SP: A program for driving instrumentation for a PC

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SP: A PROGRAM FOR DRIVING INSTRUMENTATION FROM A PC

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1 Introduction

This paper is a memorandum of the work developed from December 1986 by the author to fulfill several successive development contracts between TENNECO España S.A. and the Software Department of the UPC (Polytechnic University of Catalonia. The department was formerly the "Departament de Mètodes Informàtics" and is now the "Departament de Llenguatges i Sistemes Informàtics").

The contract specifications covered initially only the capture of data from a spectrophotometer (called SP II) and its subsequent graphic presentation on a plotter. The visualization of data was done following the GKS graphics standard [ISO 85].

Several months later, other aspects were added: the control of motions of Hamilton pumps through optical multiplexers (Optomux), and the entry of temperature data from a transducer. In section 2, there is a general overview of the machine, together with the general layout of the program. In section 3, there is a detailed explanation of the spectrophotometer data reading operation. In section 4, the graphical presentation of data. In section 5, the command of pump motions. And in section 6, the capture of temperature data. Finally, there are sections to outline future lines of action and acknowledgements.

2 General overview of the machine

In fact, there have been two machines. The first one, SP II, was a static spectrophotometer: a sample of dye, manually diluted to adequate proportion was placed on a holder, and, then, the commanding host computer, in practice a PC, delivered a set of commands, a series of flashes were sent through the liquid, some photoelectric cells measured light intensities at several wave-lengths, and data were sent back to the host computer. At this stage, the graphics package started action, and the data were presented and plotted. The second machine, SP III, is more
sophisticated. Dye is injected through a pump, and diluting water through another pump, and the mixture goes through a measurement chamber to an outlet. Measurements, data capture and processing are similar to the SP II, but everything must be carefully timed, to fulfill the final purpose which is the control of concentration of the dye. Besides this, there is a lateral problem of measure of the temperature of the original dye bath, because the ensuing light transmittance of the dye is a function of its temperature. As far as we have seen, several sub-problems can be found in the general task: The transmission of data (including diagnostics and error codes of the spectrophotometer) from the sp-meter to the computer, the transmission of orders from the computer to the sp-meter, the processing of data inside the computer, and their presentation as graphic sketches on specialised displays, the transmission of commands from the computer to the pumps (located in the sp-meter), and the ancillary reading of temperature data.

3 General layout of the program

All programs have been written in FORTRAN, namely on MicroSoft Fortran, but all rules of structured programming have been enforced, to achieve the highest possible degree of reliability, maintainability and readability. This means that programs were derived from algorithms previously written in structured pseudo-code.
The main source of inspiration for the algorithms were the programs supplied by Tenneco España S.A. These programs were written in Pascal, and were very sound, both in their general conception and in the detail coding. But they were quite hard to port to Fortran, mainly because of their strong use of non-primitive types for all kinds of variables, and because of the implicit check on bounds (for arrays) performed at execution time by Pascal. There was also a very intense use of modularity, which forced the manual elaboration of the graph of calls between procedures involving some 50 procedures and eight levels of calls.
The final outcome has been a set of different programs: one for data capture and command of the sp-meter, one for processing the data and showing graphical results, one for the command of pumps.

4 Data reading operation

The capture of data leaving the spectrophotometer is performed through a cascade of procedures, handling the different levels of detail of the tasks to be performed. This means that the top procedure is set to command the whole perspective of the operation; and going progressively down to procedures that read an array of data, those that handle a single number, until the bottom ones, ready to get only one character. To simplify transmission of data, every item of communications is a string of ASCII-coded characters. The data returned from the spectrophotometer the host computer are discriminated between several kinds of possible classes of objects, and each class undergoes a specific treatment; numerical data are stored and processed to be displayed graphically.
5 Graphical presentation of data

The visualization of scientific data is an interesting subject of ongoing research, and some papers are generally accepted as milestones [BFK 84] [Brodie 80]. Although the equipment proposed to perform the presentation was a pen plotter with a specific package of built-in procedures to command the machine, a choice was made to adhere to international standards. This implied the development of another package of procedures to act as an interface between the standard calls to GKS routines in Fortran, and the actual invocation of the specific driving routines of the plotter. But we felt that the advantages of portability of the final product are very important. The resulting routines can be used to visualize the plots through a great variety of graphics peripherals; provided that the user has installed some implementation of GKS with the corresponding drivers for the plotter, screen, workstation, or other. We have performed outputs on several PC graphics cards: CGA, VGA; and no problem has arisen.

6 Command of pump motions

After the introduction of the third generation of spectrophotometers (SP III) there was a need to control from the general supervising program the motions of pumps. This was done through a separate package of programs. These programs give commands to the SP III that state first of all the positions of the T-valves on each one of the two pumps; they then proceed to order some quantified movements of each one of the pumps. The desired result is to bring to the test chamber a certain quantity of dye diluted in water, in a very well controlled proportion, in such a way that the light transmittability of the mixture falls into the optimal range for the photometric diodes to work with maximum precision.

7 Capture of temperature data

One of the final stages of development will be the data acquisition from the general dye bath, to know the actual temperature of the mixture.

8 Future work

Several ancillary developments can be improved in the frame of this work. The most important might be the assessment of the dynamic parameters of the dye bath: its time constant, and the damping characteristic of the whole system. Although it is highly improbable, the system could go into self-induced oscillations, through a positive feed-back, and derive grossly from its intended behaviour after a few cycles.
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References


