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An Effectual Analysis on Energy Aware Clustering Approaches in Wireless Sensor Networks

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ABSTRACT
With the advent and frequent use of remote monitoring objects, the wireless technologies are escalating at swift rate. As per the research reports, the market of wireless sensor networks in North America was more than 2 billion dollars in year 2013 while it is proposed to touch 6 billion dollars in year 2018 and it will be a huge growth. In the deployment of wireless networks, there are certain factors and features which are taken care because of vulnerabilities and assaults. Energy consumption and optimization is one of the key domains of research in wireless sensor network because the lifetime of wireless nodes are very less. The development of energy aware wireless sensor networks is in research from a long time because of the increasing issues related to lesser lifetime of nodes in the wireless environment. The traditional lifetime of wireless nodes even in smart grids is 835 days while the other wireless nodes die in maximum 30 days. Many times, The battery time of wireless sensor nodes is very few days which is a costly affair. It is difficult and cost consuming to redeploy the wireless nodes to reform the network and cost of clustering. This research manuscript focus on the assorted models and algorithms developed and implemented for the energy optimization on multiple aspects. In the literature analytics, it is found that there is need to integrate nature inspired approaches or soft computing approaches so that the existing scenarios of energy consumption in wireless networks can be managed effectively. After deep literature review in work, a novel and performance aware approach Nature Inspired Approach (NIA-LEACH) is proposed be developed and implemented so that the optimization level can be improved. The proposed approach NIA-LEACH is expected to have higher degree of lifetime, accuracy and overall optimization factors. In this work, a new NIA shall be developed so that the energy can be optimized and overall network can be retained for long time. Nature Inspired Approaches are widely used for solving optimization problems from a long time and that's why this dimension is adopted to be implemented in the wireless networks. The proposed approach shall be evaluated on multiple parameters including energy optimized, accuracy, turnaround time and overall performance of the network.

Keywords -Energy Optimization, Energy Aware Wireless Networks, Energy Harvesting in Wireless Sensor Networks, Energy Conservation in Wireless Networks

INTRODUCTION

Wireless communication [1] involves the transmission and sharing of information in multiple nodes without using the electrical conductor. The wireless communication depends on the radio technology and related assorted aspects for effective and secured data transmission [2]. A wireless network can be of any type including Cellular Network, Global Area Network, Wireless PAN, Wireless LAN, Wireless Mesh Network, Space Network, Wireless MAN, Wireless WAN and other variants for the data transmission and sharing of resources.The key features of Wireless

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Networks includes Multi-hop Routing, Dynamic and Effective Load Balancing, Network Access Control, Autonomous, Distributed Operation, Dynamic Network Topology, Network Scalability, Light Weight Terminals , Scalability, Speed of deployment, Decreased dependence on infrastructure, Mobility and Quality of Service, Portability, Transportation and many others.

The key attributes of wireless sensor networks include:

- Efficient and Ease of implementation
- Remote Monitoring and Real Time Logs
- Utilization of power imperatives for hubs utilizing power devices or vitality reaping
- Low maintenance cost with minimum resources
- Reduced cost of installation and hardware
- Versatility of wireless networks with sharing of resources
- Versatility to send the huge size data in limited bandwidth and channels
- Capabilities to deliver the services in adverse and stringent conditions
- Cross-layer architecture support and convenience in managing

The key components and internal aspects of a Wireless Network comprises

Source – Source Node (Mote)
CH – Cluster Head (Aggregator)
BS – Base Station (Tower)

Figure shows the sensor node with the components integrated for the classical implementations. As in the figure, there are multiple components which work and collaborate together for data transmission and communication with the base stations or satellites.

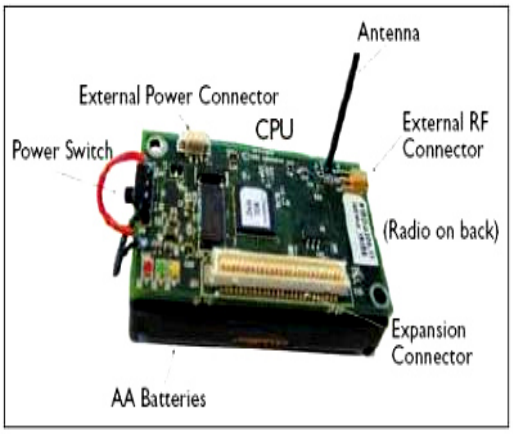

Figure 1: Internal Aspects of WSN Node

The traditional components associated with the wireless sensor nodes include power switch, power connector, expansion connector, radio unit, antenna, batteries and external radio frequency connector. It is evident that battery is one of the key component by which the overall lifetime of the node as well as communication channel is decided. This is the key point in energy optimization and conversation in the wireless sensor nodes.

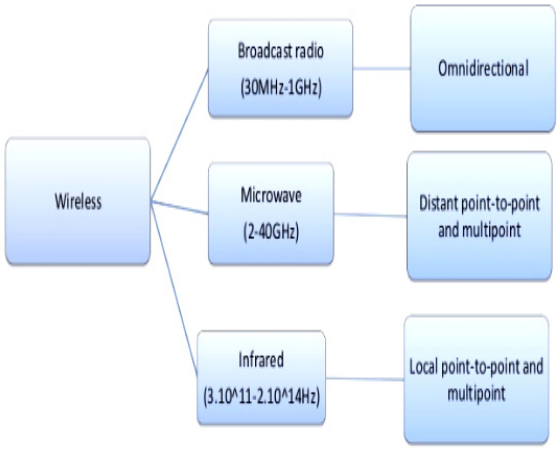

Figure 2: Modes of Wireless Communication

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Table 1: Comparison between WSN and Mobile Ad Hoc Networks

Wireless Sensor Networks	**Mobile Ad Hoc Networks**
Energy Consumption more and generally non rechargeable due to remote and sensitive locations	Energy is not the issue because of recharging
Very far and not accessible physically in general	More close of Human Experts / Users
Data Aggregation / Grouping	No need of aggregation
Clustering	Each mobile node act as router itself
Security and Integrity are the key issues	Security is not an issue as it is always very close to human user

Figure 3 depicts the traditional architecture and components associated with the wireless sensor node with the inherent structure.

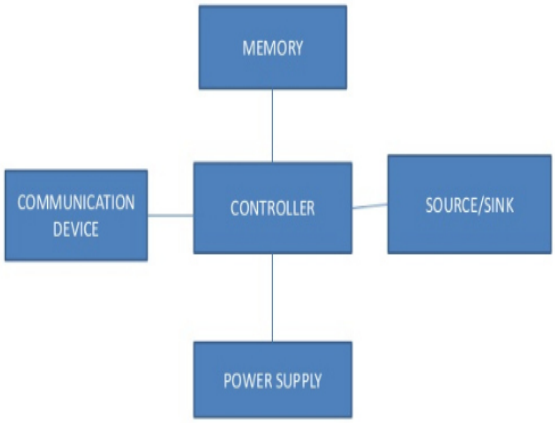

Figure 3:Classical Format of WSN Node

Energy Conversion Mechanism

It refers to systems for rummaging electrical energy from a given energy source. The decision of energy transformation component is nearly fixed to the decision of energy source. In the event of sun powered energy, the change system is the utilization of sun oriented boards. A sun oriented board acts like a current source and the measure of current produced is specifically relative to its size/ range and power of episode light. Henceforth, contingent on the pre-requisites, greater boards with bigger range or more number of sun based boards are utilized. In the event of mechanical wellsprings of energy like strolling, paddling, pushing catches/keys, change to electrical energy is carried out suing piezo-electric components.

Piezo-electric movies and ceramics endless supply of power and produce electric energy: Bigger the extent of the film, bigger is the measure of energy collected. Wind energy is reaped utilizing rotors and turbines that change over round movement into electrical energy by the rule of electromagnetic impelling.Energy gathering gives various profits to the end client and a percentage of the real advantages regarding the EH that is suitable for WSN are expressed as well as explained in the accompanying rundown. Energy gathering arrangements can be:

Reduce the reliance on battery or simply power aspects: With progression of the microelectronics innovation, force utilization of sensor hubs aregetting leaser and lesser, subsequently gathered encompassing/ environment energy may be sufficient to take out battery totally.

Reduce establishment cost: Self-power wireless sensor hubs don't oblige force links wiring and courses, thus they are anything but difficult to introduce and they likewise diminish the overwhelming establishment cost.

Reduce upkeep cost: Energy gathering takes into account the sensor hubs to capacity unattended once situated and disposes of administrations visits to supplant batteries

Traditional Approaches for Energy Regain and Harvesting

In wireless networks, there are mobile nodes which are connected to each other using radio

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or related transmission line without any physical infrastructure. Wireless Network refers to a specific scenario having mobile nodes connected via mobile routers, base stations or satellites using which the overall network can be controlled and monitored. There are number of applications in which wireless sensor networks are integrated. In classical way, the wireless networks are implemented for the ease of mobility, remote accessibility and cross region connectivity. One of the traditional real life implementation is vehicular ad hoc networks (VANET) [4] in which the vehicles are equipped with wireless devices. In this scenario, the minimum distance of vehicles on road can be measured at run time which reduces the scope of any catastrophe on road.

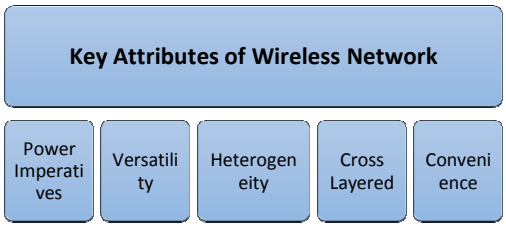

Figure 4: Key Attributes of Wireless Sensor Networks

Following table underlines the comparative analysis of wireless standards on assorted parameters and factors. By this aspect, the deep review on the protocol based analysis can be done.

Table 2: Comparative Pragmatic Analysis of Wireless based Standards

	Bluetooth	**Wi-Fi (a)**	**Wi-Fi (b)**	**Wi-Fi (g)**	**Wi-MAX**
International Standard	802.15	802.11a	802.11b	802.11g	802.16
Frequency (GigaHz)	2.5	5	More than 2	2.4	2 - 66
Speed (Mbps)	Around 1	54	11	More than 50	Around 100
Range Parameter (mt)	10	More than 50	More than 80	More than 100	More than 50
Advantages	Low Cost	Speed	Less Cost	Speed	Range
Limitations	Range Issues	Cost Factor	Speed	Cost and Range both	Cost

Energy Model in Under Water Sensor Networks (UWSN)

As energy is the major constraint in Underwater Sensor Networks. In this model the innovative mechanism is proposed for the energy resource for the sensors castoff in underwater, the conversion of tidal energy into the electrical energy, so the positioned sensors will not exoneration after limited days in assessment of using the Li-Ion batteries.

As tidal energy is a form of kinetic energy which is derived from the below equation

$$E = \frac{1}{2}mv^2$$

There are two types of tides, which are mentioned below:-

- Solar Tide → it is based on the Sun.
- Lunar Tide → it is based on the Moon.

As if we compare both tideswe find that the height of lunar tide is more than the solar tide∵ of gravitational power of moon, so we can say that in the night we find the high tides, due to that more energy generation is there. According to the study of ocean current we find that every moment there are tides through which we can generate the electrical energy

for the sensors which we positioned in the ocean at various levels.

Height of Solar Tide: As we study in the day time at the top of the oceans there are the tides of 1Mtr. If we go downwards in the ocean at 500Mtr the height of tide is 2-3Mtr and if we go again 500Mtr down in the ocean then the height of tide is 4-5Mtr.

Height of Lunar Tide: As we study in the day time at the top of the oceans there are the tides of 2Mtr. If we go downwards in the ocean at 500Mtr the height of tide is 3-4Mtr and if we go again 500Mtr down in the ocean then the height of tide is 5-6Mtr.

DFD FOR ENERGY MODEL IN UNDERWATER SENSOR NETWORKS

DFD for energy model is mentioned ahead:

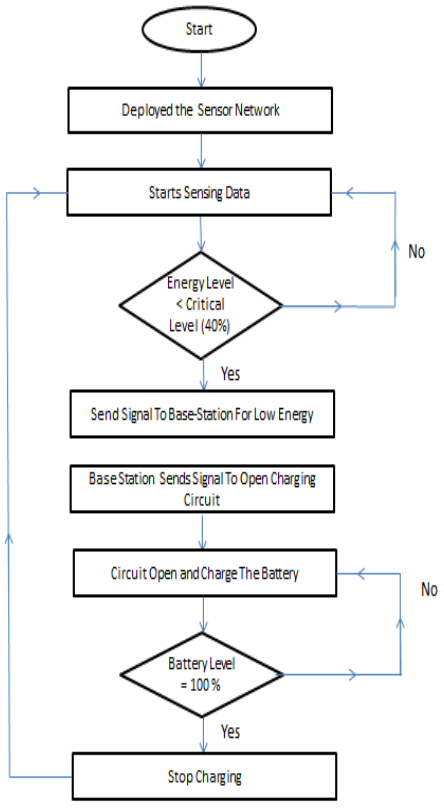

Figure 5: Data Flow Diagram of Energy Model

LITERATURE REVIEW

A number of researchers and practitioners have worked on the analysis of remote sensor technology and energy optimization but there is huge scope for the improvement in cases where energy aware data transmission and integrity is necessary due to huge requirements of confidentiality & integrity with greater degree of accuracy. A number of research papers and manuscripts are analyzed from the time span of (2015-2017) so that the latest trends in energy optimization and lifetime of wireless sensor networks can be evaluated.

G. Rama Subba Reddy et al.(2017)presented an effectual Review of Clustering and Energy Optimization dimensions inWireless Sensor Networkswith the deep evaluation of architectures and protocols prevalent and adopted by the academicians and researchers for energy optimization and harvesting in wireless sensor networks

Rahimeh Ghasemzadeh et al.(2017)worked on the development and Implementation of a new algorithm SFLA LEACH for energy optimization and overall effectiveness in the wireless networks. The proposed architecture and protocols provide the higher lifetime and accuracy in the wireless sensor network environment. The novel approach is presented with better results as compared to LEACH, WEEC, BN-LEACH, GA-LEACH and related variants

Arzoo Miglani et al.(2017)proposed a novel approach Energy Aware and Trust Aware (EETA-LEACH) for improving the lifetime and overall performance of wireless sensor networks.The work is related to energy optimization as well as security to repel back the malicious nodes so that the energy cannot be consumed by wicked nodes. The work focus on the trust based routing module as well as trust based energy optimization in wireless environment. The dying time in EETA-LEACH is quite delayed to improve the overall lifetime of network environment

Paola G. Vinueza Naranjo et al.(2017)devised a new approach Prolong Stable Election Protocol (P-SEP) to improve the energy aware routing in wireless networks.The proposed P-SEP is giving better results as compared to DCHS-LEACH AND M-SEP in terms of longer lifetime, minimum packets loss and higher degree of performance for multiple nodes in the wireless environment. The work effectually presents the association and effectiveness in fog computing which is one of the research areas for wireless environment.

K. Vijayan et al.(2016)presented Energy Aware and Load Balanced approach with Cluster Arrangement Energy Efficient Routing Protocol (CAERP). The work is proposed and implemented to escalate the dynamic cluster formation in the wireless network environment and overall lifetime of the wireless sensor nodesThe proposed CAERP is having four modules Dynamic Clustering, Cluster Head (CH) Selection, Effective Routing and Energy Aware Secured Data Communication. The results compared to Q-LEACH are enhanced with higher survival rate and minimum average energy consumption.

Hamid Ali Abed Alasadi(2016)developed the performance aware approach Energy Efficient Hierarchical Clustering Mechanism (EEHCM) for residual energy management and survival of nodes. The hierarchical clustering based approach is giving better results as compared to traditional LEACH. The projected approach takes care of communication cost, residual energy and distance matrix with the base station to escalate the overall lifetime.

Muhammad Tahir, Fazlullah Khan et al.(2016) derived and simulated an energy aware model EEC for frequent evaluation and deep analytics of the energy consumption taking place in wireless sensor networks.The choice of nodes and clustering protocols are taken care in the wireless environment so that the overall performance and lifetime of the nodes can be improved.

Basma Fathi et al.(2016)presented a novel approach integrating K-Means Clustering and Particle Swarm Optimization (KPSO) for higher degree of optimization and effectual results.KPSO provides the optimization and harvesting aspects with traditional LEACH. The hybrid approach KPSO is presented with more than 40% better as compared to the classical approach.

Asgarali Bouyer(2015)underlines the projected an energy aware and performance focused approach Fuzzy C-Means (FCM) is developed with simulation model. The results compared with traditional LEACH are better and giving higher lifetime to the network.

Gopi Saminathan Arumugam et al.(2015)devised a novel Energy Efficient LEACH (EE-LEACH) to integrate the energy aware routing with minimum packets loss and greater degree of lifetime in the wireless nodes. The concept is based on the forwarding of nodes having specific residual energy so that selected cluster heads can lead the overall network with higher degree of accuracy

Amjad Mehmood et al.(2015)presented the integration of Vice Cluster Head for Energy Optimization in Wireless Sensor NetworksIntegration and implementation of a new cluster head titled vice cluster head (VCH) so that the backup or candidate node for cluster head can be available without any delay in case of failure of cluster head

Mustapha Khiati et al.(2015)delivers an effective Approach titledBroadcast over Duty-Cycle and LEACH(BOD-LEACH) is presented and developed for improvements in the overall communication and minimization of latency in wireless environmentThe broadcast path takes care of the base station and valid communication lines so that the channel cannot be under choke situation and energy can be optimized with higher lifetime

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Inferences Drawn and Research Gaps

There is huge scope of escalation in traditional LEACH because of increasing use of wireless nodes in the smart grid and high performance applications including energy aware secured networks. With the integration of nature inspired algorithms, the performance of classical LEACH can be escalated and such algorithms are not widely implemented so far in association of LEACH. LEACH is one of the prominent approaches for energy aware routing in Wireless Networks, still this approach is under research because of escalating assaults and energy consuming assails. In this research work, the need to devise and implement a new and effectual approach with variant of LEACH is proposed with title NIA-LEACH which refers to nature inspired algorithm based LEACH. By this approach, the overall optimization factors can be enhanced with higher degree of accuracy and performance.

The approach of River Formation Dynamics (RFD) is presented here in which the energy level and network transmission is considered analogous to the water drops in a river. The threshold value of energy can be checked at each phase of simulation and further optimization can be implemented using a novel formulation.

In the mathematical mode, the notations are specified as follows –

h –Extraction of the Best Fit Parameters and Sediments from River (Network Environment)
Δ - Fuzzy value with the degree of freedom by which the variations can be done in the Mathematical Model.

ϕ - The parameter directly associated with Δ so that the regression and correlation factor can be associated

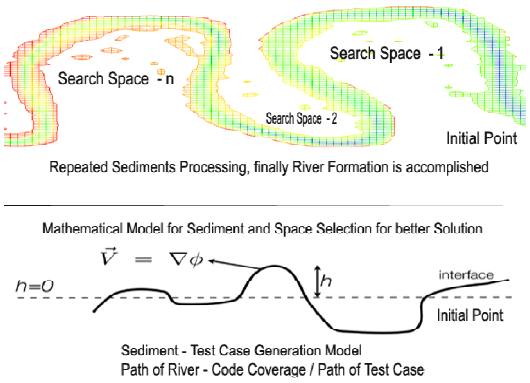

Figure 6: River Formation Dynamics

Conclusion

Wireless sensor networks require higher level of energy aware performance and integrity because of the identification and sensing of the malicious traffic and related security factors. There is need to devise the new variants of LEACH and can be tested withDynamic topology so that the consistency can be checked and evaluated. The weights and related properties can be set on the real time dynamic networkIntegration of dynamic security approaches so that the key can be more secured. The proposed novel approach is proposed to be effective in terms of higher integrity, security and performance with the implementation of existing approach based on the dynamic clustering can be used for any type of network.

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