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A CLOSED LOOP MOBILE POWER CONTROL SIMULATOR

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Abstract—In this research project, predictive power control in Code Division Multiple Access (CDMA) systems in urban environments is investigated. Predictive filtering of estimated received signal power has been proposed, and a class of FIR-type polynomial filters has been investigated with simulations. The simulations show that FIR polynomial predictors can provide smoothed signal power samples with the signal-to-noise ratio (SNR) improved by ca. 5 dB, without any delaying of the signal. Driven by these results, a CDMA power control simulator is being constructed for actual controller development in COSSAP (Communications Simulation and System Analysis Program by CADIS GmbH, Germany) environment. This paper briefly introduces the simulator concepts.

As the CDMA systems are inherently interference limited, it is of paramount importance to keep the transmission power of each mobile user as low as possible [1]. This is crucial in the uplink transmission (from mobile to base station), where all the mobile units need to be controlled by the base station to keep the *received power level* from each mobile unit constant in the average. The need for power control has been widely studied, and the capacity of a CDMA system is found to greatly depend on the power control function [1], [2]. The mobile transmitter power control for counteracting Rayleigh fading is achieved through a closed power control loop for which it is necessary to estimate the received power level.

A CDMA closed loop power control simulator [3] is depicted in Fig. 1. The simulator consists of mobile transmitter, radio channel, base station receiver, and power controller models. The simulator operates on chip level, and all the models are presented in the complex baseband domain. In the earlier studies, signal-to-noise ratio (SNR) was used as the measure of the predictor performance, and the applicability conditions for a class of FIR polynomial predictors for Rayleigh fading prediction were found [4], [5], [6], [7]. While SNR certainly gives implications of the applicability of the predictors, current controller research directly addresses the two main objectives: *reducing the variance of the received power level* and, *reducing transmitter power consumption*. Both affect the interuser interference, and thus the CDMA system capacity. The latter one naturally also contributes directly to the mobile power consumption. The main question is that how to decide when to apply which transmission power level given limited controller dynamics, while maintaining the same (or better) bit error rate (BER) as with a conventional reference power controller. The new simulator directly outputs actual achieved BERs and variances of the controlled channel output power. Also, relative transmitter power consumption is measured by cumulative mobile transmitter power level setting.

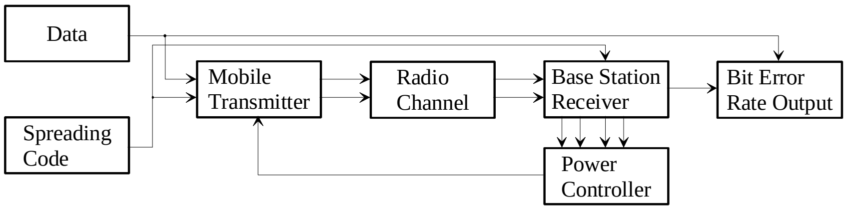

Fig. 1. Overall diagram of a single user CDMA closed loop power control simulator.

In the simulator, the component models are kept as simple as possible, to observe the effects of power control schemes. Also, the simulator is kept as modular as practical from the simulator execution time point of view, to allow for easy employment of different component models. The mobile transmitter takes the data bits an input, applies differential coding and binary phase shift keying (BPSK), and spreads the bit sequence with a pseudonoise spreading code. After spreading, transmission power level is set. At each power control instant, for example every 12 bits, or approximately 1.2 ms, the transmitted signal level is altered ±1 dB according to the power control bit received from the base station. The transmission is fed to the channel model, which is, for example, a single path Rayleigh fading channel with carrier frequency set to 1.8 GHz, and also some receiver is noise added. The variance of the channel output power is calculated and monitored after applying the fading but before adding the receiver noise. Also in the channel, interference is applied. Interference can be modeled either as additive white Gaussian noise (AGWN), or by actually adding several faded transmissions from other independent transmitters with different data, spreading code and Rayleigh fading. The interferers can be either perfectly power controlled, or have the same type of power control system as the monitored transmission system. For the controller research, the receiver is assumed to be exactly synchronized, and the spreading code perfectly known. As the simulator contains an actual feedback loop, implementation of the loop delay requires extra attention. In the simulator, the delay in applying a new transmitter power level setting is a parameter. This delay includes all the propagation and processing delays, but does not affect the synchronization. In the simulator presented in this paper, control decisions are based on predicted received power level estimates. On the other hand, also received signal-to-noise ratio based controllers are to be considered. Also, other controller types are considered [8].

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