Path Loss Models for Orchard Environments and Their Implications

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Future farms and orchards will become increasingly depend upon wireless sensor and actuator networks to enable a variety of applications including pest control, precision irrigation, fertilizer delivery, frost detection, fire detection, detection of crop maturation, silage monitoring and livestock tracking. Although trial and experimental deployments of such networks have been deployed at numerous locations during the past decade, it appears that the majority of such deployments have been planned in an ad hoc manner. Although a large number of propagation studies have been performed in residential, commercial, industrial, urban and suburban environments, relatively few have been performed in agricultural environments. As a result, designers have relatively little to guide them as they plan large-scale deployments.

Here, we present the results of a propagation measurement campaign conducted in both conventional and high-density fruit orchards located in and around Keremeos, BC. Path loss was measured in both the 915 MHz and 2.45 GHz licence-exempt bands over ranges between 10 and 200 metres in both node-to-node and node-to-gateway configurations where the nodes are located at various heights above the ground and the gateways are located at various heights above the canopy. Measurement data were collected in conventional orchards in which the distribution of individual trees is essentially isotropic and in high-density orchards in which much smaller trees are planted in long and narrow rows. In the latter case, measurement data were collected in both the cross-row and along-row directions and revealed significant differences between the two cases. We use the results to compare the performance and practicality of different wireless network topologies that employ gateway-to-node, node-to-node and node-to-relay configurations to achieve the desired coverage. Moreover, we also share a method for designing a data collection strategy and reducing the data collected that reduces the amount of data required to the minimum but which extracts the maximum information.