DOA ESTIMATION USING ANN TECHNIQUES FOR ASYNCHRONOUS DS/CDMA SYSTEMS

K.A.D.A.V.Kariyapperuma

thesis submitted in partial fulfillment of the requirements of the Degree of Master of Science
(Major component of research)

Department of Electronic and Telecommunication Engineering

University of Moratuwa

Sri Lanka

June 2006

ABSTRACT

The demand for the mobile communication services is increasing rapidly and this necessitates finding new ways to use the spectrum more efficiently. As a solution, smart antenna systems are found to be promising. For a smart antenna system to operate efficiently, accurate Direction of Arrival (DOA) information of the sources are needed. This thesis proposes a new technique for estimating the DOA accurately in asynchronous DS/CDMA systems using neural networks.

The general spectral based techniques, such as MUSIC and ESPRIT, were simulated and analyzed. In order to estimate accurately using these methods the number of sources should be less than the number of antenna elements in the array. In addition, they cannot be operated in multipath environments. The processing power requirement of spectral based techniques and parametric based techniques is high to be operated in real time. These conditions disqualify the techniques, to operate in DS/CDMA systems. The techniques, which have been developed for DS/CDMA systems, were analyzed. Generally, most of the algorithms rely on information such as, complex attenuating factors, synchronizing information of all users, including themultipaths. In addition, they heavily rely on the Gaussian distribution of MAI, which is not a realistic assumption in dominating MAI environments. As a solution to these, a new analytical and training combined method is proposed in this thesis.

The signal rcccived at the antenna array contains the DOA information of the desired signal, MAI and Gaussian noise, and the DOA is extracted by mitigating the MAI and noise components. This is performed in three stages: an initial temporal processing stage followed by a spatial or antenna array processing stage and a final NN stage. The MAI is reduced at all three stages while the Gaussian noise is reduced mainly at spatial processing and the NN stages. All three stages use non-complex techniques and therefore the algorithm is computationally very efficient.

Using a 6-element isotropic antenna array, the system was simulated under different environmental conditions such as varying signal to noise ratios, varying multipaths and for untrained sources and no assumptions were made unlike in the simulations of the previous workers. The arrival of a signal is first detected within a 10° sector and then the exact direction is estimated with a very high accuracy using the estimation NN. A new preprocessing technique is proposed which leads for a small training data set and a training and generalizing time.
The results arc very promising and the mathematical reasoning supports them.