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WSN Implementation Study to Optimize Energy Consumption for Manufacturing Units

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ABSTRACT:
A study on the implementation of wireless sensor networks (WSNs) in optimizing energy consumption for manufacturing units might read as follows:This study aims to investigate the potential of WSNs for optimizing energy consumption in manufacturing units. The proposed approach involves the deployment of sensor nodes throughout the factory floor to collect real-time data on energy consumption and production processes. This data is then transmitted wirelessly to a central server for analysis and optimization. The study includes a detailed review of existing literature on WSNs and energy optimization in manufacturing, as well as an analysis of previous data to identify potential areas for improvement. It is expected that the study's findings would provide important light on the viability and efficiency of WSNs for energy optimization in industrial units.
Keywords: WSN, Energy Optimization, Energy Balancing, MATLAB, L-pso.

I. INTRODUCTION

Due to their potential to totally transform how we collect data, Wireless Sensor Networks (WSNs) have received a lot of attention in recent years, process, and analyze data in various fields. In the context of manufacturing units, the use of WSNs can offer significant benefits in terms of optimizing energy consumption, reducing costs, and improving efficiency.This study aims to investigate the implementation of WSNs in optimizing energy consumption for manufacturing units. The study will examine the different approaches and techniques that can be used to design and deploy WSNs in manufacturing units and evaluate their effectiveness in reducing energy consumption(Thangamuthu, 2021).According to the International Energy Agency, manufacturing accounts for approximately 37% of global energy consumption, making it a significant contributor to greenhouse gas emissions. By implementing WSNs, manufacturing units can monitor and control energy consumption in real-time, reducing wastage and improving sustainability.Previous studies have demonstrated the effectiveness of WSNs in optimizing energy consumption in various industries, including manufacturing. For instance, a study by(Liu, L., Zhang et al., 2017)demonstrated the successful implementation of WSNs in a chemical plant to monitor and control energy consumption. Similarly, a study by (Shao, X., Li & Zhang, 2019)demonstrated the potential of WSNs in optimizing energy consumption in a textile manufacturing plant.The implementation of WSNs in manufacturing units can also facilitate predictive maintenance, This can reduce downtime, continue strengthening, and extend the life of equipment. In the long run, this can result in significant cost reductions for production units.The implementation of WSNs in manufacturing units can offer significant advantages in terms of cost savings, increased productivity, and energy usage optimization. The goal of the research is to provide light on the various methods and procedures that may be employed to develop and deploy WSNs.in manufacturing units, as well as their effectiveness in reducing energy consumption.

II. ENERGY BALANCING IN WSN

This can reduce downtime, continue strengthening, and extend the life of equipment. In the long run, this can result in significant cost reductions for production units.(Kumar Pattnaik, 2016). Energy balancing aims to distribute the energy consumption of the nodes evenly so that some nodes do not consume their batteries faster than others, leading to premature node failure and network degradation.

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There are several techniques for energy balancing in WSNs, including:

1. Routing protocols: Routing protocols can be designed to balance energy consumption across nodes by selecting energy-efficient paths for data transmission. For example, To lower the energy consumption of nodes farther distant from the sink node, several routing methods use multi-hop communication.(Mahapatra & Yadav, 2015).
2. Sleep scheduling: Sleep scheduling is another technique that can help balance energy consumption in WSNs. In this technique, nodes are put into sleep mode when they are not needed, which reduces their energy consumption. Sleep scheduling can be based on various criteria, such as node proximity to the sink node, data traffic load, or time.
3. Duty cycling: Duty cycling is a technique that involves turning the radio on and off periodically to reduce energy consumption. Nodes can be programmed to turn their radios on only when necessary, such as when they need to transmit data or receive commands.
4. Energy harvesting: Energy harvesting is a technique that involves using alternative sources of energy, such as solar, thermal, or kinetic energy, to power the nodes. Energy harvesting can be used in conjunction with other energy balancing techniques to extend the life of the nodes.

In WSNs, energy balancing is a major problem. There are several techniques that can be used to balance energy consumption among nodes and increase network lifetime.(Belfkih et al., 2019).

III. LITRATURE REVIEW

(Rathore et al., 2021) Wireless communication and many applications paraphrase: wireless communication and various applications wireless communication and networks, encompassing home automation, industrial automation, safety, monitoring, and tracking. WSNs, however, face a number of difficult problems that impair their performance,with energy constraints being one of the primary concerns. Energy optimization strategies are needed to address these issues, and the use of appropriate energy harvesting techniques can help alleviate the problem. such as residential automation, industrial automation, security automation, monitoring, and tracking. The performance of WSNs is, however, hampered by a number of difficult problems, including radio optimization, energy harvesting process optimization, data reduction, cross-layer optimization, sleep/wake-up policies, load balancing, power requirement optimization, communication mechanism optimization, energy balancing plans, mobility-based plans, and battery operation optimization. Additionally, we have given a thorough description of protocols, algorithms, and newly developed energy harvesting devices.This systematic and taxonomical survey highlights the optimization challenges and their solutions in EH-WSNs, providing a comprehensive analysis for researchers to advance the technology.

(Galar et al., 2019) Although this review paper focuses on the use of WSN in agriculture and the food industry, it provides valuable insights into the use of WSN for energy optimization in manufacturing units. The authors review various WSN technologies, applications, and challenges, and discuss the potential benefits of using WSN for real-time monitoring and control of energy consumption.

(Kumar et al., 2018) The use of energy-efficient WSN for industrial automation, particularly energy optimization in production units, is the main topic of this literature review.The authors discuss various energy-efficient techniques for designing WSN, such as duty cycling, data aggregation, and topology control. They conclude that energy-efficient WSN can help in reducing energy consumption and improving the sustainability of industrial automation.

(Nayak et al., 2016) This literature review provides an overview of the use of WSN in manufacturing units for optimizing energy consumption. The review covers various aspects such as the deployment of sensors, data collection and processing, energy management, and communication protocols. The authors conclude that WSN can help in reducing energy consumption by providing real-time data and feedback to the control systems.

(Al-Fuqaha et al., 2015) This comprehensive survey paper provides an overview of the use of WSN for industrial process monitoring and control, including the optimization of energy consumption in manufacturing units. The authors review various WSN technologies, applications, and challenges, and discuss the potential benefits of using WSN for real-time monitoring and control of energy consumption. They also highlight the importance of developing energy-efficient and reliable WSN systems for industrial automation.

(Abdullah & Hannan, 2014) This review paper discusses the use of WSN in industrial automation, including the monitoring and control of energy consumption in manufacturing units. The authors provide an overview of the architecture,

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applications, and challenges of WSN in industrial automation. They also highlight the importance of designing WSN systems that are robust, reliable, and energy-efficient.

IV. SIMULATION OF WIRELESS SENSOR NETWORKS

Simulation of wireless sensor networks is an important aspect of research and development in this field. Simulations can help in testing and evaluating the performance of different protocols, algorithms, and applications under various scenarios and conditions without deploying actual hardware. There are various software tools and simulators available for simulating wireless sensor networks, including:

- **MATLAB:** MATLAB is a numerical computing software that is also used for simulating wireless sensor networks. MATLAB provides a user-friendly interface and a range of built-in functions and toolboxes for simulation.

These simulators provide a range of features and functionalities, such as the ability to simulate different types of wireless sensor network nodes, different types of communication protocols, and the ability to simulate different network scenarios and conditions.

To ensure efficient data communication in wireless sensor networks, high performance is required. One effective approach is to link network sensors privately and allow them to interact independently. This can be achieved by forming a star-shaped logical topology, similar to the intermediate approach. To ensure successful operation, it is important to conduct non-commercial activities within the network. It might be helpful to observe natural systems like insects, biological items, bird colonies, and large populations of different species.Networks can be divided and grouped based on the data processing method used.

- **Simple brush**. The objective is to minimize transfer time and optimize the method of knowledge transmission under room temperature conditions. The absence of backup programs is a major vulnerability that can lead to system failures.
- **Some links.**Previous studies have often focused on specific locations, which can be influenced by several factors, including network capacity, traffic distribution, network durability, and future energy consumption. These circumstances have led to the extension of previous work to address these considerations.
- **Multipurpose equipment:**Wireless sensor networks may include auxiliary devices, according to recent study to enhance their functionality. These devices can perform a variety of network functions, including assisting in route specification, monitoring node mobility, locating destinations, and optimizing the performance of WSN applications.

V. SIMULATION & RESULT

The first design created in MATLAB features of two buttons: one for a simple WSN and the other for L-PSO as the executable button.

The WSN is executed using the aforementioned buttons in two modes: the basic WSN and the suggested L-pso.

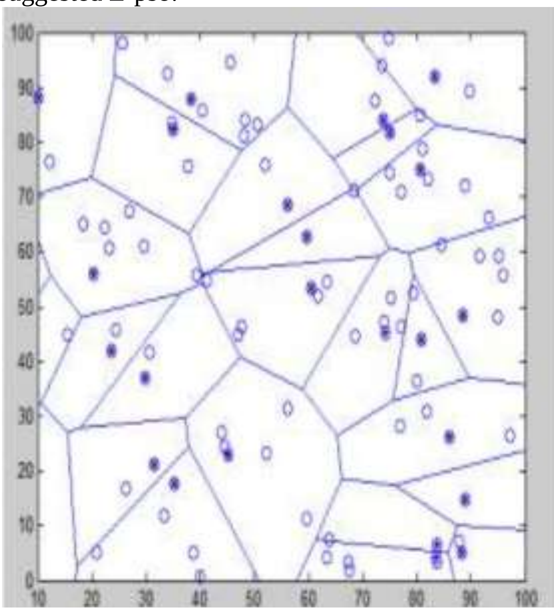

Figure:1 WSN-100 nodes

This image illustrates how sensors communicate inside a set-up Matlab network..

- The cluster head of the wsn node is represented by the black circular node.
- The wsn node is represented as a circular node.
- The clusters are shown as areas within the line.

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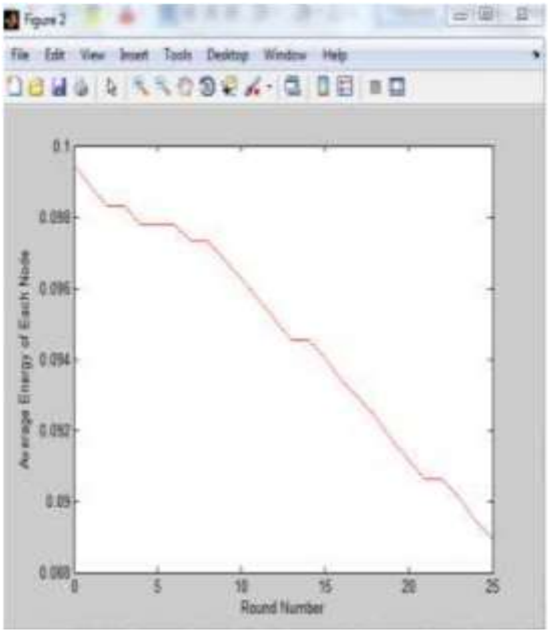

Figure:2 Average energy vs a round number of 25 nodes

- The average energy per round of wsn is shown by the following graph.
- The energy in this figure at round zero is close to one and decreases as the round number rises.
- After 25 nodes, the energy level is less than 0.9.

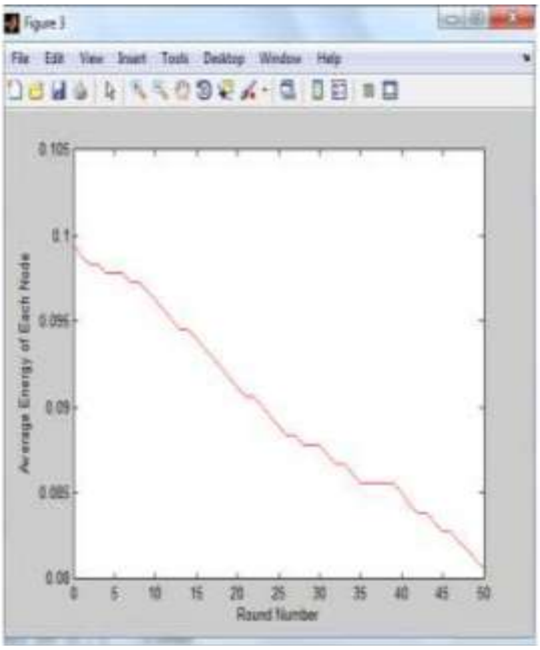

Figure 3: Average energy vs a round number of 50 nodes

- The average energy per round of the WSN is seen in the accompanying graph.
- The energy in this figure at zero round is close to one and decreases as the round number rises.
- After 25 nodes, the energy level is less than 0.9.

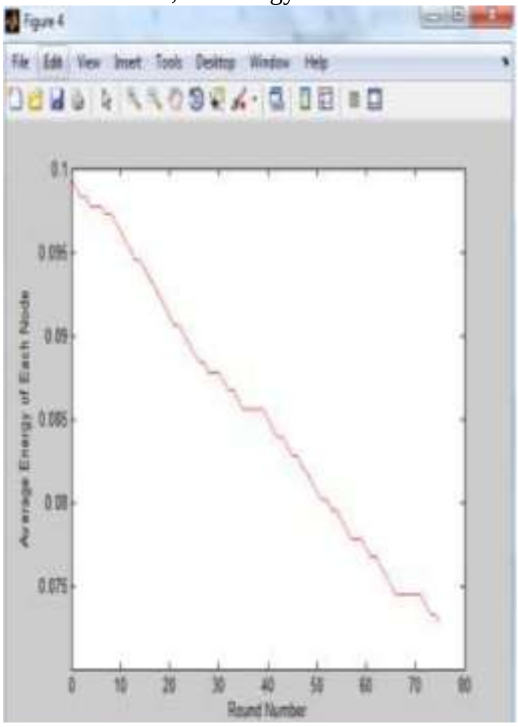

Figure 4: Energy on average vs round number - 80 round

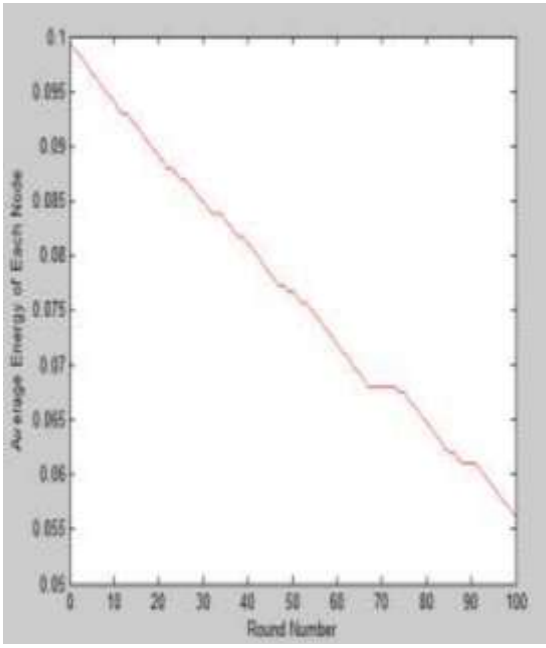

Figure 5: Energy on average vs round number

- The average energy per round of wsn is shown by the following graph.

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- The energy in this figure at round zero is close to one and decreases as the round number rises.
- After 25 nodes, the energy level is less than 0.9.

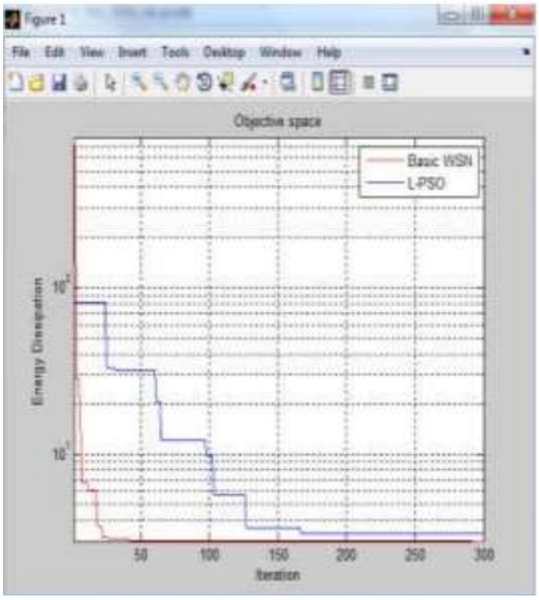

Figure 6: Comparison of the simulation results for WSN and L-PSO

The best solution obtained by PSO-WSN is : -0.0022746 -1.0006
The best optimal value of the objective function found by PSO-WSN is : 3.0012
The best solution obtained by basic WSN is : 2 0.32999
The best optimal value of the objective function found by Basic WSN is : 91.8232

Wirelessly interconnected areas have the capability to transmit data, but effective algorithms are necessary to optimize the performance of battery-operated sensors. The data collected by the sensor nodes is transmitted to the base station from the CH site, with the successful implementation of a network being a critical requirement. Since the network's energy usage is directly related to how well the nodes function, node security is a major concern in wireless sensor networks.To ensure effective control, groups and CH need to be organized, and CH should have access to details on device transmission, system integrity, and sensor nodes.Thus, CH must be able to receive and deliver this information effectively.

VI. CONCLUSION AND FUTURE SCOPE

Energy efficiency is a crucial factor in the architecture of sensor networks. This thesis introduces an improved version of the L-PSO algorithm to identify the appropriate group head collection for the LEACH-C algorithm. The hybrid approach combines PSO's methodology of searching for global clusters with the ability to locate most group headers. The proposed approach's feasibility is evaluated across various environments, power constraints, and traffic conditions.

- For battery-driven sensors, effective algorithms are required.: Battery-driven sensors are often used in wireless sensor networks (WSNs), where energy efficiency is a critical concern. To conserve energy and extend battery life, sensors need to use algorithms that optimize their power consumption. These algorithms should be designed to minimize the amount of data transmitted, reduce idle listening, and utilize sleep modes to minimize energy consumption.
- The remaining collection is received by the CH location and sent to the base station (BS): In a WSN, sensor nodes are often grouped into clusters, and each cluster has a cluster head (CH) who is in charge of gathering data from the nodes that make up the cluster. The base station (BS) will next process the data that the CH has collected.This helps to conserve energy and reduce communication overhead.
- Saving node resources is thus the main issue with WSN:The primary concern in WSNs is to conserve energy and extend the operational lifetime of the network. This is because sensor nodes are often battery-powered and replacing them can be difficult or impossible, especially in remote or hard-to-reach locations. As such, the key challenge in WSNs is to develop techniques that reduce energy consumption and increase the network's operational lifespan.
- The collection of groups and CH needs control: In a WSN, data collection is often performed by a cluster head (CH) that is responsible for collecting data from its member nodes. To ensure efficient data collection and communication, it is important to have proper control mechanisms in place. These mechanisms should be designed to ensure that data is collected from all nodes, that the CH is properly selected, and that data is efficiently transmitted to the base station.
- CH makes it possible to gather sensor nodes, consolidate information, and transfer data:The cluster head (CH) plays a critical role in a WSN, due to the fact that it is in charge of gathering data from its member nodes and sending it to the base station (BS).This enables sensor nodes to be organized into clusters,

which helps to conserve energy and reduce communication overhead. Additionally, the CH is responsible for combining and aggregating data from its member nodes, which helps to reduce redundant data transmission and improve network efficiency.

L-PSO is a metaheuristic search algorithm that can significantly extend the lifespan of wireless networks. This algorithm offers faster and simpler results compared to other approaches, and the outcomes are more robust. PSO, which is the basis of L-PSO, is inspired by the collective behavior of birds and fish in search of resources such as food, water, and shelter. In wireless sensor networks, the PSO algorithm has been utilized in various experiments and algorithms to improve their efficiency and performance.

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