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ISSUES OF LONG-HOP AND SHORT-HOP ROUTING IN WIRELESS AUDIO SENSOR NETWORKS

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This paper considers the problem of communication range selection of nodes for transmitting audio data with a predetermined Quality of Services (QoS) in Wireless Audio Sensor Networks (WASN). The various strategy of routing selection is viewed from the perspective of network lifetime and energy efficiency. We consider routing strategies with minimum and maximum communication ranges and propose a hybrid routing for audio data transmission.

Keywords: wireless audio sensor networks, long-hop, short-hop, energy-efficiency, lifetime

1. INTRODUCTION

Wireless Audio Sensor Network belongs to the class of Wireless Sensor Networks (WSN) consisting of distributed autonomous nodes with different sensors. A microphone uses as the collection data sensor in WASN. Usually obtained information is stored in nodes and sent upon request or using stream to a main point of network – base station. Because all nodes in the network are autonomous and powered by batteries the problem of network lifetime is relevant [1]. The main purpose of this work is to increase the lifetime of WASN.

To increase the network lifetime is necessary to reduce the power consumption of sensors included in the system, through using hardware with small power consumption, energy-efficiency medium access and routing protocols. Furthermore, to decrease the energy consumption of WSN is used data preprocessing on the nodes that reduce the amount of information for transmitting. However, using compression for WASN is unacceptable, because it takes additional preprocessing delay that affects on QoS [2].

2. SHORT-HOP ROUTING

Basic standard in WSN is IEEE 802.15.4, which defines physical and data link layers according to the OSI model and does not provide a dynamic channel switching within a single network. Since nodes share the same area, competing for it, there is a risk of collisions during data packet transmission, which increases the time delivery, packets lost and quality of service.

In [3] proposed a spatial reuse of channel, which keeps the transmission range as short as possible, avoiding the contention of the channel with other nodes (Fig. 1).

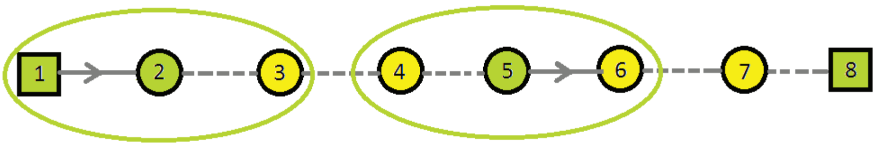

Fig. 1. The network with spatial reuse of channel

In other words, the delivery of information from source to destination nodes is going many hops over a short distance (short-hop routing). For example, nodes 2 and 5 only see neighboring nodes and do not interfere with each other during data transmission. As a result the channel capacity increases. Thereby, while decreasing power transmission, the energy resources are stored. Moreover, the spatial transmission media can be released, but increase the number of retransmissions, time delivery of packets and probability of disconnect between nodes.

According to research [4], with increase the number of nodes in the network, the overhead transmission costs will also increase. Approximately 70% of energy resources spend on the transferring of useful data in the network with 100 nodes and 30% are overhead. But the network with 300 nodes spend 40% of energy for useful data and 60% of all energy are overhead. Furthermore, when the number of nodes increases in the network, the overall energy costs in the system also increase, because it takes more packet transmission. However, the minimum energy costs account for the network with a minimum communication range (Fig. 2).

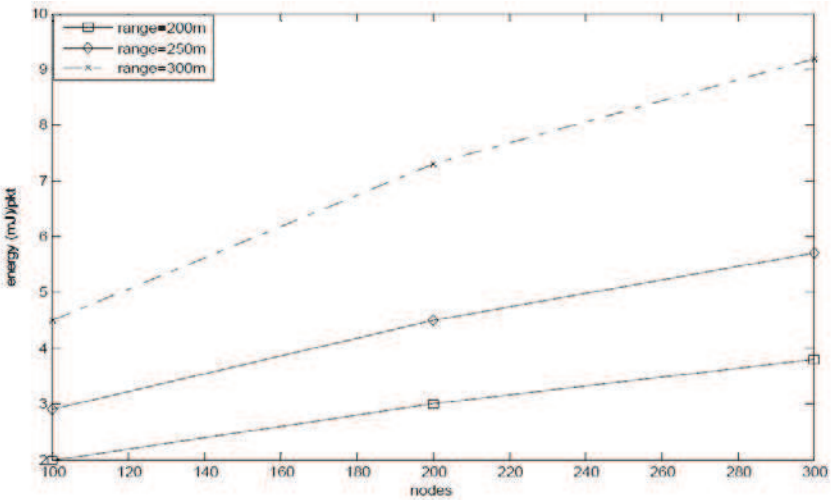

Fig. 2 Energy consumption per packet for different transmission ranges [4]

In [5] describes the reasons for the data transfer over long distances is most appropriate than the data transfer over short distances, because:

- short routing requires information coding\decoding at each nodes, which leads to additional delays and energy waste;
- in many WSNs, where sensors are randomly distributed, the high power level required for good network connectivity;
- the data transfer can be proceed with deviations from the straight route to the point of gathering information, which can also leads to additional energy waste;
- increase the number of retransmitting nodes increase the probability of failure on a route and complicate coordination process such network;
- the nodes with short-hop routing and located near the base station, denied faster, that leads to decrease of network lifetime;
- the extra data retransmission also leads to energy waste in broadcast (multicast).

Thus, the long-hop routing is better than short-hop routing for data transmission.

3. LONG-HOP ROUTING

When the audio data is transmitting over the long distances from source to destination node with overlapping in the coverage area we assume the long-hop routing (Fig. 3).

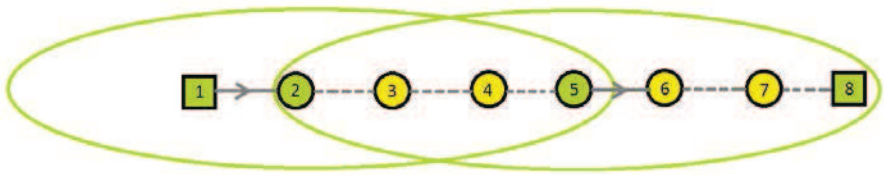

Fig. 3 Network with shared channel

For example, the TOR (Tree-based Opportunistic Routing) supposes data retranslation only those nodes that closest to the destination node [6]. The nodes 2 and 5 in Fig. 3 cover several neighbor nodes that allow to data transmission from node 1 to node 8, using node 5 and ignoring node 3 and 4. The packet delay is reduced due to the long-hop routing in the network with many nodes. In other words, the QoS for long-hop routing is higher, because the number of attempts to shared channel for data transmission are minimal, but under certain conditions, specifically, depending on network density and traffic network.

The short-hop routing provides the worse QoS, due to small probability of packet delivery, the number of nodes, involved to the data transmission, are more and consequently, the packets delay has more time delivery. As a result, the energy costs for additional data are increased and the network lifetime is decreased. To diminish the disadvantages of two routing strategy we propose to use a hybrid routing.

4. HYBRID ROUTING

By hybrid routing we mean the union of two types of routing strategy, discussed above. It is assumed that the nodes with a dynamic regulation of the communication range (from long to short distances) will have a longer lifetime with the defined characteristics of QoS (Fig. 4).

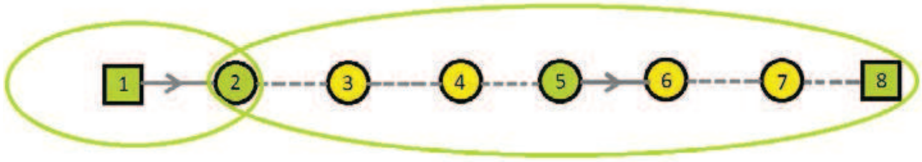

Fig. 4 Network with hybrid routing

In Fig. 4 node 1 has a small communication range and node 5 has maximum. The audio data transmission from the node 1 to the node 8 is carried out through the nodes 2 and 5. Since the long-hop routing consumes more energy resources than short-hop routing, then eventually the energy resources of node 5 will be the smallest over time, so when a certain threshold achieved, it is necessary to switch transmitter of the node 5 to the short communication range and node 2, for example, to the long communication range. The network lifetime can be increased by using the short-hop and long-hop strategies.

The authors use different wireless network models that lead to incorrect results in favor of one or the other routing strategies. For example, a successful reception of data can be incorrect determined, when the disk model is used, as well as the physical model [7]. In [8] authors propose to use the Nakagami-m model (Nakagami-m fading model) for evaluation of the data channel instead of Rayleigh channel model (Rayleigh fading model), which does not take into account the number of characteristics of the channel. Thus, the used tools have a large influence on the evaluation of the system performance (energy consumption, transmission delays, packets loss). In this case, it is necessary to choose the right model of WSN, which would take into account the most important parameters for evaluation of network performance in different routing strategies. Since we consider the class of Wireless Audio Sensor Networks that QoS and power consumption are defining characteristics of the network.

5. CONCLUSION

In this paper we discuss the problem of audio data delivery with QoS in Wireless Audio Sensor Networks. The main purpose of this study is to increase the lifetime of the network using the hybrid routing, which combines long-hop and short-hop routing strategies. Each method has advantages and disadvantages. Since the use of certain models and routing algorithms produce different results, it is necessary to choose the most accurate network and channel models of Wireless Audio Sensor Networks for further research.

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IDENTIFYING SEMANTIC CONTENT-BLOCK OF TERMS AND RELATIONS IN SCIENTIFIC TEXTS

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This paper proposes a method of identifying some blocks in the scientific text to use this information for calculating the weights of semantic network nodes and arcs. This method is based on the application of fuzzy controllers.

Keywords: semantic network, scientific text, formal text sing of, fuzzy controllers

Introduction. Scientific texts in accordance with the typology of private nonfiction texts are on a par with the texts of mass communication and the official business texts. Scientific text has its own peculiarities of language and style. Consider the main features of the narration of scientific text. Scientific text is characterized by *logic*, which correlates with the main stages of scientific work: setting and understanding the problem, study the experience of predecessors, offer solutions of the problem, its proof and argumentation, generalization of data, summarizing. Stylistic feature of the scientific text is its *accuracy*. Accuracy is achieved by using a single-valued expressions, terms, words with clear lexical and semantic combinability. *Abstraction and generalization* are also main characteristics of the scientific text. Scientific text cannot be submitted without the *cliché* – steady turn of speech, ready turn of speech, standard, easily used in certain conditions. In scientific text clichés which are expressed by formal text signs of (markers, connectors, indicators), widely