A REVIEW PAPER ON ENERGY EFFICIENT OPTIMIZATION FOR WSN USING SHORTEST PATH BETWEEN NODES

[1]Sahil
M-tech scholar.
ECE department, UIET lalru.

[2]Er. Shaveta Bala
Assistant professor
Department of Electronics and Communication, UIET lalru.

Abstract: **In many applications of wireless sensor networks, a sensor node senses the environment to get data and delivers them to the sink via a single hop or multi-hop path. Many systems use a tree rooted at the sink as the underlying routing structure. Since the sensor node is energy constrained, how to construct a good tree to prolong the lifetime of the network is an important problem. We consider this problem under the scenario where nodes have different initial energy, and they can do in-network aggregation. Several protocols are proposed in performing sub aquatic communication; routing and issues related to efficiency of energy are considered as important for the underwater sensor network. With a view of overcoming those issues, researches related to underwater sensor network happen to be still analyzing about how to improve performance of routing. A new multi-layered routing protocol (MRP) that can be used in discovery of the efficient path and it also enhances the overall functioning of the end-to-end delay ration, effective utilization of energy, and network lifetime. We are investing technique which can reduce number of intermediate nodes to make minimum amount of energy wasted for inactive nodes**

Keywords: **WSN, ROUTING ALGORITHM, SHORTEST PATH, LIFETIME, POWER MINIMIZATION**

1-INTRODUCTION:

The wireless sensor network has played a crucial role in the recent era of the smart grid to improve data transmission performance. In electrical power system communication plays a vital role even smart grid also behaves as a data communication network. In this work, sensors devices are connected to the smart grid in order to transmit the information wirelessly [1]. Advances in microelectronics technology, computer technology and wireless communication technology have led to the development of low-power and low-cost sensor nodes in the past few years. In the recent decade, Wireless Sensor Networks WSNs) including these sensor nodes are becoming a hot research topic and have been applied in many respects including environmental monitoring, health monitoring, military surveillance, and many others as Internet of Thing (IoT). However, power supplies for sensor nodes are limited and hard to replace. In addition, nodes near the base station consume more energy than those elsewhere, since they relay the data collected by sensor nodes far away from the base station. Hence, once these sensors near the base station fail, the data collected by other sensors cannot be transferred to the base station. Then, the entire network becomes disconnected, although most of the nodes can still have a lot of energy. Therefore, to prolong the lifetime of the WSNs, minimizing the energy consumption of sensor nodes is the key challenges for WSNs [2].

Wireless Sensors networks contain small size, self- configured, distributed and autonomous Sensor Nodes (SNs), that monitor physical or environmental activities like, pressure, temperature or sound in specific area of deployment. A sensor characterized with limited computation capabilities and storage receives the data through analogue to digital converter (ADC). Then, transmit it further for transmission to a central point, known as Base Station (BS) via a wireless connectivity. Routing in WSNs is a serious of processes of forwarding information collected by sensors to the BS. In literature three categories of routing protocols are designed: location-based routing protocols, flat routing protocols and hierarchical routing protocols, Clustering protocols can perform better than others in term of balancing energy consumption and lifetime prolongation. Generally, with clustering method, the network area is divided into small groups termed as clusters, with a predefined number of leaders known as Cluster Head (CH). All the SNs gathering data and transmit it to their corresponding CH, which finally aggregates it to the BS for additional processing. Clustering has various significant advantages over classical techniques [3].

It is crucial to consider critical parameters such as network lifetime, packet delivery ratio, energy-efficient transmission, and dead node ratio to address the battery constraint issue in WSNs. Energy-efficient routing techniques play a vital role in increasing the network lifetime. The current routing protocols for WSNs are classified into two categories based on their orientation towards either homogeneous or heterogeneous WSNs, further divided into static and mobile protocols. Routing in WSNs is a challenging area of research, and packets are forwarded through multiple nodes to the base station. Therefore, sharing the packets in an energy-efficient manner while considering the battery's residual power is crucial to prolong the network lifetime. Energy consumption is a fundamental issue that needs to be addressed to improve energy efficiency. However, it has not been adequately addressed by researchers and practitioners. Despite the efforts to improve energy efficiency in WSNs, some open issues in energy-efficient routing protocol design still need to be addressed. Several energy-efficient routing protocols are available, such as low energy adaptive clustering hierarchy (LEACH), Hybrid Energy Efficiency Protocol (HEEP), threshold-sensitive energy efficient network protocol (TEEN), and power-efficient Gathering in sensor information systems (PEGASIS). Notably, LEACH is considered the father of clustering protocols. It operates in rounds, each consisting of two phases: a setup phase where clusters are formed and a steady-state phase where member nodes send their data to their corresponding cluster heads, which then transfer it to the base station. During setup, nodes exchange messages to form clusters, including cluster head announcements, member node join query messages, and cluster head Time Division Multiple Access (TDMA) schedules [4].

Wireless sensor networks are used due to their many applications in various fields such as agriculture, environmental monitoring, vehicle tracking, healthcare monitoring, smart buildings, security, and animal monitoring and tracking. In fact, due to the various applications mentioned, the lack of energy in the nodes is one of the most critical limitations of wireless sensor networks. Because it is impossible to recharge or replace the nodes in the sensor nodes. Therefore, providing an appropriate protocol that can save energy will increase the network's lifetime. One of the strategies to extend the lifetime of the network is the use of the clustering approach, which, including the hierarchical architecture can be useful in the lifetime and energy consumption of wireless sensor networks. In other words, in this architecture, clustering sensors have other advantages such as saving the power of sensor elements, increasing system adaptability and maintaining data transfer speed [5].

There is a need for energy efficient transmission of data in those areas of usage. Hence routing of data must be energy efficient so as to transmit the data at a faster rate. In this experiment, a distance vector routing algorithm is implemented to make the process of routing an energy efficient one. The main concept of our project is to find the minimum path distance between the routers by finding all the path ways between source node and the destination node. This provides the project with a greater advantage than previous algorithm used by reducing the time taken for the transfer of the data packets with minimum energy used [6].

The necessary approach in this city is to use advanced technology and informatics in order to improve the service level. Smart cities go through four actions to enhance the quality of life and the potential for economic development through a network of devices linked to the Internet and other technologies like data mining for analyzing data in different fields that would help for improving performance like prediction energy consumption and diagnosis of diseases.

These are the actions to take:

1. Collection: Data is gathered in real time via smart sensors.

2. Analytics: City services and operations are evaluated based on collected data.

3. Communication: The findings of data analysis are communicated to those in charge of making decision.

4. Proceeding: Actions are being done to enhance municipal operations, better manage assets, and improve the standard of living for city people [7].

WSN is an indispensable part of IoT. WSN is a set of sensors that are responsible for collecting and transmitting the data to the base station. Sensor nodes have many limitations. One of these limitations is that the nodes are powered by a limited source of energy such as batteries. Therefore, transmitting the data to its destination is considered a critical issue. Hence, choosing the wrong path to transmit the data affects the lifetime of the sensor nodes, which could lead to consuming more energy. Moreover, the sensors will run out of energy faster. This will negatively affect the network's lifetime. Furthermore, it will lead to missing important data. Thus, transmitting the data to its destination is a big challenge. Therefore, many researchers are proposing intelligent solutions to solve this issue. The usage of efficient routing algorithms can solve this issue. That’s why researchers are working on proposing efficient routing algorithms to conserve energy and extend the lifetime of the network [8].

Each sensor will be capable of sensing and transmitting. Sensor node senses the environment and transfers the data to the sink node. Coverage depends on the sensing range and Connectivity of the node to reach sink depends on the communication range. Connectivity can be defined as an ability of the sensor node to sense the environment and transfer the information through the network to reach the data sink.Heterogeneous wireless sensor network consists of many sensor nodes with different energy, communication range and sensing range. Each sensor nodes are battery powered (energy). Energy is being a most important one because the battery present in the sensor node cannot be replaced often. The node has a non-rechargeable battery or impossible to replace batteries in most sensor fields. To lengthen the lifetime of the WSN, clustering is the key technique. Clustering will dynamically re-assign the member nodes in the cluster. So the network disconnection due to energy drain out nodes can be avoided. Energy consumption of the sensor node is reduced to increase the lifetime of the network, Only few works focus on lifetime maximization in heterogeneous WSN [9].

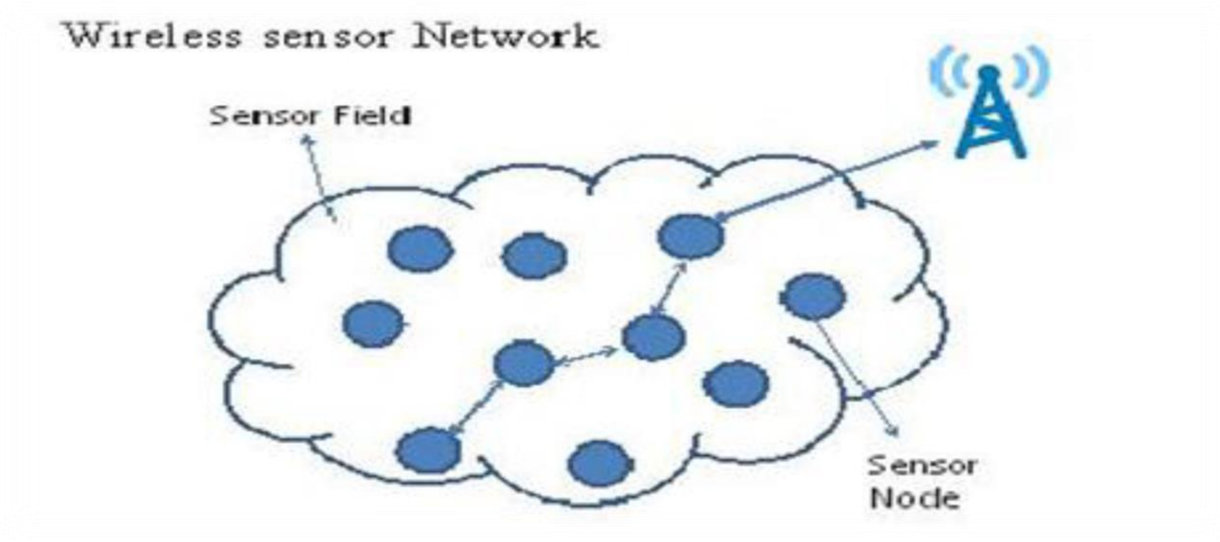

Figure 1.1: Wireless Sensor Network (WSN)

For WSNs with controllable trajectories, most existing approaches focus on how to design the optimal trajectory of the mobile sink to improve the network performance. Consider mobility control and develop the algorithms that generate ferry routes that meet traffic demand and minimize weighted packet delay. The mobile base station starts the cluster organization by broadcasting a beacon message while traversing the network. Introduce a mobile data observer and present a heuristic algorithm for planning the trajectory of the mobile data observer and balancing the traffic load in the network. A distributed and network assisted sink navigation framework to balance energy consumption and collection delay by choosing the appropriate number of multiple hops. Xing et al. [3] propose a rendezvous design to minimize the distance in multi-hop routing paths for local data aggregation under the constraint that the tour length of the mobile collector is no more than a threshold [10]. The applications of wireless sensor networks have increasing every day in life suitable for monitoring and environmental applications like household industrial, military affairs, traffic management, medical applications, surveillances etc..,[2]. The group of nodes is connected in a single network called cluster. Each cluster is controlled and monitoring by a cluster head [3]. The data is easily communicated through base station with the help of cluster head. So we introduced the energy efficient clustering algorithm to enhancement of the network capacity and also network life time [11].

For paddy field monitoring, the sensor nodes are often deployed in a grid topology. The main important issues for WSN monitoring application are to maximize the network lifetime and minimize the end-to-end network delay. A node that ran out of the energy will cause data loss in the corresponding sensing area. This will also affect the routing performance of the intermediate nodes. Critical event such as sudden flooding could happen in the paddy field especially after a heavy rain. Such sensor readings are very critical and need to be sent to the user as fast as possible. Any delay in taking the right action will cause the owner of the farm a huge loss. However, most studies in the past do not focus much on the network delay, which is an essential performance measure in real-time interactive agricultural monitoring through Internet and cellular network. Our work aims to optimize the network in achieving higher network lifetime and shortening the end-to-end network delay [12].

A wireless sensor network (WSN) is a network of small, low power and autonomous devices, also known as nodes, which are deployed in a given environment to measure and monitor various environmental parameters. These nodes are interconnected with each other and can communicate with each other either directly or indirectly. They are typically powered by batteries or other energy sources and can be used for a variety of applications, such as monitoring temperature, humidity, air quality, weather, and more.

The nodes of a WSN are typically equipped with sensors that measure various environmental parameters, such as temperature, humidity, air pressure, and more. The data collected by these sensors is then transmitted to a central node, known as a base station, which collects and processes the data. The base station can then transmit the data to a remote server, which can then be used for further analysis and processing.

1.2-COMPONENTS OF A WSN:

A wireless sensor network consists of three main components: nodes, gateways, and a base station.

The nodes, also known as sensor nodes, are small, low-power, autonomous devices that are deployed in the environment to measure and monitor various parameters. They are typically equipped with sensors, such as temperature, humidity, air pressure, and more, as well as a transmitter and receiver. The nodes communicate with each other through radio waves. The gateways are devices that are used to connect the nodes with the base station. They are typically used to extend the range of the nodes, as well as to provide additional processing power. The gateways also act as a bridge between the nodes and the base station, allowing the nodes to communicate with the base station.

The base station is the central node in the WSN. It is responsible for collecting and processing the data from the nodes, as well as transmitting the data to a remote server. The base station is typically connected to the Internet, allowing the data to be transmitted to a remote server for further analysis and processing.

1.3-WIRELESS SENSOR NETWORK ARCHITECTURE:

The architecture of a WSN is typically divided into three layers: the physical layer, the data link layer, and the application layer.

The physical layer is responsible for providing the nodes with a physical connection to the base station. It typically consists of radio waves, as well as other technologies such as infrared and Bluetooth. The data link layer is responsible for providing the nodes with a logical connection to the base station. It typically consists of protocols such as the IEEE 802.15.4 protocol. The application layer is responsible for providing the nodes with the ability to communicate with the base station. It typically consists of protocols such as the ZigBee protocol.

1.3.1-TYPES OF WSN:

Depending on the environment, there are five distinct types of Wireless Sensor Networks.

1.3.2-TERRESTRIAL WIRELESS SENSOR NETWORKS

Terrestrial WSNs are employed to facilitate communication between base stations with great efficiency, and consist of thousands of wireless sensor nodes put in place either in an unstructured (ad hoc) or structured (Pre-planned) manner. The sensor nodes are scattered randomly throughout the designated area when they are released from a set plane in an ad hoc fashion. In this wireless sensor network (WSN), the battery power is very restricted; however, the battery is fitted with solar cells for a supplementary energy source. Energy efficiency of these WSNs is accomplished by employing low duty cycle operations, lowering any delays, and utilizing the most suitable routing, and many others.

1.3.3-UNDERGROUND WIRELESS SENSOR NETWORKS

The cost of establishing underground wireless sensor networks is higher than terrestrial WSNs due to the cost of equipment, installation, and upkeep. These networks are composed of several sensor nodes that are buried beneath the ground and keep track of underground conditions. For data transmission from the sensor nodes to the base station, additional sink nodes are put in place above the surface. The battery power of the sensor nodes is constrained and it is hard to recharge them. Furthermore, the underground setting makes wireless communication hard to achieve due to the strong attenuation and signal-loss rate.

1.3.4-UNDERWATER WIRELESS SENSOR NETWORKS

Approximately 70% of the planet is covered by water, and this environment comprises numerous sensor nodes and vehicles. To acquire data from the sensors, autonomous underwater vehicles are employed. An issue with underwater communication is its slow transmission, as well as the bandwidth and sensor malfunctions. When they are operating underwater, wireless sensor networks are fitted with a restricted power source that is not able to be recharged or replaced.

1.3.5-MULTIMEDIA WIRELESS SENSOR NETWORKS I

t has been suggested to use multimedia wireless sensor networks to be able to track and supervise events that can be described as multimedia, including video, audio, and images. These networks are constructed of low-cost nodes that have built-in microphones and cameras. These nodes are interconnected wirelessly so that data can be compressed, retrieved, and associated. The problems associated with multimedia WSNs are heightened power usage, massive bandwidth requirements, data processing, and compressing processes. Furthermore, multimedia content necessitates a great deal of bandwidth in order for it to be transmitted properly and effortlessly.

1.3.6-MOBILE WIRELESS SENSOR NETWORKS

Commonly known as MWSNs. A Mobile WSNs network contains a collection of sensor nodes that are able to move independently and interact with the surrounding environment. The mobile nodes are also equipped with the capacity to compute sense and communicate. Mobile wireless sensor networks are far more flexible than those that are fixed in one spot. There are many advantages to using MWSNs instead of static wireless sensor networks, such as an enhanced coverage area, higher energy efficiency, and an increased channel capacity.

1.4-WSN NETWORK TOPOLOGIES:

WSNs can be organized into different network topologies, depending on the application and the type of network. The most common types of network topologies are:

1.4.1-Bus networks: Bus networks consist of multiple nodes that are connected to a single line. In this type of network, data is transmitted from one node to the next, following the path of the line. Star networks: Star networks consist of a single node, known as the master node, that is connected to multiple nodes. In this type of network, data is transmitted from the master node to the other nodes.

1.4.2-Tree networks: Tree networks consist of multiple nodes that are organized into a tree structure. In this type of network, data is transmitted from one node to another along the branches of the tree.

1.4.3-Mesh networks: Mesh networks consist of multiple nodes that are interconnected with each other. In this type of network, data is transmitted from one node to another until it reaches its destination.

1.5-APPLICATIONS OF WSN

These networks can be utilized to monitor environmental conditions, like detecting forests, identifying animals, spotting flooding, forecasting, and predicting the weather. Additionally, they are also employed in commercial tasks such as predicting and monitoring seismic activity. Wireless sensor networks are commonly used for a variety of transport system applications including tracking traffic, dynamic routing control, and keeping an eye on parking areas, etc. Applications that are related to health, such as those which track and observe the activities of patients and medical professionals, make use of these networks.

These networks are deployed in military applications such as tracking and environmental surveillance. Sensor nodes are dropped into the designated area and can be remotely operated by a user. They are also useful for tracking enemies and detecting security issues. These networks are utilized for quick emergency reactions, keeping track of industrial processes, automatically regulating the climate of a building, observing ecological systems and habitats, and observing the structural health of civil structures. The Wide Area Tracking System (WATS) is a prototype setup and a device designed to locate any ground-based nuclear weapon such as an atomic bomb. Furthermore, there are several other Wireless Sensor Networks (WSNs) that are implemented for the purpose of threat detection.

1.6-CHALLENGES OF WSN

Despite their many benefits, WSNs also have some challenges. One of the biggest challenges is power management, as the nodes of the network need to be powered in order to operate. Data transmission range of the nodes is limited, meaning that the network may need to be expanded in order to cover larger areas. WSNs are vulnerable to security threats, as the data transmitted between the nodes is not encrypted.

2-LITRETURE SURVEY:

Rekha and Mahadevaswamy [13], Adaptive Zigbee-Aquila communication protocol (AZACP) was used to find the optimal shortest path for transferring data. AZACP finds the shortest optimal path for transmitting the sensed data to base station with low cost and less time consumption. Fault detection was the process of automatically identifying the fault in the transmission line and isolate the faulty nodes to ensure the efficient data transmission in WSN. Here, Enhanced Recurrent Equilibrium Neural Network (ERENN) was introduced to identify the fault in data transmission. It recognized the strength of the signal to transmit the sensed data and checks the quality of the data in transmission line between the nodes. software and compared with existing approaches like Adaptive Error Control (AEC), Gallager Humble Spira (GHS), Genetic Algorithm-Ticket Based Routing (GA-TBR), Improved Grid based Routing and Charging (IGRC) and Emperor Penguin Optimized Self-healing Strategy (EPOSH). The proposed approach provided better performance in terms of evaluating performance metrics like throughput, delay, reliability, average residual energy, number of total transmission, network lifetime, efficiency and Bit Error Rate (BER).

Xie *et al.* [13], proposed an energy-efficient routing mechanism by introducing intentional mobility to wireless sensor networks (WSNs) with obstacles. In the sensing field, Mobile Data Collectors (MDCs) can freely move for collecting data from sensors. An MDC begined its periodical movement from the base station and finally returns and transports the data to the base station. In physical environments, the sensing field may contain various obstacles. A research challenge was how to find an obstacle-avoiding shortest tour for the MDC. Firstly, author’s obtained the same size grid cells by dividing the network region. Secondly, according to the line sweep technique, the spanning graph was easily constructed. The spanning graph composed of some grid cells usually includes the shortest search path for the MDC. Then, based on the spanning graph, a complete graph by Warshall-Floyd algorithm was constructed.

KHEDIRI *et al.* [15], proposed and evaluate a new centralized energy-efficient clustering protocol for homogenous WSNs, which was called Distance energy evaluated DEE. In DEE, the cluster-heads (CHs), were elected by a probability based on the ratio between distance and residual energy of each node. The probability of being CH according to their initial and residual energy, finally, the simulation results seemed that DEE achieved more effective messages and longer lifetime than current important clustering protocols in homogeneous environments.

Verma [16] , analyzed key parameters for sensor network applications, including network lifetime, packet delivery ratio, energy-efficient transmission, and dead node ratio. Author examined the effectiveness of clustering in wireless sensor networks for achieving efficiency. The research focused on the Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol and proposed an enhanced algorithm that improves network lifetime, throughput, and the number of alive nodes. Article evaluated the performance of the improved LEACH protocol and compared it to other protocols currently in use. The results indicated that the proposed method significantly improved the protocol's performance, making it a promising method for efficient routing in wireless sensor networks.

ARAFAT *et. al* [17],developed an analytical model to determine the optimal number of clusters by considering intra- and inter-cluster transmission distances to reduce the overall transmission distance and number of transmissions. Finally, a routing algorithm to ensure energy-efficient packet delivery from CH to sink was proposed. Simulation outcomes revealed that the proposed DECR significantly outperforms the existing clustering and routing protocols in various performance metrics.

Xiang *et. al* [18],investigated the application of CS to data collection in wireless sensor networks, and author aimed at minimizing the network energy consumption through joint routing and compressed aggregation. Author first characterized the optimal solution to this optimization problem, and then proved its NP-completeness. A mixed integer programming formulation along with a greedy heuristic, from which both the optimal (for small scale problems) and the near-optimal (for large scale problems) aggregation trees were obtained.

Tabibi and Ghaffari[19], a new method called particle swarm optimization based selection (PSOBS) was proposed to select the optimal rendezvous points. By applying PSO, the proposed method was capable of finding optimal or near-optimal rendezvous points to efficient management of network resources. In the proposed method, a weight value was also calculated for each sensor node based on the number of data packets that it receives from other sensor nodes. The proposed method was compared with weighted rendezvous planning based selection (WRPBS) algorithm based on some performance metrics such as throughput, energy consumption, number of rendezvous points and hop count.

Krishnamoorthy *et. al* [20], presented a range-free radial basis function neural network (RBFN) and Kalman filtering- (KF-) based algorithm named RBFN+KF. The performance of the RBFN+KF algorithm was evaluated using simulated RSSIs and is compared against trilateration, multilayer perceptron (MLP), and RBFN-based estimations. The simulation results reveal that the proposed RBFN+KF algorithm showed very low location estimation errors compared to the rest of the three approaches. Additionally, it was also seen that RBFN-based approach was more energy efficient than trilateration and MLP-based localization approaches.

Jabbar1 *et. al* [21], incoming routing approach using a mix of the fuzzy approach besides hybrid energy-efficient distributing (HEED) algorithm for increasing the lifetime and node's energy. The FLH-P proposal algorithm was split into two parts. The stable election protocol HEED approach was used to arrange WSNs into clusters. Then, using a combination of fuzzy inference and the low energy adaptive clustering hierarchy (LEACH) algorithm, metrics like residual energy, minimal hops, with node traffic counts are taken into account. A comparison of FLH-P proposal algorithm with LEACH algorithm, fuzzy approach, and HEED utilizing identical guiding standards was used for demonstrating the performance of the suggested technique from where corresponding consumed energy as well as lifetime maximization. The suggested routing strategy considerably increases the network lifetime and transmitted packet throughput, according to simulation findings.

Shivaprakasha and Kulkarni [22], proposed a new Energy Efficient Shortest Path (EESP) algorithm for WSNs, which managed uniform load distribution amongst the paths so as to improve the network performance as compared to the traditional shortest path routing strategy.

3-CONCLUSION:

In WSN utilizing minimum power by nodes due to employing shortest path between nodes makes an efficient tradeoff between power consumption and passive node formulation. In this review article, we came to this conclusion that, shortest path optimization can be employed with the WSN to make efficient power consumption by the nodes. When node is not in active state, power consumed by that nodes will be minimum. By employing this strategy hop length will be less.

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