PRESENT INSTRUMENTATION AND FUTURE TRENDS IN REAL TIME ANALYSIS EQUIPMENT

by

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Dr. Ira M. Langenthal received his B.E.E. from City College in 1959 and M. Eng. and Ph.D. in Electrical Engineering from Yale University in 1960 and 1964 respectively. His doctoral research work was supported through a Bell Telephone Laboratories Research Grant and culminated in a dissertation entitled, "An Analysis of Random Angle Modulated Waveforms." In 1964, he was the recipient of the Honeywell Award for his distinguished individual performance in graduate electrical engineering.

While attending Yale, Dr. Langenthal was consultant to Hazeltine Research Division, working in the areas of modulation theory and signal analysis for pulse compression systems and multiple target detection studies for high resolution radar. While at Hazeltine full time (1960-1962) he worked in the areas of A-J communication and synchronization theory, signal processing, noise analysis, stochastic processes, detection and coding theory.

At General Applied Science Laboratories, (later Marquardt Industrial Products Company) one area of his work had been concerned with a statistical analysis of radar returns from turbulent ionized wakes. This was primarily concerned with the concepts of non-stationary correlation and spectral analysis of the radar return. In addition to the above, he was concerned with modulation theory, sampling and quantizing theory and digital filtering and its application to signal processing and analysis. He has also been involved with funded contract work in digital filtering and its application to advanced communication systems. During the month of July, 1966, Dr. Langenthal was invited by the Institute for Defense Analysis (I. D. A.) to participate in a study program concerned with the signal processing techniques applicable to military communication satellites.

In April 1967, Dr. Langenthal participated in the founding of Signal Analysis Industries Corporation, where he is presently Vice-President and Director of Research. Dr. Langenthal has supervised and performed analysis work in the area of digital filtering for communication applications and non-coherent signal processing techniques with applications in A.S.W. and radar.

During the past 1½ years, Dr. Langenthal has been spending considerable time in sales and marketing, developing new markets and applications for SAICOR's signal processing equipment as well as defining new product concepts.

As a member of the adjunct staff of Brooklyn Polytechnic Institute, Dr. Langenthal is teaching graduate courses in probability theory and stochastic processes and detection and estimation theory. He is a member of Tau Beta Pi, Eta Kappa Nu, IEEE, PTGIT, and PTGCT. He is Vice-Chairman of the New York, Long Island, section of the PTGIT and Secretary-Treasurer of the Long Island Com-Tech Group.

Photograph not available

Mr. Kasper received his B.E.E. from the City College of New York in 1960.

Since 1960, Mr. Kasper has accumulated more than eight years of experience in a number of varied test and development engineering positions.

His engineering background includes particular emphasis on shock and vibration instrumentation and analysis.

Mr. Kasper currently holds the position of Sales Manager for Signal Analysis Industries Corp. (SAICOR) where he has been employed since May 1969. At SAICOR, he has had the opportunity to review hundreds of equipment and interface problems posed by a broad range of customers.

ABSTRACT

In the past instrumentation available to the diagnostician for analysis of machinery problems was limited to swept narrowband filter systems and, less important, parallel narrowband filter systems. Although useful for analysis of noise and vibration problems, this equipment had the disadvantage of being relatively slow and requiring frequent adjustment.

Presently available instrumentation operates in what is described as "Real Time" i.e., the analysis equipment uses various techniques that allow all available data to be analyzed and the results presented with no appreciable delay. A commonly used technique is the "time compression" technique where data is stored digitally, compressed, and converted to a high frequency signal for analysis by conventional swept filter techniques. This approach has proved to be more and more popular in recent years. Reduction in the over-all size of these instruments, addition of desirable features, and improved reliability have all contributed to this growing popularity.

These time compression spectrum analyzers are most frequently used in studying vibration problems.

Using a self-contained averager, they provide Power Spectral Density characteristics that aid the user in studying his particular vibration problem. Their compactness allows easy installation at remote machinery sites and "on-the-spot" diagnosis.

A relative newcomer to the instrumentation field is the digital correlation and probability analyzer. This instrument performs a wide variety of analysis functions that were extremely difficult or impossible to accomplish a short time ago.

Correlation Analysis provides a quantitative measure of the degree of similarity between waveforms as they are shifted relative to one another in time. If the signal is being compared with itself, the resulting function is an autocorrelation. Any two different waveforms may be compared via cross-correlation.

The detection of signals in noise, the determination of dynamic system errors, automatic adjustment and control of processing plants, localization of interference sources, directional reception of signals, determination of speech patterns and evaluation of ballistocardiograms are but a few applications.

Probability Analysis is concerned with the amplitude variations or properties of a waveform. The probability density function provides information concerning the likelihood that a function lies within prescribed (amplitude-voltage) bounds. The probability that a measurement will not exceed a particular value is provided by the probability distribution function. In addition to being a measurement descriptor vital data is imparted by this probability information. The likelihood of excessive wind gusts, the determination of peak structural loading, the evaluation of system nonlinearities, the determination of error rates and other performance criteria and the verification of analytical models are some of its many uses.

In some applications it is necessary to detect the presence of a signal buried in noise and to preserve its waveform. For a particular class of waveforms this is accomplished by a SIGNAL ENHANCEMENT or signal recovery procedure.

These digital instruments have characteristics similar to the time-compression spectrum analyzers in that they can be readily moved to a required machine site, provide on-line analysis, and move on to a new assignment. Numerous operator convenience features and high reliability contribute to their popularity.

In complex systems such as multi-stage turbines, the sources of noise and vibration are numerous and complex. The dual channel correlation analyzer offers the ability of identifying a particular source and determines its contribution to the over-all vibration level.

A third category of currently available processing tools is the software oriented Fast Fourier Transform Analyzer (FFT). This device most commonly offers a wide range of processing capabilities including those detailed above. This approach offers all processing requirements in one package. Primary disadvantages are size which precludes convenient transport to a local job site and relatively high cost which prevents truly widespread use.

These systems are most frequently seen in the design center where various concepts can be implemented and evaluated on prototype systems prior to commitment to production.

Future trends in analysis instrumentation go toward more compact, all digital, higher speed operation. Most promising is the hard wired FFT that combines the advantages of present day portable spectrum analyzers and correlators with the wider range of functions available in software oriented systems. Specifically, systems will be available with significantly higher processing speeds and finer resolution. These features will allow the user to perform more detailed analysis of his machinery problems to identify and correct problem areas before they become troublesome.