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AUTOMATIC SPECTRUM ANALYSIS FOR THE FIELD

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Convenience, reduced operation costs, speed and error free repeatability are some of the attractive features of any automatic system. Automated Spectrum analysis is no exception. Any task that is repetitive, or that requires many repetitive actions, can be automated, though not always economically.

With the advent of standard interfaces, and all digital processing, the spectrum analyser became ripe for automation for such tasks as:-

1. Production line test and quality assurance.
2. Plant monitoring for machinery health.
3. Bulk data analysis.
4. Structural analysis.
5. Automatic control systems.
6. Bulk data storage for later statistical analysis.

There are immediate benefits to be had from automated spectrum analysis. Errors are reduced as all analysis parameters may be controlled. Report ready plots may be easily produced to a consistant scaling hence avoiding ambiguities and difficulties in interpolation due to scale anomalies. The operation may be de-skilled once the engineer is confident that the system is operating satisfactorily. Calibration can be checked by a simple software subroutine or be carried out by question and answer routines from the computer. This leads to the elimination of a calibration procedure as a tedious exercise.

The result is perhaps a direct cost reduction in man power and a greater efficiency, providing time for detailed analysis, and a general improvement in throughput. An automatic analysis system can be broken down into several stages.

INPUT SECTION

Figure l refers to a typical system layout.

Typical inputs are microphones, displacement probes, velocity pick-ups, accelerometers and strain gauges, though any dynamic electrical signal may be used.

Most transducer outputs need to be conditioned before either tape recording or input to the spectrum analyser. Conditioning may be part of a system already in existence as say in the case of large plant monitoring. In any event the output from the conditioning units or tape recorder will often be controlled by an automatic channel selector (not a multiplexer). In this case a complete set of calibration data must be stored for each channel to avoid system bottlenecks. However, whatever the application, periodic calibration is always necessary.

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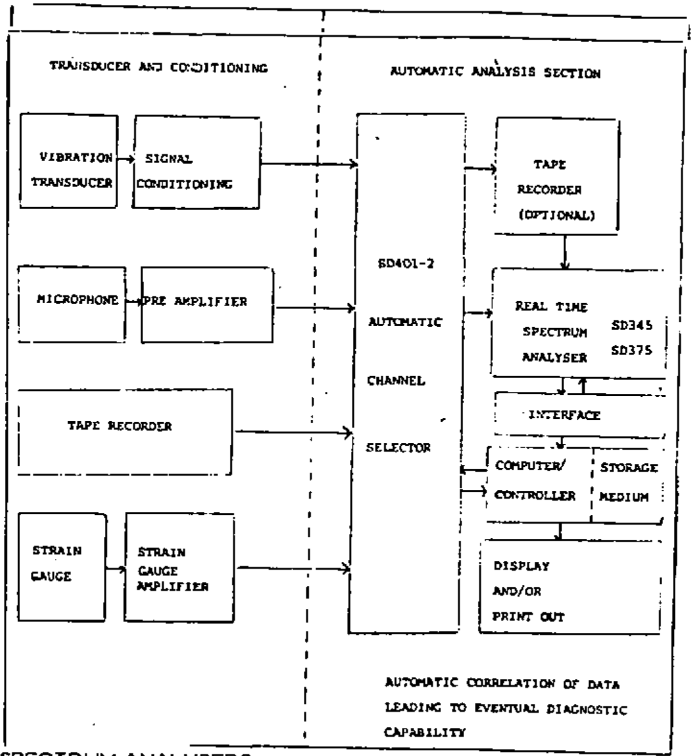

Figure 1:

A typical automatic analysis system

SPECTRUM ANALYSERS

The choice of spectrum analyser begins with the requirement for one or two channels. The primary requirement for two channel analysis is the need for phase measurements between channels. In 90% of cases where phase is not required, a single channel analyser will suffice.

Other parameters to be considered are:-

1. Resolution - most units are 400 lines.
2. Real time rate - analysis speed.
3. Ability to input and output time domain data.
4. Ease of calibration.
5. Can unit be easily removed from the system if required for other or more detailed analysis.
6. Interface flexibility is vital. IEEE-488 general purpose interface and RS232C are most common in data communications, both should be available together.
7. Full remote control is essential.
8. The analysers input and output data and control sets and subsets indicate its flexibility in an automatic system. See list below.

Typical Analyser Interface Summary (Spectral Dynamics SD345)

SET NAME	IN	OUT	ADDRESS	FORMAT
DATA	x	x	01	ASCII/BINARY
HIGH SPEED DATA	-	x	02	ASCII/BINARY
PLOTTER	-	x	03	ASCII
TIME DATA	x	x	04	ASCII/BINARY
SUBSET NAME				
CONTROL	x	-	08	ASCII
IDENTIFIER	x	x	09	ASCII/BINARY
STATUS	-	x	10	ASCII/BINARY
SPECT/TIME DATA	x	x	11	ASCII/BINARY
FRONT PANEL OVERLAY	x	x	12	ASCII/BINARY
FRONT PANEL SINGLE	x	-	10	ASCII/BINARY
GRIDS	-	x	14	ASCII/BINARY
ANNOTATION	x	x	15	ASCII
TABLE DATA	-	x	16	ASCII/BINARY
CALIBRATION	-	x	17	ASCII/BINARY
TIME DATA	x	x	18	ASCII/BINARY

INTERFACE

There are two prime instrument interfaces in use today and many others less well defined. These two are the IEEE-488 1975 General Purpose Interface Bus and RS232C interfaces.

IEEE-488

The IEEE interface is an 8 data line full handshake interface that is addressable and works in a similar way to a small telephone exchange. There are some rigid rules, though these are not typically restrictive. The main attraction of the IEEE interface is that it is well defined and most instruments that have this interface will communicate with any computer controller that has an IEEE interface. The prime specification as far as spectrum analysis is concerned is that the data is transferred in a byte serial form (that is there are eight data lines sending one bit form each from a byte together). The result is a universal interface that is acceptably fast for most instrument users and is very flexible.

RS232C

This bit serial interface is most commonly used in modem or telephone transmission of digital data. There is no handshake facility. Once data transfer is initiated it continues at a fixed rate until it is terminated by a terminate command.

It can be observed that though simpler in concept the RS232C interface is not universally standardised. Thus, there is no guarantee that an instrument with this simple two wire interface will work with an instrument with a supposedly similar interface.

In general it can be said that the RS232C interface has a slower data transfer rate than the IEEE-488, and its compatibility is not as good.

Less common interfaces include binary coded decimal and 16 bit parallel (usually very fast and required for high speed data transfer applications).

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THE COMPUTER CONTROLLER

Selection of a controlling computer is dependent on the task in hand. The main parameters to be considered are:-

1. Quantity of data to be handled - required operating memory size of the controller?
2. Speed of data processing by computer if required controller process speed?
3. Does data need to be stored or output or both? Peripheral devices to the computer and built in features.
4. Programme size and complexity - language type?
5. Graphic display or just graphic outputs?
6. Ease of use?
7. Cost?

A four hundred line spectrum will require a minimum of 400 bytes of computer storage and may be up to 3200 bytes depending on the number format. Processor speed may be significant if 400 lines of data are to be manipulated. Any data manipulation must be operated on all 400 lines in sequence, thus time may become a principal factor.

Many computers contain their own data and programme storage facility, display and printer. Others have more limited capability. Units with built in features are generally cheaper than multi unit systems.

The program language and ease of use of the system go hand in hand. If a system is bought complete, fully automated and self contained then it will do a specific task and may not be easily reprogrammable. On the other hand a system bought unit by unit is more often required for multi task use, and is more versatile and easily reprogrammable. Complex languages and advanced programs may be a severe restriction in operation. Things that are not understood are often under utilised or mis-used.

A typical automatic system may contain:-

1. An SD345 spectrum analyser with IEEE and RS232 interfacing.
2. An HP85 desk top computer with built in display, (for graphics) printer, cassette storage and 32K bytes of memory.
3. A digital plotter that may be run from either the HP85 or the SD345 directly or from the SD345 under control of the HP85.
4. Basic programming language for ease of use.

OUTPUT

Data that is carefully input and processed should be output to a device that is consistent with the quality of analysis. The range of plotters, printers, hard copiers and continuous plots now available is vast. The job requirement will lead to the specification of a particular device.

IN CONCLUSION

Careful consideration must be given not perhaps so much to what an automatic spectrum analysis system does but how it does it and what each of the constituent items of the system can and cannot do.

Spectrum analysis is a complex task full of pitfalls before the addition of sophisticated computing capability. Failure to understand the basic processes will lead to poor results and under utilisation of the equipment. It is best not to try to run before one can walk.

What is often lost in automated signal analysis is the awareness and protection provided by the human senses clubbed together.