USER ORIENTATED SOFTWARE FOR SIGNAL ANALYSIS

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ABSTRACT A conflict exists between dedicated analysis instruments which are easy to use but inflexible and general purpose computers which are adaptable but require program development. A software package has been developed which permits easy and interactive manipulation of analysis parameters in a general purpose operating system.

INTRODUCTION

The development of signal analysis systems has historically evolved from analogue instruments. With the application of the FFT through the use of a computer, development initially followed with instrument-like equipment, modern examples of which are highly sophisticated. Following the early development it was soon recognised the computer could be used for more specialised tasks, and hence programming languages, suitable for signal analysis, were developed. A conflict was thus introduced; whether an easy to operate instrument with limited functions is preferable to a programmable system offering considerable flexibility but requiring programming skills. Such has been the advance in micro-electronics that hybrid systems are feasible, using multiple processors for different requirements. Indeed such a solution is ideal when the programming needs are for post-processing of standard analysis functions.

A further question is now raised; whether a programmable system is needed for specialised analysis techniques, or more conventional forms of data processing. For example, application of the Cepstrum function or multidimensional transforms requires special application of analysis techniques; whereas automatic sensor correction or narrow-band classification requires conventional data processing.

In the authors experience a general purpose computer operating system with choice of programming languages and signal analysis library has the advantage of unlimited scope of application and widespread software support, this latter factor being frequently underestimated. However, the choice is dictated by the requirements of the research programme, its resources and perhaps personal inclination.

One other essential requirement of any programmable system, used in a general purpose signal analysis environment, is for some form of interactive communication with the software.

A program may be run repeatedly with only minor modifications to the parameter menu which controls its activity. In fact it was the desire to achieve the best of both options, that is instrument-like manipulation with software flexibility, that inspired the soft-panel approach, to be described.

The usefulness of a dedicated instrument can be extended by means of overlay panels which redefine the function of the various controls. Initially the soft-panel concept was simply to mimic a complete control panel on a computer display, using perhaps a light pen to control it. However, a somewhat modified version has been produced, which is conceptually in the form of a book, where the chapters relate to major topics and the pages to detailed aspects. The technique amounts to nothing more than a simplified means of passing control data to a program.

Naturally the work was undertaken in order to achieve the research objectives in hand and consequently it may be considered as under developed. However, the software is felt to be reasonably general and of interest to others requiring such facilities. FORTRAN has been used where possible.

METHOD OF USE

Once the soft-panel program has been initiated, a chapter and page is selected for display, fig 1 shows a typical example. The format was chosen to suit the Teletronix 4010 storage display and consists of a system message area and a status area at the top of the screen, a parameter value area to the right of the screen and a parameter information area occupying the remainder of the display. The latter consists of up to 28 lines of text which may simply be operator information or may describe associated parameters or commands to the computer. In fact each of the 28 lines is unique and is designated as one of 6 different types as follows:-

TYPE 0 — The line contains operator information only; no other action is taken.

TYPE 1 — The line describes a command to the computer to perform some task.

TYPE 2 — The line describes a name parameter, that is an alphanumeric string of up to 12 characters.

TYPE 3 — The line describes a two-position switch which can be set off or on. Labels are attached to the switch describing its functions.

TYPE 4 — The line describes a decimal parameter the current value of which is given in the parameter area.

TYPE 5 — The line describes an integer parameter the current value of which is given in the parameter area.

Having presented a page on the display the program enters 'line mode' whence any reference to lines of type 2, 4, 5 (by typing the line number) invites a new value of the relevant parameter. A reference to a type 3 line automatically changes the switch and its new label displayed, a reference to type 1 activates that command (ultimate completion of which returns automatically to the page), and a reference to type 0 has no effect at all. Since a storage type display is used, new parameter values are entered in the space provided (see fig 1). Normally one or a few parameters would be modified and a command issued which results in some graphical output, or the like. However, the software automatically assess when the display must be refreshed. Parameter values are (invisibly) tagged with preset values and minimum and maximum limits (if desired) and certain keywords are recognised for special treatment, such as activating the various graphics peripherals or resetting the page to its preset conditions. Mistakes or other unacceptable responses are reported in the system message area, which can also be used to report the outcome of an activity.

Using this system the usual repetative sequence of signal analysis operations is much simplified. An operator can easily change the form of side lobe control he is using, or the resolution, or averaging etc and quickly re-run the data. Fig 2 shows a narrow-band display page from which detailed display routines can be initiated. Here, the initial analysis has been completed (with preliminary graphical output) and the results stored by the computer. Actually the programs attempt to find the requested function from whatever result file is presented, but TRI-SPECTRUM results (ie two auto spectra and the cross spectrum) can be used to derive any display format (1). Furthermore, certain chapters may be devoted to general operating instructions, or details of analysis procedures etc, thus permitting a teach-yourself capability. Other embelishments, which have not been described, extend the usefulness and ease of operation of the system.

IMPLEMENTATION

The principle of operation is straightforward. Each page is stored on magnetic disk in a direct access file. The soft-panel program references the text information as well as the parameters values, which may get modified; it arranges this information on the display and proceeds interactively with the user. A command line terminates this program and initiates the user program which in turn re-activates the soft-panel program on completion.

A library of sub-routines is available to the user permitting programs to be developed and incorporated into the facility without difficulty. In particular parameter values are found by a sub-routine whose parameter list is variable, so any number of parameters can be obtained from any position on the page. Having obtained the input data in this way, or any other way (the data being analysed will be obtained from another source) there are no restrictions on the complexity of the program.

FINAL REMARKS

The object of this presentation has been to illustrate some ideas on the use of computers in research involving signal analysis, consequently details of the programming have been avoided. Also the resources are not available to develop foolproof software, or a system which is as good as the imagination can make it.

Use of a storage type display, rather than a video one, imposes limitations on what can be achieved. On the other hand of course, this type of display is a low cost device with low software overheads and good resolution.

The author has used this system as a building block for chapters on routine third octave analysis, narrow-band analysis, multidimentional analysis as well as certain mathematical models in structural acoustics.

REFERENCES

1. Otnes, RK and Enochson, L
Digital Time Series Analysis
Wiley

DISCUSSION

R. Seynaeve What sort of users do you have?

C Richardson As a small research group we have only a few users, three or four, who work closely together. However, most interest is related to end results not system software.

R. Seynaeve How long has the system been in use?

C. Richardson About a year, but with some components, such as graphics, already available.

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System
Messages

Status
Information   CHAP PAGE LINE <CR> BUSY            GT   PLT  VDU  LO    HI
               1    4                             ON   OFF  OFF
                1
                2              DEMONSTRATION PAGE
                3              ------------- ----
                4
                5     THE FOLLOWING FOUR LINES ARE EXAMPLES OF
                6 EACH TYPE OF LINE:-
                7
                8 GIVE THE TIME AND DATE
                9 NAME OF SHIP IS ......................H.M.S.   VICTORY
               10 VERTICAL SCALE (LINEAR/LOG)                     LOG
               11 INTEGRATION TIME (SECONDS)                        2.0000
               12
               13     TRY SELECTING EACH  (IN ANY ORDER) SO AS
               14 TO ADJUST VALUES. THE SYSTEM WILL PROMPT YOU
               15 IF MISTAKES ARE MADE.
               16
               17     THE CONTENTS ARE LISTED ON PAGE 2,
               18 TO PROCEED TYPE 0<CR>2<CR> OR SELECT A NEW
               19 CHAPTER BY TYPING 0<CR>0<CR>.

                                                          Parameter
                                                          Values
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FIG. 1 A TYPICAL PAGE

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CHAP PAGE LINE <CR> BUSY            GT   PLT  VDU  LO    HI
 4    2                             ON   OFF  OFF
  1
  2 DISPLAY PARAMETERS:-
  3     TYPE: 1/MAG 2/PHI 3/REAL 4/IMAG 5/ARGAND        1
  4     VERTICAL SCALE (LOG/LINEAR) ............       LOG
  5     VERTICAL SCALE MINIMUM (LIN) (BOTH -0 )         0.00000
  6     VERTICAL SCALE MAXIMUM (LIN) (FOR AUTO)         0.00000
  7     VERTICAL SCALE MINIMUM (LOG) (BOTH -0 )         0.00000
  8     VERTICAL SCALE MAXIMUM (LOG) (FOR AUTO)         0.00000
  9     HORIZONTAL SCALE MINIMUM     (BOTH -0 )         0.00000
 10     HORIZONTAL SCALE MAXIMUM     (FOR AUTO)         0.00000
 11     CROSS WIRE CONTROL ......................       OFF
 12
 13 DISPLAY:-
 14     SAMPLED WAVEFORM
 15     DIRECT FOURIER TRANSFORM
 16     AUTO SPECTRUM
 17     AUTO SPECTRUM DIFFERENCE (APS1-APS2)
 18     CROSS SPECTRUM
 19     AUTO CORRELATION
 20     CROSS CORRELATION
 21     TRANSFER FUNCTION
 22     COHERENCE
 23     CORRELATION COEFFICIENT
 24     CEPSTRUM
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FIG. 2 A PAGE CONTROLLING NARROW BAND DISPLAY PROGRSM