FINAL REPORT

Spectral Estimation Technology

Prepared by: Dr. James A. Cadzow
Academic Rank: Professor
Department and University: Department of Electrical Engineering
Virginia Polytechnic Institute
Blacksburg, VA 24061
Prepared for: Air Force Office of Scientific Research
Period of Grant: June 30, 1981 to August 31, 1981
Date: September 1981
Grant No. AFOSR 81-0236

Approved for public release; distribution unlimited.
Spectral Estimation Technology

The basic task being examined under this grant is that of estimating the spectrum of a wide-sense stationary time series \( \{x(n)\} \). This estimation is to be based on the following set of \( N \) time series observations

\[
x(1), x(2), \ldots, x(N)
\]

(1)

which are made available through some measurement mechanism. The spectral density associated with such a time series is characterized by

\[
S_x(w) = \sum_{n=-\infty}^{\infty} r_x(n) e^{-jwn}
\]

(2)

where \( r_x(n) \) denotes the autocorrelation of the time series under analysis.

An examination of expression (2) reveals that the spectrum is dependent on the infinite set of autocorrelation parameters \( r_x(n) \) which are not generally available. In order that one use the finite set of time series observations (1) to estimate the infinite parameter spectral density (2), investigators have generally hypothesized a finite parameter model for the spectrum. The most general linear model is the so-called autoregressive-moving average (ARMA) as specified by
\[
\hat{S}_x(w) = \frac{b_0 + b_1 e^{-jw} + \cdots + b_q e^{-jqw}}{1 + a_1 e^{-jw} + \cdots + a_p e^{-jpw}}^2
\]  

During the two month period of this grant, the principle investigator and his graduate research assistant developed an adaptive method for optimally updating the autoregressive coefficients (i.e., the \(a_k\)) of the ARMA model as new observations are made available. This updating algorithm is predicated on making use of a "restricted" set of Yule-Walker equations which governs the ARMA models time domain description. This algorithm will be dependent on a projection operator formulation. The details of this procedure will be reported upon in a forthcoming publication. [1]
References

During the two months period of this grant, the principle investigator and his graduate research assistant developed an adaptive method for optimally updating the autoregressive coefficients of the autoregressive – moving average (ARMA) model as new observations are made available. This updating algorithm is predicated on making use of a "restricted" set of Yule-Walker equations which governs the ARMA model's time domain description. This algorithm will be dependent on a projection operator formulation.
The details of this procedure will be reported upon at the forthcoming, 1982 International Conference of Acoustics, Speech, and Signal Processing in Paris.