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CZECH TECHNICAL UNIVERSITY IN PRAGUE
Faculty of Electrical Engineering
Department of Computer Science & Engineering

Review of the PhD Thesis

On Distributed and Real-Time Routing in Sensor Networks

submitted by

Ing. Jiří Trdlička

The doctoral thesis submitted by Ing. Jiří Trdlička is focused on data routing in sensor networks. The main goal of all methods presented in the thesis is to optimize the total energy requirement.

The contribution of the thesis is primarily presentation of several approaches to routing function generation in the following three chapters:

The Chapter 2 presents the description of the network and of the sensor network data flows in Multi-Commodity Network Flow Model. Two different approaches to Real-Time behaviour of the sensor network are used for the model description, and the use of the model for Linear Programming has been tested by the commercial solver CPLEX 9.1. Presented results indicate time required to find the optimal routing graph (generally hundreds of seconds).

The Chapter 3 presents three distributed algorithms developed by Ing. Trdlička (TLDRA, OLDRAi and OLDRAo). Algorithms are tested and data related to the quality of the result (closeness to the optimum after a number of iterations) are presented.

Finally Chapter 4 presents the distributed algorithm fot the Real-time description, which is similar with the second solution in the Chapter 2.

In the following paragraphs I will present some notes related to the main approach to the goal of the thesis, which I would like to be clarified during the defence.

Routing methods developed and tested by Ing. Trdlieka are based on the unique network topology. Nodes of the network are placed randomly into square areas of the network array (let say containing 10 times 10 areas). The network consists of all nodes (in this case 100 nodes) and all links having the length till double of the square area size. I have to say that I prefer generally utilised structure of the ad-hoc and sensor networks, where the nodes are randomly distributed over the whole network array (i.e. without dividing it into identical square areas). The topology of the network, which includes these nodes, is generally obtained from a useful algorithm, which results in the graph fulfilling, for example, the Gabriel graph condition. Such an approach supports a way to energy optimization in wireless networks.

Moreover, I would like to see the relation of the basic network structure used in the thesis to the real world technologies.

If I did not make a mistake, all the presented algorithms are leading to distribution of data flows between sensors and target nodes into routes that optimize the total energy. In many networks (specifically in networks with more nodes) restricting the energy of individual nodes could be significant as well, or even more.

Character of the thesis is highly mathematical, so I would prefer to see the similar forms of problem description. As an example, the expressions 3.1.1 and 3.3.1 - 3.3.3 could be analogous. Moreover, link capacity limit μ in the chapter 3 can be seen only deeply in algorithms TLDRA, OLDRAi and OLDRAo.

The comparison of the algorithm TLDRA, OLDRAi and OLDRAo is done on the basis of the number of iteration required to approach the optimised energy. However, these tests are based on multi-in single-out flows for TLDRA and single-in single-out flows for OLDRAi and OLDRAo. Is there some effect of the different selection of flow types on the resulting iteration numbers?

In the conclusion of the section 3 failures of the network lines and/or nodes are mentioned as a possible positive contribution of distributed methods. However, all the algorithms are using constant arrays A. How the failure of a link or a node can be distributed and used in the algorithms and what is its energy price?

To conclude, although I had some notes to the presented thesis, I can assert, that the thesis solves important and timely topics, it presents well the ability of his author, Ing. Jiří Trdlička, to work in the very interesting area of the software research, and that the results presented in the thesis could create a good area for the future research. I believe, that his short presentation during the defence will be more oriented on the relation of his algorithms to the area of real-world wireless sensor networks.

I can recommend the thesis, in the interpretation of the Law 111/98 in the Digest, for the defence and judge the candidate worthy to be awarded by the PhD degree in Control Technologies and Robotics at the FEE CTU in Prague.

Prague, February 26th, 2012

doc. Ing. Jan Janeček, CSc.