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MODIFIED METHOD OF CLUSTERING FOR WIRELESS SENSOR NETWORKS

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МОДИФІКОВАНИЙ МЕТОД КЛАСТЕРИЗАЦІЇ БЕЗПРОВІДНИХ СЕНСОРНИХ МЕРЕЖ

У статті описується модифікований метод кластеризації сенсорних мереж, який застосовується для підвищення енергоефективності системи, що базується на використані декількох критеріїв в сукупності для відбору головного вузла і формуванні кластеру та на поєднанні двух схем звітності сенсорів.

Wireless sensor networks (WSNs) consist of a large amount of sensors to collect and transmit data, which are widely used in various activities nowadays. In a cluster-based WSN, the cluster head (CH) is responsible to collect data from the cluster members (CMs) in each cluster, to aggregate the collected data and then to send it to the sink.

CH selection, cluster formation and data transmission are considered as the main things needed to be optimized for energy saving. Many criteria were investigated: residual energy (like DEEC, REACH-ME, SEP, LEACH-CE, etc. [1]); distance and location (Euclidean distance calculating among nodes [2]); node density (PS-LEACH – extension of LEACH [3]).

The main aim of monitoring applications built on the grounds of wireless sensor networks is to detect some event and send actual and accurate information to users. More often than not the detected event may spread to a larger region or/and may change its location (Figure 1, a-b).

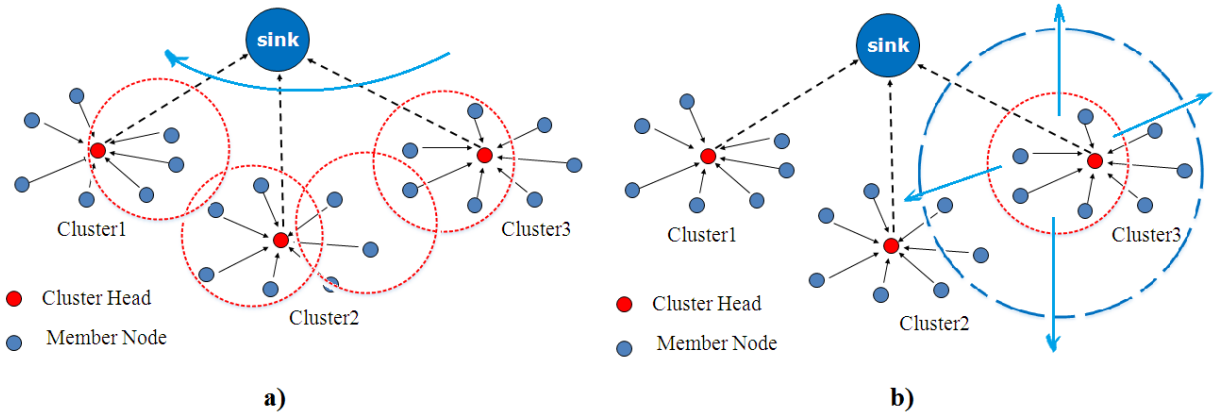

Fig. 1. Event migration (a) and extension (b) example.

So additionally, it is needed to modify nodes schedule depending on event appearance and its changes to aim energy efficiency.

Proposed method is extended - it takes for account not one, but several criteria at once to get common rule for CH's selecting and cluster formation. It is proposed to exam and take for account all described above criteria together to reduce and balance the energy consumption as a result.

By the way, it combines two reporting schemes together - event-driven and time-driven schemes to provide both energy efficiency and data transmission accuracy. Method applying and main steps are shown on Figure 2:

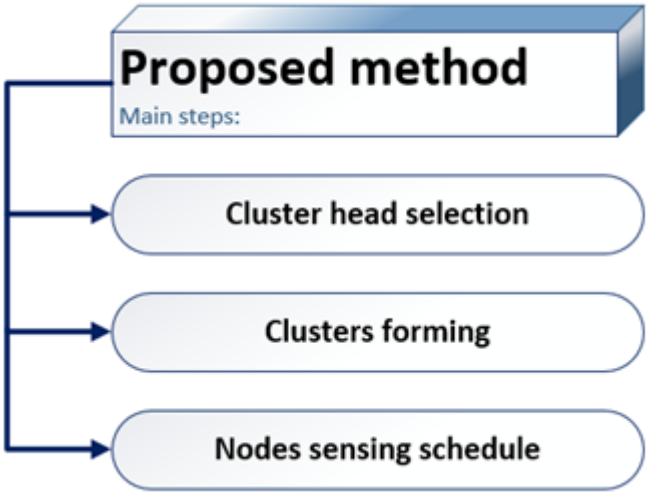

Fig. 2. Proposed method main steps

Cluster head selection.

1. Suppose that amount of cluster heads for every round is constant and determines by r(d) – mean ratio of CHs to all nodes from formula (1) [3]:

$$H(d) = \begin{cases} \dfrac{r(d)}{1 - r(d) \times [\varphi mod(1/r(d))]}, & if\ d \in \bar{S}; \\ 0, & Otherwise. \end{cases} \quad (1)$$

2. In every round, a particular sensor device d obtains a random uniform value between 0 and 1 and it is compared with the threshold H(d). Threshold depends of active sensing region of node μ(d) criterion – ratio of part of node sensing region, which is separately practiced by only this defined node to rest of node sensing region, sensed by this node and by other near placed nodes. It calculates using values of Euclidian distances among nodes. Sensor device with smaller value of μ(d) is been given higher likelihood of being cluster head.

3. If obtained value is less than threshold, this sensor elects himself as pretender to be a cluster-head and transmits their residual energy to base station.

4. Base station chooses r(d) nodes with max residual energy to be CHs.

CH's reselection. Frequent updating of CHs results in additional energy consumption. When the residual energy for CH is less than some energy threshold, the nearest CM with residual energy more than in CH is selected.

Clusters forming.

1. Calculating own value of active sensing region μ(d) node considers other nodes placed in its sensing region. Nodes with large amount of near placed nodes and with high residual energy reserve is chosen as a CH.

2. Suppose that making this calculating, every node knew locations of other ones, every such group of nodes with chosen CH forms in result own cluster.

Nodes sensing schedule.

Data sensing and transmission combines two schemes – event-driven + time-driven (Figure 3).

The event-driven data-reporting scheme can be used to save energy. Nodes communicate at a low frequency. Then they transmit data to CHs only when they sense a change (substantial difference between two adjacent sampling instant).

Once an abnormal phenomenon is detected, data reporting switches to the time-driven scheme - sensors in the event area send data to CHs periodically at a higher frequency.

After the abnormal phenomenon disappears, data transmission will switch back to the event-driven scheme.

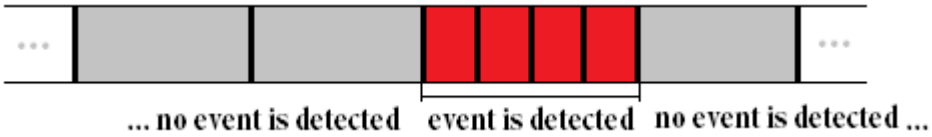

Fig. 3. Switching from event-driven to time-driven reporting.

Conclusion. The CH's selection and clusters formation significantly influence on energy consumption of sensor network, so generally it was considered particular criterion separately from other ones, which decreases accuracy towards energy consumption and enhancing its efficiency. Moreover energy saving is directly connected with nodes work time and downtime duration, which is impossible to evaluate without event consideration.

Proposed modified method involves several criteria in clustering algorithm, which leads to more justified decisions in terms of energy, as well as it applies joint event-driven and time-driven data sending scheme to ensure both high energy efficiency and performance exactness.

References

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