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Energy Efficient Homogeneous Routing in Clustered Wireless Sensor Networks among Obstacles

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ABSTRACT

An essential problem of studies in Wi-Fi sensor networks (WSNs) is to dynamically organize the sensors into a Wi-Fi network and direction the sensory facts from sensors to a sink. Clustering in WSNs is an effective technique for prolonging the network lifetime. In most of the traditional routing in clustered WSNs assumes that there is no impediment in a field of interest. Although it isn't always a practical assumption, it removes the consequences of barriers in routing the sensory statistics. In this paper, we first suggest a clustering approach in WSNs named strength-efficient homogeneous clustering that periodically selects the cluster heads consistent with a hybrid of their residual strength and a secondary parameter, inclusive of the utility of the sensor to its buddies. In this manner, the selected cluster heads have same variety of pals and residual strength. We then present a course optimization method in clustered WSNs amongst limitations the usage of Dijkstra's shortest path algorithm. We display that our work reduces the common hop count number, packet put off, and strength-consumption of WSNs.

Keywords : Clustering, Energy-efficient, Obstacles, Routing.

I. INTRODUCTION

A typical Wi-Fi sensor network (WSN) includes several tiny and coffee-power sensors which use radio frequencies to carry out distributed sensing obligations. WSNs find their packages in lots of areas that include plant monitoring, battle field surveillance, fire detection, and leakage of toxic chemicals, radiations, and gasoline detection [1]–[5]. In such WSNs, a massive number of sensors are deployed in a field of hobby (FoI) in stochastic manner. In stochastic deployment, sensors are typically dropped randomly in big numbers to assure reliability [1], [4], [6], [7]. Minimising the energy fed on even as making sure the connectivity of a network is an important trouble to be addressed in WSNs due to the fact the batteries powering the sensors won't be on hand for recharging frequently. Cluster-based totally routing in WSNs has been investigated via researchers to attain the network scalability and management, which maximizes the life of the community with the aid of using nearby collaboration amongst sensors [2]–[5], [8] In a clustered WSN, every cluster has a cluster head (CH). CHs periodically acquire, aggregate, and forward records to the sink.

In any software of WSNs, connectivity is considered to be an important metric to measure the first-rate of provider of WSNs. A network is stated to be connected if all sensors inside the FoI can attain to the sink. Geographic routing [9] has been considered as an appealing approach in large scale WSNs as it does now not require the worldwide topology of a WSN. A sensor can make routing selections based totally on the geographic function of itself and its pals.

The sensor forwards the sensory records to a neighbour, that is closest to the sink. This reduces the average hop count number. However, geographic routing cannot optimize the range of hops while a sensor has no neighbour towards the sink. This trouble is known as neighbourhood minimum problem in the literature . The occurrence of the problem can be caused by many factors, including sparse deployment of sensors, bodily obstacles, and sensor screw ups.

II. METHODS AND MATERIAL

A. Major Contributions:

In this paper, we endorse an power-efficient homogeneous clustering method in WSNs and a path optimization approach in clustered WSNs among obstacles. The main contributions of our work on this area are as follows:

1) We propose an Energy-efficient Homogeneous Clustering (EHC) technique in WSNs that selects the CHs to create a connected spine network. EHC is a disbursed method, wherein sensors make local selections on whether to sign up for a spine community as a CH or to a member of a cluster. The decision of each sensor is primarily based on their residual strength and an estimate of the way many of its neighbouring CHs will benefit from it being a CH. We provide a allotted method wherein CHs rotate with time, demonstrating how localized sensor choices result in a homogeneous related worldwide topology.
2) We propose a Route Optimization Technique (ROT) in clustered WSNs among limitations. ROT bureaucracy an power-efficient path between the CHs decided on by EHC method and the sink. ROT makes use of Dijkstra's shortest path algorithm . What attracts us is that we do no longer change the underlying forwarding strategy of existing geographic routing . ROT works below the routing layer and above the MAC and bodily layers in WSNs.
3) We analysis message and time complexities of our work that are almost most reliable. We derive an expression to estimate the power consumption of the network considering EHC and ROT strategies. The relaxation of the paper is organised as follows: In the next phase, we briefly discuss the literature to address the clustering and the local minimal hassle in WSNs. We propose EHC and ROT techniques in Section II. The complexity evaluation and the strength intake calculation of EHC and ROT are presented in Section III. In Section IV, we gift the simulation outcomes carried out to evaluate the choice of EHC and ROT. We finish the paper in Section V.

B. Clustering in WSNs:

The restricted battery power and the difficulty in recharging the batteries in a adversarial surroundings require that the sensors be deployed with a high density for a long life of WSNs. Distributed clustering strategies are greater useful in WSNs. Low Energy Adaptive Clustering Hierarchy (LEACH) [9] selects CHs based on a predetermined probability in order to rotate the CH role among the sensors to stability of the residual electricity of the sensors. Following the idea of LEACH, a number of protocols were provided within the literature [9], [10]. Hybrid Energy-Efficient Distributed (HEED) [8] clustering selects the CHs based totally on the residual energy of sensors and a secondary parameter, including proximity to its buddies. SPAN selects CHs based totally on the residual electricity and quantity of pals [6]. The CHs shape a connected network this is used to ahead the information. An Energy Efficient Clustering Scheme [5] allocates a fewer variety of sensors to clusters with longer distances to the sink. A Fuzzy-good judgment based totally clustering technique is proposed in [2].

C. Local Minimum Problem:

Several geographical routing protocols had been proposed in recent years to cope with the local minimal hassle in WSNs. Most of the present answers for the local minimum trouble use perimeter routing approach (PRT) [9], [10]. By the PRT, while grasping forwarding fails at a local minimum, i. E. no buddies toward the sink, packets tend to be routed alongside the hollow obstacles. The Greedy Perimeter Stateless Routing (GPSR) makes use of grasping forwarding and switches to perimeter routing mode whilst a local minimal hassle is reached. The right-hand rule is used inside the perimeter routing mode, wherein packets are forwarded along the brink counter clockwise at the face of a planar graph. It provided the idea of Hole Avoiding In develop Routing protocol (HAIR) to bypass holes in advance. In WSNs, packets are commonly routed from sensors to a sink. When a sensor recognizes itself as a local minimal, it asks its neighbour sensors to mark itself as a hole sensor. Data packets are despatched to non-hole sensors while feasible. Li et al. proposed a brand new geographic Hole Bypassing Forwarding (HBF) protocol to cope with the hole diffusion trouble in WSNs. The HBF protocol fashions a hole using a virtual circle whose radius is adjustable inside a sure variety and is calculated on a per-packet foundation. The records associated with the virtual circle is used for deciding on an anchor point to bypass the hole so as for a packet to reach a specific sink sensor. Nguyen et al. offered a singular routing protocol named Greedy Forwarding with Virtual Destination (GFVD) strategy. The primary concept is that during the transmission of a packet, a brand new destination called virtual vacation spot is installed place whilst the packet is forwarded to a caught sensor. The abstracted holes protocol in [5] makes use of a dispensed convex hull algorithm to achieve a consistent direction stretch with decrease verbal exchange and garage overhead.

Motivation:

The work on this paper is encouraged by means of the following boundaries found in the literature. The paintings [2], [9]–[10] requires all CHs to carry out direct transmissions to the sink, hence it suffers from the price of lengthy-distance transmissions. As a end result, the sensors which are a ways far from the sink draining their energy much in advance than others. The paintings [10] calls for multiple rounds to form a clustered WSN. The a couple of rounds introduce communication and processing overhead and taxing the electricity as a result. Moreover, HEED [10] has a worst case processing time complexity of O(N) in line with sensor, where N is the variety of sensors in the WSN. A sensor buddies with a CH in a step. A cluster with a better CH diploma might also emerge as notably loaded. Another drawback of present clustering strategies [5] is they require more than one transmission power tiers for routing the statistics. Such techniques aren't appropriate for low-value sensors which have typically unmarried power level. The work [10] makes a detour path along the fringe of the hollow or barriers. A new detour is required over and over, which causes partial breakdown of the WSN. In [6] because of the proper-hand rule, GPSR does no longer reap shorter routing paths. Similarly, GFVD [10] does not assemble a shorter routing path and may burden the power consumption of sensors. The anchor can be some distance from the hollow in [10], and thus detouring the hole in an extended route. In précis, there are no paintings within the literature on routing in clustered WSNs among limitations. The existing paintings specializes in man or woman components, i. E., on clustering, routing, or routing quantity barriers in WSNs. Considering those boundaries inside the literature, we recommend an EHC approach in WSNs that periodically selects CHs according to their residual electricity and the software of the sensor to its neighbours. The predominant difference between existing clustering techniques and EHC approach is the application of the CHs in WSNs. In the EHC approach sensor turns into a CH if the software of the sensor is higher than its neighbours. Different from the existing paintings, a CH in EHC method has most 11 neighbouring CHs and does not make any assumptions approximately the density of sensors. The worst case processing time and area complexities of EHC technique is O(1) according to sensor. We gift a direction optimization technique in clustered WSNs among barriers using Dijkstra's shortest direction algorithm.

ROUTING IN A CLUSTERED WSN:

A. Network Model :

A community consists of N sensors, deployed at random uniformly in a FoI among limitations. The sensors are desk bound and powered by using the batteries. We expect the binary disc conversation version in which a sensor, denoted with the aid of s, can communicate with other sensors within the disc of radius C focused at s, denoted by A(s ,C), where A(s, C)=πC2. Thus, C denotes the communiqué variety of s. Two sensors i and j can speak with each other at once and are known as friends if the Euclidean distance among them is not greater than C. The wide variety of neighbouring CHs of a CH is said to be the CH degree. In this paper, the lifetime of WSNs is the time from the begin of the network operation to the dying of the first sensor inside the community. The lifetime of WSNs is split into rounds to stability the strength intake among sensors. Each round consists of phases: selection segment and operating section. At the start of a spherical, all sensors participate in the selection segment to form a clustered WSN using the EHC approach. In the running segment, the sensory records from the sensors in a cluster are transmitted without delay to their CH which then aggregates and forwards information to other CHs, which en-direction to the sink the usage of ROT.

B. Energy-Efficient Homogeneous Clustering (EHC):

In this segment, we first advise EHC approach after which describe its properties.

i. **EHC Description:** EHC works inside the following two steps to shape a clustered WSN:

- **Initial cluster head election:**

The intention of this step is to opt for the CHs in a disbursed way. Let P be the probability that the predicted variety of CH-applicants for a round is okay of N sensors in . The possibility that there are as a minimum one CH-candidate inside the area A(i, C) is $1 - e^{-k\|A(i\,,C)\|/\|\varphi\|}$ is with high possibility [30]. The opportunity P is consequently given via

$$P = k/ N \quad (1)$$

where $1 - e^{-k\|A(i\,,C)\|/\|\varphi\|} \geq 0.99$

$$\geq \frac{1.46\|\varphi\|}{NC^2} \quad (2)$$

The possibility P is both saved in each sensor off-line or can be despatched via the base station to begin with on the time of deployment. At the start of every round, sensor i selections a random quantity in (zero, 1). If the random quantity is less than P, then sensory is a CH-candidate. With this mechanism, approximately k of N sensors are elected as CH-candidates. The random range does now not depend upon the previous round. Note that if a sensor i elects to become a CH-candidate, i proclaims an advertisement message CH advert(i, Ei, ni) to inform different sensors of its availability, wherein Ei and ni are the residual electricity and the list of neighbouring CHs of i, respectively. Advertisement contention happens while more than one CH-candidate put it on the market at the identical time. To clear up the contention, we use a randomized again-off delay. The randomized back-off delay for a CH-candidate i is denoted through delay .

$$1i = \left(\frac{E_{init} - E_i}{E_{init}} + R\right) * T \quad (3)$$

In which Einit, R, and T are the preliminary power of sensors, a random range in (0,1), and the round-journey delay for a small control packet, respectively. The randomized back-off delay assures that a CH-candidate with higher residual electricity amongst its buddies could have better chance to become a CH. The preference of delay1i is a reasonable technique for lightly intake of power of the sensors whilst stopping additional overhead. The CHs elected in this step are denoted.

Algorithm of Initial cluster head election:

The goal of this step is to elect the cluster head in a distributed manner.

- Set $n_i < -\{\emptyset\}$ initially neighbours will be zero.
- Pick random numbers R and R1 in between (0,1).
- Check for the condition P ≤ R1 and expiry of delay time.
- If true
- Sensor "i" is a initial cluster head ICH.
- Broadcast a message C Advertisement (particular node i ,initial energy Ei ,neighbouring CH of i for ni)
- And if i^{th} sensor receives message from j th sensor that C Advertisement (particular node j ,initial energy Ej , neighbouring CH of j for nj)
- J is also a ICH.
- Add j to the neighbour list of i that ni.

Algorithm of Connected network formation:

Associated message: the message which has sent from non- cluster head to the cluster head.
Advertisement message: the message which has sent from cluster head to the non -cluster head.
Case 1 : If sensor i is a CH then if associated message from i^{th} sensor to j^{th} CH then j is a Non-cluster head(NCH).If advertisement message from i^{th} sensor to j^{th} then j is a gateway cluster head (GCH).
Case 2 : sensor i is a Non-cluster head(NCH)

PART - A: if delay time is expired

Case: 1 no neighbour (no CH) then i is a GCH.**Case: 2** if number of neighbours is one then i is a (NCH).
Case: 3 if CH are not connected then i is a GCH.
PART - B : if delay time is not expired then i is a Non-CH(if any message comes) Associated message comes i is a NCH.Advertisement message comes i is a NCH.

C.Route Optimization Technique (ROT) :

The purpose of a path optimization approach is to acquire a course from the supply to the sink however we also want to attain the aim at a minimal cost , i. e. Shortest path in terms of hop counts among obstacles. Most of the literature on routing in WSNs does now not have any special treatment for the boundaries in a FoI [1], [4], [6]. In this segment, we suggest ROT in clustered WSNs that optimizes the path period all through statistics transmission with none extra overhead. We don't forget m obstacles in , where m ≥ zero. Each sensor is aware of approximately its location. Let view-vertices V = $\bigcup_{i=1}^{m} V_i$ j i is a fixed of view-vertices of an impediment i, 1 ≤ i ≤ m and n > 0 [32]. The view-vertices of all of the barriers are saved in every sensor first of all at the time of deployment or may be updated by means of the sink. Fig. 2 indicates the view-vertices of two barriers. 1) ROT Description: In the early section of ROT, a backbone network is constructed using the proposed EHC, where a sensor is a CH or a member of a cluster. Consider a source CH i and a sink t as shown in Fig. 2. Before sends information to the sink t, it identifies the barriers between t and itself. If there is no obstacle, i forward facts to t using geographic forwarding (GF) [16]. Otherwise i finds a shorter path (SP) to t, denoted by it , via the view vertices of boundaries the usage of Dijkstras shortest direction (DSP) set of rules. I sets the view-vertices along SP because the intermediate destinations (IDs). When statistics reach the closest CH of a ID, denoted by way of j, ROT reruns among j and t to find a brand new SP. The pseudo code of ROT is defined in Procedure three. 2) Property of ROT: Due to the barriers inside the FoI, the direction generated within the literature [9] can deviate some distance from the shortest course. Fig three illustrates an instance of the course formation in ROT and GPSR. The Euclidean distance among source i and sink t is d +b. Ab ×l rectangular shaped obstacle separates i and t such that t is at the back of the impediment. The length of the direction fashioned by using ROT and GPSR are $\sqrt{\left(\frac{l}{2}\right) + d^2 + (\frac{l}{2} + b\ )}$ and d+l+b , respectively. If d =l and d >> b, the path reduce in ROT is given by 2d-

$$\frac{\left(\sqrt{d^2+\frac{d^2}{2}}\right)+\frac{d}{2}}{2d} * 100 = 19\%. \qquad (4)$$

The path shrink reduces the energy consumption during routing the sensory data and therefore prolongs the lifetime of WSNs, stability, and delay.

Algorithm of Route optimization technique:

The goal of a ROT is to achieve a shortest path in terms of hop counts among obstacles.

Step 1 : if i^{th} sensor is a source then send data to CH.

Step 2 : else if i^{th} sensor is a CH.

Case 1: if there is a obstacles then apply algorithm for finding shortest path.

Case 2: if there is a no obstacles then send to destination by using greedy forwarding method (GFM).

Step 3: else i^{th} sensor is a Non CH then send date to destination by using GFM.

Properties of EHC Technique:

First assets of a clustered WSN are that each one sensors clustered. Line 10 in Procedure 2 illustrates that an isol sensor turns into a CH. Therefore, every sensor in WSN is either

a CH or a member of a cluster. All CHs are connected is second one belongings of connected WSNs. Line 14 Procedure 2 suggests that if a sensor has or gre neighbouring ICHs, which are not related, the sensor t into a GCH. Third property in a connected clustered WS that every NCH has precise one CH.

III. RESULTS AND DISCUSSION

Simulation Results:

We have deployed 50 nodes(i.e,) sensors and we assign number to each node from 1 to 50 as n1,n2,n3…..n50. we calculate probability of each node by using the formula Pi =ki/ N. After performing algorithm1 we get 8 nodes as cluster heads and rest of the nodes as non-clustershead.

From the below fig 1 we observe that green nodes considered as non cluster heads and lavender colour nodes as cluster heads.The cluster head which is inside the circle as initial cluster head.

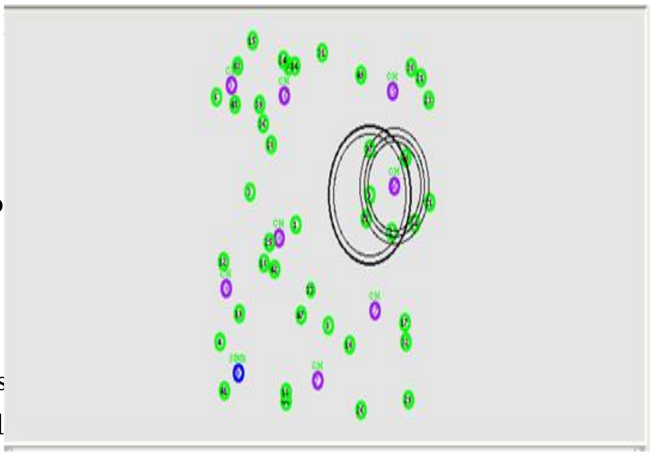

Fig:1 Initial cluster head selection animation window

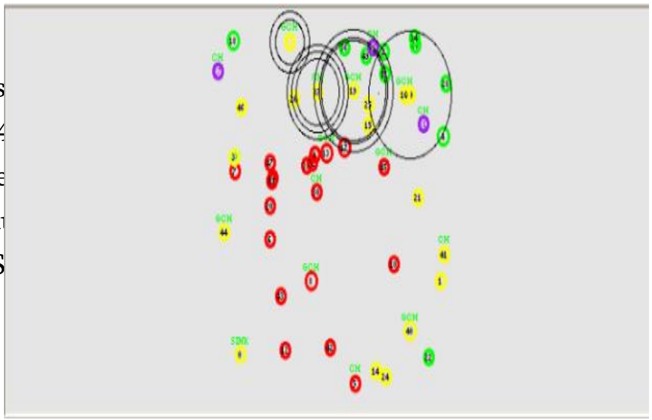

Fig: 2 connected network formation & ROT animation window

From the above fig 2 we observe that yellow nodes as gateway cluster heads and red colour nodes as dead nodes. After performing algorithm2 &3 we connect the cluster wireless sensor network among the CH,GCH and NCH by using the route optimization technique which is based on dikshatras shortest path algorithm.

From the below fig 3 shows that the average hop count decreases as the communication range increases from 25m to 100m. We compare our work with GPSR. It illustrates that for all the protocols, the average hop count increases with obstacles since a geographic routing protocol does not guarantee shortest routing path among obstacles. shows that EHC-ROT-GPSR achieve a good gain in the average hop count for the routing the packets. This is because in EHC-ROT-GPSR, only CHs participate in routing.

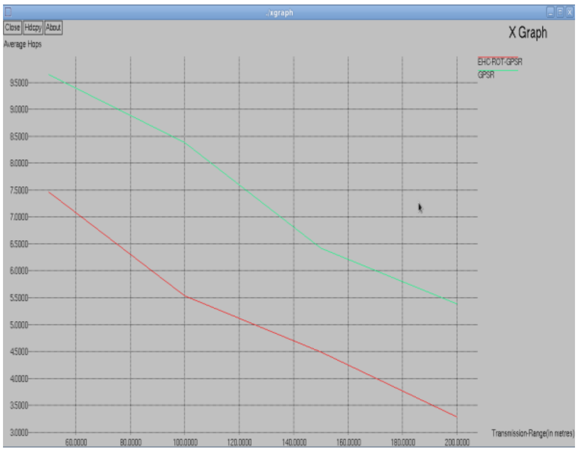

Fig: 3 Transmission Range VS Average Hops

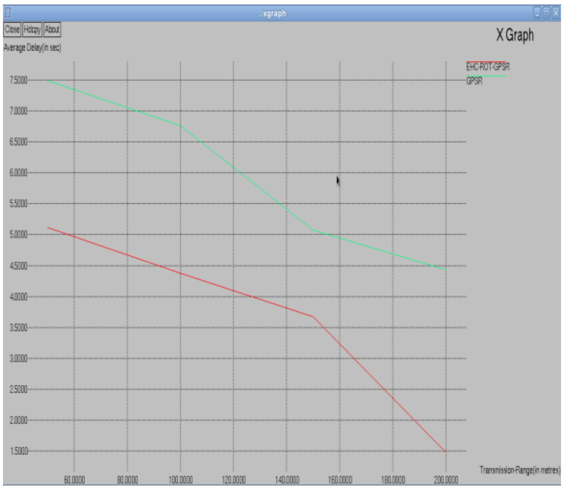

Fig: 4 Transmission Range VS Average Delay

From the above fig 4 shows the Average delay in WSNs for the entire duration of the simulation for GPSR and EHC-ROT-GPSR. It can be concluded that when EHC is not used, all the sensors remain active to provide the routing for a short duration. also illustrates that ROT-GPSR is consumed less delay than GPSR. This is because a geographical routing without ROT requires more number of the average hop count.

From the below fig 5 shows the energy consumption in WSNs for the entire duration of the simulation for GPSR and EHC-ROT-GPSR. It can be concluded that when EHC is not used, all the sensors remain active to provide the routing for a short duration. also illustrates that ROT-GPSR is consumed less energy than GPSR.This is because a geographical routing without ROT requires more number of the average hop count for routing the packets.

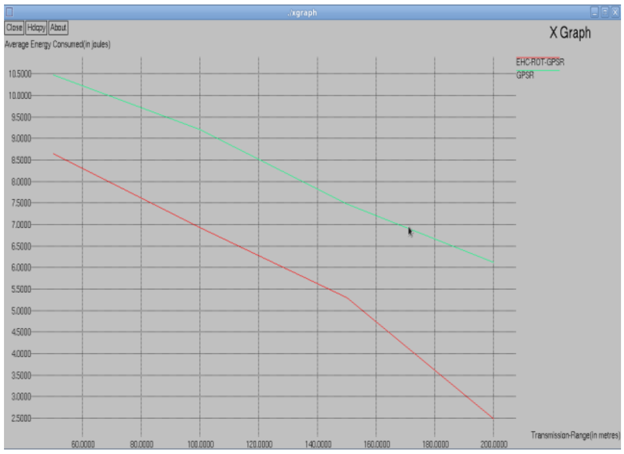

Fig: 5 Transmission Range VS Average Energy Consumed

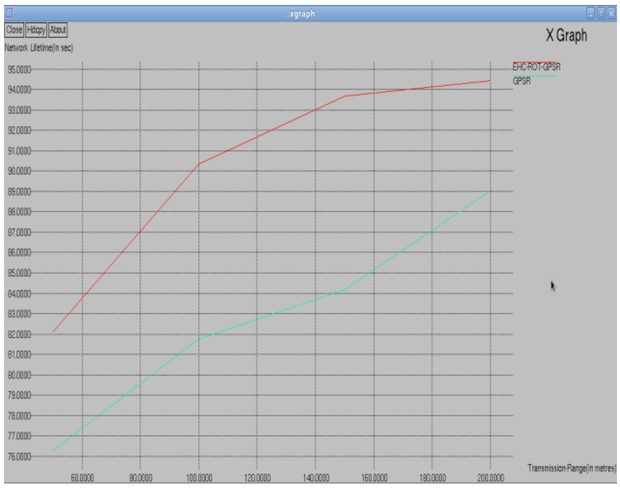

Fig: 6 Transmission Range VS Network Lifetime

From the above fig 6 the network life time of a how long the nodes live inside the network. Shows the overall network lifetime for the entire duration of the simulation for GPSR and EHC-ROT-GPSR. We conclude that the network life time increases comparing to GPSR. EHC-ROT-GPSR achieve a stable performance for the entire duration of the simulation.

From the below fig 7 The packet delivery ratio of a flow is the ratio of the number of packets that are received by the sink over packets submitted to the network by the source. shows the overall delivery ratio for the entire duration of the simulation for GPSR and EHC-ROT-GPSR.

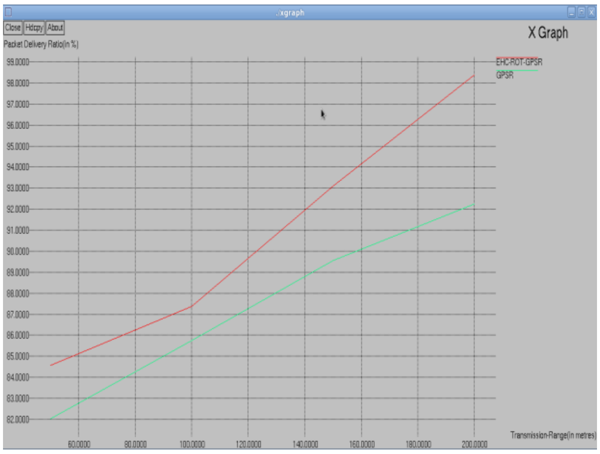

Fig: 7 Transmission Range VS Packet Delivery Ratio

We conclude that the packet delivery ratio reduces as the average hop count increases. EHC-ROT-GPSR achieve a stable performance for the entire duration of the simulation

IV. CONCLUSION

In this paper, we proposed a distributed approach to determine if a sensor in WSNs is a CH to meet the desired connectivity requirements. We mainly focused on energy-efficient clustered WSNs to prolong the lifetime of WSNs. We also proposed a technique to optimize the routing path among obstacles in clustered WSNs. We simulated the performance of the proposed EHC and ROT for different network scenarios and demonstrated that the energy consumption and average hop count in WSNs are reduced due to the clustering of sensors and optimization of routing path, hence the lifetime of WSNs is increased. The results demonstrated that the geometry and location of the obstacles should be considered to compute an optimized routing path.

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