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REAL TIME ANALYSIS

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72/ 81 Techniques in Digital Analysis of Analogue Data

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With the expanding role digital computers are being confronted with in data analysis, existing software systems must be regularly updated or else have a built in flexibility in order to cope with novel demands for the analysis of analogue data. The Data Analysis Centre, I.S.V.R., has developed a software system based upon the concept that an analysis must consist of a series of programmes, each performing a specific basic function. As a result, the various programmes may be arranged in numerous sequences to provide the variety sought by each individual analyser. The case studies to be presented have been chosen to show some of the demands being put upon techniques in the digital analysis of analogue data, which may have been thought of as being routine.

An important and quite basic analysis is the evaluation of the Power Spectral Density Function of an analogue signal. Such an analysis had to be performed upon data from a model investigation studying the response of tall structures to natural winds. This investigation involved the measurement of pressure forces and velocity fluctuations. The power spectrum of the pressure fluctuations had to be determined in a relatively small frequency range, 0 to 150 Hertz, consisting of very narrow band peaks. However, the spectrum of the velocity fluctuations had to be evaluated over a very broad frequency range, 0 to 10 Kilohertz. The problems caused by this type of analogue data could be enumerated as follows. To determine a power spectrum with fine resolution over both a narrow and wide frequency range. To evaluate each power spectrum with the same degree of statistical accuracy. To keep the computational time to a minimum. A power spectral analysis based upon the Fast Fourier Transform quite readily resolved each condition sought by the analyst.

The evaluation of the Mean and the Root Mean Square of a data signal is another very basic and often performed analysis. However, when the parameters to be estimated are to be determined for points rotating in space, from analogue data measured at a fixed point, the technique is no longer elementary. The mean value and the root mean square of both the relative and the absolute velocity are to be evaluated at points translated into the rotating frame of reference of the rotor using data from a fixed transducer measuring the fluid velocity downstream of the blades of a turbo-fan. Since the phenomenon being measured is cyclic, the continuous analogue signal will contain one value for any specific point in the rotating system from each cycle. Therefore, the required parameters must be calculated by the method of ensemble averaging. As a result, all of the data necessary for subsequent analysis had to be acquired simultaneously with another signal of pulses marking the beginning of each cycle for future reference purposes. The accuracy to be realized and the computational time needed will both be significantly influenced by the method in which the data is digitized. Any disadvantage in terms of computational time, is strongly offset by the relative simplicity of investigating the parameters of a rotating system with a fixed probe rather than trying to attach the probe to the rotating system.

The need to be able to design a system corresponding to a situation that occurs rarely is one which is often required. This design is dependent upon the analysis of a considerable amount of data representing the various and numerous conditions which are possible occurrences. This particular case concerns a pressure cell model for determining from hydraulic model tests the various pressure distributions for which the shells of reinforced concrete caissons have to be designed, corresponding to a situation that occurs once per century. The significant feature of the technique here is in being able to acquire the necessary and considerable amount of data by being able to discriminate between what is acceptable and what is not while the analogue data is being digitized.

Subsequently, this data will be interpreted to prototype values from which desired parameters may be calculated and presented in a suitable graphical form for evaluation.

In each of the cases cited, the entire analysis of analogue data was performed by using individual programmes as components in the method of analysis. Because of this, the techniques used for these analysis could be chosen on the basis of flexibility and efficiency.