



ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 5, May 2016

Enhancing Energy and Stability to Improve the Lifetime of Mobile Sink Based Clustering Protocol in WSN

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ABSTRACT: Vitality opening issue is a basic issue for information gathering in Wireless Sensor Networks. Sensors close to the static sink go about as transfers for far sensor and in this manner will drain their vitality rapidly, coming about vitality gaps in the sensor field. Abusing the portability of a sink has been generally acknowledged as an effective approach to ease this issue. Be that as it may, deciding an ideal moving direction for a portable sink is a NP-difficult issue. Subsequently, this paper proposed a Mobile Sink based versatile Immune Energy-Efficient bunching Protocol (MSIEEP) to ease the vitality gaps. MSIEEP utilizes the Adaptive Immune Algorithm (AIA) to manage the versatile sink in light of minimizing the aggregate dispersed vitality in correspondence and overhead control parcels. Also, AIA is utilized to locate the ideal number of Cluster Heads (CHs) to enhance the lifetime and solidness time of the system. The execution of MSIEEP is contrasted and the beforehand distributed conventions; to be specific LEACH, LEACHGA, A-LEACH, meeting and MIEEPB utilizing Matlab. Reproduction results demonstrate that MSIEEP is more dependable and vitality proficient when contrasted with different conventions. Moreover, it enhances the lifetime, the strength and the precariousness time frames over the past conventions, since it generally chooses CHs from high-energy hubs. In addition, the portable sink expands the capacity of the proposed convention to convey bundles to the destination.

KEYWORDS: Remote Sensor Networks, Immune Algorithm, Clustering Protocols, Mobile Sink, Energy Hole Problem.

I. INTRODUCTION

Remote sensor frameworks, now and again called remote sensor and actuator frameworks, are spatially appropriated self-decision receiving wire to screen physical or natural conditions, for instance, temperature, sound, weight, et cetera. Receiving wire measure and screen including conditions in the enveloping environment, for instance, heat, pressure, vibration, closeness of articles et cetera. The estimations and checked events are then sent towards a static be submerged. Direct show to be submerged does not guarantee particularly balanced scattering of the imperativeness load among radio wire of the framework. Thusly, various bundling traditions have been especially proposed for WSNs to upgrade data mixture frameworks, equality scattering of the essentialness load among reception apparatus in WSN and along these lines grow the framework lifetime.

These traditions extensively vary dependent upon the centers sending, the framework and radio models, and the framework designing. Additionally, the sensor centers near the static be submerged go about as exchanges heedlessly picked and the remaining imperativeness of each center point is not considered in CH determination process. Another



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tradition called Amend LEACH (A-LEACH) was created, forelecting CHs in a passed on outline and upgrading the robustness time of two-phase dynamic heterogeneous WSNs. WSNs with versatile be submerged s have pulled in a lot of thought. The likelihood of IAR is picking a couple reception apparatus as administrators. By then, the be submerged moves near an administrator and gets data in case it is in the extent of the authority, and if not, the be submerged picks a sensor as an impermanent hand-off center point which gets data from pro and advances it to be submerged . Adaptable Be submerged based Routing Protocol for dragging out the framework lifetime in grouped WSN has been tended.

In MSRP, the be submerged moves to CHs having higher essentialness in the packed framework to accumulate recognized data from themIntelligent Agent-based Routing tradition to guarantee viable data transport to be submerged and reduces signal overhead. Another enhancing LEACH bundling count with convenient be submerged and meet center points was displayed. This figuring merges the use of the LEACH estimation, convenient be submerged and meet centers to ensure the benefits of the hole count and improve the CH determination process. Likewise, it reduces essentialness usage in WSNs furtherthan in ordinary LEACH, particularly when the framework is considerable.

Adaptable be submerged Improved Energy-Efficient PEGASISBased guiding tradition has been presented. MIEEPB presents the be submerged convenience in the multi-arrangement model and segments the sensor field into four areas, thusly achieving more diminutive chains and decreasing weight on the pioneer center points. The be submerged moves close by its heading and stays for a period at settled zone in each area to guarantee data amassing. Grants a particular bearing and stops at settled visit regions. This makes the recieving wire near the modified visit zone to scramble their essentialness faster than various center points. consequently in this postulation, we use a control adaptable be submerged guided in perspective of minimizing the scattered essentialness of all sensor center points.

For this circumstance, the radio wire incorporating the be submerged change after some time, permitting to all recieving wire in the framework to go about as data exchanges to the versatile be submerged and henceforth modifying the stack among all centers.

Imperativeness opening issue be an essential issue for datagathering in Wireless-Sensor Networks. Recieving wire near the staticbesubmerged goes about as exchanges for far sensor and along these lines will deplete their energyvery quickly, coming to fruition essentialness crevices in the sensor field. Exploitingthe convenience of a be submerged has been by and large recognized as a capable wayto moderate this issue. Nevertheless, choosing an optimalmoving heading for a versatile be submerged is a NP-troublesome issue. Consequently, this postulation anticipated a Mobile Be submerged based adaptable safe force able batching Protocol to facilitate the imperativeness crevices. M-S-I-E-E-P uses the Adaptive Immune Algorithm to deal with the convenient be submerged in light of minimizing the total spread essentialness in correspondence and overhead compose packages. Likewise, An I-An is used to find the perfect measure of Cluster Heads to upgrade the life range and soundness periodof the framework.

The execution of M-S-I-E-E-P is differentiated and the officially appropriated traditions; particularly LEACH, LEACHGA, A-LEACH, meeting and M-I-E-E-P-B using Matlab. Generation results show that M-S-I-E-E-P is more tried and true also, essentialness profitable when stood out from various traditions. Additionally, it improves the lifetime, the quality and the flimsiness time periods over the past traditions, since it for the most part picks CHs from highenergy centers. In addition, the adaptable be submerged forms the limit of the proposed tradition to pass on packs to the destination.

II. PROPOSED CONTRIBUTIONS

A tradition, we use a limited convenient be submerged to guided considering minimizing the scattered essentialness of each sensor centers. The sensor playing field is isolated into R level with sum districts toward jam imperativeness given that data is transmit more than less bobs. This reduces the amount of drop packages and defer in order to package needs to reach to the be submerged because the flexible be submerged moves along the remain as such stops at the visit range



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closer to the receiving wire center points to each region in the sensor field. Moreover, disconnecting the radio wire playing field into little regions requires receiving wire with little correspondence extend as opposed to the whole sensor field require sensor with considerable correspondence achieve ensure system connecting the center points and be submerged. We trust three visit way plans the compact be submerged. To develop the proposed tradition, the going with suppositions about framework duplicate is considered:

- ✚ Antenna is inert, and everybody know zone by method for G-P-S part or persuaded control strategies.
- ✚ The intra group recognized information is significantly related, thusly data accumulation frameworks can be used to solidify a couple associated signs into a singular length-settled pack.
- ✚ The correspondence direct symmetric the equivalent obliged essentialness to convey a message interfacing two center points).
- ✚ Submerged BE SUBMERGED is flexible in addition to resource rich device.

System Design:

Various batching traditions for normal WSNs, which made out of standing receiving wire centers and a standing be submerged have showed up a written work. shortcoming Adaptive group Hierarchy (L-E-A-C-H) plays a fundamental clustering tradition that delivered. In L-E-A-C-H, C-H assembles in addition to sums data from the receiving wire in its own pack and pass a data to the submerged specifically. Then the issue of L-E-A-C-H tradition a subjectively determination of C-Hs. Channel require customer toward show the fancied probability as C-Hs in order to usages making sense of if center transforms into a C-H. In any case, genetic Algorithm based (L-E-A-C-H-G-A) proposed uses G-A to find perfect probability of C-Hs (popt). Channel GA upgrades the C-Hs edge limit, yet in the meantime C-Hs are subjectively picked and the remaining essentialness of each center point is not considered in C-H determination process. Another tradition call Amend L-E-A-C-H (A-L-E-A-C-H) has made, and picking C-Hs in a flowed structure in addition to improving an unfaltering quality time of twofold phase dynamic blended Wireless sensor networks. A flexible be submerged have pulled a ton thought starting late. In makers developed a scholarly go between base bearing discovering (I-A-R) tradition guarantee capable data transport to be submerged and diminishes banner flood. The likelihood of I-A-R is picking a couple receiving wire as pros. By then, the be submerged moves near an administrator and gets data if it is in the extent of the expert, and if not, the be submerged picks a sensor as an impermanent exchange center which gets data from administrator and advances it to be submerged .

The division constrained flexible be submerged issue is characterized as a mixed entire number straight preparing and considered novel heuristic to find a perfect visit for the be submerged considering growing the total of stay times in the midst of the visit. Flexible Be submerged based Routing Protocol (M-S-R-P) for drawing out the framework life range in assembled Wireless Sensor Networks has been tended to. In M-S-R-P, the be submerged moves to C-Hs having higher essentialness in the assembled framework to accumulate distinguished information. Another propelling L-E-A-C-H gathering estimation with compact be submerged and meet center points was introduced.

An estimation joins use of the L-E-A-C-H computation, flexible be submerged and meet centers to secure the benefits of the L-E-A-C-H count and improve the C-H determination process. In addition, a lessens imperativeness use in WSNs more remote than in routine L-E-A-C-H, particularly a framework is sweeping. Compact be submerged better Energy all around composed P-E-G-A-S-I-S Based coordinating tradition (M-I-E-E-P-B) has been presented. M-I-E-E-P-B displays the be submerged versatility in the MultiChain model and parcels the sensor field into four regions, thusly fulfilling tinier chains and lessening load on the pioneer center points.



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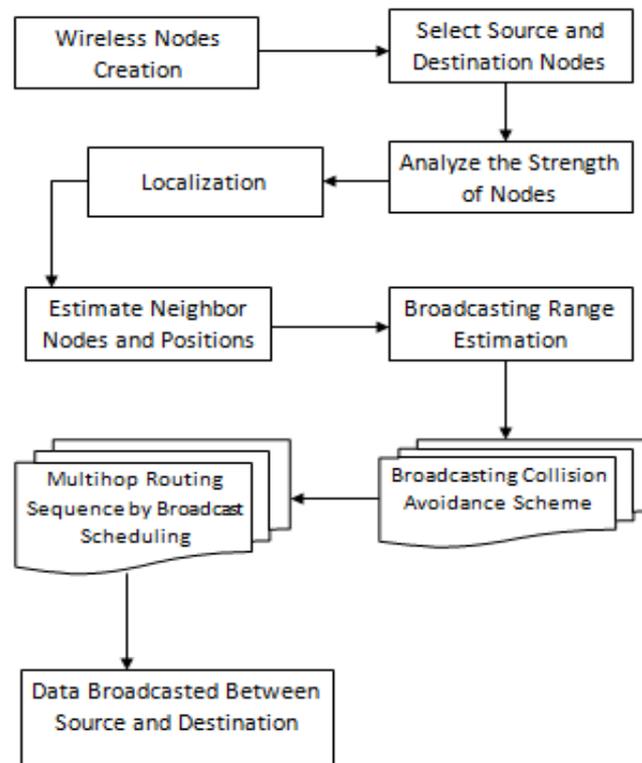


Fig. 1 System Design

The submerged moves along its heading and stay for a period changed zone at each district for guarantee data gathering. The flexible be submerged in the present guiding traditions constantly takes after a particular course and stops at adjusted visit ranges. This makes the receiving wire near the settled visit zone to disperse their essentialness snappier than various centers. We use an oversee adaptable be submerged guided in light of minimize a scattered essentialness of all receiving wire center point. A circumstance, the reception apparatus including the be submerged change after some minute, permitting to all receiving wire in the framework to go about as data exchanges a versatile be submerged and in this way modifying the pile among all center point.

III. RELATED STUDY

Remote sensor masterminds the most part get the territory of a dark center by measuring the partition between the dark center point and its neighboring hooks. To enhance both constraint precision and control accomplishment rates, the makers show another neural framework based center confinement arrangement. The new arrangement is specific since it can make the readied framework show absolutely critical to the topology through web get ready and associated topology-arranged data and along these lines accomplish more gainful utilization of the neural frameworks and more correct between center partition estimation. It is similarly unmistakable in grasping both got signal quality sign and bob numbers to gage the between center point detachments, to improve the partition estimation accuracy and furthermore restriction precision at no additional expense. Test appraisal is directed to evaluate the execution of the proposed arrangement and other fabricated cunning based center point restriction arranges. The results exhibit that, at sensible cost, the new arrangement ceaselessly conveys higher repression accomplishment rates and humbler confinement goofs than various arrangements.



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Remote reception apparatus framework is prepared out of a considerable numeral of unimportant remote radio wire that accumulates information about their enveloping surroundings and transmits them to the end customer. Since these receiving wire don't have rechargeable batteries, growing their lifetime is basic and distinctive methodologies have been proposed to construct the lifetime of the sensor center points in a framework. A vast segment of these procedures rely on upon gathering or coordinating computations. The low essentialness flexible packing chain of significance (LEACH) figuring is a profitable gathering estimation where center points inside a gathering send their data to an area bunch head. A couple of pros recommend an adaptable be submerged (MS) as a way to deal with reduce imperativeness use and a meeting center (RN) to go about as a store point for the MS. The present study proposes a computation that joins the use of the LEACH clustering estimation, MS and meeting centers (RP). Proliferation results show that this methodology is more capable than LEACH similarly as imperativeness use, particularly in gigantic regions .

The flexibility of a be submerged in improved imperativeness gainful P-E-G-A-S-I-S-based tradition (I-E-E-P-B) move the framework life range of Wireless Sensor Networks. A Multi-HeadChain, MultiChain thought and be submerged versatility impacts for the most part enhancing the framework life range of remote receiving wire. Thusly, here recommend mobile dive upgraded essentialness compelling P-E-G-A-S-I-S base directing tradition (M-I-E-E-P-B)-MultiChain model have been submerged conveyability, finish fit imperativeness use of remote reception apparatus. As the automated improvement of compact be submerged guided gas or contemporary, need to keep advancement to limits the course of adaptable be submerged should settled.

A technique, the versatile be submerged moves the length of its heading and stay a visit minute at stay zone to guarantee entire data gathering. We develop a count for bearing of flexible be submerged. We finally perform broad investigations to review the execution of the proposed system. The results reveal that the proposed way out is verging on perfect moreover better than anything IEEPB to the extent framework lifetime.

Flexible be submerged conveys new challenges to thickly sent and considerable remote sensor frameworks (WSNs). Right when the be submerged moves, nonstop zone redesigns from the be submerged can deliver pointless power use of receiving wire. we propose I-A-R, a scholarly Agent-based course discovering tradition it gives gainful data movement to versatile be submerged . Proposed figuring reduces signal overhead and improve degraded course called triangular controlling issue. We have evaluated IAR execution through both exploratory examination and entertainment tests. The results exhibit that our arrangement feasibly supports be submerged adaptability with low overhead and the change of triangular controlling issue.

Study the impact of heterogeneity of center points, similarly as their imperativeness, in remote sensor organizes that are dynamically assembled. In these frameworks a segment of the centers get the chance to be cluster heads, add up to the data of their gathering people and show it to the be submerged . We acknowledge a rate and number of tenants in reception apparatus centers are outfitted by method for additional imperativeness resources wellspring of hetero hereditary may come to fruition on account of the fundamental setting the technique framework develops. Then furthermore acknowledge that receiving wire are self-assertively (reliably) scattered and are not flexible, the bearings of the be submerged and the estimations of the radio wire field . Customary gathering traditions acknowledge that each one of the center points are equipped with the same measure of essentialness and subsequently, they can't misuse the closeness of center point heterogeneity. We propose An Amend LEACH, a heterogeneous careful tradition to drag out the time middle of the road end primary center (we incorporates a consistent quality phase), a fundamental for some application the contribution from the reception apparatus framework need to tried and true. A-LEACH relies on upon weighted race probabilities of each center to wind up group head as showed by the remaining essentialness in each center.

The past couple of years have seen extended energy for the potential use of remote sensor frameworks (WSNs) in applications such as disaster organization, fight field perception, edge certification and security observation. Receiving wire in these applications are expected to be remotely sent in extensive numbers and to work autonomously in unattended circumstances. To support flexibility, center points are often accumulated into disjoint and for the most part non-covering packs. In this paper, we show an experimental arrangement and general classification of conveyed clustering arranges.



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We contemplate different gathering counts for WSNs; highlighting their objectives, highlights, many-sided nature, etc. We also think about these batching figurings considering estimations, for instance, combining rate, bunch quality, bunch covering, range care and sponsorship for center adaptability.

Late advances in remote sensor frameworks have incited various new traditions especially proposed for sensor frameworks where essentialness care is a basic thought. A vast bit of the thought, in any case, has been given to the coordinating traditions since they may differ dependent upon the application and framework outline. This paper concentrates late coordinating traditions for sensor frameworks and presents a request for the diverse systems looked for after. The three guideline arrangements examined in this paper are data driven, different leveled and zone based. Every controlling tradition is delineated and inspected under the best possible class. Moreover, traditions using contemporary frameworks, for instance, framework stream and nature of organization showing are in like manner discussed. The paper completes up with open investigation issues.

A remote sensor framework is a multihop remote framework containing spatially dispersed self-representing radio wire with recognizing, figuring, and remote correspondence capacities. Generally, every sensor has the errand to screen and measure including conditions and scatter the assembled data toward a base station, or be submerged, for data post-examination and get ready. Various data dispersal traditions have been proposed to allow the spread of the accumulated data toward a static be submerged. Starting late, compact be submerged s were seemed, by all accounts, to be more essentialness convincing than static ones. In this article, existing data spread traditions supporting adaptable be submerged s are shortened. Moreover, be submerged flexibility is inspected, furthermore its impact on essentialness use and the framework lifetime.

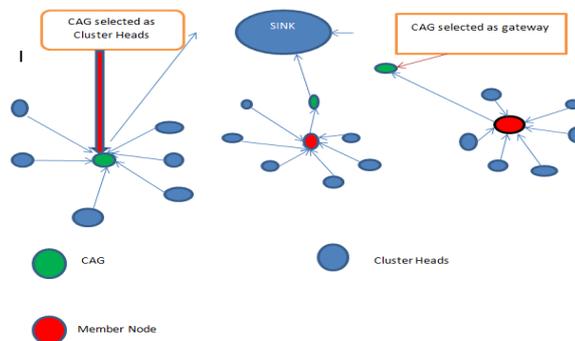


Fig. 3 A-LEACH Protocol

IV. LEACH PROTOCOL

Low-vitality versatile grouping chain of importance (LEACH) stays a T-D-M-A based M-A-C agreement coordinated by bunching besides a basic leading contract in remote device schemes (W-S-N's). Altogether cores remain not bunch crowns objective say pert hose gang head in-a T-D-M-A design, for example per the schedule completed via set pate. They do as such utilizing the base vitality expected to achieve the bunch head, and just need to keep their radios on amid their time slot LEACH equally operates CDMA so that each collection uses an alternate preparation of C-D-M-A programs, to lessen block amongst bunches.

Filter is the primary system convention that utilizations progressive directing for remote sensor systems to build the life time of system. Every one of the hubs in system type available them-selves made proximate gangs, with single middle accepted nearby way of the cluster head. All non bunch skull centers convey the re-statistics to the set crown, while the collection head hub get statistics since all the gang individuals, perform signal handling capacities on the information

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(e.g., information conglomeration), and transmit information to the remote base station. Hence, being a group head hub is significantly more vitality serious than being a non-cluster-head hub. Along these lines, when a group head hub bites the dust every one of the hubs that have a place with the bunch lose correspondence capacity.

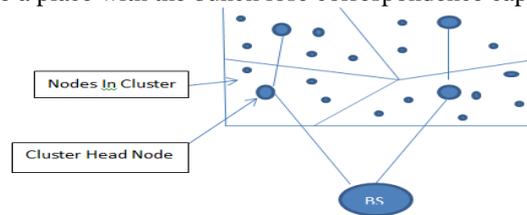


Fig. 2 LEACH Protocol Design

Filter fuses randomized turn of the high vitality team skull location it axes between the antenna to abstain from depleting the sequence of any one device in the network. Along these lines, the vitality load connected with being a bunch head is equally appropriated among the hubs. Since the group head hub knows all the bunch individuals, it can make a TDMA plan that advises every hub precisely when to transmit its information. What's more, utilizing a TDMA plan for information exchange counteracts intra-bunch crashes. The operation of LEACH is partitioned into rounds. Each stout jumps by a setup phase once the sets are arranged out follow a enduring state point wherever a few casings of information are exchanged from the hubs to the bunch head and onto the base station.

V. ADVANCED LEACH PROTOCOL (A-LEACH)

The A-Leach Protocol enhances the steady locale of the grouping progressive system and reduction likelihood of disappointment hubs utilizing the trademark limitations heterogeneity. Overpowering in (A-LEACH) mechanism trendy circles then both stout stays partitioned into two stages, the Setup stage and the Steady State; every sensor knows when each round begins utilizing a coordinated timepiece. Give us a chance to expect the situation where a rate of the number of inhabitants in sensor hubs is furnished with more vitality assets than whatever remains of the hubs. Give m a chance to be the division of the aggregate number of hubs n. We allude to these intense hubs as CAG (hubs chose as group heads or passages), and the rest $(1-m) \times n$ as typical hubs.

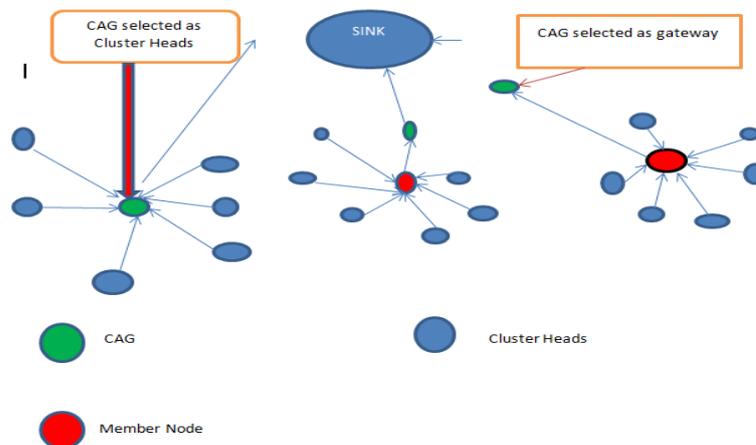


Fig. 3 A-LEACH Protocol



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VI. EXPERIMENTAL RESULTS

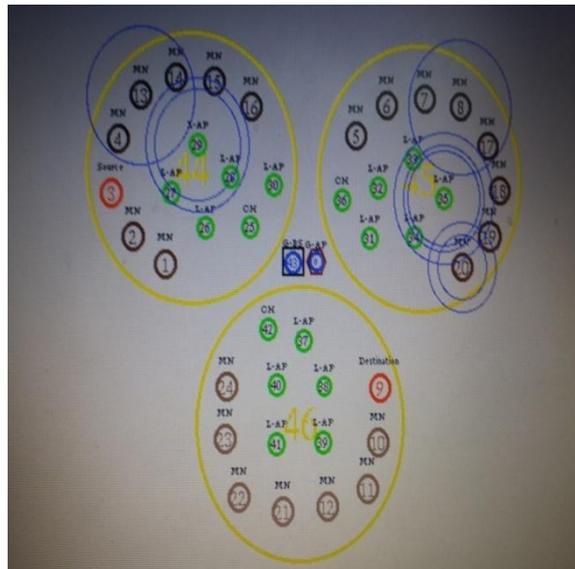


Fig. 4 Network Creation

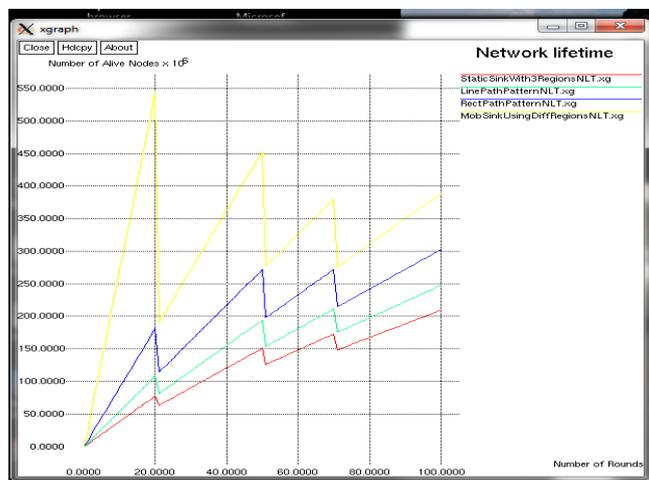


Fig. 5 Network Lifetime



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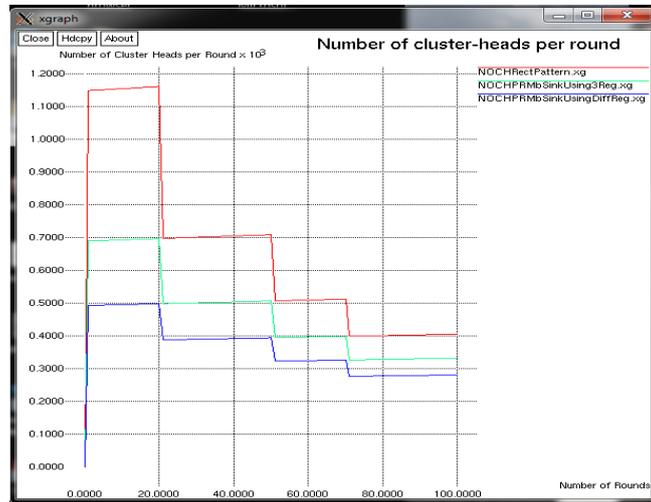


Fig. 6 Number of Cluster Heads per Round

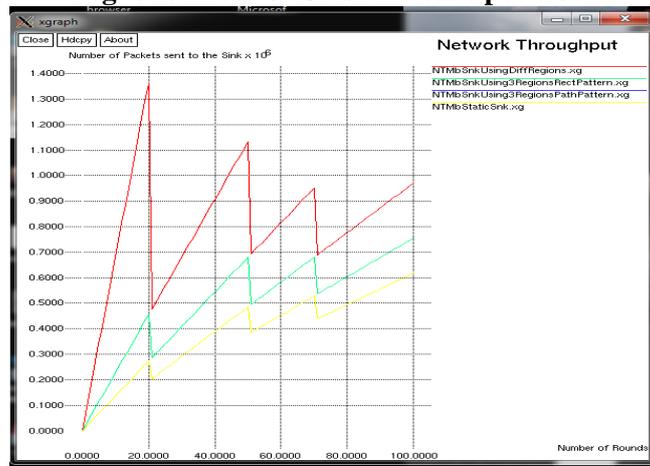


Fig. 7 Network Throughput

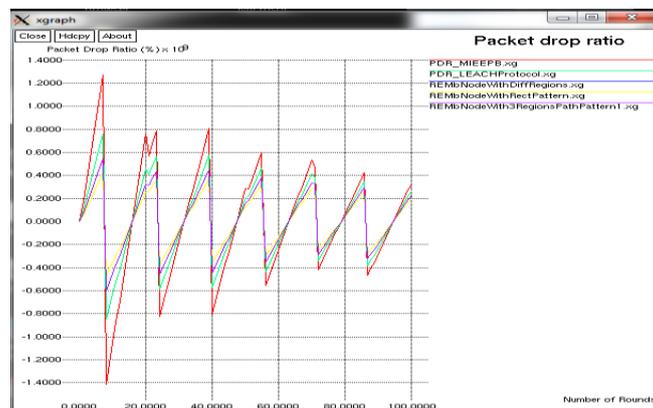


Fig. 8 Packet Dropping Proportion



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VII. CONCLUSION

In this framework, another grouping convention called Mobile Sink based versatile Immune Energy-Efficient bunching Protocol (MSIEEP) has been introduced to dispense with the vitality gap issue and further enhances the lifetime and the dependability time of WSNs. In addition, this convention uses the versatile invulnerable calculation to discover the visit areas of the portable sink furthermore the ideal number of group heads and their areas taking into account minimizing the disseminated vitality in correspondence and overhead control parcels of all sensor hubs in the sensor field. Reenactment results demonstrated that the proposed convention is more solid and vitality productive when contrasted with different conventions; to be specific LEACH, LEACH-GA, A-LEACH, meeting and MIEEPB conventions. Besides, it outflanks the past conventions as far as the lifetime, the steadiness time frame, the bundle drop proportion and the parcel delay. Notwithstanding dispose of the vitality gaps, the control portable sink that guided in view of minimizing the dispersed vitality expands the power and the capacity of the proposed convention to convey bundles to the destination.

REFERENCES

- [1] S. K. Singh, M. P. Singh and D. K. Singh, "Routing protocols in wireless sensor networks—a survey," *Int. J. of Computer Science and Engineering Survey*, vol. 1, no. 2, pp. 63-83, Nov. 2010.
- [2] E. B. Hamida and G. Chelius, "Strategies for data dissemination to mobile sinks in wireless sensor networks," *IEEE Trans. Wireless Communications*, vol. 15, no. 6, pp. 31-37, February 2008.
- [3] A. A. Abbasi and M. Younis, "A survey on clustering algorithms for wireless sensor networks," *Int. J. of Computer Communications*, vol. 30, no. 14, pp. 2826–2841, Oct. 2007.
- [4] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan, "An application-specific protocol architecture for wireless microsensor networks," *IEEE Tran. Wireless Comm.*, vol. 1, no. 4, pp. 660-670, 2002.
- [5] J. L. Liu and C. V. Ravishankar, "LEACH-GA: Genetic algorithm-based energy-efficient adaptive clustering protocol for WSNs," *Int. J. of Machine Learning and Computing*, vol. 1, no. 1, pp. 79-85, Apr. 2011.
- [6] K. G. Vijayvargiya and V. Shrivastava, "An Amend implementation on leach protocol based on energy hierarchy," *Int. J. of Current Engineering and Technology*, vol. 2, no. 4, pp. 427-431, Dec. 2012.
- [7] S. Basagni, A. Carosi, E. Melachrinoudis, C. Petrioli and Z. M. Wang, "Controlled Sink Mobility for Prolonging Wireless Sensor Networks Lifetime," *J. Wireless Network*, vol. 14, no. 6, pp. 831-858, Dec. 2008.
- [8] J. Kim, J. In, K. Hur, J. W. Kim and D. S. Eom, "An intelligent agentbased routing structure for mobile sinks in WSNs," *IEEE Trans. Consumer Electronics*, vol. 56, no. 4, pp. 2310-2316, Nov. 2010.
- [9] W. F. Liang, J. Luo and X. Xu, "Prolong network lifetime via a controlled mobile sink in wireless sensor networks," in *Proc. IEEE GLOBECOM*, Florida, USA, 2010, pp. 1-6.
- [10] B. Nazir and H. Hasbullah, "Mobile sink based routing protocol (MSRP) for prolonging network lifetime in clustered wireless sensor network," in *Proc. ICCAIE*, Kuala Lumpur, Malaysia, 2010, pp. 624-629.
- [11] S. Mottaghi and M. R. Zahabi, "Optimizing LEACH clustering algorithm with mobile sink and rendezvous nodes," *AEU – Int. J. of Electronics and Communications*, vol. 69, no. 2, pp. 507-514, Feb. 2014.
- [12] M. R. Jafri, N. Javaid, A. Javaid and Z. A. Khan, "Maximizing the lifetime of multi-chain PEGASIS using sink mobility," *World Applied Sciences Journal*, vol. 21, no. 9, pp. 1283-1289, March 2013.
- [13] M. Abo-Zahhad, S. M. Ahmed, N. Sabor and A. F. Al-Ajlouni, "Design of two-dimensional recursive digital filters with specified magnitude and group delay characteristics using taguchi-based immune algorithm," *Int. J. of Signal and Imaging Systems Eng.*, vol. 3, no. 3, pp. 222-235, 2010.
- [14] I. Chatzigiannakis, A. Kinalis and S. Nikolettseas, "Efficient data propagation strategies in wireless sensor networks using a single mobile sink," *Computer Communications*, vol. 31, no. 5, pp. 896–914, 2008.
- [15] P. Chuang, and Y. Jiang, "Effective neural network-based node localization scheme for wireless sensor networks," *IET Wireless Sensor Systems*, vol. 4, no. 2, pp. 97–103, June 2014.
- [16] T. Rappaport, "Wireless Communications: Principles & Practice," 2nd ed., Englewood Cliffs, NJ: Prentice-Hall, 2002.
- [17] X. Lu, Y. Ding and K. Hao, "Immune clonal selection algorithm for target coverage of wireless sensor networks," *Int. J. Modelling, Identification and Control*, vol. 12, no. 1, pp. 119-124, January 2011.
- [18] M. Abo-Zahhad, S. M. Ahmed, N. Sabor and A. F. Al-Ajlouni, "A new method for fastening the convergence of immune algorithms using an adaptive mutation approach," *J. of Signal and Information Processing*, vol. 3, no. 1, pp. 86-91, Feb. 2012.
- [19] K. Shinghal, A. Noor, N. Srivastava, and R. Singh, "Power measurements of Wireless Sensor Network node," *Int. J. Comput. Eng. Sci. (IJCES)*, vol. 1, no. 1, pp. 8–13, 2011.
- [20] S. K. Gupta, N. Jain and P. Sinha, "Energy-efficient clustering protocol for minimizing cluster size and inter cluster communication in heterogeneous WSN," *Int. J. of Advanced Research in Computer and Communication Engineering*, vol. 2, no. 8, pp. 3295-3305, Aug. 2013.
- [21] Q. Zhou, X. Cao, Sh. Chen, and G. Lin, "A solution to error and loss in wireless network transfer," in *Proc. WNIS*, Shanghai, 2009, pp. 312-315.
- [22] A. Ahmad, N. Javaid, Z. A. Khan, U. Qasim and T. A. Alghamdi, "(ACH)2: Routing scheme to maximize lifetime and throughput of WSNs," *IEEE Sensors Journal*, vol. 14, no. 10, pp. 3516 – 3532, October 2014.
- [23] M. M. Sandhu, M. Akbar, M. Behzad and N. Javaid, "Mobility Model for WBANs" in *Proc. BWCCA*, Guangzhou, China, 2014, pp. 155-160.