InterCriteria Analysis of ACO algorithm for Wireless Sensor Network Positioning

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Abstract. Wireless Sensor Networks (WSN) allow the monitoring of large areas without the intervention of a human operator. The WSN can be used in areas where traditional networks fail or are inadequate. They find applications in a variety of areas such as climate monitoring, military use, industry and sensing information from inhospitable locations. Unlike other networks, sensor networks depend on deployment of sensors over a physical location to fulfil a desired task. A WSN node contains several components including the radio, battery, microcontroller, analog circuit, and sensor interface. In battery-powered systems, higher data rates and more frequent radio use consume more power. There are several open issues for sensor networks such as signal processing, deployment, operating cost, localization and location estimation. The wireless sensors, have two fundamental functions: sensing and communicating. However, the sensors which are fare from the high energy communication node (HECN) can not communicate with him directly. The sensors transmit their data to this node, either directly or via hops, using nearby sensors as communication relays. Jourdan [9] solved an instance of WSN layout using a multi-objective genetic algorithm – a fixed number of sensors had to be placed in order to maximize the coverage. In some applications most important is the network energy. In [8] is proposed Ant Colony Optimization (ACO) algorithm and in [11] is proposed evolutionary algorithm for this variant of the problem. In [4] is proposed ACO algorithm taking in to account only the number of the sensors. In [5] a multi-objective ACO algorithm, which solves the WSN layout problem is proposed. The problem is multi-objective with two objective functions – (i) minimizing the energy consumption of the nodes in the network, and (ii) minimizing the number of the nodes. The full coverage of the network and connectivity are considered as constraints. A mono-objective ant algorithm which solves the WSN layout problem is proposed in [6]. In [10] are proposed several evolutionary algorithms to solve the problem. The current research is an attempt to investigate the influence of the number of ants on the ACO algorithm performance, which solves the WSN layout problem, and quality of the achieved solutions and to find the minimal number of ants which are enough to achieve good solutions. For this purpose the InterCriteria Analysis (ICrA) approach is applied. ICrA, proposed by [3], is a recently developed approach for evaluation of multiple objects against multiple criteria and thus discovering existing

correlations between the criteria themselves. It is based on the apparatus of the index matrices (IMs) [1], and the intuitionistic fuzzy sets [2] and can be applied to decision making in different areas of knowledge. Data from series of ACO optimization procedures, published in [5, 6] and [7], are used to construct IMs. ICrA is applied over the so defined IMs and the results are discussed. The InterCriteria analysis is a powerful tool for studying relations between different objects. We study three variants of ACO algorithm applied on WSN problem. Every variant is tested with various number of ants, between 1 and 10. We search the correlation between variants of ACO and number of ants. WSN problem is a multi-objective problem. When it is converted to mono-objective by summing the two objective functions, the algorithm is less sensitive to the number of used ants. When the problem is solved like multi-objective, we observe bigger difference of algorithm performance according to the number of ants. There is greater similarity between performance of the two mono-objective variants, than between some of mono-objective and multi-objective variants.

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