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An Elaborative Study on Wireless Sensor Network (WSNs) Domains: What the literature says?

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Abstract
Wireless Sensor Network (WSNs) constitutes a very lively research field. The prospects of WSN applications are highly promising to revolutionize our everyday lives. Several applications comprise landslide detection, glacial monitoring, wildlife tracking, healthcare, military applications, environmental monitoring, and a considerable quantity of applications to robotics, the internet of things. The various Research areas stated in the paper are localization, topology control, dependability, self-calibration, self-healing, data aggregation, group management, clock synchronization, query processing, sensor processing, and fusion under limited capacities, and testing and debugging. The reflected Research key areas are underlined in the form of challenges and that focus on the further and future Research guidelines of the researcher endeavoring research in WSNs and its allied domain.

Keywords: Wireless Sensor Network (WSNs), localization, topology control, dependability, self-calibration, self-healing, data aggregation, group management, clock synchronization, query processing and sensor processing.

INTRODUCTION

A WSNs, by and large, consists of a massive quantity of low-priced, controlled energy, and multifunctional sensor nodes that communicate over small distance via wireless set. These nodes by and large work collectively to carry out numerous tasks that involve tracking, monitoring and controlling prospective applications. Recent expansion in WSNs is also thought on several Quality of Service (QoS) considerations: energy, scalability, reliability, accuracy, adaptability, fault tolerance, and security. Routing in WSN is calculated as one of the most noteworthy challenges that extraordinarily affect these parameters. This is because relatively few network constraints may be present; these confine limits from the nature of the purpose, network architecture, and route establishment.[1] The WSNs development consists of sensor nodes (SNs) and a sink node, usually called a base station (BS). Sensor nodes are located in the sensing field, and Base Station is frequently positioned further away to collect and examine the sensing data. Usually, sensor nodes possibly will send data to Base Station directly or indirectly via other intermediate SN(s). Since SNs usually function utilizing controlled energy sources such as batteries, it is undesirable to substitute or recharge SNs due to high preservation cost. The case, Relay Stations (RSs), serves up a vital role to collect and advance data from SNs to BS such that the energy-restricted SNs can function for a chosen segment of the network existence. This allows subjective operation in distant terrains or disaster relief operations. [2]

LITERATURE REVIEW

Dr.Shu Yinbiao et.al. It has been prepared by the Wireless Sensor Networks project team, in the IEC Market Strategy Board. The papers discuss the history & Industrial drivers of WSN, WSN Technology, challenges of WSN, various applications in the Infrastructure Systems, Standards of WSNs and systems Standardization needs and outlook, Challenges and future standardization needs. The author has concluded with recommendations Research on system architecture and

integration technology suitable for ultra-large sensing and dynamic changes and develop a common model to ensure security. [3]

S.Randhawa et.al The Author in the paper reviews the major development and new research challenges in the wireless Sensor Network (WSN) area. It is found that a WSN has important applications such as remote environmental monitoring and target tracking. The Research areas stated in the paper are localization, topology control, dependability, self-calibration, self-healing, data aggregation, group management, clock synchronization, query processing, sensor processing and fusion under limited capacities, and testing and debugging. The author has concluded that the design of a WSN depends significantly on the application, and it considers factors such as the environment, the application's design objectives, cost, hardware, and system constraints [4]

Swati Sharma et.al. In the paper, the author in the recent Research in wireless sensor networks has led to various new protocols that are particularly designed for sensor networks, classification of Routing protocols according to design characteristics. Some of the issues and challenges lie in how to utilize the bandwidth and energy for energy applications effectively. It effectively Makes sensor nodes self-organizing and self- reconfigurable and making routing protocols secure in WSNs and to satisfy dense sensor networks with a large number of nodes. A survey is given regarding the architecture design issues, classification of protocols. The paper explores with open research issues for the realization of networks [5]

Deepa V.Jose et.al. The paper highlights the main drawback of the sensors concerning energy storage. In this paper, an energy-efficient routing algorithm with mobile sinks called MSA routing is proposed with the details about the implementation and simulation results. The author concludes that future work will be dealt with in finding the optimal path for the movement of the sinks to save energy of the nodes by reducing the number of hops that can enhance the lifetime of the entire network. A novel approach wherein mobile sinks are involved proposed with extensive simulations that showcase the efficacy of the proposed Mobile Sink Assisted (MSA) algorithm. [6]

Edwin Prem Kumar Gilbert et.al. This paper presents an overview of various research issues in WSN based applications. The application of WSN in the areas of biomedical, intelligent parking, healthcare applications, environmental, industrial, and military applications have been briefed. The author concludes with a review of the various research issues involved in the WSN applications has been outlined. The prospects of WSN applications are highly promising to revolutionize our everyday lives. [7]

Aamir Shaikh et.al. The author discusses a new wireless protocol in a personal area. ZigBee has unique characteristics, including low cost, low data rate, and low power consumption, which corresponds to a large market. This paper provides an application in the field of building automation. In this paper wireless sensor network technology is discussed along with application and it is clear that WSN proves to be emerging technology [8]

I. F. Akyildiz et.al.The future Research gap stated in the paper is the flexibility, fault tolerance, high sensing fidelity, low-cost and rapid deployment characteristics of sensor networks create many new and exciting application areas for remote sensing. The author has discussed the potential sensor networks applications, the sensing tasks, various factors influencing the design of sensor networks, communication architecture for sensor networks, algorithms and protocols developed for each layer are explored. [9]

Kay R¨omer et.al. In this paper, the author discusses the consequences of this fact concerning Close collaboration between users, applications domain experts, hardware designers, and

software developers are needed to implement efficient systems. It would be desirable to have available a (small) set of platforms with different capabilities that cover the design space. A modular approach, where the individual components of a sensor node can be easily exchanged, might partially overcome this difficulty. Principles and tools for selecting suitable hardware components for particular applications would also be desirable. The Authors have concluded by demonstrating that specific existing applications occupy different points in the design space. [10]

Ruan D. Gomes et.al. This paper discussed a Link Quality Estimator (LQE) for Industrial WSN, and a new type of node, the LQE node, that estimates the link quality in real-time, using the Received Signal Strength Indication (RSSI), and information obtained from received data packets. The proposed LQE is capable of capturing the effects of multipath, interference, and link asymmetry. Adaptive mechanisms, such as dynamic channel allocation or adaptive routing, are used to deal with the variations in the link quality of Wireless Sensor Networks (WSN). The author concludes that the development of dynamic multi-channel protocols, using the LQE node and the link quality estimator described in this paper, is proposed as future work. Besides, improved simulation models will be developed to allow the simulation of multi-channel protocols in industrial environments. Finally, experiments with a large number of nodes will be performed using simulation, and experiments in real industrial environments. [11]

Oladimeji et. al. The paper proposes a novel Heuristic Algorithm for Clustering Hierarchy (HACH), which successively performs a selection of inactive nodes and cluster head nodes at every round. Inactive node selection employs a stochastic sleep scheduling mechanism to determine the selection of nodes that can be put into sleep mode without adversely affecting network coverage. The author has concluded that further experiments demonstrated that our protocols can perform even better under different heterogeneity levels of wireless sensor network settings and still maintain acceptable performances. [12]

Thaha Muhammed et.al. In this paper, the author discusses and surveys various fault detection techniques and provides a new taxonomy to integrate new fault detection techniques. They have performed a qualitative comparison of the latest fault detection algorithms. From qualitative analysis, selects a list of techniques that are analyzed quantitatively. Also, discuss the shortcomings, advantages and future research directions for fault detection in wireless sensor networks. A survey is the first to provide a quantitative and qualitative comparison in this area of Research. The authors have concluded and have outlined prospective future research challenges and issues for fault detection in WSN. The drawbacks of existing fault detection strategies in WSN calls for developing techniques that take into account mobility, dynamic error status, parameter selection, fault replacement and recovery, and robustness against attacks. [13]

Yusuf Idris et.al. In this paper, the author has shared a broad overview of two wireless standards, Bluetooth and ZigBee, with a quantitative evaluation in terms of the transmission time, protocol complexity, and power consumption. Furthermore, network size, range and security are also preliminary compared. It provides a comparative study of these two wireless communication standards, evaluating their main features and behaviors in terms of various parameters, including the transmission time, network size, range, security and power consumption. This paper would help engineers in selecting an appropriate protocol while designing applications. The author has concluded that for applications requiring high bit rates over short distances, like wireless stereo headphones, Bluetooth remains the best technology. [14]

M Kafi et.al. The author discusses to enhance the existing schemes and fill the gaps. The deep classification and analysis of these protocols have shown that reliability concerns different layers rather than a single one, starting from the MAC to routing, to arriving, to the transport layer. Analyses reveal that none of the proposed protocols detects and overcomes all the kinds of lack of reliability. For that purpose, we have discussed their shortcomings to allow thinking about their enhancement to face a lack of reliability. The cross-layer design of new reliability protocols represents a good choice to recover all the possible reliability failures. [15]

Amit Sarkar et.al. The author in this paper mainly aims to categorize the routing problems and examines the routing-related optimization problems. The different features related to energy, security, speed and reliability problems of routing are discussed. The literature is subsequently analyzed based on the simulation environment and experimental setup, awareness over the Quality of Service (QoS), and the deployment against various applications. Besides, the optimization of the routing algorithms and the meta-heuristic study of routing optimization are explored. The author has concluded the future challenges include security routing, energy demand and multi-objective routing. [16]

G Reddy et.al. In this paper, the author describes a well-known protocol in wireless sensor networks called LEACH. LEACH is the first low energy protocol introduced in WSN, which saves energy and increases sensor networks' lifetime. With the number of advantages of the LEACH protocol, it also comes with some drawbacks. To overcome those drawbacks and make LEACH more efficient many descendants of LEACH protocol are introduced. Some of them like E-LEACH, LEACH- B, HEED, LEACH-F, TL-LEACH, MULTI-HOP LEACH, LEACH-C, LEACH-M, I-LEACH, CELL- LEACH and V-LEACH are described in this paper that how these protocols overcome the disadvantage of the LEACH protocol and make the sensor networks more efficient.[17]

Literature Review Findings

Based on the Literature Review, the following findings were observed that highlighted Research issues that are predominately focused are mentioned below.

The research domain of WSNs is enhancing as the technology is advancing, and its relevance is proven worldwide. The highlighting Research Issues that are predominately focused are mentioned below.

- Biological Research Applications, including Biological Task mapping and Biological Signal Monitoring.
- Commercial applications involving Smart Parking, Vehicular Telematics, Intra-car Security,Event Detection, Structural Health Monitoring.
- Environmental applications relating to Greenhouse Monitoring and Habitat Surveillance.
- The Designing of WSNs needs close collaboration between users, hardware designers, and software
- developers to implement inefficient systems.
- WSNs adaptable critical criteria like Deployment, Mobility, Cost, Size, Resources, Energy, Heterogeneity, Communication Modality, Infrastructure, Network Topology, Coverage, Connectivity and Network size.
- Key Factors that influence Sensor Network Design like Fault Tolerance, Scalability, Production costs, Hardware constraints, Sensor Network Topology, Environment, Transmission Media, Power Consumption.

- Recent Advances in WSNs include the need for Topology and Coverage Control, Quality of Service (QoS) Provision, Security and Privacy Concerns.
- A Major Research An issue in WSNs Performance Enhancement is, Routing in sensor networks with a
- the limited and rapidly growing set of Research areas.

Research Gaps

Based on Literature Review, various Research Gaps were identified.

1. **Real-World Protocols requirement** for handling real-world problems by considering the theoretical concepts and synthesizing novel solutions into a complete system-wide protocol for real-world applications and High real-time transmission.
    - Invent new protocols that account for the communication realities of real-world environments.
    - Test the individual solutions on real platforms in real-world settings and Synthesize novel solutions into a complete system-wide protocol stack for real applications.
    - Energy-efficient MAC Protocol for WSN's: A good MAC protocol should easily accommodate such network changes. Other important attributes include fairness, latency, and throughput and bandwidth utilization. These attributes are generally the primary concerns in traditionally wireless voice and data networks; however, they are secondary in sensor networks.
    - Work on the different layers on the WSN protocol stack.
    - Design and develop better MAC layer protocols and come up with a unified framework for

    performance enhancement.
2. **System Architecture**: Need for Non-Unified System and Network Architecture framework

having System qualities and Architecture divergence.
    - Challenges Furthermore, Future Standardization needs.
    - Disunity:Communication, coordination and unified planning are not available from the different standard organizations.
    - Incompatibility: Standards are complex and diverse. Different standards developed by different
    - standard organizations are not compatible.
    - Design and develop efficient Routing Algorithms and, if possible, using Cross-Layer Approach.
3. **Restricted Security and Privacy**: As most of the attacks that are performed on WSNs are insertions of false information by compromised nodes within the networks.
    - Recent Advances in WSNs include the need for Topology and Coverage Control, Quality of Service (QoS) Provision, Security and Privacy Concerns.
    - Key Factors that influence Sensor Network Design like Fault Tolerance, Scalability,Production costs, Sensor Network Topology, Environment, Transmission Media, Power Consumption.
    - The development of enhanced WSN node deployment strategy to optimize network performance.

- Design. Moreover, develop algorithms for performance enhancement of Wireless Sensor Networks.

4. Power Consumption has always been a challenge for WSN's designs.

Power: It has always been a challenge for WSN's designs. One way to prolong the network lifetime is to design the energy-efficient algorithms and hardware that uses power intelligently.

- The main drawback of the sensors is resource-constrained nature, especially concerning energy storage. WSNs use battery-operated computing and sensing devices.
- The key constraints in the development of WSNs are limited battery power, cost,memory limitation, computational capabilities and the physical size of the sensor nodes.
- Transducer design: Developing new sensor transducers design that is compact, low power, and cost-effective. It is an inappropriate electronic circuitry to extract digital data using sensor feedback to enhance the data collection with the electronics and provide low noise outputs using sensor arrays.

5. They are reducing Hardware cost by producing low cost and tiny sensor nodes.

- Hardware cost: To produce low cost and tiny sensor nodes. It can be achieved by recent and future progress in the fields of Micro-Electro-Mechanical Systems (MEMS).
- A the minute structure is an attractive feature of the sensors. They can be easily accommodated in sensing or monitoring devices; however, the energy storage,processing and memory capabilities are drastically reduced.

6.The Performance Enhancement WSN Techniques are linked with the routing techniques classified based on the network structure. Many factors are taken into account for the maximization of the lifetime of wireless sensor networks, such as minimizing the power consumption, low-cost operation, optimal routing algorithms, forwarding of residual power to every node to avoid the abbreviating of power in nodes, using an improved version of protocols and also communication models.

- Investigate optimized protocols to cater to specialized WSN application requirements.
- Investigate new WSN applications where the new algorithms can be efficiently utilized.

CONCLUSION:

Exciting and challenging research challenges lie ahead before this becomes a reality. The study's objective is to present a comprehensive review of the recent literature in a wireless sensor network. This paper reviews the significant development and new research challenges in this area. The various research Gaps are identified in the domain of WSNs, which include Biological Research Applications, Commercial applications, Environmental applications. A variety of adaptable critical criteria like Deployment, Mobility, Cost which is essential in designing of sensor nodes is discussed. Recent Advances in WSNs include the need for Topology and Coverage Control, Quality of Service (QoS), WSNs Performance Enhancement in Routing in sensor networks with a limited and rapidly growing set of Research areas are highlighted. Stimulating and complex research challenges recline ahead before this, which becomes a reality of Research areas. The reflected Research key areas are underlined in the

form of challenges and that focus on the future Research strategy of the researcher endeavoring research in WSNs and its allied domain.

References

[1] A. Sajid, R. A. Wagan, K. Wei-Xin, and A. A. Wagan, "A Review: Threshold Based Clustering Schemes of Routing Protocols for Heterogeneous Wireless Sensor Networks An Interactive Code Generator and Profiler View project Web technologies used for virtual classroom View project A Review: Threshold Based Clustering Schemes of Routing Protocols for Heterogeneous Wireless Sensor Networks," 2018.

[2] P. Kumar, M. P. Singh, and U. S. Triar, "A Review of Routing Protocols in Wireless Sensor Network," *Int. J. Eng. Res. Technol.*, vol. 1, no. 4, pp. 1–14, 2012.

[3] IEC, "Internet of Things : Wireless Sensor Networks Executive summary," *Dr.Shu Yinbiao*, p. 78, 2014.

[4] S. Randhawa, "Research Challenges in Wireless Sensor Network: A State of the Play," *arXiv Prepr. arXiv1404.1469, pp. 21–22, 2014.*, pp. 21–22, 2014.

[5] S. Sharma, "Wireless Sensor Networks : Architecture , Protocols," vol. 3, no. 1, pp. 303–308, 2013.

[6] D. V Jose and G. Sadashivappa, "Mobile Sink Assisted Energy Efficient Routing Algorithm for Wireless Sensor Networks," *World Comput. Sci. Inf. Technol.*, vol. 5, no. 2, pp. 16–22, 2015.

[7] E. Gilbert, "Research Issues in Wireless Sensor NetworkApplications: A Survey," *Int. J. Inf. Electron. Eng.*, vol. 2, no. 5, pp. 702–706, 2012.

[8] A. Shaikh and S. Pathan, "Research on Wireless Sensor Network Technology," *Int. J. Inf. Educ. Technol.*, vol. 2, no. 5, pp. 476–479, 2012.

[9] I. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "Wireless sensor networks : a survey," vol. 38, pp. 393–422, 2002.

[10] K. Romer and F. Mattern, "The design space of wireless sensor networks," *Wirel. Commun. IEEE*, vol. 11, no. 6, pp. 54–61, 2004.

[11] R. D. Gomes, D. V. Queiroz, A. C. Lima Filho, I. E. Fonseca, and M. S. Alencar, "Real-time link quality estimation for industrial wireless sensor networks using dedicated nodes," *Ad Hoc Networks*, vol. 59, pp. 116–133, 2017.

[12] M. O. Oladimeji, M. Turkey, and S. Dudley, "HACH: Heuristic Algorithm for Clustering Hierarchy protocol in wireless sensor networks," *Appl. Soft Comput. J.*, vol. 55, pp. 452–461, 2017.

[13] T. Muhammed and R. A. Shaikh, "An analysis of fault detection strategies in wireless sensor networks," *J. Netw. Comput. Appl.*, vol. 78, no. October 2015, pp. 267–287, 2017.

[14] Y. Idris and N. A. Muhammad, "A Comparative Study of Wireless Communication Protocols: Zigbee vs Bluetooth," *Int. J. Eng. Sci. Comput.*, vol. 6, no. 4, pp. 3741–3744, 2016.

[15] M. A. Kafi, J. Ben Othman, and N. Badache, "A Survey on Reliability Protocols in Wireless Sensor Networks," *ACM Comput. Surv.*, vol. 50, no. 2, pp. 1–47, 2017.

[16] A. Sarkar and T. Senthil Murugan, "Routing protocols for wireless sensor networks: What the literature says?," *Alexandria Eng. J.*, vol. 55, no. 4, pp. 3173–3183, 2016.

[17] N. A. Pantazis, S. A. Nikolidakis, and D. D. Vergados, "Energy-Efficient Routing Protocols in Wireless Sensor Networks: A Survey," *IEEE Commun. Surv. Tutorials*, vol. 15, no. 2, pp. 551–591, 2013.