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IMPLEMENTATION OF MULTIHOP PROTOCOL WITH COST FUNCTION FOR DECREASING ENERGY CONSUMPTION IN NODES

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ABSTRACT:

An essential component of the Internet of Things is a wireless sensor network (WSN). (IoT). However, a WSN-based IoT network's sensor nodes have resource limitations in terms of energy. By grouping nodes into clusters, a clustering protocol effectively ensures node energy conservation and increases the network lifetime by minimizing the transmission distance between sensor nodes and base station. (BS). However, the clustering structure of existing clustering methods has problems that negatively impact their performance. Wireless networks have become an integral part of our daily lives, with a wide range of applications such as Internet of Things (IoT), smart homes, and industrial automation. However, the energy consumption of wireless networks is a major concern, especially in battery-powered devices such as sensors and mobile devices.

The project "Implementation of Multihop Protocol with Cost Function for Decreasing Energy Consumption in Nodes" aims to reduce the energy consumption of nodes in a wireless network by implementing a multihop protocol with a cost function. The cost function takes into account various factors such as distance, data rate, and signal strength to calculate the energy consumption of the nodes. The multihop protocol enables communication between nodes through intermediate nodes, reducing the energy consumption of nodes as they do not have to transmit data over long distances.

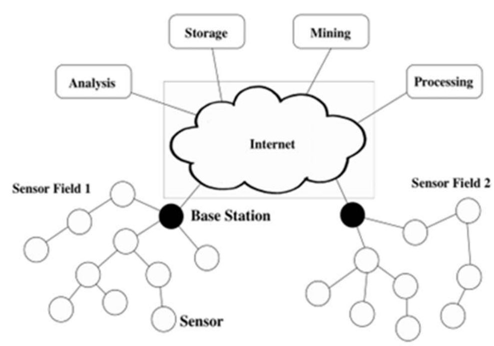
We present a routing protocol for Wireless sensor Networks that is reliable, power efficient, and has a high throughput (WSNs). To reduce energy consumption and increase network longevity, we employ a multi-hop topology. To identify the parent node or forwarder, we offer a cost function. The proposed cost function chooses a parent node with the highest residual energy and the shortest distance to the sink. The residual energy parameter balances energy consumption across sensor nodes, while the distance parameter guarantees packet delivery to the sink is successful.

Keywords: Wireless Sensor Network (WSN), Cost Function, energy consumption, multi-hop topology, residual energy, Base Station (BS), Internet of Things (IoT), network topology.

INTRODUCTION:

Technology advancements have created a numerous chance for resource efficiency in critical environments. In this context, Wireless Sensor Networks (WSNs) have ushered in a revolution. These devices, which include sensors, smartphones, and other mobile devices, are often battery-powered and operate in environments where access to a power source is limited. As a result, energy efficiency has become a critical concern in wireless networks. Wireless Sensor

Networks (WSNs) can be defined as a self-configured and infrastructure-less wireless networks to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location or sink where the data can be observed and analysed. A sink or base station acts like an interface between users and the network. Typically a wireless sensor network contains hundreds of thousands of sensor nodes. The sensor nodes can communicate among themselves using radio signals. A wireless sensor node is equipped with sensing and computing devices, radio transceivers and power components. The individual nodes in a wireless sensor network (WSN) are inherently resource constrained: they have limited processing speed, storage capacity, and communication bandwidth. After the sensor nodes are deployed, they are responsible for self-organizing an appropriate network infrastructure often with multi-hop communication with them. Then the onboard sensors start collecting information of interest. Wireless sensor devices also respond to queries sent from a “control site” to perform specific instructions or provide sensing samples. The working mode of the sensor nodes may be either continuous or event driven. Global Positioning System (GPS) and local positioning algorithms can be used to obtain location and positioning information. Wireless sensor devices can be equipped with actuators to “act” upon certain conditions.



General System Model of WSN

CHARACTERISTICS OF WSN:

It was observed that there were many similarly between sensor network and ad hoc networks, both are dynamic and on demand. Some other similar characteristics are mobility, switching and the limit capability of the battery power. WSN also has some distinct properties as listed below

A. Power Efficiency Sensor nodes are often facing problem of void and dumped due to battery power run down of sensor node. In addition, as per many researches the energy consumes by the nodes in sending data over the communication is more than the energy of the nodes in computing. Therefore, maximize wireless sensor network’s lifetime is a problem is exists.

B. Fault Tolerance The wireless sensor nodes have ability of organizing itself in the network as nodes have deployed in random fashion remote location and unreceptive environment. For preventing from fault sensor nodes have worked in collaboration to reorganize itself and used distributed algorithm to form network automatically

C. Mobility of Nodes As it knows that wireless sensor network is collection sensor network in which some nodes are movable and some are static. We say that nature of WSN is dynamic. Due to limited resources nodes can failed for battery fatigue or some other conditions, communication channel may be disrupted. Topology is also affected by adding of node or failure of node. Thus, the WSN nodes have developed the function of self-governing and self-management

D. Heterogeneity of Nodes Heterogeneous means different nature of nodes, which are different from each other by the communication range, mobility, sensing parameters and work at different protocols etc. Heterogeneous WSN are collection of various different types of sensor nodes with have different features, follow different protocol, different computation capacity and different sensing and monitoring range. Deployment of heterogeneous sensor network more typical than homogeneous wireless sensor network

E. Scalability of Node In WSNs sensor nodes are able to collecting, processing, arranging, aggregating and sending data to sink node or base station. As number of nodes increases sensor network become very large. In the large network sensor nodes are able to communicate with faraway nodes but also produce traffic problem, difficult to manage and coordinate

F. Responsiveness WSN has ability to quickly adapt itself the changes in the topology. It has considered its responsiveness. To get highly responsiveness in the network. It needs to compromise with latency of network and as well as scalability

G. Communication Failures Wireless sensor networks work in free style fashion as ad hoc in nature. Sensor device has very low communication bandwidth and low communication distance range. And also it has some mobility degree of freedom. Sensor network will also be affected by the impact of natural disaster such as mountains slid, buildings damage and storms and cyclones, heavy rain falls and thunder lighting, the remote location obstacles, weather, and many more. That’s why; it is very difficult to manage and maintain WSN run smoothly. This is an important impact of research direction in the future.

For WSN, we present a routing protocol that is high throughput, reliable, and stable. In a given area, we set up sensor nodes. Near the sink, sensors are positioned. Because sensors carry data and require low attenuation, great reliability, and extended life, they always send data directly to the sink. Other sensors track their parent node and send data to the sink via the forwarder node. It conserves node energy and allows the network to operate for longer.

LITERATURE SURVEY:

1. “An Improved Energy Efficient Clustering Protocol for Wireless Sensor Networks" by S. R. Biradar and S. C. Sharma. (International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), 2018)

This paper discusses how the proposed protocol addresses the limitations of existing protocols and improves energy efficiency through optimized cluster formation, data aggregation, and communication strategies. In summary, the literature survey in this paper provides an overview of existing research on clustering protocols for WSNs, identifies the need for improved energy efficiency, and presents the proposed protocol by Biradar and Sharma as a potential solution. It serves as a valuable reference for researchers and practitioners working in the field of WSNs, providing insights into the state of the art and potential areas for further research.

2. “Energy Efficient Clustering Protocol for Wireless Sensor Networks” by S. S. Patil and S. S. Sonavane (International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, 2018).
The literature review in the study gives a summary of the body of work on clustering procedures for WSNs, highlighting its salient characteristics, benefits, and drawbacks. The literature review starts out by highlighting the importance of energy efficiency in WSNs, taking into account the constrained power resources of sensor nodes and the requirement to increase network lifespan. It gives a concise explanation of the idea of clustering in WSNs, where sensor nodes are grouped together to improve data aggregation, communication, and energy efficiency.

3." An Energy Efficient Clustering Protocol for IoT Enabled Wireless Sensor Networks " by S. S. Gupta and A. Singh. (International Conference on Computing, Communication and Security (ICCCS), Rome, Italy, 2019).
The survey reviews existing clustering protocols that aim to extend network lifetime by organizing sensor nodes into clusters and electing cluster heads to facilitate data aggregation and communication. This research provides valuable insights into the state of the art in clustering protocols for WSNs and the need for tailored solutions to address the specific requirements of IoT applications. The survey can serve as a useful reference for researchers and practitioners working in the field of IoT-enabled WSNs, providing a comprehensive overview of existing literature and potential areas for further research.

4. " Energy Efficient Clustering Protocol for Wireless Sensor Network Using Fuzzy Logic " by S. S. Patil and S. S. Sonavane (International Conference on Cloud Computing, Data Science & Engineering - Confluence, 2019).
The article presents a novel energy-efficient clustering protocol for wireless sensor networks (WSNs) that utilizes fuzzy logic, proposed by Patil and Sonavane. The authors provide a comprehensive literature review on existing clustering protocols for WSNs, highlighting the need for energy-efficient solutions to prolong the network lifetime. They also discuss the challenges of energy consumption, network scalability, and data aggregation in WSNs. The proposed protocol utilizes fuzzy logic-based decision-making to dynamically select cluster heads based on multiple parameters such as residual energy, distance, and node density.

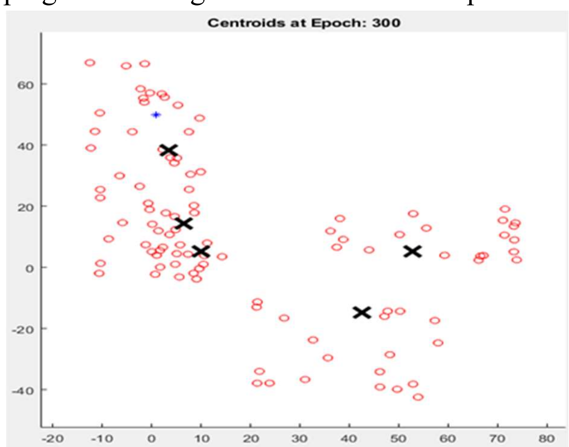
5." An Energy-Efficient Clustering Protocol for Wireless Sensor Networks Based on IoT " by Y. Liu, H. Wang, and X. Li (IEEE 7th International Conference on Energy Smart Systems (ESS), 2020).
The survey presents the key features and advantages of the proposed protocol, including its ability to adapt to dynamic network conditions and reduce energy consumption through optimized data transmission and clustering algorithm. In summary, the literature survey in this paper provides a concise overview of existing research on clustering protocols for IoT-based WSNs, highlights the challenges and requirements of such networks, and emphasizes the relevance and contribution of the proposed protocol by Liu et al. It serves as a valuable reference for researchers and practitioners working in the field of IoT-based WSNs, providing insights into the state of the art and potential areas for further research.

RECENT WORKS:

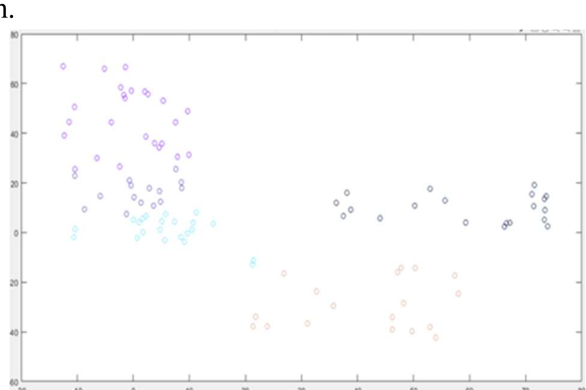
An improved energy-efficient clustering protocol (IEECP) is proposed to prolong the lifetime of the WSN-based IoT which consists of three parts:

Firstly, a modified mathematical model is proposed based on the analysis of the energy consumption model for multi-hop communications and overlapping clusters in order to determine the optimal number of clusters. Secondly, a modified fuzzy C-means algorithm (M-FCM) is proposed in order to produce balanced cluster. Thirdly, a new algorithm is proposed known as CH selection and rotation algorithm (CHSRA) that integrates the back-off timer mechanism for CH selection, with a new rotation mechanism for CH rotation among members of the cluster. This major contribution can be achieved through the following tasks:

i. Selecting the optimal number of clusters based on the modified mathematical model by considering the overlapping case among clusters and multi-hop communications.



ii. Forming balanced clusters that reduce the cost in the intra-distance based on modified fuzzy C-means algorithm (M-FCM) that result from a combination of the FCM algorithm with a centralized mechanism.



iii. Reducing the energy overhead that results from the CH selection process in each round by a new integration of the back-off timer mechanism for CH selection with rotation mechanism in one algorithm known as CH selection and rotation model (CHSRA),

iv. Balancing the communication distance among the CHs in the network based on a new objective function for the back-off mechanism, and balancing the life of the selected CHs in the cluster based on a new dynamic threshold.

Disadvantages of Existing Method

1. The proposed IEECP protocol is high on complexity.
2. It consumes more energy and this is what we're trying to improve in our proposed method.

METHODOLOGY:

The stability period of our proposed scheme is longer. Nodes are able to stay alive for longer periods of time while using the least amount of energy possible.

High throughput is aided by a long stability period and low node energy consumption.

We deploy numerous nodes in a region under this scheme. The power and compute capability of all sensor nodes are identical.

Two nodes are chosen, and these two nodes will transport data directly to the sink.

a) First phase:

During this phase, the sink sends out a brief data packet containing the sink's location in the area. Each sensor node stores the location of sink after receiving this control message. Each sensor node sends out a data packet that includes the node's ID, position in the area, and energy status. All sensor nodes are updated with the location of their neighbours and sink in this manner.

b) Forwarder Node Selection:

We designed a multi-hop approach for WSN in order to save energy and increase network throughput. The conditions for a node to become a parent node or forwarder are presented in this section. Proposed protocol elects a new forwarder in each round in order to balance energy consumption across sensor nodes and reduce network energy usage.

Every node determines whether or not to become a forwarder node based on this cost function. If n is the number of nodes, the following is the cost function for n nodes:

$$C.F\,(n)=\frac{d(n)}{R.E(n)}$$

The distance between node n and sink is denoted by d (n) and R.E (n) is the residual energy of node n, determined by subtracting the current energy of node from the initial total energy. As a forwarder, it is preferable to use a node with a low cost function. All of the neighboring nodes join forces with the forwarder node and send data to it.

Data is gathered and sent to the sink via the forwarder node.Because the forwarder node has the most residual energy and travels the shortest distance to the sink, it uses the least amount of energy to send data there. Two chosen nodes interact directly with the sink and are not involved in data transmission.

c) Scheduling:

The forwarder node provides time slots to its progeny nodes using Time Division Multiple Access (TDMA) in this phase. Every child node sends its detected data to the forwarder node at a predetermined time. A node enters idle mode when it has no data to send. Only during transmission time do nodes wake up. The energy dissipation of individual sensor nodes is minimized when sensor nodes are scheduled. Performance metric of the proposed method is Energy consumption of nodes, here we use the residual energy parameter to study network energy consumption in order to investigate the energy consumption of nodes every round.

MECHANISM:

The project "Implementation of Multihop Protocol with Cost Function for Decreasing Energy Consumption in Nodes" aims to reduce the energy consumption of nodes in a wireless network by implementing a multihop protocol with a cost function. The mechanism of the project can be explained in the following steps:

Network Topology: The wireless network consists of several nodes that are interconnected through wireless links. The nodes can communicate with each other through direct links or through intermediate nodes.

Multihop Protocol: A multihop protocol is implemented to enable communication between the nodes in the network. In a multihop protocol, the data is transmitted from the source node to the destination node through one or more intermediate nodes. This reduces the energy consumption of the nodes as they do not have to transmit data over long distances.

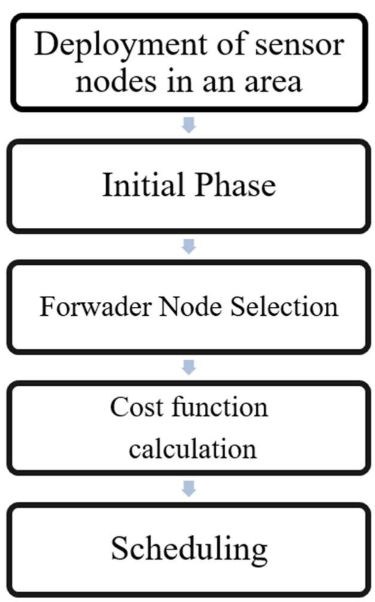
Cost Function: A cost function is used to calculate the energy consumption of the nodes in the network. The cost function takes into account various factors such as distance, data rate, and signal strength to calculate the energy consumption of the nodes. The cost function is used to select the best path for transmitting data between the nodes.

Energy-Aware Routing: Energy-aware routing is used to select the best path for transmitting data between the nodes based on the energy consumption of the nodes. The routing algorithm selects the path that minimizes the energy consumption of the nodes.

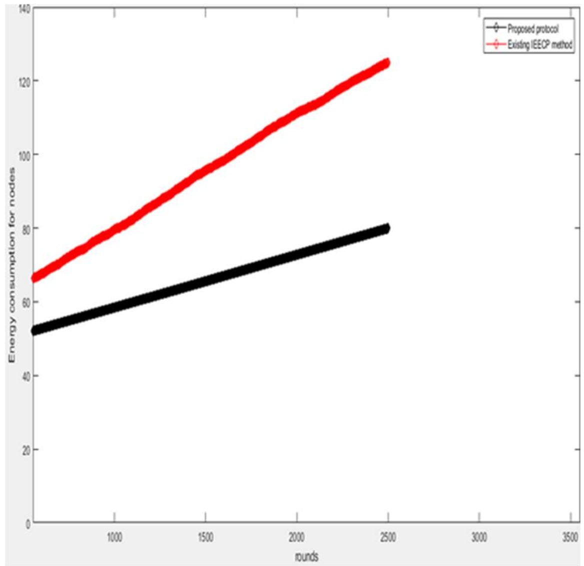
Data Transmission: Once the best path has been selected, the data is transmitted between the nodes in the network. The nodes use the multihop protocol to transmit the data through one or more intermediate nodes. The nodes also use the cost function to calculate the energy consumption of the nodes during data transmission.

Energy Consumption Optimization: By using the multihop protocol with a cost function, the energy consumption of the nodes in the network is reduced. This helps to extend the battery life of the nodes and increase the overall efficiency of the network.

BLOCK DIAGRAM:



RESULT:



We used MATLAB R2018a to run for testing the proposed approach. We compared the proposed protocol's performance to that of the existing IEECP protocol.

The suggested model employs a multi hop architecture, in which the data from each distant node is sent through a forwarder node to the sink. The cost function is used to select the forwarder node. In each round, choosing the right forwarder helps you save energy. Our multi hop design uses a separate forwarder node in each cycle to transport packets to the sink, preventing overloading of a single node.

FUTURE IMPROVEMENT:

The implementation of a multihop protocol with a cost function for decreasing energy consumption in nodes is a promising project that can lead to significant improvements in the energy efficiency of wireless networks. However, there are several areas where the project could be improved in the future to enhance its effectiveness.

One potential improvement is to explore different cost functions that can further optimize energy consumption. While the current implementation uses a simple cost function that considers only the distance between nodes, more complex cost functions can be developed to take into account other factors such as the number of hops, network traffic, and node congestion. By using a more sophisticated cost function, the multihop protocol can make more informed decisions about the best route to take, which can lead to greater energy savings.

Another area where the project could be improved is by incorporating machine learning techniques to make the protocol more adaptive. For example, by using reinforcement learning, the protocol can learn from past experiences to improve its decision-making process. This can lead to better routing decisions and further reduce energy consumption.

Overall, by incorporating these improvements, the implementation of a multihop protocol with a cost function for decreasing energy consumption in nodes can become a more effective tool for improving the energy efficiency of wireless networks.

FUTURE SCOPE:

As mentioned earlier, there is still remarkable room for enhancement in the field of Wireless Sensor Network. In this segment, we will explore these potential improvements in more detail.

Optimization of the cost function: The cost function used in the project can be further optimized to include additional factors that affect energy consumption, such as the number of hops, interference, and packet size. The optimization of the cost function could result in further energy savings for nodes in wireless networks.

Integration with energy harvesting techniques: The project's approach can be integrated with energy harvesting techniques such as solar, thermal, or kinetic energy harvesting to provide a sustainable energy source for the nodes. The integration of energy harvesting techniques could extend the battery life of nodes and further improve the energy efficiency of wireless networks.

Extension to larger networks: The project's approach can be extended to larger networks, including mesh networks and ad-hoc networks. The extension to larger networks could provide more opportunities for energy savings, particularly in applications such as smart cities and industrial automation.

Integration with machine learning algorithms: The project's approach can be integrated with machine learning algorithms to provide dynamic and adaptive energy-efficient routing decisions. The integration of machine learning algorithms could improve the efficiency and performance of the routing algorithm, particularly in dynamic network conditions.

Implementation on hardware: The project's approach can be implemented on hardware, such as microcontrollers, to create low-power, energy-efficient wireless network devices. The implementation of the project's approach on hardware could provide a practical.

APPLICATIONS:

1. Industrial control
2. Environmental monitoring,
3. Military surveillance,
4. Intelligent transportation systems and medical field.
5. Furthermore, it can function independently in harsh or high-risk places where human presence is not possible
6. Disaster relief operations.
7. Biodiversity mapping
8. Monitoring of temperature, pressure, humidity.

CONCLUSION:

In today's world, the widespread use of wireless networks has led to an unprecedented demand for energy. This demand is likely to increase in the future as more devices are connected to the network, making it imperative to find ways to reduce energy consumption in wireless networks. The implementation of a multihop protocol with a cost function for decreasing energy consumption in nodes is a significant step towards achieving this goal.

The project uses a multihop protocol that enables the transmission of data packets through multiple hops, rather than relying on direct communication between nodes. By optimizing the routing decisions made by the protocol using a cost function that takes into account the distance between nodes, the protocol can reduce the energy consumption of wireless networks.

In this significant work, we propose an cost efficient Multihop protocol to prolong the lifetime of WSN-based IoT network through overcoming the problems of the clustering structure that adversely affect the protocol performance. Evidently, the proposed protocol reduces and balances the energy consumption of nodes by improving the clustering structure.Our proposed protocol will be a beneficial contribution to the enhance that will enhance the daily operations in many areas of life, which utilize WSN in the IoT world.The stability period of our proposed scheme is longer. Nodes are able to stay alive for longer periods of time while using the least amount of energy possible. We deploy numerous nodes in a region under this scheme. The power and compute capability of all sensor nodes are identical. During this phase, the sink sends out a brief data packet containing the sink's location in the area. Each sensor node stores the location of sink after receiving this control message. We designed a multi-hop approach for WSN in order to save energy and increase network throughput. The conditions for a node to become a parent node or forwarder are presented in this section. The ID, distance, and remaining energy status of the nodes are all known to the sink node. Every node determines whether or not to become a forwarder node based on this cost function. If n is the number of nodes, the following is the cost function for n nodes:. As a forwarder, it is preferable to use a node with a low cost function. All of the neighboring nodes join forces with the forwarder node and send data to it. Data is gathered and sent to the sink via the forwarder node. Because the forwarder node has the most residual energy and travels the shortest distance to the sink, it uses the least amount of energy to send data there. The forwarder node provides time slots to its progeny nodes using Time Division Multiple Access (TDMA) in this phase.

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These references highlight the latest research on the use of AI and IoT-enabled smart exoskeletons for rehabilitation of individuals with paralysis, including the development of real-time monitoring systems, adaptive fuzzy control algorithms, and reinforcement Here are some of the latest references (published in 2022 and 2023) on AI and IoT-enabled smart exoskeleton rehabilitation of paralyzed people: learning-based control. Additionally, these studies explore the effectiveness of these devices in improving gait rehabilitation outcomes, as well as patient satisfaction and quality of life.