Frequency Hopping Techniques for Digital Mobile Radio

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A thesis submitted for the degree of Doctor of Philosophy.

May 1990.

Contents

Abstract

A fast-frequency-hopping, DPSK cellular mobile radio system is examined. The results both independently confirm and extend earlier work, and provide new results for isolated and multiple cells. All analysis and modelling is subject to common assumptions, ensuring comparisons between alternative receivers are valid.

Previous results for the performance of an orthogonally coded FH-DPSK system using a linear receiver, in correlated Rayleigh fading and white Gaussian noise, have been extended to investigate the use of spatial diversity techniques. Better results are obtained from conventional combining schemes than from an alternative diversity scheme proposed in the literature.

If user interference is modelled as a series of independent Gaussian tone interferers in individual channels of the target user's frequency hopping sequence, simulation confirms analytic results from other authors showing the linear receiver performs poorly. A receiver which makes hard decisions on every code bit before decoding and a non-linear receiver which operates on the normalized received complex envelope on each channel are investigated as better alternatives. Use of the "normalizing" receiver is found to produce considerable performance improvements over the other receivers when tone interferers are present, with slight degradation over the linear receiver in Rayleigh fading and AWGN alone. Problems are revealed with the use of Hadamard orthogonal coding in tone interference, with one solution shown to be reasonably effective in averaging out variations in user bit error rates which otherwise occur. Simulation of isolated and multiple cells indicates that around 70-80 active users per cell with a mean error rate of 10^{-3} may be achievable. Derivation and simulation of the optimum linear receiver for the FH-DPSK system show better results are possible if the interfering tones are recognized.

Other coding schemes are examined, with an improved analytical formulation of the hard decision bit error rate producing results in close agreement with simulation. Estimates of the system user capacity for several codes, with hard decision and normalizing receivers and using random hopping sequences, are presented and some schemes tested by simulation. Better FH-DPSK system performance is predicted than that previously published by other authors.