wireless sensor networks. Ad *Hoc Networks*, 3, 325–349.

4. Akkaya, K., & Younis, M. (2005). A survey on routing protocols for wireless sensor networks. Ad *Hoc Netw.*, 3, 325–349.
5. Rawat, P., Singh, K. D., Chaouchi, H., & Bonnin, J. M. (2014). Wireless sensor networks: A survey on recent developments and potential synergies. *J. Supercomput.*, 68, 1–48.
6. Vandana, R., & Gayathri, P. (2018). A Review on Energy Optimization Techniques Used in WSN. *ARPN*, 13(14), 4351-4359.
7. Kajol, M., Sawitri, S., Prajwal, V., Prachi, R., Rashmi, S., & Amrit, M. (2018). Energy Efficient Clustering Protocols: A Study. *IEEE, 2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA).*
8. Sounak, P., & Tapan, K. D. (2015). Energy efficient routing in cluster based wireless sensor networks. *IEEE, 2015 2nd International Conference on Advanced Informatics: Concepts, Theory and Applications (ICAICTA).*
9. Alka, S., Shubhangi, R., & Sandeep, K. (2016). Energy efficient routing of WSN using particle swarm optimization and V-LEACH protocol. *IEEE, 2016 International Conference on Communication and Signal Processing* (ICCSP).
10. Chaitra, H. V., & Ravikuma, G. K. (2016). A secure and energy efficient cluster optimization by using hierarchical clustering technique. *IEEE, 2016 3rd International Conference on Devices, Circuits and Systems* (ICDCS).
11. Praveen, M. K., & Senthi, T. (2014). Lifetime maximization of wireless sensor networks using energy-efficient cluster formation strategy. *IEEE, 2014 IEEE International Conference on Computational Intelligence and Computing Research*.
12. Nirmala Devi, L., & Nageswar Rao, A. (2016). Optimization of energy in wireless sensor networks using clustering techniques. *IEEE, 2016 International Conference on Communication and Electronics Systems* (ICCES).
13. Sreya, G., & Iti Saha, M. (2017). Design and testbed implementation of an energy efficient clustering protocol for WSN. *IEEE, 2017 International Conference on Innovations in Electronics, Signal Processing and Communication* (IESC).
14. Sudhir, K. (2017). Compartmental Modeling of Opportunistic Signals for Energy Efficient Optimal Clustering in WSN. *IEEE, IEEE Communications Letters*, 22(1).
15. Rimpy, S., & Shivani, S. (2017). Evaluating the performance of density grid-based clustering using ABC technique for efficient routing in WSNs. IEEE, 2017 *7th International Conference on Cloud Computing, Data Science & Engineering – Confluence*.
16. Harneet, K., & Ajay, K. S. (2010). Hybrid Energy Efficient Distributed Protocol for Heterogeneous Wireless Sensor Network. *International Journal of Computer Applications*, 4(6), 0975-8887.
17. Jihe, W., Bing, G., Meikang, Q., & Zhong, M. (2013). Design and Optimization of Traffic Balance Broker for Cloud–Based Telehealth Platform. 2013 *IEEE/ACM 6th International Conference on Utility and Cloud Computing*.
18. Daniel, S., & Luis, M. C. (2009). Towards an Optimisation of Parameters Setting in WLANs. *IEEE.*
19. Mihaela Cardei, M. T., & Thai, Y. L. W. W. (2005). Energy -Efficient Target Coverage in Wireless Sensor Networks. *IEEE.*
20. Nizar Hadi, A., Tarik Zeyad, I., & Rassim Nooraldin, I. (2013). Optimization of Energy Consumption in Wireless Sensor Networks based on Nature-Inspired Algorithms. *International Journal of Computer Applications*, 77(14), 0975-8887.
21. Ravi Chandra Reddy, G., Tarakeswara Rao, B., & Satyanarayana Reddy, B. (2015). Minimizes the Energy Consumption in Wireless Sensor Networks. *International Journal of Advanced Research in Computer Science and Software Engineering Research*, 5(1), ISSN: 2277 128X
22. Chin Keong, H., Rui, Z., & Yong Liang, G. (2015). Throughput Optimization for Massive MIMO Systems Powered by Wireless Energy Transfer. *IEEE Journal on Selected Areas in Communications*, 33(8).
23. Mohammed, A.-Z., Sabah, M. A., Nabil, S., & Shigenobu, S. (2014). Energy-Efficient Adaptive Clustering Protocol Based on Genetic Algorithm for Improving the Lifetime and the Stable Period of Wireless Sensor Networks. *International Journal of Energy, Information and Communications*, 5(3), 47-72.