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The Comparative Analysis between Distance DEEC and IOT DEEC Based on Network Lifetime and Energy Consumption

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Abstract: The family of IoT are closely connected to WSNs as many IoT systems are built around WSNs. In the same way even though it is the little battery capacity for the nodes of sensors, energy efficiency is so important. The main routing protocol being studied in this paper are the new IoT-DEEC (DEEC for the Internet of Things) and the Distance-DEEC (D-DEEC), which could lead to a huge saving in energy and prolong the leader the Network's life. With D-DEEC and IoT-DEEC, specific cluster heads (CHs) are designated by these and this is strictly to serve the aim of maximizing power consumption. The D-DEEC algorithm takes two factors into account when selecting the CHs which are more near the base station and have abundant energy level. It also features the sleep-wake system so that walking can be in CH mode or regular mode. Unsurprisingly, the IoT-DEEC saves energy compared to this one, with it limiting the staying of data in the CH and involving the distances between nodes and the CHs in the calculations of the energy consumption. Parallelly to explain the advantages of these protocols over the conventional ones the paper also suggests other points like hardware implementation issues, simulation studies and types of optimizations for energy efficiency. From the Results reported, The proposed "IOT-DEEC" would yield the excellent results when compared to Developed Distributed Energy-Efficient Clustering DDEEC, and Improving Distributed Energy-Efficient Clustering IDEEC and the Conventional Distributed Energy Efficient Clustering DEEC, which are based on increasing the nodes alive, decreasing the dead nodes, and increasing the packet to The LR t-model created more Alive nodes by approximation 22% in all rounds and decreased the highly Dead nodes by approximation 28.79% compared by conventional algorithms. The model also increased the Packet to BS by approximation 48.6% in all rounds.

Keywords: IOT internet of things, DEEC distributed energy efficient, CH cluster head.

1. Introduction

WSNs are made of compact wireless sensors that grab and spread data 'wirelessly, directly' without physical connections. These sensors are in charge of full collection of environmental data by detecting severe measurement of temperatures, humidity, light and motion, etc. Transceiver, sensor, a power source, and microcontrolling a unit make up a WSN sensor node. Real-time sensor monitoring is used for sensing purpose while data is transmitted and processed by distributed processing units onto the base station (BS) [1].

While this data is useful, the wireless sensor networks are limited in terms of speed, storage capacity, and transmission bandwidth or bandwidth of data due to the resource constraints of the sensor nodes (sN) and the challenge of power sources recharging. The researchers have devoted a significant amount of time and effort into the development of routing algorithms that will be used to determine the best way of managing power resources in the network at both the workplace and the household level [2].

Compacting strategies of routing that is in use in WSNs include the reduction of power consumption, load balancing, and the increase of network's capacity to survive the node failures. The research work contains the protocols for IOT-Distributed Energy-Efficient Clustering (IOT-DEEC) and Distance-DEEC. According to conditions such as left capacity, forwarding distance to the nearby nodes, and closer to the BS, the algorithms are able to select the cluster heads. Needless to say, energy loss can be avoided: Sleep/Wake function. Different from the DEEC approach which has been under trial, designed method decreases signal packet numbers to transmit to base station, leads to fewer idle times and becomes much more energy-efficient. DEEC protocols clustering and routing performances were highly compared to the cutting-edge DEEC clustering and routing techniques via simulations, through which we observed improved end-to-end performance, lower routing destination look-up, and clustering stability across the network [4].

The CHs (Cluster Heads) of those routing systems that use clustering to aggregate data and decrease overall energy consumption are in that case used to forward the messages. In the WSNs cluster diversity Figure, both the actions within and between the clusters, the cluster size and the communication between or within clusters are contained. CH a through its mobility and versatility advantage has an edge over HF. Mobility facilities CH going from one cluster to another, in the meantime the capability states if the network can be heterogeneous or homogeneous. Where in homogenous networks, sensors with different capacities are adopted to enhance efficiency of data transmission, in the homogeneous networks all the nodes have usual capabilities [5].

In view of the purpose of boosting wireless sensor networks energy efficiency and their longevity in use for crucial IOT implementations, it is therefore necessary to come up with and then study energy-efficient routing protocols. The major point of improvement of the D-DEEC (Distance-DEEC) protocol in our proposed IOT-DEEC will be the inclusion of the distance factor next to the remaining energy factor in the cluster head (CH) selecting procedure that already constitute the conventional DEEC protocol. To be precise, the D-DEEC protocol gives the average ratio of node to the base station (BS) and the mean distance of all nodes to the BS as the results which the protocol will evaluate next. From this point, energy-efficient nodes next closer to the BS have a higher probability of becoming clusters heads in most instances as compared to nodes farther away1.This new algorithm of prioritizing CHs near the BS is effective in enhancing network lifetime, reducing energy consumption, and reducing the node death rate unlike traditional DEEC protocol that employs a random selection of CHs. Hence, the sleep- mode by distant to reduce energy consumption by avoiding data transmission to the BS if energy levels fall below certain threshold is an additional tool at the service of D-DEEC. This will be supported by highlighting the two significant innovations which are the CH selection through space and the sleep-wake mechanism.

In order to solve this, you need to invent new routing algorithms (IoT-DEEC and D-DEEC) for IoT environments in an IoT application, where you pay special attention to the routing strategies implementation. Strategies under consideration may be for instance choice of cluster heads on the basis of distance and energy, implementation of sleep-wake system, and also maintaining CH retention threshold.

In this work we proposed a new routing algorithm and compare it with the previous work such that Developed Distributed Energy-Efficient Clustering “DDEEC”, Improving Distributed Energy Efficient Clustering “IDEEC” and the Conventional Distributed Energy Efficient Clustering “DEEC”.

This research structure includes an overview of related work in Section 2, methodology in Section 3, simulation results and analysis in Section 4, and conclusions in Section 5.

2. Related works

WSN's coverage has been touched in a number of documents in the literature exploring Wireless Sensor Networks. Besides that, the idea [6] is to suggest a routing protocol [7] specifically designed to be used in homogeneous WSNs recurs to LéACH clustering adaptation. Here, cluster heads (CHs) node is randomly selected via a process to make sure that every unit of energy will be shared equally between the whole sensor network.

The Stable Election Protocol (SEP) put forward a novel idea for selecting stable nodes-which are the nodes with higher battery residual life-to serve as cluster heads and thus improve the stability and longevity of the network. Two types of nodes are utilized: different types with fresh and upgraded ones (the latter being firmer and more likely to become coordinators). But SSEP might face the test of early emptying of stubborn nodes.

"distributed energy efficient clustering" (DEEC) protocol [8] describes a possible method to illustrate the validity of the substitution between the residual and the average node energy. The overall strategy of DEEC leans upon the cluster supervisor, the node with the highest left-over energy and mean energy [9]. [1] discussed in [10] presented an improved algorithm, TDEEC, whose probability function was enhanced and equipped it with three node types that had different remaining energy. This method tripled the still-life network on the grounds of experimental results. [11] saw IDEEC - an improvement over DEEC - while only needing a different scaling factor and a simplified power reduction made ten times.

Besides D-DEEC (D-DEEC) protocol, which was developed a few years ago by [12] and is based on the principle of structures, there is also the protocol. When it operates each node based on the distance from the base station and estimated remaining power is taken into account. The optimal number of cluster heads, decision threshold, and dissipation are derived utilising a identification of algorithm as well as formulations that are well elaborated in this paper. In contrast to the simulation results, DEEC, EDEEC, and SEP technologies were seen to have performed rather poorly in comparison to the proposed D-DEEC technology which delivered optimal energy balance together with high network performance. In [13] proposed EDEDCE, as a new form of DEDECE, for heterogeneous networks. The examined strategy has been focused on the maximum market penetration based on the last user node levels. The leftover energy of super nodes is the highest among the three, and that of advanced nodes is middle, and the standard nodes have the lowest amongst the trio. While carrying on the DEEC, the experiment whose results were demonstrated in the long-lasting network.

Like [14], TDEEC algorithm, which is a DEEC protocol's modified version, was also talked about by the authors. The protocol reviewed the probability function previously used and introduced three diverse node types characterized with residual power levels. Results of the study revealed that the method procured the outcomes related to the extension of the beginning of the network's.

lifetime. The authors of [15] then presented IDEEC, an advanced version of algorithm that will be explained in the next section.

the DEEC protocol. The real difference between DEEC and the Dissected Distributed was the fact that Improved Distributed relied on direct customer support, which DEEC didn't.

Clustering Power-Efficient Data (IDEEC) is the fundamental aspect that keep the power usage of the system from growing dramatically. Authors in [25-33] illustrate A Clustering-Based Energy Management Scheme with Distributed Block Chain Look at energy-efficient clustering with heterogeneous nodes' functionality. This contributes to network lifetime, stability, and packet delivery performance improvement in comparison with similar existing methods.

The paper suggests the IE-DEEC approach which complements E-DEEC by means of sorting the cluster heads with the proximity to the Base Station which in turn improve the network performance in the WSN of the different technologies. The proposed network protocol named TDEEC in the article improves the power savings in heterogeneous wireless sensor networks due to its mechanism of alteration of secondary head selection when it is different from the primary head and hence increases the network lifetime when compared to other protocols. Over the last few years' wireless sensor networks (WSNs) have been widely and easily used to provide reliable and low-cost remote monitoring and control process with smooth and energy-saving in many applications. Due to the constrained energy of the sensor nodes, the WSN network needs to rely on a properly designed energy-efficient algorithm that can increase the effectiveness of node energy efficiency in the heterogeneous WSN. In this paper, we also put forward an innovative distributed energy-efficient clustering algorithm (IDEEC) that can be used in heterogeneous WSNs. IDEEC uses a two-level energy model, fastens the breadth of the probability threshold, grades the probability of cluster head selection, and elevates the efficiency of average energy of the network. Simulation outcomes exhibit the superiority of IDEEC method in terms of performance search period, number of messages, mean and variance of the cluster heads in comparison with the prevailing clustering protocols. Secondly, IDEEC is time effective as it doesn't require long periods of time to run which makes it a practical model to use in life.

The growing tendency for implementing wired sensor networks indicators that this technology becomes an essential need for Mankind, which could be successfully applied in different industries. The article is about the theoretical routing on cluster-based wireless sensor networks in this work. The improvement is implemented, so that we MODLEACH, by introducing the intelligent cluster head replacement strategy and dual transmission levels on power as well. We have adjusted our modified LEACH and this outperforms the workload in performance indicators, including the number of cluster heads, throughput, and the network's life. Hard and soft thresholds reinforce the superiority of FASTENING over formation of a complex frustrating compound. Performance analysis of EM, TEM, HCE, and PHE is conducted with throughput, network life, and number of replacements taken into consideration. Whether for disaster management, combat field reconnaissance, border protection or security surveillance application, WSNs should be based on scalable and efficient clustering methods that make the networks sizeable and manageable. This paper gives the taxonomy and the types of the clustering schemes for WSN, examining different algorithms and evaluating them by corresponding metrics such as convergence time, stability of clusters, clusters overlapping, mobility of nodes, and location-aware behaviour.

One of the major problems in WSNs is energy conservation because networks lack of large scale infrastructure. Thus, energy-efficient route planning is an important component of proper WSN structure due to hardware lost of sensor nodes. For this purpose, a DEEC Distributed Energy-Efficient Clustering (DEEC) which is new modification is proposed in this article and named like, IoT-DEEC, Internet of Things DEEC. The IoT-DEEC protocol is an energy saving three-stage heterogeneous clustering model which is based on the DEEC protocol and concerned with collection of the time-efficiency balanced thresholder samples to the energy consumption model. With networks similar to the current ones, it is possible to see that the proposed model takes an IDEEC Protocol head-on when it comes to network efficiency dimensions such as packet delivery ratio, overhead, and throughput, extending the sensor network lifetime substantially.

WSNs have wide uses mainly in the Internet of Things (IoT) but have to battle serious battery power constraints. A popular approach is the purposeful use of hierarchical clustering algorithms that help reduce energy consumption in WSNs. We adopt clustering protocol LEACH by determining a threshold for the Cluster Head selection and energy ranging among the nodes. Modified LEACH protocol, which is described and shows the results of simulations, is shown better performance, however these results do not cover wide range of networks. In multiple simulation scenarios including density of area, energy, proposed algorithm demonstrates a higher stabilization time and network lifespan compared to other energy-efficient algorithms that have not been included in previous studies. [16-21].

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DDEEC and IDEEC Protocols, to address the limitations of DEEC, the DDEEC (Developed Distributed Energy-Efficient Clustering) and IDEEC (Improving Distributed Energy Efficient Clustering) protocols introduced modifications: DDEEC: This protocol calculates the ratio of each node's distance to the base station and the average distance of all nodes to the base station. This allows DDEEC to prioritize advanced nodes with high residual energy that are closer to the base station as potential CHs, leading to improved energy efficiency and network lifetime IDEEC: This protocol relies on a different scaling factor and a simplified power reduction compared to DEEC, achieving up to 10 times better performance. However, IDEEC still does not consider the distance factor in the CH selection process.

D-DEEC Protocol, the proposed D-DEEC (Distance-DEEC) protocol builds upon the DEEC approach but introduces a key innovation - the incorporation of the distance factor in the cluster head election process. Specifically, D-DEEC calculates the ratio of each node's distance to the base station and the average distance of all nodes to the base station, prioritizing advanced nodes with high residual energy that are closer to the base station as potential CHs1.Additionally, D-DEEC features a sleep-wake mechanism for distant CHs, where CHs with energy levels below a defined threshold enter sleep mode to conserve energy instead of transmitting data to the base station1.These unique features of D-DEEC, such as the distance-based CH selection and the sleep-wake mechanism, distinguish it from the conventional DEEC, DDEEC, and IDEEC protocols, and contribute to its improved energy efficiency and extended network lifetime.

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4. The DEEC model

The DEEC method employs a hierarchical structure to enable separation between the nodes in the WSN by forming clusters. Cluster Heads (CHs) calculating and transmitting the data to the base station measure the energy utilization of each link and nodes. To ensure the effective utilization of network the optimal number of nodes for each round of running should be found out. The DEEC algorithm has to choose Cluster Heads which will ensure that they are evenly distributed throughout the network by Cluster Heads energy levels. In this regard, CHs show preference for the nodes that have a larger amount of energy stockpile while providing these smaller ones with marginal benefits. In the given scenario, the chance that a specific node will act as a candidate for a CH in each round determines the total number of CHs available throughout all rounds. When you reach a higher energy node, its influence is farther-reaching than the orchestration of other powered sources in the network's energy balance during the same period [14]. Both sophisticated as well as traditional mining stations begin their operations with a Power Source of their choice. The purpose of Eq. (1) is to compute a set of expenses E(r), and for this, each node should be aware of the entire energy reservoir in the network. More precise specification of this maximization will be made in the next subsections.

$$E(r) = \frac{1}{N}\sum_{i=1}^{N} E_i(r) \tag{1}$$

Energy at start processing are the advanced and normal nodes. The objective now is to use Eq. (1) to calculate the energy aggregation E(r). Thus, every node assigned the duty of calculation must be in the same energy window within the network. Details on calculating E(r) will be needed for the give subsections. The BS receives RCs' deeds every single day. In BS networks, drops in data rates cannot be averted even whenever the transmission distance is long. Interference, such as noise and disturbances, might result in packet errors, and consequently the signal integrity could be impaired, and the interaction between the various nodes might be affected, resulting in transmission failure to the base station. The remote RPs might have to shuttle the data intermittently from their subscribers to the remote side of CHs before it reaches the BS, thus energy consumption will be higher. Therefore, all these factors together result in high traffic volumes and insufficient service time due to the low-frequency bandwidth in DEEC architecture. The method allows integration with both multi-tier and two floor energy hideous wireless sensor networks employing a cluster based technique. A two-level energy heterogeneous network uses two types of nodes: ecosystem also has primary and secondary nodes. Probabilistically clustering heads (CHs) are chosen with the probability of each node to residual energy deficit being relative to the network's mean energy. There are more likely to be early and higher CHs nodes among those hubs which have the more initial and residual energies especially in a case of advanced nodes than in the nodes which have low initial and residual energies. This natural way, the growing period process adds stability to the period, as the device may have a longer lifespan when it intervened on the different situation. Eqs. (2) and (3) showcase the two nodes of the protocol with the DEEC protocol, which are the advanced and the normal nodes respectively.

$$Pi = \frac{Popt\ Ei(r)}{(1+a*m)E(r)} \tag{2}$$

$$Pi = \frac{Popt\ (1+a)Ei(r)}{(1+a*m)E(r)} \tag{3}$$

In the DEEC protocol, (Popt) is the reference value for the average probability (Pi), (a) is a constant, and (m) is the proportion of nodes deemed advanced. In homogeneous networks, where all sensor nodes have the same initial energy level, (Popt) is the reference energy for probability (Pi). However, in heterogeneous networks, (Popt) changes and depends on the beginning energy of each sensor node. Eq. (4) also calculates the network's average energy E(r) for any round (r).

$$E(r) = \frac{1}{N} Etotal \left(1 - \frac{r}{R}\right) \tag{4}$$

(R) represents the total rounds of network lifespan, which is determined using Eq. (5):

$$R = \frac{Etotal}{Eround} \tag{5}$$

(Etotal) indicates the network's total energy, whereas (Eround) denotes the energy wasted throughout each round.

Assume (pi) indicates the average likelihood that each sensor node (si) will become a cluster leader in a round. During each round, each sensor node chooses a random integer between 0 and 1. If this value is smaller than the threshold stated in Eq. (6) below, the node qualifies as a cluster head; otherwise, it does not.

$$T(S_i) = \begin{cases} \frac{p_i}{1-p_i\left[r mod \frac{1}{p_i}\right]} & if\ s_i \in G \\ 0 & otherwise \end{cases} \tag{6}$$

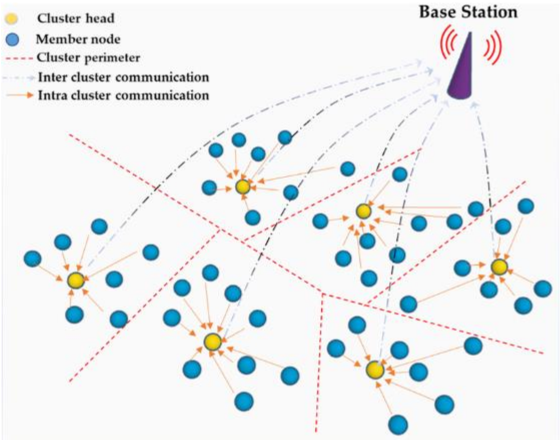

Figure. 1 The DEEC protocol

Procedure G, for lookup CHs addressing, considers sensor nodes belonging to r [3, 13] as CHs capable candidates [4].

The Fig. 1 portrays a purely a case of the node power remaining exploration. However, no matter what the case, if the remote nodes (shown in green) are advanced or not, these other remote nodes must switch to the nearby CHs because of the better signal received strength. This mandatory packethetering creates quite a burden for transmitting stop-over stations. Additionally, the additional transmission lengths place a considerable strain on the nodes resulting from the energy losses while transferring end reports to the BS unit located far away. Thereby, siltation, flooding, and other problems are directly linked to the absence of silting leads not only to increasing costs and hamper sustainable growth, but also the inefficiencies of the operations and networks related to traffic management.

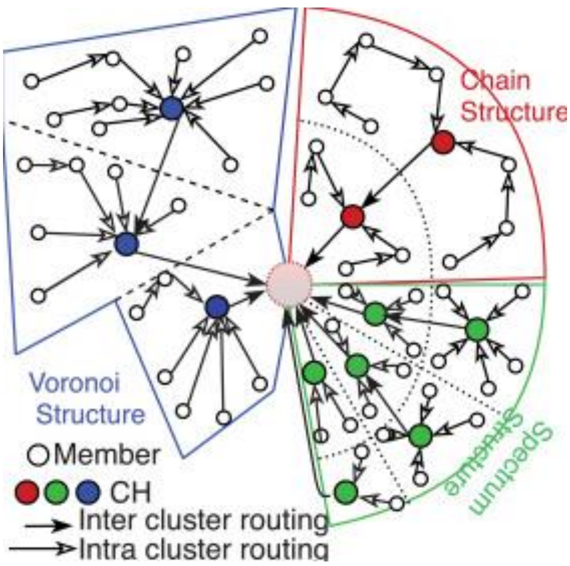

Figure. 2 Clustering Objective in Wireless Sensor Networks

4.1 Distance-DEEC(D-DEEC) protocol

The proposed Distance-DEEC protocol (DDEEC) behaves similarly to DEEC in terms of cluster formation. However, DDEEC makes changes to the election probability. It takes a novel method by calculating the ratio of two important factors: each node's (i) distance to the Base Station (BS) and the average distance of all nodes to the BS. By doing so, DDEEC emphasizes advanced nodes with high residual energy that are closer to the BS, increasing their chances of becoming Cluster Heads (CHs) compared to those farther away. This strategic change efficiently minimizes energy depletion, node mortality rates, and increases total network longevity. Fig. 2 depicts this increase.

Fig. 2 shows that nodes A, B, and C are identified as Cluster Heads (CHs) because they have a high residual energy, are close to the Base Station (BS), and are at an ideal distance from their neighbors. CHs located further away from the BS use a sleep and wake mechanism for transmission. This approach enables the BS to assess and estimate the energy necessary for distant CHs to relay data reports. Rasheed et al. [22, 23] suggest that if a CH's energy level (Eth) approaches or surpasses a defined threshold ($\boldsymbol{Q}th$), it transmits its data to the BS (Eq. (7)). Otherwise, the CH saves energy by entering sleep mode.

$$E_{th} = ((E_{TX} + E_{DA}) * k + E_{amp} * k * e^4) \quad (7)$$

Energy conservation is efficiently performed by both Cluster Heads (CHs) and nodes using the proposed technique, where ETX represents the energy wasted in sending a k-bit message across a distance d, $\boldsymbol{QPM}$ denotes the energy consumed in data aggregation, and $\boldsymbol{Q}amp$ means the energy dissipation in the power amplifier. Furthermore, this strategy improves throughput.

The modified election probability for normal and advanced nodes are defined by Eqs. (8) and (9), respectively.

$$P_i = \frac{P_{opt}E_i(r)}{((1+a*m)E(r))} * \frac{d_i}{D_{avg}} \quad (8)$$

Where di indicates the distance of individual nodes from the Base Station (BS), and $Davg$ is the average distance of all nodes from the BS.

$$P_i = \frac{P_{opt}(1+a)E_i(r)}{(1+a*m)E(r)} * \frac{d_i}{D_{avg}} \quad (9)$$

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Eq. (10) calculates the energy used by non-cluster coordinators conveying k-bits of data to the Cluster Head (CH).

$$E_{non-CHD} = E_{TX}(k, d_{to\ CH}) \quad (10)$$

The intervals between non-CHs and the CH are designated as $dto\ CH$. Eq. (11) calculates the total energy consumed by each cluster manager to send k-bits of data to the Base Station (BS).

$$E_{CHD} = \left(\frac{n}{c} - 1\right) kE_{elect} + E_{TX}(k, d_{to\ BS}) \quad (11)$$

Where $dto\ BS$ indicates the intervals from the Cluster Head (CH) to the Base Station (BS), n is the number of nodes, c is the number of clusters in the network, and $\boldsymbol{Q}elect$ is the energy spent due to the operation of radio electronics. Eq. (12) determines how much energy a group expends every round.

$$E_{cluster}d \approx \left(\frac{n}{c} - 1\right) E_{non-CHD} + E_{CHD} \quad (12)$$

Eq. (13) calculates the system's total energy expenditure.

$$E_{total} = cE_{cluster}d \quad (13)$$

Eqs. (8), (9), and (13) describe the suggested system, which successfully decreases energy dissipation while delivering data to the Base Station (BS) inside D-DEEC.

Algorithm I: Distance- DEEC protocol

```
// Initialize network parameters
Xm = network diameter (X)
Ym = network diameter (Y)
Eo = initial node energy
rmax = number of rounds
ETH = threshold energy
Sm = sleep node threshold
// Initialize sensor nodes
N = number of sensor nodes
nodes = []  // Array to store sensor node objects
for i in range(N):
  node = create_sensor_node(random_position(Xm, Y), Eo)
  nodes.append(node)
// Main loop
for r in range(rmax):
  // Count alive and dead nodes
  alive_nodes = count_alive_nodes(nodes)
  dead_nodes = N - alive_nodes
  // Identify sleep nodes
  sleep_nodes = []
  for node in nodes:
    if node.energy <= ETH:
      sleep_nodes.append(node)
      node.status = "Sleep"
  // Count packets sent to base station
  packets_sent = count_packets_sent(nodes)
  // Select cluster heads (step 10 - not implemented here)
  # This step would use factors like remaining energy and distance to BS
  # to choose cluster heads from nodes with energy > ETH
  // Check sleep node count
  if len(sleep_nodes) > Sm:
    continue  # Go back to step 6 (packet count) if sleep nodes exceed threshold
  // Cluster head operations (steps 12-14 - not implemented here)
  # These steps would involve cluster formation, data aggregation at CHs,
  # and data transmission to BS
  // Update node energy based on operations (not shown here)
  // Check for end of network lifetime (step 15 - not implemented here)
  # This step could check if all nodes are dead or a certain % are dead
  // Output results
  print(f"Round: {r}, Alive Nodes: {alive_nodes}, Dead Nodes: {dead_nodes}, Packets Sent: {packets_sent}")
```

4.2 Internet of Things DEEC (IOT-DEEC) protocol

The DEEC protocol uses a random selection mechanism to choose a Cluster Head (CH) for each cycle. Clusters are then created based on the advertising message sent by the chosen CH. Assume 100 nodes are configured in a 100 m X 100 m space. In the following round, the CHs relocate, forming new clusters. According to the DEEC algorithm, once a CH is chosen, it remains unaltered in succeeding rounds unless it totally depletes its energy over its term. Nonetheless, if a CH has not used a large percentage of its energy, it may still function as a CH in the following round due to its leftover energy. To remedy this issue, the current DEEC protocol, also known as the new protocol (IoT-DEEC), has a threshold value. If a CH's energy level exceeds the threshold, it will continue to function as a CH in the next cycle. This strategy saves energy while delivering information to the next CH throughout each round. It also provides for the control of the extra energy necessary for the formation of a new cluster caused by a fresh CH.

If the distance between node (N) and Cluster Head (CH) is smaller than d_0, energy is depleted during data transmission from (N) to the CH.

$$E_N^{CH} = D_N^{CH}(E_{ele}) + D_N^{CH}(E_{fs})(d^2) \quad (14)$$

Where $d_0 = \frac{4\Pi h_{tr} h_{rc}}{\lambda}$ (htr) and (hrc) denote the heights of the transmitting and receiving antennae, respectively, where the distance between node (N) and the Cluster Head

(CH)is $(d > d0)$.

$$E_N^{CH} = D_N^{CH}(E_{ele}) + D_N^{CH}(E_{amp})(d^4) \quad (15)$$

When the distance between the source (S) and the Cluster Head (CH) is less than (d0), the energy expended by the CH to transmit data to (S) is accounted for.

$$E_{CH}^S = D_{CH}^S(E_{ele}) + E_{DA} + D_N^S(E_{fs})(d^2) \quad (16)$$

Similarly, when the distance between the Cluster Head (CH) and the source (S) exceeds (d0), the energy consumption for data transmission from the CH to (S) is taken into account.

$$E_{CH}^S = D_{CH}^S(E_{ele}) + E_{DA} + D_N^S(E_{fs})(d^2) \quad (17)$$

The total energy consumed by CH is:

$$E_{T\_CH} = E_{CH} + E_N \quad (18)$$

The average energy consumed by CH is:

$$E_{av\_CH} = \frac{E_{T\_CH}}{N} \quad (19)$$

So saving energy for normal nodes in each round is:

$$E_{S\_N} = E_{ele} + E_{TX} + E_{amp} \quad (20)$$

Saving energy for CH is:

$$E_{S\_CH} = E_{ele} + E_{DA} + E_{TX} + E_{RX} + E_{amp} \quad (21)$$

Saving energy for all sleeping node is:

$$E_{ST} = \sum_{i=0}^{n} Ei \quad (22)$$

Average energy saving for n sleeping node is:

$$E_{S\_AV} = \frac{E_{ST}}{n} \quad (23)$$

Algorithm I: Iot-DEEC

Input:

```
// Initialization (assumed to be done elsewhere)
N = number of sensor nodes
nodes = []  // Array to store sensor node objects
BS_position = base station position  // X, Y coordinates
// Main loop
while True:  # Loop until network lifetime ends
  // Count alive and dead nodes
  alive_nodes = count_alive_nodes(nodes)
  dead_nodes = N - alive_nodes
  // Identify sleep nodes
  sleep_nodes = []
  for node in nodes:
    if node.energy <= 0:
      node.status = "Dead"
    elif node.energy <= ETH:
      sleep_nodes.append(node)
      node.status = "Sleep"
  // Count packets sent to base station
  packets_sent = count_packets_sent(nodes)
  // Calculate maximum distance to base station (step 6)
  max_distance = calculate_max_distance(nodes, BS_position)
  // Enter threshold energy (step 8) (assumed ETH is already defined)
  // Select cluster heads (steps 9-11)
  cluster_heads = []
  for node in nodes:
    if node.status == "Alive" and node.energy > ETH:
      cluster_heads.append(node)
      node.status = "ClusterHead"
  // Handle sleep nodes (steps 14-16)
  for node in sleep_nodes:
    if node.energy > 0:
      node.status = "Normal"
    else:
      node.status = "Dead"
  // Cluster head operations (steps 17-23)
  for ch in cluster_heads:
    ch.broadcast_cluster_formation()  # Step 18
    ch.power_level = "High"  # Step 19
```

```
// Check cluster head energy (step 23)
for ch in cluster_heads:
  if ch.energy <= ETH:
    # Handle CH death (steps 24-25) (implementation details omitted)
    pass
// Check for end of network lifetime (step 27) (implementation details omitted)
if network_lifetime_ended():
  break  # Exit loop if network is dead
// Repeat the loop
```

Pi: Election probability of node i to become a cluster head, $Popt$: Reference value for the average election probability, a: Constant used in the election probability calculation, m: Proportion of advanced nodes in the network, $Ai(r)$: Residual energy of node i in round r, $A(r)$: Average energy of the network in round r, $E(r)$: Average energy of the network in round r, R: Total number of rounds in the network lifetime, $Etotal$: Total energy of the network, $Eround$: Energy consumed per round, ci: Distance of node i from the base station

$cavg$: Average distance of all nodes from the base station, $ERX(k,\ d)$: Energy consumed by a non-cluster head node to receive k bits of data over a distance d, EAD: Energy consumed for data aggregation, $Eamp$: Energy consumed by the power amplifier, k: Number of bits in the data message, d: Distance between nodes, $d0$: Distance threshold, htr, hrc: Heights of the transmitting and receiving antennas, respectively and λ: Wavelength of the transmitted signal D-DEEC Protocol.

Eqs. (8) and (9): These equations define the modified election probability for normal and advanced nodes, respectively, in the D-DEEC protocol. The key difference is the incorporation of the distance factor ($ci/cavg$) in the equations, which prioritizes advanced nodes that are closer to the base station as potential cluster heads. Eq. (10): This equation calculates the energy consumed by a non-cluster head node to transmit k bits of data to the cluster head over a distance $cnon-CH$. Eq. (11): This equation calculates the total energy consumed by a cluster head to transmit k bits of data to the base station over a distance $cCH-BS$. Eq. (12): This equation determines the total energy consumed by a cluster in each round, which is the sum of the energy consumed by non-cluster head nodes and the cluster head. Eq. (13): This equation calculates the overall energy consumption of the network by multiplying the energy consumed by a cluster (Eq. (12)) with the number of clusters (c). Eq. (14): This equation calculates the energy consumed by a node to transmit k bits of data to the cluster head when the distance between the node and the cluster head is less than the threshold $d0$. Eq. (15): This equation calculates the energy consumed by a node to transmit k bits of data to the cluster head when the distance between the node and the cluster head is greater than the threshold $d0$.

Table 1. Simulation parameters of Iot- Deec

Parameter	Description	Value
Xm	Distance at X-axis	100m
Xy	Distance at X-axis	100m
-	Base station node position	(50-50)
N	Total number of sensor nodes	100 nodes
P_{opt}	Probability of CH	0.1
E_t	the total energy of the network	0.5 J
E_{mp}	energy dissipation: Receiving (multipath loss)	0.0013/pJ/bit/m^4
E_{fs}	Energy dissipation: free space model loss	10/pJ/bit/m^2
E_{DA}	energy dissipation: Data Aggregation Energy	5/nJ/bit

Table 2. Simulation parameters of D-Deec

Parameter	Description	Value
E_{elec}	Energy used due to running of radio electronics.	5 nJ/bit
E_{fc}	Energy of free space	10 pJ/bit/m2
E_{mp}	Energy of multi path	0.0013 pJ/bit/m4
E_o	Normal Energy	0.5J
Message size, k	Probability of CH	4000 bits
N	Number of nodes	100
P_{opt}	Reference value of average probability	0.1
E_{DA}	Data aggregation cost expended in the cluster heads	5nJ/bit/message

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Table 3 Comparison table of DEEC variants with a focus on IoT-DEEC

Variant	Clustering Approach	Energy Consumption	Scalability	Data Delivery
Basic DEEC	Random selection with higher probability for nodes farther from sink	Uneven drain due to static CH selection. Nodes near sink die faster.	Limited	Limited guarantees, prioritizes energy efficiency over guaranteed delivery.
TDEEC	Uses threshold probability based on distance and residual energy	More balanced than Basic DEEC, but still static CH selection.	Optimized for resource-constrained devices	Optimized for resource-constrained devices, prioritizes energy efficiency.
EDEEC	Two-level clustering with advanced CH selection for better load balancing.	More balanced than Basic and TDEEC, but complexity increases.	Optimized for resource-constrained devices	Optimized for resource-constrained devices, prioritizes energy efficiency.
IoT-DEEC	Dynamic clustering based on factors like residual energy, node density	Minimizes energy consumption through dynamic CH selection and lightweight protocols.	Excellent scalability for large-scale deployments.	Can integrate data prioritization or QoS mechanisms for critical data.

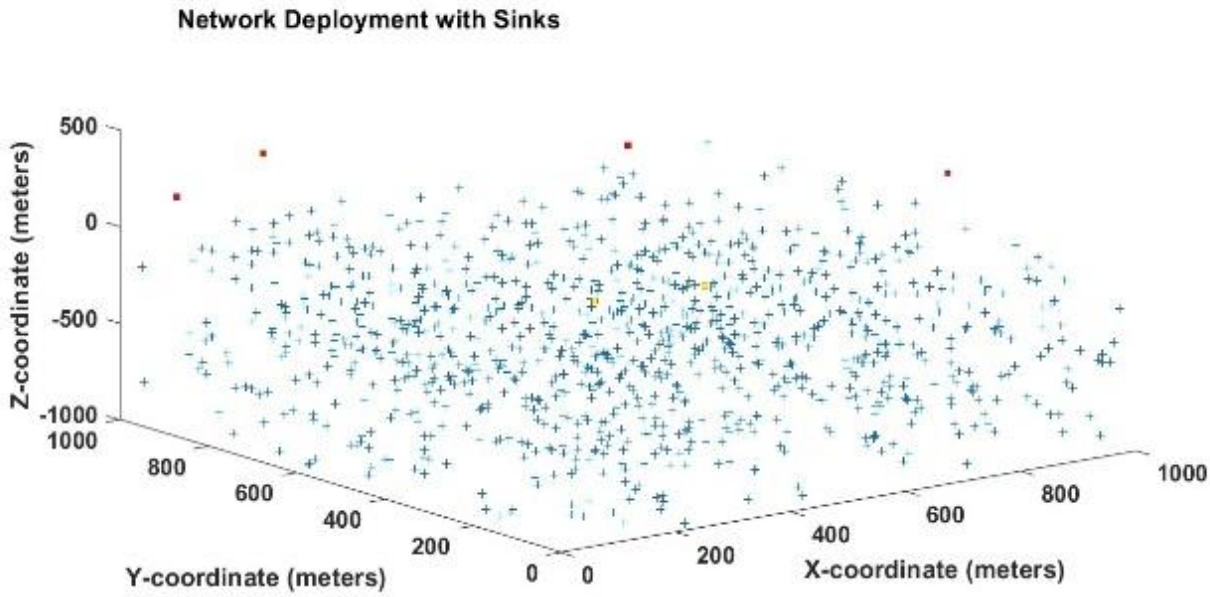

Figure. 3 Network Deployment with Sink

5. Simulation the results

In this section, the efficacy of TDEEC and the newly developed routing protocol D-DEEC for heterogeneous wireless sensor networks is evaluated using MATLAB R2018a. The experiment involves the random deployment of 100 nodes throughout a 100m × 100m field, with a base station (BS) located distance from the centre. Following deployment, all nodes remained immobile, and energy loss caused by signal collisions and interference between nodes' signals was ignored. This study used the Simulation Parameters for IOT-DEEC and D-DEEC, which are shown in Tables 1 and 2, respectively [24].

Fig. 3 shows how this code replicates a 3D network with randomly arranged sensor nodes and pre-defined sink positions.

The snapshot in Fig. 4 presents a sensor node transferring information to the sink node which mimics a WSN. Besides the setting of networking parameters (cluster heads, communication energy costs, signal loss modes), it also lays down the number of cluster heads and network attributes (number of nodes, cluster head frequency, and initial energy. Next the algorithm will be run again starting from the sink and endlessly placing nodes (randomly) beside each other during the rounds. Simulation of a

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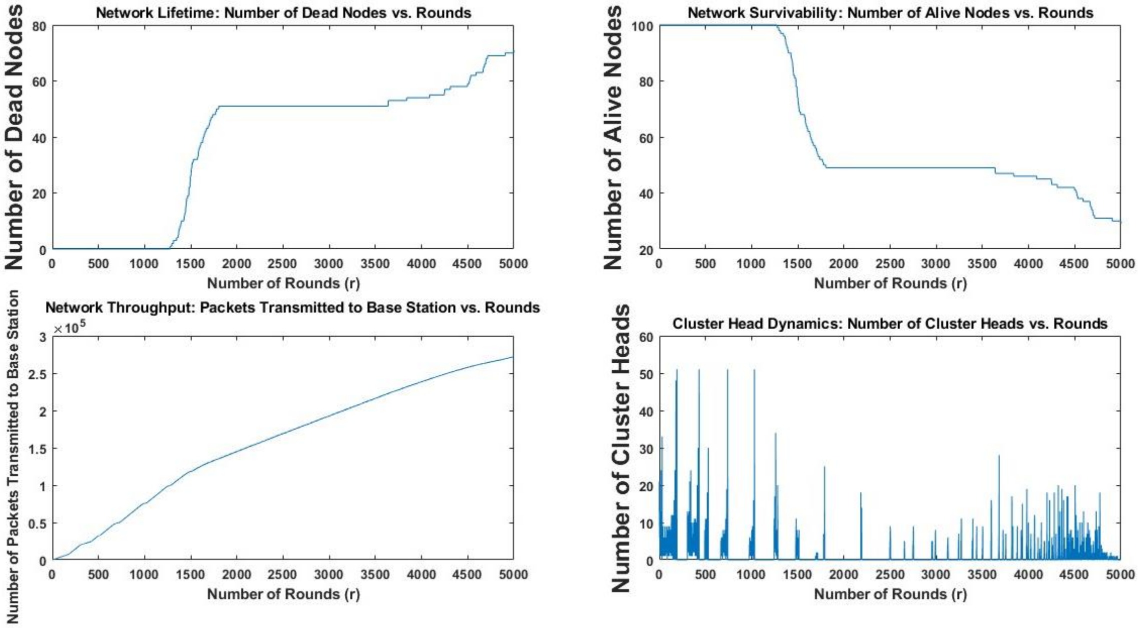

Figure. 4 Simulation Result

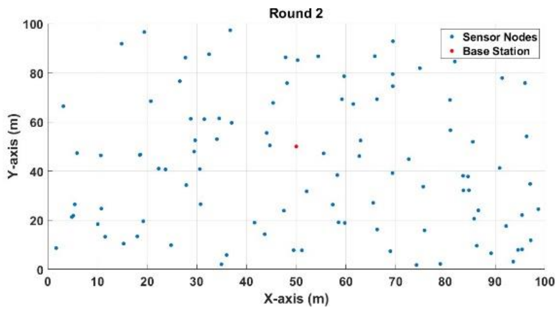

Figure. 5 Round Result

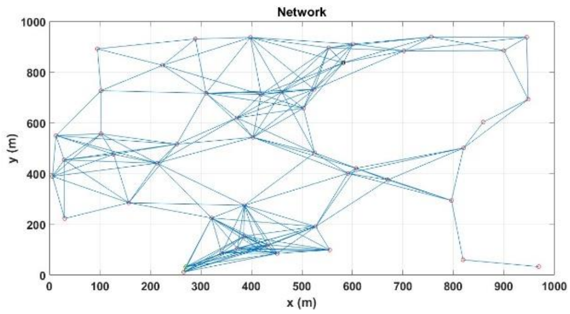

Figure. 6 Network x, y

Wireless Sensor Network (WSN) involves monitoring metrics such number of alive nodes, number of packets received-transmitted, cluster head election, distance calculation, establishing route, and transferring data unit while consuming energy. In such simulations the protocol LEACH (an enhanced routing protocol that is able to extend network lifetime) is mostly used.

As the illustration shows, this code replicates a Kind of Wireless Sensor Network (WSN) which employs the LEACH protocol for energy conservation. It specifies the dimensions of this network, of the nodes, the initial energy, and the way different types of energy will be dissipated. The nodes are then positioned, in a random manner, and the cluster structures are further initialized. The biggest problem with the main function, though, is that it is still missing. The programme automatically generates the LEACH probability (for CH selection) sectors and data transmission (with energy usage updates) sections in its code but does not model how the cluster heads receive data and perform aggregate and transfer it to the BS using LEACH. It may simulate a power consumption model that takes into account just a couple of cycles even though real time simulation would be expensive.

The code attends to factors like dead/alive nodes and cluster head, however the lack of LEACH procedures connects these to performance e.g. data flow and energy usage. Consequently, the model set out here gives the impression that the LEACH be loss will be adequately simulated. Other factors and the protocol design should be considered additionally.

Apply the code of Wireless Sensor Networks (WSN) LEACH protocol in Figs. 6, to 9. I suspect the naming of the figures is a means by which we can recognize which is which; like one for the number of the dead nodes vs rounds. This part of the code loads

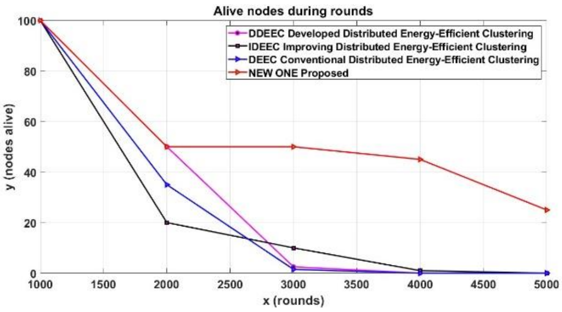

Figure. 7 Alive Nodes

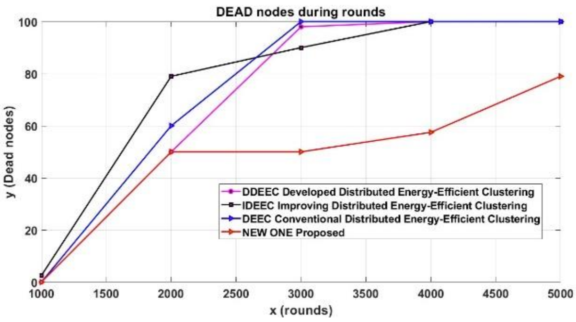

Figure. 8 Dead nodes

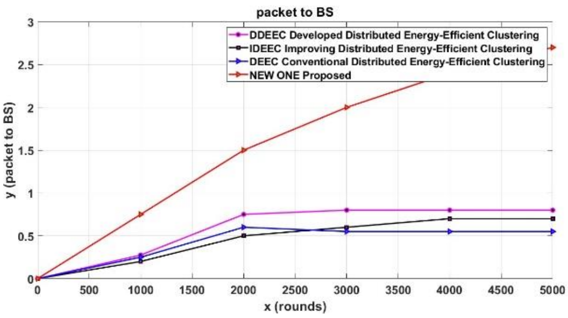

Figure. 9 Numbers of packet

and configures network settings, implements the LEACH protocol, and monitors the performance measures. Nevertheless, the LEACH data transfer and energy consumption commands have not been introduced. Overall, what we aim to provide is the basis for the engineering a LEACH version of the WSN, but the full network behaviour is complete only if the LEACH protocol is implemented.

In Figs. 7, to 9 after simulations the new IOT-DEEC achieved the remarkable result comparing to the conventional DEEC ‘DEEC”, Developed DEEC ‘DDEEC” and Improving DEEC “IDEEC”.

6. Conclusion

This study analyzes two routing protocols for Wireless Sensor Networks (WSNs): D-DEEC and IoT-DEEC. Both protocols aim to improve network stability and energy efficiency. D-DEEC selects CHs based on energy levels and distance from the base station, while IoT-DEEC uses a valuation threshold. The report summarizes simulation outcomes and findings for both methods. Future research could include more detailed performance analysis, implementation of protocols in sensor devices, and exploration of other energy-saving strategies for WSNs. In this result, the “IOT-DEEC” model achieved remarkable performance compared to the “IDEEC” and “DEEC”. Its performance was better such as increasing the alive nodes, decreasing the dead nodes, and increasing more packets to BS during rounds. The results show that the proposed "IOT-DEEC" outperforms the Developed Distributed Energy-Efficient Clustering (DDEEC), Improving Distributed Energy Efficient Clustering (IDEEC), and the Conventional Distributed Energy Efficient Clustering (DEEC) in terms of increasing the number of alive nodes, reducing the number of dead nodes, and increasing the packets sent to the base station (BS) during rounds. The number of alive nodes increased by approximately 22% during rounds, the number of dead nodes decreased by approximately 28.79% during rounds, and the packets sent to the BS increased by approximately 48.6% compared to the previous techniques.

Conflicts of Interest

The authors declare no conflict of interest.

Author Contributions

The paper conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing—original draft preparation, writing—review, and editing, visualization, have been done by 1st author. The supervision and project administration has been done by 2nd author.

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