Selecting Cluster Heads for Low Power in Wireless Sensor Networks for Internet of Things

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Abstract:
Sensor networks are in high demand because they are becoming one of the most useful methods of transmitting data through networks, thanks to recent improvements in technology. WSN is currently expanding its reach into a wide variety of interdisciplinary scientific and technological domains. The sensing and relaying of information inside a Wireless sensor Network WSN takes place over a large number of geographically dispersed nodes. The sensor nodes in a network often have a meager power supply, which is why they are outfitted with small batteries. As a result, maximizing the WSNs' battery life is the most fundamental challenge. However, clustering techniques have been used in sensor networks, and this has a significant impact on energy efficiency.Energy and longevity concerns for IoT networks are among the most pressing problems facing the modern, connected society. The answer to this problem is clustering, in which all nodes are organized into virtual clusters and one node acts as the cluster head. Choosing the most efficient cluster head may significantly save costs. This idea is especially important for the IoT, which is rapidly spreading to new places like forests and the smart agricultural industry.

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Introduction

The "Internet of Things" (IoT) is a network of interconnected physical objects (e.g., machines, wireless devices, people, agents, and even animals) that lack a central controlling node. Everything that makes up the network is given a unique identifier. In the Internet of Things sphere, ensuring high-quality user-to-user and/or user-to-device communication channels is crucial. The real-time activity of sensor nodes enables people to engage with their physical surroundings in more meaningful ways. The ocean environment and physical parameters like pressure, temperature, sound, and pollution may all be monitored using these low-power and flexible nodes. Putting the idea of the Internet of Things into practice requires wireless sensor networks, often known as WSNs. It facilitates the exchange of data and communication amongst the many nodes that make up an IoT system. The processing power, bandwidth, storage capacity, and battery life of this kind of network are all limited in comparison to those of other networks. Data transfer tasks that are replicated cause a greater quantity of energy to be wasted in the network than the original data transfer operations. Consequently, reducing the amount of redundant data sent over the network may help save power and extend the life of the system. Wireless sensor networks (WSNs) may be useful in many settings where traditional networks would be impractical. However, we call the network made up of Internet of Things devices used to monitor remote regions, including forests and/or smart agricultural areas, a sensoricIoT network since its nodes are often small, disposable sensors. It's vital to remember that the sensor-based Internet of Things consists of countless individual sensor nodes, each of which typically includes a radio transmitter, a central processing unit (CPU), and a power source (typically a battery). Improving the energy efficiency of such networks is a serious challenge, in part because the batteries used in lightweight sensors cannot be replenished. Therefore, cutting-edge methods are crucial to improving energy efficiency and extending the useful life of sensor-based IoT devices. Many other strategies, such as topology control routes and security, have been studied in this context. One strategy that has had a lot of success in improving energy efficiency is adopting a hierarchical organizational structure.The power efficiency of topological control may be enhanced by placing nodes in a hierarchical structure. As a result, less power is required to maintain connections across great distances. Specifically pertaining to a hierarchical framework, node clustering is a crucial tactic. Bandwidth loss, congestion, and mistakes in IoT networks are all mitigated by this method. This is due to the fact that for a given total number of nodes, less information exchanges may take place simultaneously between the environment and the central station or sink. However, the state of the art does not adequately meet the need for an accurate mathematical modeling of cluster head (CH) selection in the Internet of Things.

When nodes in a region are organized into a cluster, they are better able to share information with their CH. CHs collect data provided by cluster nodes and send it to the sink or base station, usually after compressing it. The energy efficiency and lifespan of IoT networks can be greatly improved by selecting the optimal CH (Selecting the optimal CH is as important and effective as the algorithm used for clustering due to the reduced connection-tion traffic in the network). There are two main types of criteria used to choose CHs:The first method is to use a clustering algorithm. Methods that give methods for selecting the CH often fall into the second group and typically make use of one of the first-order algorithms. They maximize the effectiveness of the process through which CH nodes are selected. Because most second-order algorithms are based on AI techniques for tackling optimization difficulties and methods that employ analytics to realize an optimum solution (), the practical outcomes of these approaches are superior to those of the first. Energy-efficient routing methods are crucial in the Internet of Things (IoT) because of the limited computation, storage, and battery power available. Tree-based routing is used in IoT because of its energy efficiency. A root is selected in tree-based approaches before the date is sent. These techniques provide a connection across modes by constructing a hierarchical root between nodes. With an MST, the path between these IoT nodes may take on the form of a tree.In an undirected, connected graph, a spanning tree is a subgraph that links all of the vertices together. It's possible that the same graph has many spanning trees..

Related Work

First-order algorithms' declared goal was clustering, but they also presented a technique for choosing the CH node implicitly. The LEACH method is widely used in this field. Each existing node in the cluster passes acquired data to the associated CH during the setup phase of this technique, and during the stable state phase, all data is transferred from the existing nodes to the CH. Each CH sends its data straight to the base station when it has been collected. Nodes with low batteries have a greater chance of becoming CH, however this value varies on each individual node. Additionally, the PEGASIS well-known protocol is one of the LEACH advancements that employs a chain of nodes to initiate data transmission from the most distant node, with the expectation that each node in the chain would thereafter transfer its data to the most near neighbor.

In large-scale networks, this algorithm's trade-off of balancing energy usage within a chain for longer latencies in data transmission makes it impractical. For persistent ad hoc networks, Younis and Fahmy (2004) offer a distributed clustering algorithm called HEED. This protocol enables communication between CHs and the base station across several hops as well as single-hop communication inside each cluster.Unlike LEACH, which chooses clusters at random, this method uses the remaining energy to pick the primary set of CHs and the cost of intracluster communications to determine whether or not to join a cluster. The degree or proximity of a node to its neighbor determines this cost.

Other approaches to determining the CH node have also been developed in addition to the aforementioned algorithms. An method suggested by Varghese (Varghese, 2016) takes into account the potential of each node in addition to energy, throughput, and distance from the base station while choosing the CH.Some broad strategies are employed in the second-order procedures, and they can include evolution-ary algorithms, machine learning, fuzzy systems, and so on. Using characteristics like remaining energy, the number of CHs, the total intracluster communications lengths, and the total CH distances to the base station, a fitness function is created to determine which CH should be chosen using a genetic algorithm (Pal et al., 2015). A CH may also be chosen using fuzzy logic, as suggested in the works of Gajjar, Sarkar, and Dasgupta (2014) and Barolli et al. (2012). Many optimization issues in various parts of the WSN have recently been solved using an ant colony optimization approach, with positive results. An method inspired by the ant colony optimization procedure is presented in Sharma et al. 2014. The authors use ACO in IoT routing, creating an optimum path based on the most likely method and the required quantity of pheromone to go from the source node to the sink. This approach uses a random selection of CHs for the initial LEACH configuration..

Particle congestion optimization is another well-known optimization method that may be used to choose up CH nodes with success. A novel approach to choosing a CH is presented in Ni et al. 2015, which employs fuzzy clustering (Chiu, 1994) for initial node clustering and the tried-and-true PSO algorithm for choosing the CH.The Nave Bayes function is a data mining approach used by Jafarizadeh, Keshavarzi, and Derikvand (2017) to identify the CH node in a WSN. The choice of CH is based on a number of factors, including the node's remaining energy and the sum of the local distances from all of the member nodes to the CH node. To further improve efficiency, an intracluster spanning tree (Lachowski et al., 2015) might be used. In addition, a spanning tree-based clustering approach is provided by C. Li et al. (2011). They claim that by doing so, they have increased the scalability of their clustering algorithm and hence increased the lifespan of their network. In 2014, Saravanan and Madheswaran introduced the BASA-WMST technique, a hybrid evolutionary algorithm for data routing in the IoT that makes use of the Bee Algorithm and Simulated Annealing to produce a Weighted Minimal Spanning Tree. The sensor nodes in this strategy are placed in the field at random. The optimum data path is determined when the nodes are partitioned into clusters and the optimal number of clusters is assessed. For a multihop network, this approach computes the MST from the weighted graph, which is then used to find the shortest route between the cluster's individual nodes. According to research by Chapuis et al. (2017), the following are the top methods for resolving shortest route problems:

• Breadth-first search and depth-first search are both types of searches; however, a simple implementation of depth-first search may not always provide the best results.If all edge weights are non-negative, Dijkstra's method finds a solution to the Single-Source Shortest Path issue. This approach is able to calculate shortest pathways from any start nodes to any destination node without increasing the runtime complexity.• Like Dijkstra's algorithm, the Bellman-Ford method finds the shortest path between two sources, but unlike Dijkstra's algorithm, edge weights may be negative.

The All Pairs Shortest Path issue can be solved via the Floyd-Warshall method.

Objectives of Research

•IoT network development.

•A hash-based addressing method is built right into the devices themselves.

•Power consumption may be lowered by creating a data aggregation system.

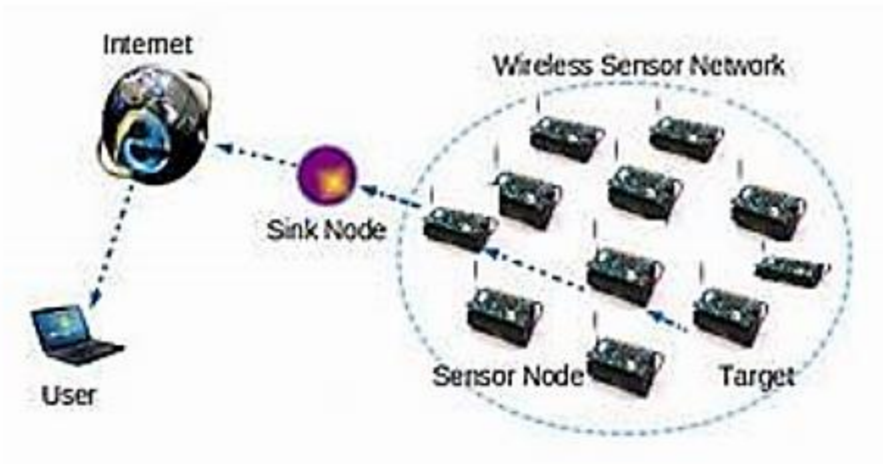

Figure.1 wireless sensor network

Concerns about nanotechnology span from potential biomedical risks to concerns about robotic control. Whatever the worry, one thing is certain: progress in science and technology continues to accelerate at a dizzying rate. The future advantages of a just, user-centric, and global Internet of Things [1],[2],[3] can only be realized via knowledge of such advancements and the issues they offer. In fact, the Internet of Things (IoT) is a catchall term for the idea that networked devices may detect and gather data about the physical environment, then exchange that data with one another and with us through the internet. The Internet of Things (IoT) is a network of physical items like phones, cars, fridges, and televisions.WSN has dedicated sensors for monitoring and at the central location it organizes its collected data

Applications

• Spatial surveillance One of the most useful use of WSN is in area monitoring. When a WSN is used for area monitoring, a phenomenon is tracked throughout a certain geographical area.

Air quality measurements Several communities have installed wireless sensor networks to continuously monitor toxic gas levels. Ad hoc wireless networks provide for more portability than hardwired deployments, which is useful for testing purposes in a variety of locations.

• Detection of forest fires It is possible to establish a network of sensor nodes in a forest in order to determine whether a fire has really begun there. These nodes are fully equipped with sensors for monitoring environmental conditions and chemicals released by the forest fires.

The water quality monitoring system checks the characteristics of water in dams, rivers, subterranean water reserves, lakes, and seas. Using several wirelessly dispersed sensors enables the generation of a more accurate, error-free map of the water's state.

• Environmental sensing: several applications exist for keeping tabs on environmental factors. Unpleasantly harsh settings are a problem for everyone, and they all contribute to a decreased power supply.

• Healthcare monitoring: implantable, wearable, and environment-embedded sensor networks are just a few examples of the different kinds of sensor networks used in healthcare. Medical implants are those that are placed within a patient's body. Devices of this kind are worn on or carried in close proximity to the user's skin. Environment embedded systems make use of the various sensors already available in the surrounding area.

• Protection against natural disasters Wireless sensor networks may be used to stop the spread of calamities like floods before they cause widespread destruction. Using enabled or strategically placed wireless nodes in the river, we can track the rise and fall of the water level in real time.

Because of the importance of security in fields such as the military and medicine, Security Gateways are not included, and the insecure working environment of WSN may form several weak places that draw opponent. The technique may be used for device addressing. Aggregation was created for the sole aim of lowering energy use. A Kerberos-based security mechanism has been designed for user authentication.

Characteristic Features Of WSN

Aggregating data Due to limitations in available resources (such as battery life, processing speed, storage space, network throughput, etc.), data aggregation in sensor networks is not feasible. Data aggregation is a strategy used to overcome this issue by combining redundant data sets into a single, energy-efficient one.

• Security Gateways are not provided, and the unprotected working environment of WSN may comprise several weak spots that attract adversaries. This is especially concerning when WSNs are used for sensitive applications, such as those in the medical and defense sectors.

Implementation

For the purpose of device addressing, an algorithm known as Secure Hashing Algorithm has been developed. This approach may be used to assign addresses to devices.Aggregation was created to help lessen the burden on the electricity grid. A Kerberos-based security mechanism has been designed for user authentication.MATLAB serves as the platform for the EEMST method. The number of clusters may be taken into account while calculating the network lifespan under varying conditions. Additionally, various base station installation sites are analyzed as their relative importance to the network's lifespan is evaluated. The simulation was run for 30 iterations at each level, and the results were averaged to assure accuracy.First, we ran a series of tests to see how the network lifespan changed across various configurations in the EEMST algorithm, so that we could gauge the effectiveness of our suggested approach. The first configuration (config 1) had a network size of 200x200, an initial energy of 2 J, and base station coordinates of (100,100). We investigated how the total number of clusters affects the lifespan of the network using this technique.

Conclusion

An effective system has been developed and tested using real-time sensors for the purpose of monitoring the parameters and controlling the device. The Internet of Things (IoT) is cutting-edge innovation that will determine the future of device management and user interaction. We can improve data collecting and management by introducing the idea of the data collection.

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