### **Literature Survey on Energy-Efficient Protocols for Wireless Body Area Networks (WBANs)**

#### **1. Introduction**

Wireless Body Area Networks (WBANs) are critical in healthcare applications, enabling real-time monitoring of physiological signals such as heart rate, blood pressure, and body temperature. The small, battery-operated sensors in WBANs, however, pose significant challenges due to their limited energy capacity. Therefore, optimizing energy consumption while maintaining network performance is a key research focus in WBAN technology.

#### **2. Energy-Saving Techniques**

Boujnah and Mars (2016) proposed an energy-saving method using a **Discrete Time Markov Chain (DTMC)** to model user posture and sensor activity, reducing energy consumption without compromising data transmission. Their approach minimizes energy usage during non-critical states and prolongs the life of WBAN devices.

Similarly, Cicioğlu and Çalhan (2018) evaluated a **Dynamic HUB Selection (DHS) Algorithm**, where the network’s coordinator node is dynamically selected based on the remaining energy levels. Their results showed significant energy savings and extended network life, particularly by addressing the limitations of fixed node architectures.

#### **3. Cluster-Based and Optimization Protocols**

Javaid et al. (2013) introduced a **Cluster-Based Routing Protocol** that organizes sensor nodes into clusters to balance energy consumption across the network. This method prevents energy depletion in individual nodes and enhances the overall network’s longevity.

In contrast, optimization-based approaches like **Particle Swarm Optimization (PSO)** and **Teaching-Learning-Based Optimization (TLBO)**, examined by Misra et al. (2021), aim to select optimal relay nodes in WBANs. TLBO, in particular, outperforms traditional algorithms by providing higher energy efficiency and better throughput, making it ideal for real-time healthcare monitoring.

#### **4. Trends and Gaps**

A growing trend in WBAN research is the use of hybrid systems that integrate multiple optimization techniques, such as combining cluster-based and dynamic selection methods. However, many studies still focus on static WBAN environments, with limited research on **mobility-based optimizations** and the dynamic conditions often encountered in real-world healthcare settings.

#### **5. Conclusion**

Research on energy-efficient protocols for WBANs highlights various innovative methods, from posture-based optimization and dynamic HUB selection to cluster-based and optimization protocols like TLBO. While significant advancements have been made, future work should focus on improving these protocols to handle dynamic network conditions and further enhance energy efficiency in practical applications.

#### **6. References**

* Boujnah, N., & Mars, F. (2016). *Energy saving in WBAN networks under rate constraints*. 4th International Conference on Control Engineering & Information Technology (CEIT).
* Cicioğlu, M., & Çalhan, A. (2018). *Performance Evaluation of Dynamic HUB Selection Algorithm for WBAN*. IEEE CEIT.
* Javaid, N., et al. (2013). *Cluster-based energy-efficient routing protocol for WBAN*. Procedia Computer Science.
* Misra, S., et al. (2021). *i-MAC Wireless Body Area Network for Healthcare IoT*. IEEE Systems Journal.

**Literature Survey: Energy Conservation Mode Based on Dijkstra’s Algorithm with Link Cost Function for WBANs**

**1. Introduction**

Wireless Body Area Networks (WBANs) play a pivotal role in health monitoring, relying on sensor nodes to collect and transmit critical physiological data. The efficient functioning of these networks is paramount, particularly given the energy constraints of the sensor nodes. This survey critically evaluates the first paper titled **"Energy Conservation Mode Based on Dijkstra’s Algorithm with Link Cost Function for Wireless Body Area Networks (WBANs),"** demonstrating its superiority over alternative routing strategies highlighted in other studies.

**2. Overview of the First Paper**

**Title**: Energy Conservation Mode Based on Dijkstra’s Algorithm with Link Cost Function for Wireless Body Area Networks (WBANs)

**Abstract**: This research introduces an innovative routing mechanism that addresses energy efficiency and network longevity by utilizing a modified version of Dijkstra's Algorithm, enhanced with a Link Cost Function. Through empirical performance evaluations, it is shown that the proposed method significantly improves key performance indicators such as packet delivery ratio, end-to-end delay, and throughput compared to established protocols like AODV and DSR. The findings indicate an extension of network lifetime through optimized energy utilization among sensor nodes.

**3. Comparative Analysis of Relevant Literature**

**3.1. Key Contributions of the First Paper**

* **Energy Efficiency**: The paper emphasizes energy optimization by adapting Dijkstra's Algorithm to consider node energy levels, leading to more informed path selection. This contrasts sharply with traditional protocols that do not integrate energy metrics in their routing decisions.
* **Enhanced Performance Metrics**:
  + **Packet Delivery Ratio**: The first paper showcases a higher packet delivery ratio, ensuring reliable data transmission, which is critical for health monitoring applications where data accuracy is essential.
  + **Reduced End-to-End Delay**: The study demonstrates a significant reduction in end-to-end delays, crucial for applications requiring real-time data processing and responsiveness.
  + **Improved Throughput**: The Dijkstra-based algorithm provides higher throughput by efficiently managing energy distribution across nodes, enhancing overall network performance.

**3.2. Relevant Studies for Comparison**

1. **Ehyaie et al. (2009)** - *Using Relay Networks to Increase Lifetime in Wireless Body Area Sensor Networks*
   * **Objective**: Introduces a relay-based routing protocol that aims to enhance communication efficiency through relay nodes.
   * **Key Findings**: The use of relay nodes helps improve network lifetime by distributing energy usage.
   * **Limitations**: This approach does not address mobility, which can significantly affect node performance and efficiency in dynamic environments. Moreover, relay nodes may introduce additional latency, contradicting the goal of efficient communication.
2. **Guo et al. (2010)** - *Packet Forwarding with Minimum Energy Consumption in Body Area Sensor Networks*
   * **Objective**: Focuses on minimizing energy consumption during the packet forwarding process.
   * **Key Findings**: The proposed mechanism shows significant energy savings, emphasizing static scenarios.
   * **Limitations**: The research predominantly addresses static node conditions and fails to accommodate the dynamics of real-world environments, leading to inefficiencies in mobile or varying node scenarios. The lack of consideration for node mobility and dynamic link conditions limits the practical applicability of the findings.

**3.3. Comparative Performance Summary**

The first paper's Dijkstra-based algorithm stands out for its holistic approach to energy management, addressing both energy efficiency and real-time performance. Unlike AODV and DSR, which often result in higher energy consumption and prolonged delays due to their fixed routing strategies, the proposed method actively adapts to node energy levels, extending network lifetime and maintaining performance.

| **Performance Metrics** | **Dijkstra-based Algorithm** | **AODV** | **DSR** | **Ehyaie et al. (2009)** | **Guo et al. (2010)** |
| --- | --- | --- | --- | --- | --- |
| Packet Delivery Ratio | High | Moderate | Moderate | Low | Moderate |
| End-to-End Delay | Low | High | High | Moderate | Moderate |
| Throughput | High | Moderate | Moderate | Low | Moderate |
| Energy Efficiency | High | Low | Low | Moderate | Moderate |

**4. Discussion**

* **Synthesis of Findings**: The Dijkstra-based algorithm outperforms existing protocols by integrating energy metrics directly into the routing process. This not only enhances packet delivery but also ensures efficient energy use, thereby prolonging network lifetime. This adaptability is crucial for WBANs, where varying node conditions are commonplace.
* **Trends and Gaps**: While existing literature emphasizes various aspects of performance (e.g., delay minimization and throughput maximization), the Dijkstra-based approach is unique in its thorough focus on energy conservation across diverse node distributions. Current studies tend to overlook mobility and environmental variations, which remain vital for the practical deployment of WBANs.
* **Future Directions**: Future research should focus on adaptive algorithms that dynamically respond to changing network conditions. Integrating energy harvesting methods could enhance sustainability and operational longevity, addressing one of the primary challenges in WBANs.

**5. Conclusion**

The proposed Dijkstra-based algorithm represents a significant advancement in the field of WBANs by effectively enhancing energy efficiency and extending network longevity. By addressing the critical issue of energy consumption through optimized routing decisions, this approach is especially vital for health monitoring systems, where consistent, reliable performance is paramount. In comparison to alternative methods such as AODV, DSR, and the relay-based protocol by Ehyaie et al. and Guo et al., the first paper stands out as the most suitable choice for your project, given its innovative approach and comprehensive consideration of real-world operational conditions.