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EVENT MONITORING USING MOBILE WIRELESS SENSOR NETWORK: DETERMINATION OF OPTIMAL GROUP HEAD AND DEPLOYMENT OF SENSORS

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INTRODUCTION

During a recent few decades, wireless mobile sensor networks (WMSN) has been studied widely. WSNs have applications in various fields, such as environmental and real-world habitat monitoring, machine surveillance, precision farming, indoor control, intelligent alarms, and military applications [9] [10]. Basically, WMSN is composed of a large number of sensors. A sensor is able to move after an initial deployment and has limited resources such as low battery, low computation, etc. Due to their ubiquitous and flexible nature, wireless sensor networks (WSNs) have been intensively investigated recently for event monitoring applications [11] [12] [13]. In such applications, numerous sensor nodes are deployed in the space, and operate collaboratively to monitor, report, and react to various physical events. When an event of interest occurs, it is detected by sensor nodes. Reports are then generated and forwarded to a sink via multi-hop communication [14] [15]. According to the received reports, the sink may detect the event and perform appropriate actions, e.g., inform the forest administration in case of a fire.

Thus for WSN systems, it is crucial to have the reports delivered to the sink in a timely manner. Therefore, one of the most important performance metrics for event monitoring WSNs is the event detection delay [16]. Currently, the typical event detection method relies on decisions made at the sensor node(s) based on predefined data thresholds for normal environments [17]. The rationale behind such threshold based approaches is that when events occur, there will be detectable changes in environmental data. Thus, an event can be captured once the observed sensory data exceed the predefined thresholds.

Among several challenges, coverage is one of the most important research topics in WMSN [18] [19] because it provides detection of events in a region of interest. It is highly desirable to consider barriers that are able to detect any moving objects among multiple hubs in an event-driven environment [20] [21] [22] [23]. Whenever a new event occurs (i.e. new hubs are added into the network) the appropriate barriers with the support of the new event should be constructed to guarantee detection of any movement between the updated hubs [25] [26] [27] [28]. So, in the event-driven environment, the following issues can be addressed: (i) A set of multiple hubs can be updated frequently. (ii) The formation of barriers can be changed whenever a new event occurs. It follows that it is also highly appropriate to consider a barrier-coverage which is able to detect any moving objects among multiple sides or hubs simultaneously in the event-driven environment [29].

RELATED WORKS

In 2020, Zygowski and Arunita [1] have presented 3 Mixed Integer Linear Programming (MILP) configurations for optimal guiding of a mobile node. The objective was to transmit the mobile node such that the needed coverage level should be attained within a particular period. The initial configuration increased the coverage area, whereas the 2nd and 3rd minimized the needed time. Further, the betterment of the adopted model was computed via simulations by means of different movement abilities, network sizes and node sensing. The experimentations have revealed that the presented method significantly enhanced the realistic time frame over the compared schemes.

In 2017, Kim *et al.* [2] have designed a novel framework of "barrier, event-driven partial barrier" that monitored the object's movement in the event-driven surroundings. Subsequently, two diverse problems were defined properly. Initial one concerned on minimizing the sensor count that generated whole event-driven biased barrier. The second one concerned on minimizing the entire moving distance of sensors. Furthermore, the outcomes demonstrated that the designed model has minimized the total distance and it also recovered the faulty barriers, thus minimizing the complexity of the network.

In 2017, Lu *et al.* [3] have developed a technique for environmental monitoring using "event-triggered finite-time control scheme for mobile sensor networks (MSN)". The developed method was independently performed by every sensor nodes and it included 2 phases: initial phase deployed "finite-time consensus algorithm", whereas the subsequent one was an "event-triggered rule". The "consensus algorithm" was deployed for enabling the velocities and positions of sensor nodes that rapidly tracked the velocity and position of an effective leader in limited period. The "event-triggered rule" was exploited for reducing the update frequency of controllers for saving the resources of sensor nodes.

In 2017, Suescun and Cardei [4] have considered WSN that was exploited for environment monitoring. Moreover, a mobile sink was considered that performed as the gateway among the WSN and Internet. Here, numerous distributed approaches were proposed for combined event detection. When data was gathered by sink, it was distributed by means of the IoT. Further, the performance of the developed technique was analyzed in terms of average remaining energy, proportion of compound events practiced effectively, and the count of hops to arrive at sink.

In 2019, Le *et al.* [5] have focused on WSN with dynamic sinks that contained several sinks, whose positions get changed at regular intervals. In addition, the positioning of minimum counts of nodes for target coverage was considered in this work. In particular, two problems were formulated here. The initial one termed as target coverage (TCOV) issue concerned on placing sensor nodes for enclosing the entire targets. The subsequent one termed as network connectivity (NCON) issue concerned on positioning relay nodes that connected sensor nodes with sinks. In the end, the experimental results had shown the supremacy of the established model in terms of time complexity and necessary nodes.

In 2018, Sun *et al.* [6] have established a novel shortest path connectivity and coverage algorithm (SPCCA) for WSN that reduced the energy utilization and extended the life span of network. The major process of SPCCA was: Initially, every node determined if it was the redundancy node. Subsequently, the sleepless nodes enter into the active mode and the redundancy nodes entered into the ready-to-sleep mode via the node assortment technique. Thus, the energy balance was assured and the blind spot was avoided. The attained outcomes illustrated the superiority of the established scheme in terms of network life span, NCON, cost and TCOV.

In 2018, Qadori *et al.* [7] have explored a clone mobile-agent itinerary planning (CMIP) approach for reducing task length when enhancing the throughput of event-to-sink in realistic appliances, particularly while the mobile agent (MA) was allocated for visiting a huge count of source nodes. In the end, simulations were done in greatest memory-based MIP (GIGM-MIP) and the established model has revealed better outcomes when compared over the traditional model in terms of throughput, minimal task length.

In 2020, Hajjej *et al.* [8] have presented a novel game theory scheme that depends on reinforcement learning for recovering "Coverage Holes" in a shared manner. In the presented work, the mutual action of sensing range modification and node reposition was selected by every sensor node for reducing the gaps in TCOV. At the end, the simulated outcomes demonstrated the betterment of presented scheme in terms of overall coverage in the existence of arbitrary damage occasions, when compared over the existing schemes.

PROBLEM DEFINITION

Table 1 demonstrate the reviews on event monitoring using mobile wireless sensor network. Initially, MILP was presented in [1] that offers improved area coverage along with optimal paths. Nevertheless, runtime efficiency has to be focused more. Greedy algorithm was developed in [2] that reduces count of sensors with minimal movement distance, but it have to consider more on unmanned aerial vehicles (UAV) factors. In addition, Finite-time consensus algorithm was used in [3], which provides minimal error and it is highly stable; nevertheless, it needs deliberation on fixed communication topology. Also, Grid Flooding algorithm was employed in [4] that provide minimal energy consumption with shorter paths. However, it requires consideration on cost. Likewise, Euclidean Steiner tree Model was presented in [5] that Solves the NCON issues and it concerns on the minimal count of nodes. However, it needs consideration on optimal placement of nodes. In addition, SPCCA was deployed in [6] that avoid blind spots with assured energy balance. Nevertheless, new forms of WSN can be explored more. CMIP model was deployed in [7] that provide minimal task length and high throughput, however, energy utilization has to be concentrated more. Game theory was presented in [8] that offer reduced utilization of energy with higher coverage; but, deep Q-learning can be exploited for more optimal outcomes. There, these limitations have to be considered for improving the event monitoring using mobile wireless sensor network effectively in the current research work.

Table 1: Features and challenges of event monitoring using mobile wireless sensor network

Author [citation]	**Adopted methodology**	**Features**	**Challenges**
Zygowski and Arunita [1]	MILP	❖ Improved area coverage ❖ Optimal paths	❖ Runtime efficiency has to be focused more.
Kim *et al.* [2]	Greedy algorithm	❖ Reduced count of sensors ❖ Minimal movement distance	❖ Have to consider more on unmanned aerial vehicles (UAV) factors
Lu *et al.* [3]	Finite-time consensus algorithm	❖ Highly stable ❖ Minimal error	❖ No consideration on fixed communication topology.
Suescun and Cardei [4]	Grid Flooding algorithm	❖ Minimal energy consumption ❖ Shorter paths	❖ High cost.
Le *et al.* [5]	Euclidean Steiner tree Model	❖ Solves the NCON issues ❖ Minimal count of nodes	❖ Need consideration on optimal placement of nodes.

Sun *et al.* [6]	SPCCA	❖ Avoids blind spots ❖ Assured energy balance	❖ New forms of WSN can be explored.
Qadori *et al.* [7]	CMIP model	❖ Minimal task length ❖ High throughput	❖ Need more concern on energy utilization.
Hajjej *et al.* [8]	Game theory	❖ Optimal coverage ❖ Reduced utilization of energy	❖ Deep Q-learning can be exploited for more optimal outcomes.

RESEARCH METHODOLOGY

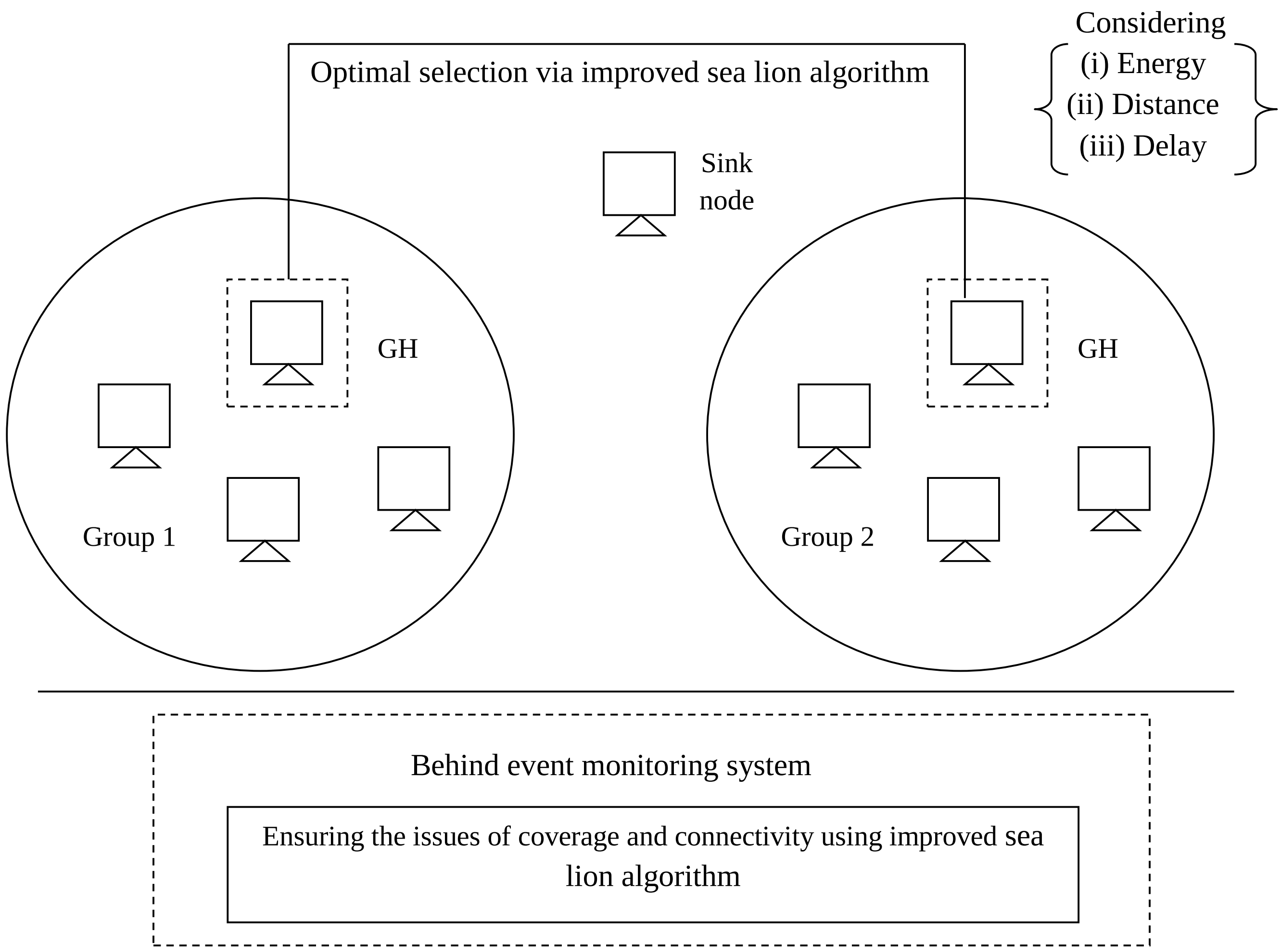

Figure 1: Working Principle of Proposed event monitoring model using mobile wireless sensor network

One of the primary applications of the Wireless Sensor Networks (WSNs) is monitoring the behaviour of complex events or objects. Event Monitoring entails both recording the state of a system and detecting sudden changes in it, and giving an alarm if such changes occur. This application requires energy efficiency in order to provide long-lasting event monitoring capability. Therefore, this proposal intends to introduce energy efficient algorithm for event monitoring using mobile wireless sensor networks. This technique collects the needed data from the mobile sensors using a mobile sink. The mobile sink is responsible to process the collected data to detect and monitor the environment events. Before this process, the mobile sensors group themselves and each group selects a group head (GH). Therefore, the communication will take place only via GH. However, the selection of appropriate GH is critical issue and hence this proposal intends to introduce a new **improved optimization algorithm (Improved sea lion algorithm) for selecting the optimal GH** with respect to **delay, distance and energy** respectively. In fact, this optimal selection paves the way for optimal path to the mobile sink, thereby ensures the accuracy and speed of environmental event detection or monitoring. Behind this work, there is a need of WSN designees with the identification or determination of sensor nodes to be moved and the position to which they have to be deployed to establish the target coverage and network connectivity. This is known as mobile sensor deployment (MSD). Here, the major issues include target coverage and network connectivity. The solutions provided for MSD problems are deploying the mobile sensor nodes with minimum cost to cover the specified target and to **enable connectivity among sink and coverage sensors by neighbouring rest nodes that offers energy saving solutions.** This proposal makes its emerging contributions in these issues by utilizing the proposed algorithm (Improved sea lion algorithm) for exploiting the maximum coverage area of target and also to relocate the rest of mobile sensor nodes to maintain connectivity with the sink. In fact, "SLnO algorithm [24] is a new nature inspired Metaheuristic optimization algorithm and it imitates the hunting behaviour of sea lions in nature. The overall architecture of the proposed scheme is demonstrated by Fig. 1.

EXPECTED OUTCOME

The proposed event monitoring using mobile wireless sensor network will be simulated in **MATLAB**, and the experimental investigation will be carried out. The performance analysis will be done by comparing the proposed model over several state-of-the-art models with respect to data loss rate, cost, and security analysis as well.

REFERENCES

[1] Christopher Zygowski, Arunita Jaekel, "Optimal path planning strategies for monitoring coverage holes in Wireless Sensor Networks", Ad Hoc Networks, vol. 96, January 2020, Article 101990.

[2] Hyunbum Kim, Heekuck Oh, Paolo Bellavista, Jalel Ben-Othman, "Constructing event-driven partial barriers with resilience in wireless mobile sensor networks", Journal of Network and Computer Applications, vol. 82, pp. 77-92, 15 March 2017.

[3] Q. Lu, Q. Han, B. Zhang, D. Liu and S. Liu, "Cooperative Control of Mobile Sensor Networks for Environmental Monitoring: An Event-Triggered Finite-Time Control Scheme," IEEE Transactions on Cybernetics, vol. 47, no. 12, pp. 4134-4147, Dec. 2017.

[4] C. Aranzazu-Suescun and M. Cardei, "Distributed algorithms for event reporting in mobile-sink WSNs for Internet of Things," Tsinghua Science and Technology, vol. 22, no. 4, pp. 413-426, Aug. 2017.

[5] Phi Le Nguyen, Nguyen Thi Hanh, Nguyen Tien Khuong, Huynh Thi Thanh Binh, Yusheng Ji, "Node placement for connected target coverage in wireless sensor networks with dynamic sinks", Pervasive and Mobile Computing, vol.59, October 2019, Article 101070.

[6] Geng Sun, Yanheng Liu, Han Li, Aimin Wang, Ying Zhang, "A novel connectivity and coverage algorithm based on shortest path for wireless sensor networks", Computers & Electrical Engineering, vol.71, pp.1025-1039, October 2018.
[7] H. Q. Qadori, Z. A. Zukarnain, M. A. Alrshah, Z. M. Hanapi and S. Subramaniam, "CMIP: Clone Mobile-Agent Itinerary Planning Approach for Enhancing Event-to-Sink Throughput in Wireless Sensor Networks," IEEE Access, vol. 6, pp. 71464-71473, 2018.
[8] Faten Hajjej, Monia Hamdi, Ridha Ejbali, Mourad Zaied, "A distributed coverage hole recovery approach based on reinforcement learning for Wireless Sensor Networks", Ad Hoc Networks, vol.101, 15 April 2020, Article 102082.
[9] Amany Abu Safia, Zaher Al Aghbari, Ibrahim Kamel, "Distributed Environmental Event Monitoring using Mobile Wireless Sensor Network", Procedia Computer Science, vol. 155, pp. 335-342, 2019.
[10] Xiu Zhang, Xiaohui Lu, Xin Zhang, "Mobile wireless sensor network lifetime maximization by using evolutionary computing methods", Ad Hoc Networks, vol. 10115 April 2020, Article 102094.
[11] Wei Zhou, Ping Li, QinJu Wang, Narjes Nabipour, "Research on data transmission of wireless sensor networks based on symmetric key algorithm", Measurement, vol. 1531 March 2020, Article 107454.
[12] Deebak B.D., Fadi Al-Turjman, "A hybrid secure routing and monitoring mechanism in IoT-based wireless sensor networks", Ad Hoc Networks, vol. 97 February 2020, Article 102022.
[13] Pingzhang Gou, Gang Mao, Fen Zhang, Xiangdong Jia, "Reconstruction of coverage hole model and cooperative repair optimization algorithm in heterogeneous wireless sensor networks", Computer Communications, vol. 153, pp. 614-625, 1 March 2020.
[14] Wei Fang, Xinhong Song, Xiaojun Wu, Jun Sun, Mengqi Hu, "Novel efficient deployment schemes for sensor coverage in mobile wireless sensor networks", Information Fusion, vol. 41, pp. 25-36, May 2018.
[15] Sharma Vikrant, Patel R.B., Bhadauria H.S., Prasad D, "Glider assisted schemes to deploy sensor nodes in Wireless Sensor Networks", Robotics and Autonomous Systems, vol. 100, pp. 1-13, February 2018.
[16] Maher Rebai, Matthieu Le berre, Hichem Snoussi, Faicel Hnaien, Lyes Khoukhi, "Sensor deployment optimization methods to achieve both coverage and connectivity in wireless sensor networks", Computers & Operations Research, vol. 59, pp. 11-21, July 2015.
[17] Hoang Thi Huyen Trang, Le The Dung, Seong Oun Hwang, "Connectivity analysis of underground sensors in wireless underground sensor networks", Ad Hoc Networks, vol. 71, pp. 104-116, 15 March 2018.
[18] Feng Li, Jun Luo, Shiqing Xin, Ying He, "Autonomous deployment of wireless sensor networks for optimal coverage with directional sensing model", Computer Networks, vol. 108, pp. 120-132, 24 October 2016.
[19] Abdelkader Khelil, Rachid Beghdad, "ESA: An Efficient Self-deployment Algorithm for Coverage in Wireless Sensor Networks", Procedia Computer Science, vol. 98, pp. 40-47, 2016.
[20] Geng Sun, Yanheng Liu, Han Li, Aimin Wang, Ying Zhang, "A novel connectivity and coverage algorithm based on shortest path for wireless sensor networks", Computers & Electrical Engineering, 31 October 2017.
[21] F. Wang, D. Wang and J. Liu, "Traffic-Aware Relay Node Deployment: Maximizing Lifetime for Data Collection Wireless Sensor Networks," in IEEE Transactions on Parallel and Distributed Systems, vol. 22, no. 8, pp. 1415-1423, Aug. 2011.
[22] M. Rebai, H. Snoussi, L. Khoukhi and F. Hnaien, "Linear models for the total coverage problem in wireless sensor networks," 2013 5th International Conference on Modeling, Simulation and Applied Optimization (ICMSAO), Hammamet, pp. 1-4, 2013.
[23] R.Cerulli, R.De Donato, and A.Raiconi," Exact and heuristic methods to maximize network lifetime in wireless sensor networks with adjustable sensing ranges", European Journal of Operational Research, vol. 220, no. 1, pp. 58-66, July 2012.
[24] Masadeh, Raja & Mahafzah, Basel & Sharieh, Ahmad. "Sea Lion Optimization Algorithm", International Journal of Advanced Computer Science and Applications, vol. 10, pp. 388-395, 2019.
[25] B. R. Rajakumar, "Impact of Static and Adaptive Mutation Techniques on Genetic Algorithm", International Journal of Hybrid Intelligent Systems, Vol. 10, No. 1, pages: 11-22, 2013, DOI: 10.3233/HIS-120161.
[26] B. R. Rajakumar, "Static and Adaptive Mutation Techniques for Genetic algorithm: A Systematic Comparative Analysis", International Journal of Computational Science and Engineering, Vol. 8, No. 2, pages: 180-193, 2013, DOI: 10.1504/IJCSE.2013.053087.
[27] S. M. Swamy, B. R. Rajakumar and I. R. Valarmathi, "Design of Hybrid Wind and Photovoltaic Power System using Opposition-based Genetic Algorithm with Cauchy Mutation", IET Chennai Fourth International Conference on Sustainable Energy and Intelligent Systems (SEISCON 2013), Chennai, India, Dec. 2013, DOI: 10.1049/ic.2013.0361.

[28] Aloysius George and B. R. Rajakumar, "APOGA: An Adaptive Population Pool Size based Genetic Algorithm", AASRI Procedia - 2013 AASRI Conference on Intelligent Systems and Control (ISC 2013), vol. 4, pages: 288-296, 2013, DOI: https://doi.org/10.1016/j.aasri.2013.10.043.

[29] B. R. Rajakumar and Aloysius George, "A New Adaptive Mutation Technique for Genetic Algorithm", In proceedings of IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), pages: 1-7, December 18-20, Coimbatore, India, 2012, DOI: 10.1109/ICCIC.2012.6510293.