Chapter V

SUMMARY

5.1 Conclusion and Discussion

The problems and the historical backgound of a system identification have been presented in Chapter 1. The difference of the results obtained by using the discrete and the continuous cross-correlation methods has been shown in Section 2.4. The error due to the derivative terms of the system impulse response when the input signal and the output signal are cross-correlated by the discrete method is less than the error from the same source when the correlator is used. The correlator which performs the continuous cross-correlation method provides the cross-correlation function at discrete time $t = \Delta t$. Thus, the more sampling points of the impulse response are required, the longer period of the b.m.l.s. must be used. The ordinary discrete cross-correlation method provides the same number of the sampling points as the correlator when the same b.m.l.s. is used. The new method of cross-correlation technique presented in Section 2.5 provides more sampling points for the same b.m.l.s. input signal. To obtain the same number of sampling points, the ordinary method needs the b.m.l.s. of longer period than the new method. As a result, the cross-correlation time taken by the ordinary method is longer than the cross-correlation time taken by the new method. This is shown by the results of the computer programs in Appendix F and Appendix G. When the new method is used, from Eqns. (74), (75), (76), and (77), the value of g(0) and the points of the system impulse response concerning with g(0) are affected by the errors due to the d.c. offset of the autocorrelation function and the d.c. bias in the input signal. Thus, the other points which are not included those errors are obtained with more accurate results.

The digital computer was used to determine the system impulse response from the cross-correlation function obtained by the correlator and reduce the errors. Now, in this research, the digital computer is used to perform the discrete cross-correlation operation from the sequences of the output signal and the input signal. The system impulse response with minimised errors is determined at the same time.

The examples of the computer programs are shown in Chapter 4. The computer models are (a) $g(t) = e^{-t}\sin t$, (b) $g(t) = e^{-t}$, (c) $g(t) = e^{-t}-e^{-10t}$, and (d) $g(t) = e^{-t}\cos 2t$. All of them have the dominant time constant of one time unit. Therefore, the time period of the b.m.l.s., $N\Delta t$, used as an input signal must be equal to or more than 5 time units and the steady-state outputsignal starting at the time $N\Delta t$ is used to cross-correlate with the input signal in order to keep the error within 1 percent.

It is seen from the results obtained by the computer programs that the errors are about 1 percent as expect. For the system which the values of the time derivatives of the impulse response are high such as the model with the impulse response $g(t) = e^{-t}-e^{-10t}$, the less sampling frequency of the output signal used in the cross-correlation operation causes more error in the estimated impulse response. The accuracy in calculating the error due to the derivative terms explained in Appendix C is inversely proportional to the time space between the adjacent points of the impulse response. Thus, the higher the values of the time derivatives of the system impulse response are, the more sampling points ot the output signal need. As an example, for $g(t) = e^{-t}-e^{-10t}$ and $m = 1$ in program CHAINAN1, the error obtained when $N = 127$ is less than the error obtained when $N = 31$.

The correlation times for $N = 31$, $m = 4$ in program CHAINAN1 and for $N = 63$, $m = 4$ in program CHAINAN2 are less than the correlation times for $N = 127$, $m = 1$ and for $N = 255$, $m = 1$ four times respectively. This shows how the new method gives an advantage over the ordinary discrete cross-correlation method.

5.2 Recommendations for Future Studies

Through this study, the cross-correlation between a pseudo-random binary maximum length sequence input signal and the output signal is performed by using the digital computer to determine the impulse response of a linear system with single input and single output. There are many interested subjects to be studied in the similar manner as this research. The futher studies are suggested as follows:

(a) The study in the use of the digital computer to minimise the other errors, such as the error due to the input and the output transducers, may be studied.

(b) The discrete identification methods studied in this research may be applied to the on-line hybrid computer.

(c) The applications of the methods of identification and minimisation of errors described in this research to a time-variant linear system, a linear system with multi-input and multi-output, and a non-linear system may be studied.