

ABSTRACT

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The present thesis is concerned with the development of the theory of linear and nonlinear shift register sequences, their practical generation, and use in system identification by means of crosscorrelation methods.

The sequential behaviour of autonomous linear binary feedback shift register is studied in some detail. Methods are described to evaluate all the null sequences of a given shift register characteristic polynomial irrespective of its factorable features. Given a binary cyclic sequence of maximum length or otherwise, the problem of determining the corresponding characteristic polynomial is solved. Useful properties of the characteristic polynomials and their null sequences are stated.

A comparative study of the existing correlation schemes for the measurement of linear system impulse response is made, using a pseudorandom binary sequence (prbs) as test signal. As a result, a new correlation scheme is described in which simultaneous crosscorrelation of the system output with the input prbs and its phase inverse is effected to obtain an accurate estimate of the dynamics without incurring errors due to test signal imperfections and corrupting effects of system noise and drift. Also a quick method of finding shift register connections for delayed versions of the basic sequence is brought forth.

The theory of multilevel shift register sequences is developed. Methods are presented to derive the sequential behaviour analytically from a knowledge of the logical structure. Attention is given to the synthesis problem of realizing a given cycle structure. A quick method of finding the shift register connection for delayed versions of the basic p-nary sequence is advanced. Some properties of the multi-level sequences are discussed. An attempt is made to generate a 4-level m-sequence by means of binary logic.

The current status of correlation art using pseudorandom sequences in a linear multivariable system dynamic analysis is systematically exposed. To overcome the shortcomings in the characteristic of the test signals used in current schemes, the theory of p-level shift register-ideal sequences, which have impulse like autocorrelation with zero bias, is presented. Using the ideal sequences some improved schemes are proposed for uncorrelated system input signal for use in the multi-input / output system identification.

The Volterra series expansion of the response of a nonlinear system is described. The development of correlation method using pseudorandom sequences for identifying the kernels that occur in this expansion is presented. To shorten the correlation time associated with the currently used antisymmetric sequences, a new correlation pattern of system testing is introduced, by which employing binary signals, the first-and second order kernels can be effectively identified within reasonable correlation time.

The theory of nonlinear feedback shift register sequences is developed. A simple method is described to form the polynomial version of a nonlinear feedback logic starting from the cycle structure of the shift register. Further, a technique is introduced for the prediction of the cycle set of a product feedback shift register from a knowledge of its factors. The contralinear feedback shift register is seen to be a special class of nonlinear product feedback shift register. Properties of nonlinear shift registers and their sequences are stated.

It is concluded that the linear shift register m-sequences, by virtue of their statistical properties, deterministic and simple means of generation, and feasibility of adequate control over its parameters, provide a convenient test disturbance signal for the dynamic analysis of linear and nonlinear systems by means of the crosscorrelation method. The polynomial form of nonlinear feedback logic provides a flexible description for the nonlinear case and is likely to open up as yet abundant untapped source of codes for a number of new applications.
