E-HORM Energy Hole Removing Mechanism in WSNs

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Motivation

- Energy efficiency is the main issue in WSNs
- Due to uneven energy consumption energy holes are created
- Sensor nodes deplete more energy due to energy holes
- Our work is to remove energy holes to balance energy consumption

Energy Holes

- Sensor nodes in targeted area consume more energy due to dense deployment
- Unbalance energy utilization is main reason for the creation of energy holes
- Random deployment of nodes is another reason
- More nodes due to dense deployment will increase the hardware cost
- After energy hole problem, no data will be transmitted to sink
- In routing schemes for optimal path, intermediate node depletes more energy which expands the area of energy hole

Network Life and Energy Holes

- Due to energy holes problem nodes deplete energy more quickly
- Greater data load near the sink, nodes deplete their energy more quickly and leading to the death of the network.
- This phenomenon reduces the network lifetime
- How to avoid the energy hole becomes a vital research now a days

Energy Holes Removing Techniques

1. Nonuniform node deployment
2. Sensor redistribution
3. E-HORM Energy Efficient Hole Removing Mechanism
   i. Place the sensor nodes in different densities according to their distances
   ii. Mobile sensor is used to reallocate the sensor node to fully cover the targeted area

E-HORM Propose Scheme

- E-HORM scheme has three major phases
- Initializing phase, Threshold calculating phase, Cluster formation and Sleep/Awake scheduling phase
- We first calculate the threshold energy of maximum distant node
- Each node determines its energy level before data transmission
- If energy level of any node is less than threshold energy, it moves toward sleep mode
- When number of sleep nodes $n > 10$, the first sleep node turn into active mode

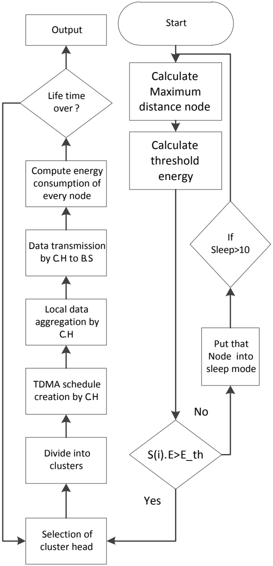

Output
Start
Life time over ?
Calculate Maximum distance node
Calculate threshold energy
Compute energy consumption of every node
If Sleep>10
Data transmission by C.H to B.S
Local data aggregation by C.H
Put that Node into sleep mode
TDMA schedule creation by C.H
No
Divide into clusters
S(i).E>E_th
Yes
Selection of cluster head

Figure : 1

Simulation Parameters

Table : 1

Simulation Parameters

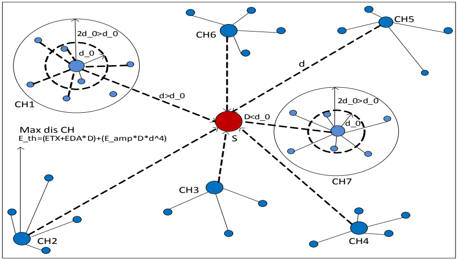
Symbol	Description	Value
X_m	Distance at x-axes	100 meter
Y_m	Distance at y-axes	100 meter
N	Total number of nodes	100 Nodes
E_0	Total energy of network	0.5 j
P	Probability of cluster head	0.1
E_{RX}	Energy dissipation: receiving	$0.0013/pj/bit/m^4$
E_{fs}	Energy dissipation: free space model	$10/pj/bit/m^2$
E_{amp}	Energy dissipation: power amplifier	$100/pj/bit/m^2$
E_{ele}	Energy dissipation: electronics	$50nj/bit$
E_{TX} E_{DA}	Energy dissipation: transmission Energy dissipation: aggregation	50/nj/bit $5/nj/bit$
d_0	Reference distance	87 meter
n	Number of sleep nodes	10 Nodes

Sensor Node Sleep Scheduling

- We determine the energy level of each node according to their distance from sink
- **Case 1**
- $E_0 > E_{th}$: When remaining energy is greater than the threshold energy, the node is in active mode
- **Case 2**
- $E_0 < E_{th}$: When remaining energy is less than the threshold energy, the node turns into sleep mode

E-HORM Formulation

- Cluster head forward both the data generated by itself and its members
- **CH Receive the following data**
- $(D_1 + D_2 + D_3 + ... + D_N)$
- **CH Forward the following data**
- $(D_{CH} + D_1 + D_2 + D_3 + ... + D_N)$



E-HORM Energy Consumption

- When the distance between N and CH is $d < d_0$. The energy consumption

$$E_N^{CH} = D_N^{CH}(E_{ele}) + D_N^{CH}(E_{fs})(d^2) \tag{1}$$

- When the distance between N to CH is $d > d_0$

$$E_N^{CH} = D_N^{CH}(E_{ele}) + D_N^{CH}(E_{amp})(d^4) \tag{2}$$

- Energy consumed by CH to transmit data to the S when distance between them is $d < d_0$

$$E_{CH}^{S} = D_{CH}^{S}(E_{ele}) + E_{DA} + D_{CH}^{S}(E_{fs})(d^2) \tag{3}$$

- When distance CH and S is $d > d_0$

$$E_{CH}^{S} = D_{CH}^{S}(E_{ele}) + E_{DA} D_C H^{S}(E_{amp})(d^4) \quad (4)$$

$$E_{Total\_CH} = E_{CH} + E_N \quad (5)$$

$$E_{Average\_CH} = \frac{E_{Total\_CH}}{N} \quad (6)$$

- Energy saving for normal node

$$E_{Save\_N} = E_{elec} + E_{TX} + E_{amp} \quad (7)$$

- Energy saving for CH is

$$E_{Save\_CH} = E_{ele} + E_{DA} + E_{TX} + E_{RX} + E_{amp} \quad (8)$$

Simulation Results iLEACH

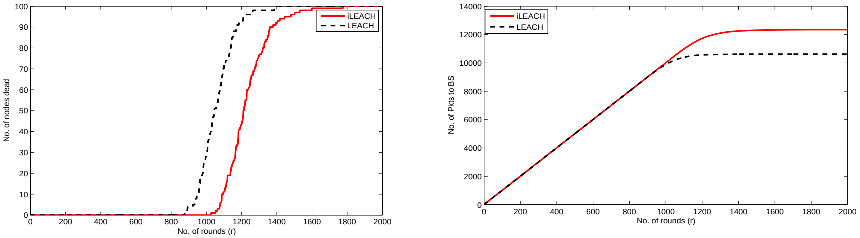
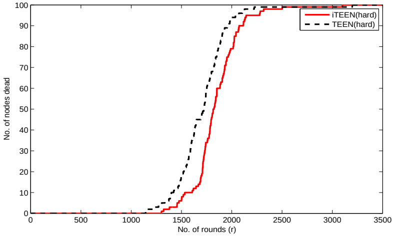


Figure : 2

(a) No of dead nodes (b) Packets to BS

- We implement sleep and awake mechanism to avoid energy holes
- In LEACH the probability of coverage holes are grater than iLEACH due to randomly deployment of sensor nodes
- Sleep awake scheduling reduces the interference caused by closely deployed sensor nodes
- Stability period and network lifetime of iLEACH is greater then LEACH

Simulation Results iTEEN



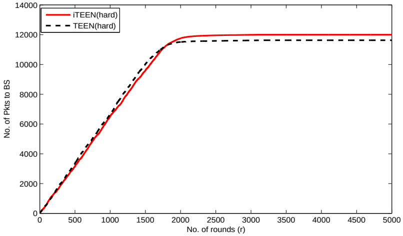


Figure : 3

(a) No of dead nodes (b) Packets to BS

- TEEN is homogeneous routing protocol
- All nodes have the same energy level
- Low energy nodes move towards sleep mode for some rounds to save energy
- Node deplete balance energy to prolong stability period and network lifetime

Simulation Results iSEP

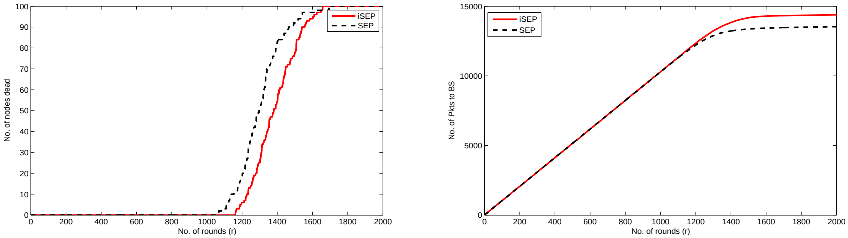


Figure : 4

(a) No of dead nodes (b) Packets to BS

- SEP and DEEC are heterogeneous routing protocol having normal and advance sensor nodes
- Advance nodes have more energy than normal nodes
- The death ratio of normal nodes is greater than advance nodes
- Ratio of normal nodes in sleep mode is greater than advance nodes due to less energy
- Sensor nodes consume balance energy and enhance the network lifetime

Simulation Results iDEEC

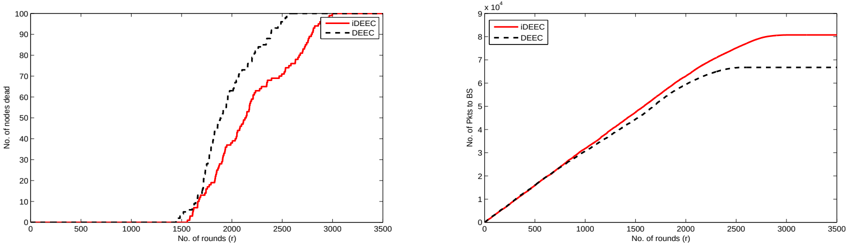


Figure : 5

(a) No of dead nodes (b) Packets to BS

- DEEC is multilevel heterogeneous routing protocol
- All nodes have the different energy level
- The death ratio of less energy nodes is greater than other nodes
- Sleep and awake mechanism turns the less energy nodes into sleep mode to enhance the network lifetime

Conclusion

- Main focus is on energy hole problem
- Random deployment causes the creation of energy holes
- Energy hole problem is mitigated by using sleep and awake process
- My scheme outperforms in terms of energy efficiency and network lifetime

Questions

Thank you!