Title: Jamming-Aware Quality-of-Service Enhancement in Wireless Sensor Networks

Abstract

A wireless sensor network (WSN) comprises of a large number of sensor nodes, which are responsible for sensing certain environmental phenomena such as temperature, humidity, pressure, and movement of objects. Applications of WSNs span across multitude of domains, viz., environment monitoring, battlefield surveillance, health monitoring, and target tracking. Jamming remains one of the principal factors which causes disruption within a WSN. The fundamental operating principle of a jammer is to transmit high power radio signals with frequency same as the nodes in the network and break the ongoing communication by decreasing the signal-to-noise ratio (SNR). A proactive jammer constantly emits noisy signals and prevents diverse of communications within its range in a particular frequency band. On the other hand, a reactive jammer senses the medium first and jams it only when there is ongoing communication. The effects of jamming on the network is often highly detrimental and demands efficient techniques to counter the same.

In this Thesis, we propose Quality-of-Service (QoS) aware techniques to avoid the effects of jamming on a WSN. The existing techniques to diminish the effects of a jammer are often inapplicable in the context of WSNs, as the nodes in a WSN are highly energy-constrained. We first propose a topology control scheme in the presence of jammers for WSNs (TC-JAM), in which the sink node identifies the jammed nodes based on the neighbor node information received from the nodes and inform the same to the un-jammed nodes. Under such a scenario, the un-jammed nodes vary their transmission power and the jammed nodes set their power to the minimum level, so that energy consumption for the jammed nodes is minimized and the overall SNR of the network is improved. Next, we propose link quality-aware path selection in the presence of jamming (LAPSE). The jammed nodes are excluded and a path is set using the un-jammed nodes. A path, which has the best link quality from the set of nominated paths, is selected using the optimal decision rule. This improves the packet delivery ratio and network lifetime. In the next work, we assume that the jammer is intelligent enough to jam multiple frequencies. Also, nodes in the network are capable of switching frequencies based on the jammer's intervention. The nodes' decisions of switching the frequency to avoid the effects of a jammer are based on the optimal decision rule to maximize the throughput of the network. In our final work, the jammed region is identified by the centralized node. The jammed nodes are instructed to move to un-jammed region with optimum angle and velocity, so that the packet delivery ratio is improved and the network energy consumption is reduced. Performance results show that the proposed scheme reduces the energy consumption of the overall network by up to 32.7%, and the network overload reduces by 44.13-50.12%, which, in turn, increases the lifetime of WSNs.

Keywords: Jamming Avoidance, Wireless Sensor Network, Frequency Hopping, Optimal Decision Rule, Transmission Power Level, Mobile Wireless Sensor Networks