Variation of HEED Protocol with Multiple Sink Nodes in WSN

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WSN에서 다중 싱크 노드를 갖는 HEED 프로토콜

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1. INTRODUCTION

Wireless sensor networks (WSN) is a network involving nodes which intellect surroundings and collect data from observing area and connect over wireless links: the data collected is forwarded via single hop or multi hops relaying to a sink [1]. Sensor nodes are resource constrained in terms of energy, processor, memory, low range communication and bandwidth [2].
A sensor node constitutes four subsystems: detecting unit, processing unit, communication unit and the power unit[3]. Researchers have tried to improve the clustering methods and routing algorithms in a bid to prolong the network lifetime of the WSN. In this paper we examined and enriched the performance of HEED protocol through deployment of multiple sink nodes to mitigate the energy hole problem and also modified the clustering operation by considering intra communication cost a function of variable power levels with a maximum node degree for creating of dense clusters.

2. RESEARCH DETAILS AND METHODS

HEED (Energy-Efficient Distributed Clustering) protocol is classical clustering algorithm based on the hybrid combination of two parameters. one parameter depends on the node's residual energy, and the other the parameter is the intra cluster communication cost [4]. The HEED operation for clustering is divided into three phases; the initialization phase, the main processing phase and finalization phase in which each sensor join the least communication cost CH or announce itself as a CH.
HEED protocol adapts a hierarchical design where the network is organized into clusters.
The probability of becoming a CH is give as follows.

$$CH_{prob} = C_{prob} \times \frac{E_{residual}}{E_{\max}} \quad (1)$$

where, $E_{residual}$ is the estimated current energy in the node and E_{max} is a reference maximum energy (corresponding to a fully charged battery), which is typically identical for all nodes. CH_{prob} is the probability of becoming CH node and C_{prob} is the expected portion of CH nodes in WSNs.

However, HEED protocol faces a couple of challenges which hinder its optimal performance and these include:

- Some cluster heads near the sink may die earlier because of the overhead on them. Therefore to distribute the load evenly we propose to use multiple sink nodes.
- The protocol suffers a consequential overhead as it needs several niters to form clusters. This can be improved by using reduced cluster radius with advanced nodes (nodes with high energy).

For proper clustering we suppose communication cost being a function of cluster density, Taking up the node degree, the network achieves a good distribution of cluster head by minimization of clusters number with full coverage.

Let S be the set of all advanced nodes (S_n) and normal nodes (S_m) deployed in the region of interest. A normal node S_{mi} is considered to be a neighbor of advanced node S_{mi}, if S_{mi} lies within the radio range of S_{ni}, where S_{ni}, $S_{mi} \in S$. We define Node Degree (S_{ni}) as the total number of neighbors of advanced node S_{ni}, then:

$$Node\ Degree\ (S_{mi}) = count\ (\{S_{mi} \mid dist\ (S_{ni}, S_{mi}\} < R_c,\ S_{mi} \in S,\ S_{mi} \neq S_{\ni}\}) \quad (2)$$

Where dist (S_{ni}, S_{mi}) represents the distance between node S_{ni} and node S_{mi}, R_c denotes the node radio range and count stands for the number of elements in a finite set.

To generate dense clusters with a variable power levels for intra cluster communication for all nodes, the cost function should be proportional to $\frac{1}{Node\,degree}$ so as to have a CHs closer to the sink nodes.

For simulation, we used Matlab. 500 sensors were deployed in random way with initial energy of 2J each and two sink nodes placed outside the sensor area in a deterministic manner in a field of 200 X 200 square meters as shown in fig. 1.

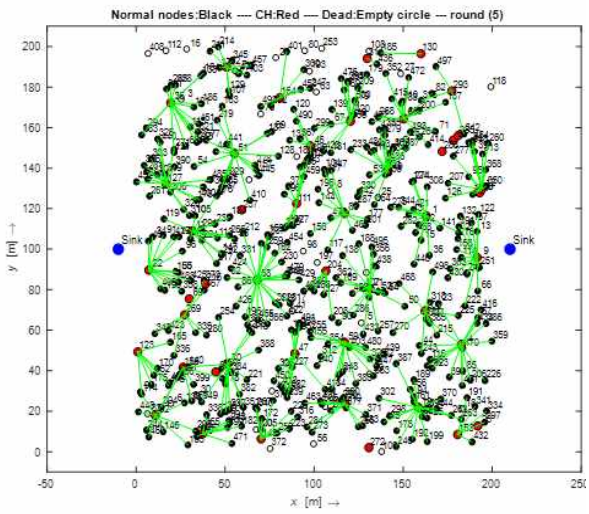

Fig.1. Sensor field with two sink nodes, 500 sensors deployed at a cluster range of 25m.

3. SIMULATION RESULTS

In the analysis, we used the same energy model used in [4], in the process of transmitting *l*-bit message over a distance *d* the energy expended by the radio is given by:

$$E_{TX}(l,d) = \begin{cases} lE_{elec} + l\,\epsilon_{fs}d^2, & d > d_0 \\ lE_{elec} + l\,\epsilon_{mp}d^4, & d > d_0 \end{cases} \quad (3)$$

To receive *l*-bit message, the radio expends

$E_{rx}(l,d) = l\,E_{elec}$

E_{elec} = 50nj/bit, ϵ_{fs}=10pj/bit/m^2, ϵ_{mp}= 0.0013pj/bit/m^4

We examined the network lifetime for HEED protocol and the proposed which is defined as time interval from the start of operation of the sensor network until the death of the last alive node. We observed that using the proposed enriched HEED was improved by 41.288% as compared to HEED shown in fig. 2.

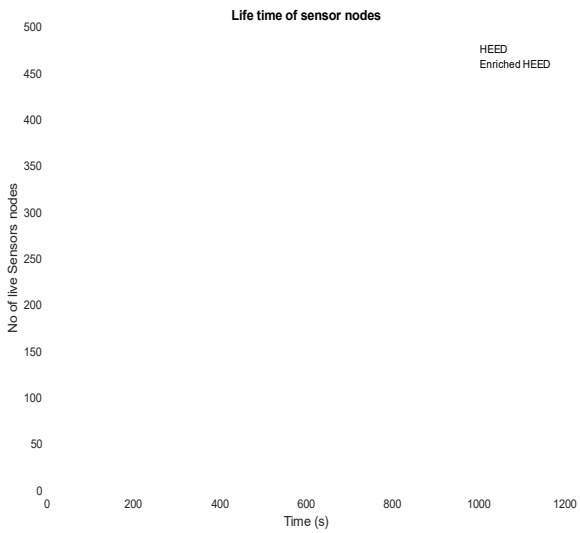

Fig. 2. The network lifetime of a sensor network using one sink and two sinks within a given period of time

4. CONCLUSION AND FUTURE WORK

In this paper, we propose the use of node degree as a cofactor to the secondary parameter for clustering in HEED and the deployment of multiple sink nodes, we achieved an even distribution of a cluster heads and the deployment of multiple sink nodes reduced on the overhead on the cluster heads around the sink. Thus improving on the network lifetime of the WSN. In future work we propose to incorporate the intercluster communication cost function in the cluster operation.

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