## 2. Literature Overview

Calhoun [Cal88] gives a good, easy-to-read introduction to the field of cellular systems and after that Lee [Lee86] provides a somewhat more mathematical basic reading on mobile communication. [Eur93] is the GSM (Groupe Spécial Mobile, i.e., Global System for Mobile Communications) standard, and [Bai94] outlines third-generation mobile radio design issues. GSM is classified as a second-generation system. [Has93] is a tutorial-survey paper to indoor radio propagation issues. Among many other things, the classical Jakes' Rayleigh fading channel model is presented in [Jak74], and a comprehensive study of propagation models with recommendations is given in [IEE88]. [Par92] can be recommended for reading on mobile radio propagation channels. Propagation power-spectral theory is discussed in [Gan72] where, for example, typical power spectra for some antenna geometries are derived. A channel simulators are described in [Has79]. In the last of which, Jakes' Rayleigh fader [Jak74] is implemented using a microprocessor. Computer models for some fading channels are described in [Loo91].

In [Mag94], several concepts of spread spectrum (SS) systems are clearly stated. [Sim85] along with [Pic91] serve as more mathematical basic references to SS systems, and [Car86] is a course book on communication systems. [Sch90] is a plain English introduction to both direct-sequence (DS) and frequency-hopping (FH) SS systems. A code-division multiple-access (CDMA) system overview with power control analysis is given in [Lee91]. Definitely one of the main issues in CDMA systems is the system capacity which is also discussed in [Gil91] with reference to interference suppression. A feed back power control model for CDMA systems is presented in [Ari93] and signal-to-interference (SIR) based capacity analysis is continued in [Ari94]. [Åst87] serves as a general reference to adaptive feedback control. A SIR based power control algorithm for mobile-to-base station transmissions in a time-division multiple-access (TDMA) system is analyzed in [Cha94]. In [Gej92], the base station-to-mobile link power control in CDMA systems is discussed on the basis of carrier-to-interference ratio (CIR). CIR based optimum power control is analyzed in [Zan92], and CIR based analyses of centralized and distributed power control schemes are given in [Gra93] and [Gra94], respectively. Effects of imperfection in CDMA power control systems are discussed in [Pra92], [Kud93], [Pri96], and [Kim97]. Call blocking probability in terms of average number of users requesting service, i.e., Erlang capacity, in a power controlled CDMA system is analyzed in [Vit93b]. Other references on the effects of power control on CDMA system performance and capacity include [Mil92], [Kud92], [Kim93], [Vit93a], [Ton94] and [Vit94a]. Also, a variety of neural network based solutions to the problems of communications technology have been proposed in the literature. For example, multiuser detection (MUD) performance of neural networks in CDMA systems is compared to performances of conventional techniques in [Miy93]. Channel equalization using neural networks is proposed by Kechriotis [Kec94]. Channel equalization schemes are used at the receiver to decrease the effects of channel distortions, e.g. power signal fading and interuser crosstalk interference, and to recover the transmitted symbols. [Fre91] is a basic course book on neural networks.

[Par87], [Orf90], and [The92] serve as the starting points to digital signal processing methods. Heinonen-Neuvo (H-N) polynomial predictors, used in this work, are introduced in [Hei88]. The method for implementing the first or the second degree H-N predictors of any length with a fixed number of arithmetic operations is given in [Cam91]. A signal processing oriented view to Newton-type predictors is presented in [Ova91b]. Optimization of polynomial predictors for any application specific prefilter is derived in [Laa93]. Extensions of the Newton's backward prediction algorithm to linear smoothed Newton and to median smoothed Newton predictors are introduced in [Ova91a]. The linear smoothed Newton predictors are further extended to recursive ones in [Ova92]. Cellular mobile system concepts are brought together with predictive filtering by application of polynomial predictors to predictive estimation of received signal power in mobile CDMA communications systems. This application is discussed in *the Publications* with illustrative simulations. Detailed statistical analysis on power prediction is carried out by A. Huang in [Hua95], [Hua98] and [P5].

## 2.1 Related Papers by the Author

In addition to *the Publications*, the author has been a minor co-author in a few papers related to the field of predictive power control. The research results presented in these papers are reviewed in the Thesis.

In [Gao96], Gao introduces a hybrid neural network (NN) approach to the received power level prediction problematics. In that paper, predictive minimum description length (PMDL) principle is employed in NN structure optimization. In [Gao97a], the predictive NN concepts are develop in to a NN structure with a context memory component, i.e., the NN is given an ability to remember the aspects of the inputs not only through the change of weights but also explicitly using non-processing memory neurons that feed information from upper layers back to the lower layers. The concepts of [Gao97a] are illustratively elaborated in [Gao97c], where Gao also gives the tedious derivations of the PMDL principle and its usage to NN structure optimization.

General NN theory still has many unknown components. In [Var97], Varone fills one of these. In this paper, frequency responses of some NNs, originally designed for prediction of Rayleigh fading, are estimated and analyzed. Even though the NNs as non-linear systems do not possess frequency responses in the common sense, it is possible to estimate input-dependent frequency responses for them. This work gives new tools for NN designers to understand the fundamental properties of NNs.

In [Hua98], Huang gives demanding derivations for the optimum power estimator based on the Wiener model with a complex-valued input. Also, simulation results applying the optimum power estimators in a single user mobile transmitter closed loop power control system are given.