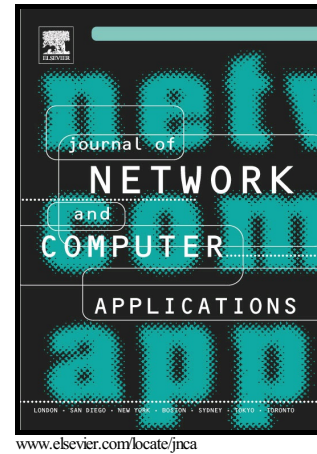# Author's Accepted Manuscript

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Ahmed I. Saleh, Khaled M. Abo-Al-Ez, Ahmed A. Abdullah

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A Multi-Aware Query Driven (MAQD) Routing Protocol for Mobile Wireless Sensor Networks Based on Neuro-Fuzzy Inference

Ahmed I. Saleh[1], Khaled M. Abo-Al-Ez[2], Ahmed A. Abdullah[3]

[1]*Faculty of Engineering, Computers Engineering and Systems Dept., Mansoura University, Mansoura, Egypt*
[2]*Faculty of Engineering, Electrical Engineering Dept., Mansoura University, Mansoura, Egypt*
[3]*Faculty of Engineering, Communication Dept., Delta University, Gamasa, Egypt*

Abstract

A Mobile Wireless Sensor Network (MWSN) is composed of mobile sensor nodes, whereby the life time of a sensor is specified by the life time of its battery. MWSN is used to measure a mobile object parameters then transmit the sensed data to center station called Sink Node (SN). Routing of the sensed data is a challenging issue since several parameters and restrictions should be managed carefully in MWSN. Although the sensor's power (e.g., sensor's battery level) is a critical issue, managing data transmission time is also a considerable subject especially for real time applications. Several routing protocols had been proposed for MWSN, however, each protocol considers a single type of awareness (such as; long life, delay time, total energy...). While some protocols consider the sensor's energy to maximize the network lifetime, others aim to find the shortest path to reach the destination. In this paper, a multi-aware query driven (MAQD) routing protocol will be proposed for MWSN based on a neuro-fuzzy inference system. MAQD considers four types of awareness; the long life of the sensor, delay time of data transmission, total cost of the network, and the shortest transmission path. Hence, based on the selected type of awareness, a fuzzy inference system selects the proper path for routing data. MAQD is a query driven protocol, accordingly, SN can collect data from some/all sensors by employing a request (REQ) message in which the awareness type is specified. MAQD is simulated and tested using OPNET 14.5 and compared with the latest MWSN routing protocols. Simulation results have shown that MAQD outperforms the selected competitors routing protocols (LEACH, ERTLD, RACE, SPIN, EAR2, DCBM, and Rumor routing) as it introduces the best data delivery with the minimum routing overheads in terms of time penalties and power consumed.

1. Introduction:

A wireless sensor network (WSN) is a network which is constructed using several tiny low energy devices called sensor nodes. These nodes are deployed to monitor environment parameters, such as motion, vibration, temperature, sound, or pressure and pass their data packets through the network. In this network, one or more nodes should serve as sink(s), which is the network central point. The sensed data is collected by the sink node (SN) where it can be stored and processed [1]. WSN nodes may be fixed or movable. They communicate with each other either directly or through intermediate nodes in a multi-hop manner. For fixed nodes, the communication between nodes becomes simpler as the data paths are pre-defined, however, it is a challenging issue in the case of movable nodes at which the network topology is devilishly changing.

WSN nodes (e.g., sensors) have low data concentrator, so they route data packets autonomously through the network according to a per-defined delivery mechanism [2]. In WSN, energy is a critical resource that determines the lifetime of the sensor, and accordingly the lifetime of the whole network. As each sensor has its own battery, which is used as the unique power supply, it is important to use as little power as possible to minimize the energy consumption. Actually, there are two main operations that consume the power of a sensor's battery, which are; digital processing and transmission operations. As the transmission operation consumes the most power, many routing protocols have been developed to find the most efficient routing scheme that consumes the least amount of energy to extend the lifetime of the network [3].

Recently, several WSNs have been successfully deployed with mobile sensors in which nodes are either equipped with motors for active mobility or attached to mobile objects for passive mobility. For example, researchers has been