Adaptive Arrays and Diversity Antenna Configurations for Handheld Wireless Communication Terminals

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(ABSTRACT)

This dissertation reports results of an investigation into the performance of adaptive beamforming and diversity combining using antenna arrays that can be mounted on handheld radios. Handheld arrays show great promise for improving the coverage, capacity, and power efficiency of wireless communication systems.

Diversity experiments using a handheld antenna array testbed (HAAT) are reported here. These experiments indicate that signals received by the antennas in two-element handheld antenna arrays with spacing of 0.15 wavelength or greater can be combined to provide 7-9 dB diversity gain against fading at the 99% reliability level in non line-of-sight multipath channels. Thus, peer-to-peer systems of handheld transceivers that use antenna arrays can achieve reliability comparable to systems of single-antenna handheld units, with only one-fifth the transmitter power, resulting in lower overall power consumption and increased battery life. Similar gains were observed for spatial, polarization, and pattern diversity.

Adaptive beamforming with single- and multi-polarized four-element arrays of closely spaced elements was investigated by experiment using the HAAT, and by computer simulation using a polarization-sensitive vector multipath propagation simulator developed for this purpose. Small and handheld adaptive arrays were shown to provide 25 to 40 dB or more of interference rejection in the presence of a single interferer in rural, suburban, and urban channels including line-of-sight and non line-of-sight cases. In multipath channels, these performance levels were achieved even when there was no separation between the transmitters in azimuth angle as seen from the receiver, and no difference in the orientations of the two transmitting antennas. This interference rejection capability potentially allows two separate spatial channels to coexist in the same time/frequency channel, doubling system capacity.
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