An Efficient Approach for Node Localisation and Tracking in Wireless Sensor Networks

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Submitted in partial fulfilment of the requirements for the degree Magister Technologiae: Electrical Engineering in the Department of Electrical Engineering & French South African Institute of Technology (F'SATI) Faculty of Engineering and the Built Environment. Tshwane University of Technology.

ABSTRACT

Wireless technologies have been rapidly spreading all around the world and have become embedded in most of our modern technologies. Mobility, portability, low cost, and the ease of network installation are the key features that have recently encouraged the development and growth of mobile ad-hoc network (MANet). A particular kind of MANet is the Wireless Sensor Network (WSN). Localisation of the sensors in these wireless networks is a key enabling technology because the data collected by the sensors is meaningless without knowing the accurate geographic location of the node. Node localisation has been the subject of intense study in the recent literature. Various approaches for location estimation of stationary nodes in WSNs have been presented. To date, existing algorithms that perform localisation in WSN with mobile nodes, as discussed, in are less effective, less accurate, and power hungry. Moreover, many of them use mobility of beacon nodes only to improve the localisation of static nodes in WSN. Some localisation techniques for stationary WSN, such as Multidimensional Scaling (MDS) and Curvilinear Component Analysis (CCA), reported to be accurate in some network topologies, cannot be applied in their current formats for accurate and efficient localisation in MWSNs because of their computational complexity. On the other hand, the range-based approach such as the iterative and collaborative multilateration methods requires a high percentage of anchor nodes. The accuracy reported for this approach is up to 25% of the transmission range [3], which falls short of many applications. This shortfall is caused by the inaccuracy of the range measurements. Progressive advances in semiconductor technologies have decreased the size, power requirements and cost of wireless devices, while increasing computational capability. Such advances have allowed modern wireless devices to be increasingly mobile and capable. These advances have also enabled the use of Micro-Electro-Mechanical Systems (MEMS) technology to construct a variety of cheap and efficient sensors. Sensors like accelerometer and magnetic compass are embedded in most modern wireless devices and can be combined with existing methods to increase accuracy of and efficiency of the localisation process. The objective of this research is to use the node orientation, coupled with antenna radiation pattern of each node, to improve the Received Signal Strength (RSS) range measurement technique. As energy efficiency is critical to WSNs, it is necessary to minimize both computation and communication costs in any operation involving WSNs, including during the localisation process. To achieve that, accelerometer measurements are used to reduce the number of iteration of the optimisation process during the refinement phase by computing more accurately an initial position for the optimisation using

dead reckoning and approach the localisation in a distributed manner. The contribution of this is the investigation and development of an efficient localisation algorithm that can be used on a low cost wireless sensor board developed using existing technology. A review of the existing methods is conducted to highlight the key aspect to consider when developing an efficient localisation algorithms. A mathematical modelling of the proposed algorithm is developed and simulation is conducted to analyse the performance of the algorithm. An exhaustive test bed hardware has been designed on which the algorithm can to be validated.