Mobile Sink as Checkpoints for Fault Detection Towards Fault Tolerance in Wireless Sensor Networks

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ABSTRACT
A WSN consists of a large number of limited computation and storage capability wireless sensor nodes, which communicate wirelessly. These sensor nodes typically communicate in short range and collaborate to accomplish the network function. To increase the range of sensing and with the advent of MEMS, mobile sensors and sinks is the technology the world is moving to. This paper presents a network of mobile sensors and a sink. A mobile sink is selected as check-point to have the recoverability of the network. A Fuzzy Rule based system (FRS) is used to construct and select efficient static sensor nodes having adequate resources as Check Point Storage Nodes (CPSNs). The objective of FRS is to increase the probability of recovery of check-pointed data subsequent to a failure, thereby allowing a distributed application to complete its execution successfully. Simulations show FRS’s better recovery probabilities in comparison to a random check-pointing arrangement.

KEYWORDS
Checkpoint, Fault Detection, Fault Tolerance, Fuzzy Ruleset, Mobile Sink, Wireless Sensor Networks

INTRODUCTION
Wireless sensor networks (WSN) is considered as one of the most important and game-changing technologies for the current millennium as per Yiming Zhou et.al. (2007). In the past two decades, there has been an increasing interest shown by both academia and industry across the world in tapping this technology towards novel solutions. A WSN usually consists of a large number of low-cost, low-power, and multifunctional wireless sensor nodes, which communicate wirelessly but have limited computation capabilities. These sensor nodes typically communicate in short range and collaborate to accomplish the network function, for example, environment monitoring, military surveillance and industrial process control. The fundamental philosophy behind WSN is that, while the capability of each sensor node is limited, the cumulative power of the entire network is sufficient for the required mission.

Based on the method of connection, the WSNs would be either conventional network in which the sensors deployed in the region of interest are known and the network is established with the deployment of the sensors. The other type is the adhoc WSN in which the nodes connect with each

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other in an adhoc manner and the position or other parameters of the sensor nodes are not known initially at the time of the network formation. Such networks are typically established in disaster management sites where the dynamics of the region of interest is rather very active.

The WSNs tend to operate in adverse environmental conditions and are likely to have network breaks or data loss. Fault detection and subsequently fault tolerance has therefore become an active research area to ensure the fidelity of the network.

The future WSN applications are expected to incorporate a standardized mix of hardware and software solutions. But as we stand today, the network designers are still juggling between the tradeoffs that they have to adopt so as to minimize the deployment costs, hardware and software overheads, improve system reliability, ensure security and maximize performance. Wireless embedded designers therefore are required to assess these tradeoffs and choose the right transducer and battery technology, frequency of wireless operation, output power and networking protocols etc so as to achieve best results as proposed in R. Szewczyk et al. (2005). The sensors are a compact, small, battery-powered device, and therefore have limited energy resource. Therefore, energy consumption is a critical issue in sensor networks. We are interested in sensor networks in which a large number of sensors are deployed to achieve a given goal. All data obtained by member sensors must be transmitted to a sink or data collector. The longer the communication distance, the more energy will be consumed during transmission as explained by the author W.R. Heinzelman et al. (2000). These classic issues are being addressed by network algorithms and their optimization methods. While conventional mathematical methods have been used, lately interest has built in the research community towards nature inspired algorithms like PSO and use of fuzzy logic based optimization.

With advent of Micro Electro Mechanical Systems (MEMS) as proposed by I.F. Akyildiz et al. (2002), remote correspondence and low power outlines have helped rapid development in the field of Wireless Sensor Networks. The sensor hubs in wireless networks comprise of predominantly four units that are detecting, correspondence, handling and control supply. A sensor senses the physical state of the environment. This paper employs mobile sinks is to collect the sensed values from the static sensors deployed in the region of interest (ROI). The static sensors have limited storage and processing capabilities. A mobile sink is used to collect the data from the sensors aggregates, pre-process the data and further carries it to base station for offloading the data. The Base Station (BS) then further analyses the data for the decision-making process. Once the data is transferred to the BS (Base Station) the mobile sinks are free for storing fresh data from the sensors in the ROI. The possibility of loss of data in the process has been arrested in form of a fault tolerance mechanism. In subsequent paragraphs, this methodology has been explained. In subsequent paragraphs, this paper brings out a methodology of fault detection for the data. A concept of Check Point Sensor Nodes (CPSN) has been introduced, which aid in this endeavor. Though the paper has limited to applying this concept to static nodes, the same can be extrapolated to dynamic nodes by minor tweaking.

**LITERATURE SURVEY**

Routing protocols have been developed to optimize, deployment of sensors, localisation of pre-deployed sensors, clustering of nodes, identification of cluster heads, identification of sinks, Mobile sinks and their optimised path travel and finally fault tolerance and security with an ultimate aim to establish a secure, high–fidelity, long life wireless sensor networks. Research up to year 2006 was more or less concentrated on clustering and protocols for static nodes. With advances in MEMS and robotics, the concept of dynamic or mobile sinks was introduced.

Pritee Parwekar et al. (2016) brings out a protocol using high packet delivery and reliability of the network using fuzzy logic based on Link Quality Indicator (LQI), Received Signal Strength Indicator (RSSI), and number of hops to the base station. Nazir and Hasbullah (2010) propose a cluster based routing protocol, Mobile Sink Based Routing Protocol (MSRP) to overcome the hotspot problem. To achieve this, MSRP clusters the network and nominates the cluster head based on the residual energy
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