# An energy-efficient node selection scheme in wireless sensor networks

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**Key Words:** Wireless Sensor Networks; Multiple-Input Multiple-Output; energy-efficient; node selection

**Abstract:** A cooperative node selection scheme based on credibility for the problem of cooperative node selection is proposed in wireless sensor networks. A credibility model is given considering the cluster head nodes of subjective reliability and obtained from other nodes impersonality and reliability, the model can provide accurate judgment for cluster head nodes. On this basis, a cooperative node selection scheme is proposed based on the credibility model considering the residual energy of nodes and the channel gain between nodes and data fusion center. Simulation results show that the proposed cooperative node selection scheme can balance the energy consumption of cluster nodes , and can reduce the total energy consumption.

## Introduction

For the cooperative transmission in wireless sensor networks, a series of node selection schemes are proposed. The existing cooperative node selection schemes mainly focus on considering the residual energy of the cooperative nodes, the distance between the cluster head nodes and the cluster nodes or the channel state information. Bravos G N [1]proposed based on residual energy of cluster nodes and cluster head nodes between the link quality and intra cluster nodes cooperative nodes selection scheme, the scheme can obtain higher cooperative diversity gain, so as to reduce the energy consumption and prolong the survival time of the network. Zhou Z [2] proposed energy efficient cooperative communication scheme, the scheme for minimizing wireless sensor network node transmission power, an optimal relay node to assist the cluster head nodes to transmit information. Node selection scheme is also proposed for the residual energy of the channel gain between the cluster node and the data fusion center, but these schemes are assuming cooperative nodes completely credible, no potentially malicious nodes exist. In fact, potentially malicious nodes are often in the network, especially the distributed network like wireless sensor networks. A cooperative node selection scheme based on credibility for the problem of cooperative node selection is proposed in wireless sensor networks.

## System model

Without loss of generality, based on the cooperative MIMO model proposed for wireless sensor networks in [3] by Cui S, a cooperative miso system model as Figure1 shown is established between a node as cluster head (CH) and data fusion center (DFC) communication .

Subjective and objective credibility are obtained by value estimation method [4]for the cluster head node, these two results are combined linearly, eventually comprehensive credibility value for

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the candidate node is as (1) shown.

$$T = w_0 T_{\mathrm{d,c}} + w_1 \sum_{i=1}^{K} T_{\mathrm{d},i}^2 T_{\mathrm{d},i,\mathrm{c}} / \sum_{j=1}^{K} T_{\mathrm{d},j} \tag{1}$$

where $K$ is the number of directly estimate value for credibility of the threshold value $T_{\mathrm{th}}$ of cluster head which exceeds other nodes of the cluster, $w_0$ and $w_1$ are the weight of the credibility of subjective and objective credibility respectively, and $w_1$ is the sum weight value for objective credibility weights from all nodes which exceeds the threshold value, $w_0$ and $w_1$ vary from different standards and the environment, but always meet $w_0 + w_1 = 1$ . Compared to other nodes, the direct estimation of the candidate nodes is more reliable than that of the other nodes, so the weight must be constrained by (2).

$$w_0 > \max\left( T_{\mathrm{d},j} / \sum_{j=1}^{K} T_{\mathrm{d},j} \right) / \left( 1 + \max\left( T_{\mathrm{d},j} / \sum_{j=1}^{K} T_{\mathrm{d},j} \right) \right) \tag{2}$$

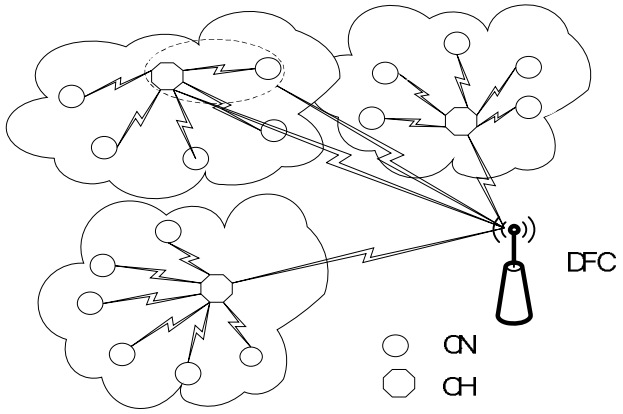


Fig.1 collaborative transmission model based on cluster network structure

**Cooperative Node selection scheme**

On the basis of the credibility model established on the last section, this section proposes a cooperative node selection scheme. Specific selection process is summarized as follows:

Step1. Broadcasting RTS information to the data fusion center and cooperative request information to cluster the neighbor node from the cluster head node; DFC broadcast CTS information after receiving information from the RTS of the cluster head nodes; according to the information, all nodes which received CTS information from the data fusion center will estimate channel quality between the node and the data fusion center, these nodes and their remaining energy information and channel gain in TDMA and sent to the cluster head node and the response from the cluster head nodes cooperative request.

Step2. After receiving information from neighbor nodes, according to the node selection scheme $r_l = \arg\max_{i \in D(r)} |h_i|^2$ , The cluster head will selects a node $r_l$ as the node of the candidate node collaboration, $D(r)$ is a node set which the residual energy exceeds present residual energy threshold $E_{\mathrm{th}}$ among neighbor nodes, but the credibility value of these nodes is unknown;

Step3. The cluster head node obtains the direct observation credibility value of the node $T_{\mathrm{d\text{-}obs},i}$

through the information exchange between the neighbor nodes in the set $D(r)$. Then, based on the reliability value of the last time $T_{\text{d-pre},i}$, the subjective credibility value of cluster $T_{\text{d},i}$ head node $r_i$ is calculated to determine the subjective credibility $T_{\text{d},i}$ of cluster head nodes $D(r)$ to the set of nodes $C(r)$ is larger than that of the nodes;

Step4. The cluster head node set $C(r)$ except for the candidate nodes $r_l$ of neighbor nodes, broadcasting to estimate the credibility of candidate nodes cooperative request, the neighbor node in the set of candidate nodes of subjective reliability estimation, then according to formula (1) credibility will be passed to the cluster head node as cluster head node on the candidate node is objective credibility value $T_{\text{ind},i}$;

Step5. Cluster head nodes obtain the value of the subjective credibility and objective credibility, the use of linear weighted method (2) to obtain the overall credibility $T$ of the candidate nodes, the weighted coefficient depends on the specific environmental conditions;

Step6. Comparing the credibility $T$ the candidate nodes of and credibility threshold $T_{\text{th}}$. If $T > T_{\text{th}}$, the candidate node $r_l$ will be selected as the collaborative node of the cluster head node, and then the next step, otherwise the candidate nodes will be excluded from the set, and go to the step2 until $D(r) \subseteq \varnothing$;

Step7. If $D(r) \subseteq \varnothing$, that is the neighbor nodes of the cluster head nodes can not be used as their cooperative nodes, the cluster head node will give up the cooperative transmission.

After the cooperative node is determined, the cluster head node and the cooperative node are combined with the space-time code[5-6], and then the encoded information is transmitted to the data fusion center through the cooperative MISO channel.

**Numerical Results**

This section gives some simulation to prove the performance of cooperative node selection scheme. Fig2. gives performance curve in collaboration with the credibility of the nodes on the bit error rate .Assuming the average received signal to noise is 10dB, 50 nodes in the cluster, the energy threshold is 0.5 (normalized energy values) and other simulation parameters is described in[3], from Fig2., the average bit error rate decreases with the increase of the credibility of the node values, the greater credibility of cooperative nodes, the bit error performance is better.

As shown in Fig.3,When the distance between cluster head node and data fusion center is 50m, the transmission energy consumption of 1 bits is estimated by several credibility models. When the bit error rate is lower than a certain value, if using traditional reliability model (such as watchdog model, direct estimation of credibility model) to calculate credibility value and selecting cooperative nodes, the selected cooperative nodes transmit information estimated energy consumption a lot less than the actual energy consumption, the cluster head node cannot make the right choice. the credibility model proposed as (1) is used to calculate the credibility value to select

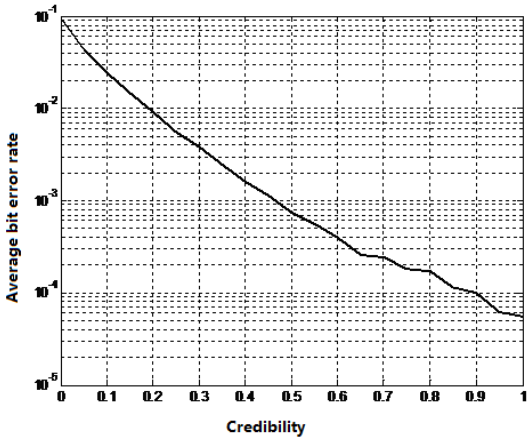


Fig. 2 credibility value vs the bit error rate of the cooperative node

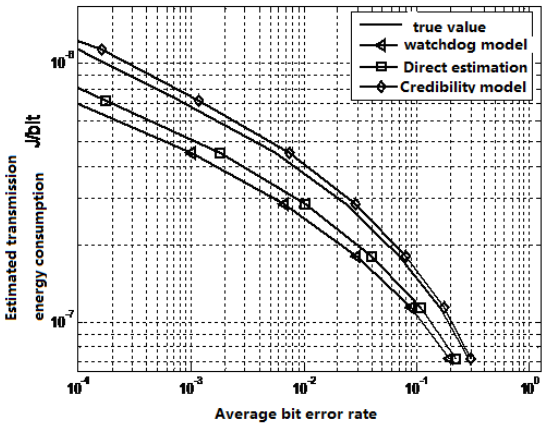


Fig. 3 Transmission energy consumption performance

the cooperative node, which estimates the energy consumption is very close to the actual energy consumption, and can provide a more accurate judgment for cluster head nodes.

## Conclusion

This paper presents a credibility-based cooperative node selection scheme to the wireless sensor network, first of all, to establish the credibility model considering the cluster head nodes of subjective reliability and obtained from other nodes impersonality and reliability, the model can provide accurate judgment for cluster head nodes. On this basis, a cooperative node selection scheme is proposed based on the credibility model considering the residual energy of nodes and the channel gain between nodes and data fusion center. Theoretical analysis and simulation results show that the proposed cooperative node selection scheme can balance the energy consumption of cluster nodes in a certain extent, and can reduce the total energy consumption, and gain a certain energy efficiency gain.

## Acknowledgement

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