무선 센서 네트워크를 위한 효율적인 에너지와 커버리지 클러스터링 방법

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An Energy and Coverage Efficient Clustering Method for Wireless Sensor Network

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Abstract

Due to technological advances, the manufacturing of small and low cost of sensors becomes technically and economically feasible. In recent years, an increasing interest in using Wireless Sensor Network (WSN) in various applications, including large scale environment monitoring, battle field surveillance, security management and location tracking. In these applications, hundreds of sensor nodes are left to be unattended to report monitored data to users. Since sensor nodes are placed randomly and sometimes are deployed in underwater. It is impossible to replace batteries often when batteries run out. Therefore, reducing energy consumption is the most important design consideration for sensor networks.

Clustering Operation

Our proposed method for CH selection is distributed, and generated locally without BS involvement. Initially every node calculates its own *delay time* depends on its remaining energy level as follows:

$$T_{delay} = (1 - E_{remaining} / E_{max}) + \alpha$$

E_{max} is the initial power energy of battery and α is a random number that prevents collisions of nodes that have the same remaining energy level. We define $\alpha \in [0, 0.1]$.

The node with the smallest delay time expires first and broadcasts a *Candidate Cluster Head*(CCH) declaration message at range R and becomes a CCH node. A node becomes a CM node whenever three CCH messages from three neighbor nodes are received. Since the coverage efficiency of such node is very low, therefore, this node gives up for declaring itself as a CCH node and becomes a CM node. Meanwhile, a CCH node still may become a CM node if other three CCH messages are received from neighbor nodes, whose delay time expires later. Details are discussed in *self-pruning algorithm* which is in the next section.

After CCH declaration process finishes, all CCH nodes broadcast a CH declaration message in the range R at a random time $\beta \in [0, 0.1]$, which is to avoid the message collisions. If two or more CCH nodes are in the same cluster range, which is depicted in [Fig.1], the one with highest energy level becomes a CH node and other CCH node(s) becomes CM node(s).

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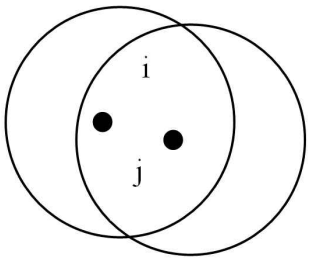
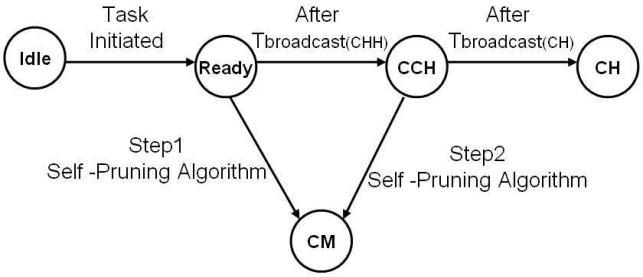
In our proposed method, CCH nodes are generated through the process we described above. However, some CCH nodes may locate into the same cluster area. [Fig.1] illustrates a topology of CCH nodes, where circles represent communication range. Our goal is that if node *i* becomes a CH at the end of competition, there will not be another CH node within the same communication area. In [Fig.2], *i* and *j* are both CCH nodes, and then we choose the one CCH node with higher energy level.

The operation of our method is divided into a series of consecutive tasks. [Fig.2] shows the state transition of nodes in our method. All nodes transit from *Idle* state to *Ready* state after a task is initialized by a sink node. When a new task broadcast from the sink node, all nodes start to calculate their own delay time based on remaining energy level.



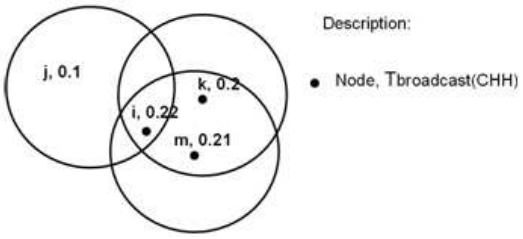
[Fig.1] A competition situation



[Fig. 2] State transition

Self-Pruning Algorithm

Our self-pruning algorithm is applied to two situations. One is shown in [Fig.3], in which any node can broadcast a CCH message before being pruned by neighbor nodes. Another situation is depicted in [Fig.1], where all CCH nodes compete for CH nodes. In order to describe our algorithm clearly, we divide our algorithm into two steps. Step one is shown in [Fig.3]. Also we call step one a CCH competition process. Because all the CCH nodes are generated from this step and then compete for CH nodes in step two, which is shown in [Fig.1].



[Fig.3] Process for pruning node *i*

Conclusion

To increase the lifetime of wireless sensor networks, we illustrate a novel cluster head selection protocol, which is based on energy level and coverage efficiency of nodes. During clustering, nodes keep silent until a delay time expires, which is determined according to remaining energy level. Nodes with high energy level and coverage efficiency are selected to be CHs, meanwhile, more than two cluster heads are not allowed in the same cluster. Thus, CHs are well distributed. In addition, [Fig.1] and [Fig.3] are enough to satisfy all the possible cases to make selecting CH nodes effectively.