Simulation of a RAKE receiver in a CDMA system using Simulink/Matlab

by

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Summary

The direct-sequence code-division multiple-access (DS-CDMA) systems have recently attracted significant interest as a mobile cellular communication system by reason of its ability to suppress a wide variety of interfering signals including narrow-band interference, multiple access interference (MAI) and multipath interference. In the presence of frequency-selective fading, the capacity of the system can be enormously enlarged through multipath diversity gained by utilizing Rake receiver structure. In the present thesis after the theoretical analysis of the transmitter, the channel and the Rake receiver, a Rake receiver was constructed in the SimulLink environment of Matlab. Its behavior was studied for a variety of pulse shapes and number of users and the results was annotated.

In the first chapter there is reference at the CDMA systems and its differences from the other multiple access systems. These systems (CDMA) are based on spread spectrum techniques. The main techniques of this kind are referred and more analytically the direct sequence spread spectrum. The benefits of spread spectrum, the form and the signals of the system and the way they are created are underlined. There is special reference at the receiver of the system and the possible ways for cross-correlation of the recovered signal.

In the second chapter the radio-communication channel is analyzed. The formation of the multipath is illustrated with mathematical analysis, its fading, as well as the Doppler and the time delay spread. There is special reference about the Rayleigh distribution.

In the third chapter there is reference and analysis of the forms of diversity reception. Three main combining techniques of diversity reception are analyzed: the Selection Diversity in which the path with the higher signal to noise ratio, snr, is selected for the demodulator, the Equal Gain Diversity Combining in which the decision variables from all the fingers are combined at the receiver with equal gain.
for the derivation of the total decision variable and the Maximal Ratio Combining in which the decision variables from all the fingers are combined at the receiver with different gain in proportion to its snr for the derivation of the total decision variable.

The fourth chapter is the chapter in which the idea of Rake receiver is entered. In the Rake receiver the signal has an autocorrelation function with such a bandwidth that is allowable the isolation of the multipath coefficients and the selection of a path. The Rake receiver consists of a line of delayed cross-correlators i.e. the basic structure of a Rake receiver is a tapped delay line. There is mathematical analysis of this line and some kinds of Rake demodulators are referred.

In the fifth chapter the necessity of the raised cosine-filter and the benefits of these different shapes of the pulses are underlined. In the sixth chapter there is the theory behind the construction of the model. The system and the model of the channel is being described and there is mathematical representation and analysis of all the signals on the channel, the input and the output of the receiver.

The seventh chapter includes the tranceiver in the SimuLink environment and the simulation. There is description of the construction of the model in every part of the tranceiver – transmitter, channel, Rake receiver, derivation of the decision variable – possible differences with the theory and the set data while the waveforms at several hubs of the tranceiver are indicated as well. After the reference to special parts of the simulation that must be taken into account, the results of the simulation i.e. the diagrams BER - snr for different number of users, joint the processing gain and the diagrams of the BER - number of the users for different snr’s are indicated. Annotation of the results and comparison with the bibliography is followed.