Abstracts of the 1988 ASYST Conference[1]

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Analysis and Modeling Only

Simulation of Satellite in the Scintillation Channel

Y.V. Lo
Department of Electrical Engineering, PHE 422
University of Southern California
Los Angeles, CA 90089

Over the years, scientists have searched for a comprehensive and mathematically tractable scintillation (ionospheric) channel model (ref. 1) for analyzing the performance of satellite communication systems. Applications of such a model include the Deep Space Network (DSN) of NASA and the strategic defense program (SDI) of the AIRFORCE. In the past, there are primarily two approaches to model the ionosphere, physics (ref. 2,3) and strageties (ref. 4,5). Recently, there is the joint approach which combines the advantages of the previous methods (ref. 6).

The purpose of this paper is to present the joint approach based on the plasma theory formulation and its implementation using the *multiple phase screen* algorithm (MPS)[2] through the ASYST program. The plasma formulation starts from the basic Maxwell's equations which characterize the behavior of radio signal propagation in the ionosphere. Under appropriate assumptions, the Maxwell's equations reduce to the random Helmholtz equation. This is a second order partial differential equation with a random driving force. The existence and uniqueness of the solution of this equation is warranted based on the *random fixed point theorem* in Functional Analysis.

The unique solution can be evaluated either analytically or numerically. The analytical solution will provide the transformation from which explicit statistics of the received signal amplitude and phase can be obtained. However, in most cases a closed form analytical solution can not be derived. The other alternative is to evaluate the system performance numerically. The MPS makes use of the *Monte Carlo technique* and the forward and inverse Fourier transforms to generate samples of the signal phase processes. This is easily implemented using the random number generators and the FFT operators in ASYST. The cumulative amplitude and phase statistics can be stored in an array as a function of *signal to noise ratio* (SNR). Finally, the satellite link performance over a wide dynamic range can be displayed on logarithmic scales using the ASYST graphics subroutines.

Biomedical Applications

Algorithm for On-line Measurement of Specific Airway Conductance in Guinea Pigs

B.S. Anderson , D.B. Rayburn, A.J. Januszkiewicz, R.O. Willmott and G.R. Ripple
Walter Reed Army Institute of Research Washington, D.C.

Specific airway conductance (SGaw) is a measurement of pulmonary airflow resistance independent of changes in lung volume. Determination of SGaw without the surgical placement of pressure transducers requires the extraction of the initial 20-msec segment of inspiratory flow signals obtained from a pneumotachometer and a body plethysmograph. On-line monitoring, identification of the 20-msec segments with subsequent mathematical computations in a near real-time manner requires optimal use of ASYST® software. A guinea pig pulmonary function data acquisition system

[1]Proceedings are available from the Institute for Applied Forth Research, Inc., 70 Elmwood Avenue, Rochester, NY 14611 USA Mastercard or Visa accepted, $25 plus $5 shipping an handling.

[2]James, JC. Automated Blood Pressure Control in Pigs with Nitroglycerin Infusion. Master's Degree Thesis. University of Alabama at Birmingham, 1986.

has been developed using two personal computers. One computer performs the acquisition and equipment calibration and the other stores and analyzes the data. Flow and pressure signals are collected continuously at 500 Hz, achieving a high level of signal resolution. A waveform scroller board is used to display the collected signals. The data is transferred in five second intervals, to the analysis computer via the General Purpose Interface Bus. The inspiratory portions of each breath are found at the transition from negative to positive flow. Flow signals are integrated to obtain inspiratory volumes. Changes in flow and volume are used to determine SGaw. Data is stored in both ASYST® and Lotus 1-2-3® file format for additional analysis. Execution speed of the analysis algorithm is greatly improved through advanced array operations and stack manipulation commands, provided by ASYST® software.

Controlled Stimulus Presentation and Data Acquisition in Evoked Brain Potential and Cognitive Psychology Experiments

George Fein, Ph.D.

University of California, San Francisco
and San Francisco VA Medical Center

A very general purpose system for studying human information processing will be presented in which the researcher uses menus and parameters to define experimental protocols by choosing from among stimulus presentation, data acquisition and data reduction options. A number of features of the system will be described, including: (1) use of expanded memory so that very large and complicated experiments can be run, (2) instances of an experimental condition, (3) timing stimulus presentation and data acquisition using background tasks, foreground loops and, when available, DMA A/D acquisition, (4) synchronization of trials to external events, (5) integration of D/A, digital I/O, CRT and computer generated tone stimuli, (6) on-line monitoring for artifacts on the A/D channels and of responses (digital I/O bits) specific to the experimental condition, with classification of trials into categories based on response measures and presence or absence of artifacts, (8) on-line display of the status of the experiment, (9) a module to interactively give the subject practice on any protocol, (10) data into a protocol's data reduction specifications, (11) the file structure, and (12) integration of ASYST's powerful graphics features.

Estimation of Model Parameters in ASYST Using a Directed Search

David Hary

Integrated Scientific Resources, Sun Valley, California
and

Michael B. Jaffe

Dept. of Biomedical Engineering
University of Southern California, Los Angeles

A modified Nelder-Mead adaptive simplex algorithm was implemented in ASYST to permit the estimation of the parameter values of mathematical models (model identification). Parameters were determined by a search that was directed to find the optimal model output according to a given optimization function (e.g., cost or gain). First, a simplex of N+1 vertices was constructed, such that each vertex was associated with a model of different parameters of each vertex, recursively, so as to optimize the model associated with each vertex. Finally, the standard error of each parameter was approximated from the residual values of the optimization function and the sensitivity of this function to changes in the value of that parameter.

The algorithm is designed to permit users to identify their own models and to use their own optimization functions and criteria for ending the search. In addition, with the use of dynamic memory allocation (Tokens), parameter sets of different sizes can be estimated.

The algorithm was tested with analytical functions (Rosenbrock's parabolic valley and Powell's quadratic functions) and a model of drug removal from the blood, and was used to find the parameters of the dynamic relationship between air flow and pressure in human breathing.

Measurement and Analysis of Mechanical Properties of the Respiratory System with ASYST

Michael B. Jaffe and Stanley Yamashiro

Department of Biomedical Engineering
University of Southern California

The mechanical input of the human respiratory system was estimated by application of the forced oscillation technique (FOT) with software running in the ASYST environment. This software was developed in a relatively short period of time and permitted rapid online data collection and analysis. The input impedance of spontaneously breathing subjects was estimated by applying with an audio speaker & forcing function of computer-generated bandlimited Gaussian white noise at the subjects mouth and measuring the resultant pressure and flow. These two channels of data were low pass filtered and sampled at 400 Hz. The periodogram method of spectral analysis was used to calculate the cross and

auto-spectra of the measured pressure and flow signals. From this the input impedance, defined as the ratio of the cross-spectra of these two signals and auto-spectra of the pressure, the coherence function, a measure of noise and the linearity of the system, were calculated. The real and imaginary parts of impedance calculated over the frequency range of 5 to 100 Hzz were compared to previous results and fitted with models to extract parameters of physiological significance. The ASYST software was found to provide a convient means of trying a wide variety of alternative signal processing strategies and quickly evaluating their consequences.

Monitoring Maternal Patients at Increased Risk for Oxygen Desaturation or Nighttime Hypotension

Jerome C. James, III
Veterans Administration Medical Center
Birmingham, Alabama

ASYST has been used to create a data acquisition, display, and storage system for the Department of Obstetrics and Gynecology at the University of Alabama at Birmingham to study the effects of maternal oxygen desaturation and hypotension on the fetus during sleeping hours. Continuous monitoring and recording of maternal blood pressure and oxygen saturation for a period of 48 hours generates very large amounts of data easier and faster. In addition, a wider range of analysis methods is possible because data can be processed.

The system consists of a Compaq Plus microcomputer connected through an analog-to-digital (A/D) board to an Ohmeda FinaPres (TM) blood pressure monitor, an Ohmeda pulse oximeter, and a Hewlett Packard Fetal Monitor. In addition, the FinaPres monitor is connected through RS232C serial communication. Maternal oxygen saturation, pulse rate, and uterine activity and fetal heart rate are sampled through the A/D board, and maternal systolic, diastolic, and mean arterial pressures and pulse rate are collected via RS232C serial communications. Maternal oxygen saturation, uterine activity, and fetal heart rate are displayed graphically. All other data is displayed numerically. At 30 minute time intervals, data is stored to hard disk.

Monitoring and Data Acquisition During Testing of a Prototype Blood Pressure Controller

Jerome C. James, III
Veterans Administration Medical Center
Birmingham, Alabama

An automatic closed-loop controller of blood pressure with the infusion of intravenous nitroglycerin has been tested on pigs (1). Monitoring of the pig's vital signs and the controller performance was accomplished with a Compaq Plus microcomputer programmed with ASYST. The computer contained a 12 bit analog-to-digital (A/D) convertor board and a serial port. Analog connections were made to monitors of left atrial pressure (LAP), systolic, diastolic, and mean arterial pressure (MAP), and heart rate. The controller was connected to the computer through the serial port. With ASYST, the computer was programmed to sample the analog signals once per second. At ten second intervals, the computer averaged the last ten samples and placed them in an array for later storage. Also at this time, MAP and the drug infusion rate were plotted and all other data printed on the console and a printer. At 30 second intervals, the computer received the controller set point, the drug infusion rate, and the volume of drug infused via RS232C serial communication from the controller.

Additionally, the computer was programmed to perform input/output for the controller through serial communication. This function allowed the computer to select or change blood pressure set point and minimum LAP allowed and to initialize control.

The program was used in 31 controller test on 11 pigs. Data collected was later analyzed using comparisons and plots generated ASYST. Blood pressure was maintained within +/- 5 mmHg of the set point 96% of the time of control.

Patient Monitoring and Data Acquisition During Hemodialysis

Jerome C. James, III
Veterans Administration Medical Center
Birmingham, Alabama

The patient-machine interaction of hemodialysis requires that many variables be monitored. Modern dialysis machines and blood pressure monitors have made the frequent machine and patient monitoring tasks available to computer application. A dialysis patient monitoring and data acquisition system has been developed at the Birmingham VA Medical Center based on a personal computer programmed in ASYST. This system has the dual purpose of monitoring individual dialysis treatments and collecting data for development and testing of models of a patient's response to hemodialysis.

The computer is connected to a Fresenius A2008D dialysis machine and an Ohmeda FinaPres (TM) blood pressure monitor through RS232C serial communication. Patient weight is monitored through connection of dialysis chair digital scale to an analog-to-digital converter board. Patient blood sample composition and demographic data are entered through

the keyboard. Mean arterial pressure and body weight are displayed with real-time graphics and other data can be selected from a menu for numerical display in a data window. Interactions to treatment can be entered to the system at the time performed. At 30 minute intervals, all variable data is saved to hard disk.

Oxygen Consumption Measured Simultaneous with Rebreathing Cardiac Output-Comparison of Experimental Data with Lung Model

Michael C. Kallay, MD and Richard W. Hyde, MD

University of Rochester Medical Center

Rochester, New York 14646

A simple method of calculating oxygen consumption ($V0_2rb$) from data collected during a 15 second rebreathing period provides a completely non-invasive and readily repeatable hemodynamic assessment at rest and exercise. When compared to steady-state $V0_2(V0_2ss)$, $V0_2rb$ overestimates $V0_2ss$ by 11 + 12% in 12 normal subjects at rest. This error diminished with exercise. In 11 patients with lung disease, $V0_2rb$ underestimates $V0_2ss$ by 21 + 14%.

We developed a computer simulation of rebreathing based on a single alveolus connected to the rebreathing bag via a dead space using ASYST. We modeled the transfer of oxygen from alveolus to blood using the Kelman equation which approximates the shape of the hemoglobin dissociation curve. This model confirmed $V0_2rb$ is an accurate method to estimate $V0_2ss$ in subjects with normal lungs at rest or excerise. Errors of 20% will occur if inspired oxygen in the rebreathing bag is increased above ambient $p0_2$. However, the model predicted $V0_2rb$ will overestimate $V0_2ss$ when the dead space is increased. Since this is opposite to the observed error in $V0_2rb$ in lung disease, uneven V/Q distribution may cause additional errors not accounted for by the simple lung model.

Automated Pressure-Volume Loop Determinations of Cardiac Left Ventricular Function

J.L. Maglaty, H.F. Solomon, G. Kath, and C. Fioravanti

Merck, Sharp, and Dohme Research Laboratories

West Point, PA 19486

The ASYST Scientific System has been used on a PC to automate the collection of pressure-volume loops on dog hearts so that numerous drug regimens can be evaluated for drug intervention on a daily basis. An AST Premium/286 personal computer (PC) synchronously acquires the cardiac pressure information utilizing a pressure transducer, a Tecmar LabMaster analog-to-digital (A/D) converter, and a synchronous trigger interface (developed in-house). A Technicare Gamma Camera, in conjunction with a Siemens Nuclear Medicine computer, acquires the ventricular blood volume information. The ASYST program acquires over 400 cardiac pressure waveforms from the A/D, triggered by an EKG signal. The heartbeat (R/R) time intervals are also acquired, simultaneously, from the synchronous interface. Both time and pressure data are stored in separate arrays of 64 kB each. When data acquisition has stopped, the arrays are processed to obtain the mean pressure wave and R/R interval for the data collection period. Once processed, the data can be displayed graphically as pressure vs. time, R/R interval histogram, R/R interval vs. collection time, and pressure-volume information from the gamma camera system is entered manually into an integer array and then plotted versus the pressure array. Up to six loops can be displayed on the monitor simultaneously for purposes of comparison. This system is useful for obtaining integrated measurements for the assessment of developmental cardiovascular candidates.

Data Acquisition and Analysis of Phasic Transmittal and Aortic Flows, Atrial and Ventricular Pressures and Ventricular Dimension Signals

Octavio E. Pajaro, Robert W.M. Frater, and Edward L. Yellin

Albert Einstein College of Medicine

Bronx, New York 10461

We use ASYST in the cardiovascular physiology research laboratory to study chronically instrumented conscious dogs. Signals are obtained from transducers measuring pressures in the atria and ventricles, flow probes measuring aortic and transmittal flows and ultrasonic crystals measuring ventricular dimensions. A flexible system of data acquisition was designed. The user can uniquely configure each experiment. The conversion delay is set as short as possible (24kHz) in order to sample all channels, in effect, simultaneously. Thus, while all channels are sampled at the rate specified by the task delay. By appending arrays to each data file, data files can contain one or several data arrays. Each data file will vary in length depending on the time necessary to record an intervention. ASYST is used for data analysis by defining the cardiac cycle with four phases; ejection, isovolumic relaxation, diastolic filling period and isovolumic contraction. The cycles and phases are defined by establishing certain criteria such as the maximum derivative of left ventricular pressure to define the beginning of each cycle, or the transmittal flow zero crossover to define the end of diastole. Routines were written to identify these points and sequentially number each cardiac cycle. With the cycles so defined, hemodynamic parameters are calculated and stored in arrays containing information for each beat.

Use of ASYST at the Department of Physiology of the University of Kiel

Dr. Harald Wiese
Physiologisches Institut
der Christian-Albrechts-Universitat Kiel
Hermann-Rodewald-Strabe 5

One main problem in our department is the analysis of EMGdata taken from cats running on a treadle. For this purpose there are several electrodes implanted into different muscles. The EMG signals are amplified and stored on a multi channel FM recorder in analog form (up to ten channels in parallel). To study the movement (especially the ground contacts of the legs) videos (with a normal video camera or a x-ray camera) are taken at the same time.

EMGs and viseos are linked together via a PCM time recorder. The PCM time is recorded on the direct channel of the tape and is shown on a display for the video.

The EMG recordings are then written to a (multi-channel) chart recorder to mark the interesting sequences that should be AD converted for further analysis.

AD conversion is done with a Data Translation DT 2821F board with a special software program allowing direct to disk transfer with sampling frequencies up to 100 kHz. We need such high frequencies because we want to sample all ten channels simultaneously with up to 10 kHz per channel over several seconds, i.e. we get several megabytes of data in a single data file (the software was bought before we got ASYST and until now we had no time to this job with ASYST).

Chemistry (including Spectroscopy and Spectrometry)

ASYST Software for Pulsed Endor Spectroscopy

D. Deutsch and R.W. Kreilick
University of Rochester, Rochester NY 14627

A superheterodyne Fourier transform electron nuclear double resonance spectrometer is described. The spectrometer will be used for investigations of various physical properties of metalloproteins, ultimately obtaining information about the structure of the metal binding site. The pulse programmer and data acquisition system of this spectrometer are controlled with a program written in ASYST An outline of the ASYST software is given along with programming examples. Emphasis is on the programmable computer interfaces between the radio frequency pulse generator and the CAMAC crate data acquisition system.

Computerization of Titration Analysis using ASYST

Louis Campisi and Ming Huang
Iona College, New York

Titration is a volumetric method of chemical analysis in which the concentration or amount of an unknown solution may be determined by the addition of a carefully measured volume of a solution of known concentration until both the known and the unknown have just reacted completely. Traditionally the analysis involves manual addition of measured volumes of a chemical reagent, the titrant, from a buret to a flask containing a solution of the second reactant until the end point is achieved. In acid-base titrations the end point is noted by a color change in a visual indicator or rapid change in pH per increment of titrant added.

The computerized version of the acid-base analysis involves interfacing a pH sensor and an analytical balance to the PC through a DAS-8 analog input board and an RS-232 serial interface while using ASYST to program and control the processes. The fact that ASYST supports the various hardware interface and provides data acquisition, analysis, and graphics in an integrated system enables real time data display and analysis together with higher efficiency and accuracy of the process.

Extraction and Analysis of Spectroradiometric Data from Externally Created DOS Files

Lawrence S. Iwan
Eastman Kodak Company
Image Electronics Center

Reflection spectra of illuminated samples are acquired by a spectroradiometer interfaced to a personal computer. The spectroradiometer/PC combination operates as a stand-alone instrument with the manufacturer's proprietary software, but stores acquired data in MS-DOS binary files. ASYST's random file access functions were incorporated into code to read the spectral data from selected series of these files into arrays. Additional ASYST-coded routines are invoked to convert the data into spectral reflectanance, calculate reflection spectra with other illuminants, determine the CIE color vectors, and plot spectra and chromaticity. Processed data are stored in ASYST data files. ASCII data files are also written from ASYST to make the data available to other languages and computers.

Femtosecond Spectroscopy with ASYST

Wayne H. Knox
AT&T Bell Laboratories
Holmdel, NJ 07733

We describe an ASYST-based AT&T PC system which controls a femtosecond spectroscopic laboratory. This system provides for GPIB control of multichannel data acquisition devices, submicron digital stepping controllers and lock-in amplifiers. ASYST-based systems allow one to build arbitrarily complex laboratory control structures while providing simple testing of individual components. Having built such a laboratory control structure with an ASYST-based PC, one has simultaneously at hand high-speed data acquisition capabilities and analytical tools which allow for rapid and direct comparison of experimental results with theoretical models. Advances in capacity and speed of PC-based analytical capabilities can be immediately utilized in such a laboratory to evaluate more sophisticated theoretical models on-line, and a number of other improvements can be contemplated.

Presenting Maes

MUBANGA N. -E.J. Delgado
Spectro Systems France, Tour du Credit Lyonnais
129 Rue Servient - 69431 LYON CEDEX 03- FRANCE

MAES is a software package codes on ASYST and essentially intended for a qualitative and quantitative analysis of surfaces and interfaces by electron spectroscopy.

First developed for AUGER Electron Spectrometry, the multitechnical aspects of the analysis algorithms used in MAES is also suitable for ESCA's spectra and is being extended to other electron spectroscopies techniques such as EELS.

The MAES's aim is to extract and handle the spectrum data in electron spectrometry by means of the latest scientific and data processing techniques. The ultimate purpose is not only to reach an accurate quantitative analysis, but also to improve the user's research and up-date his knowledge.

MAES is a modular system which provides the following functions:

- a manipulation module of data (differentiation, smoothing, integration etc...) on spectrum.
- an analysis module with
  - reading on drive and hard disk
  - RS232C file management
- automatic procedure for:
  - Peak detection, background removal, element nature identification, concentration calculations,
  - interactive corrections of automatic calculations
  - graphic display
  - saving of calculations in mass memory
  - peak synthesis due to different physical models
- MAES file management module system
- file management module of data bank
- simulation module including
  - peak synthesis (Gaussian, Lorentzian, mixed)
  - peak manipulations, data, interpolations and extrapolations
  - addition and/or suppression of peaks
- file management systems with acquisition under computer control
- crystallographic calculations (being developed).

ASYST software for a PC driven NMR spectrometer

G. Polder, P.A. de Jager and H. Van As
Agricultural University
Dept. of Molecular Physics
Dreijenlaan 3
6703 HA Wageningen
The Netherlands

The study of plant-water relations using NMR is part of the scientific research program of our department. The spectrometer used on our laboratory has been described recently. Here we present the software aspects of a home-built portable NMR spectrometer for automatic measurements of relaxation times and sapstreams in stems of intact plants. The system requirements are:

1) the computer must give a repetitive pulse sequence to a gradient system of a magnet, and a high frequency transmitter, with a time resolution of typically 0.5 msec.
2) the computer must acquire analog data detected by a receiver.

The hardware is housed in three units.

1) A 30 kg U-shaped permanent magnet with field adjustment, gradient and RF coils.
2) A 10 MHz transmitter and receiver
3) An ATT 6300 (IBM-PC XT compatible) containing a LabMaster data acquisition board (Scientific Solutions) controls the spectrometer. This unit provides the data acquisition (ADC), the field shift control (DAC) and the pulse generator with field gradient on/off control. The LabMaster allows an acquisition time of 0.03 msec. At present faster data acquisition boards are available.

The software is written in ASYST and is subdivided in three different parts.

1) The device drivers for the counter chip (AM9513) of the LabMaster, which are not included in standard ASYST.
2) A collection of words for basic use of the spectrometer. These words combined with the standard ASYST words are a highly flexible programming tool.
3) A user interface which is implemented as a menu structure. It has two modes. In the direct mode it is possible to call the basic spectrometer words. In the program mode you can create own application using these words and the standard ASYST words.

Control

Computer-Assisted Control Engineering Using ASYST

Hany K. Eldeib, Arthur Kyle, and Diego Osorio
Department of Electrical and Computer Engineering
George Mason University
4400 University Drive
Fairfax, VA 22030

This paper describes two projects that use Asyst to help undergraduate and graduate engineering students gain a better understanding of computer-based control. The objective of the projects is to enable a student or an engineer to analyze, design, and implement microcomputer-based control systems using a menu-driven, simple program. The first effort is concerned with the development of a menu-driven tool that helps the user to design a proportional, integral, plus derivative (PID) compensator for a closed loop dc motor control system. The program allows the user to describe the mathematical model of the process to be controlled and the parameters of the PID controller. The user can then simulate the system and modify the design parameters until the simulation results are satisfactory. Finally the program enables the user to implement the controller and observe the performance of the control system in real-time.

The second project deals with the design and implementation of a more advanced controller; a self-tuning adaptive control system for the same dc motor system. The system identifies the mathematical model of the unknown process in real-time using least-squares estimation and uses a pole-placement algorithm to control the process. The system, which is under development, contains a simulation option to verify its operation and a real-time control option. It is intended to help graduate students understand the operation and design of adaptive control systems and will be used in research concerning implementation problems of adaptive control systems.

An ASYST System for Machine Tool Control

Dr. Regis J. Leonard
Carnegie-Mellon Institute
Computer Engineering Center
4616 Henry Street
Pittsburg, PA 15213-2683

A number of industries have identified a need for generating unique and arbitrary waveforms for use in testing and debugging. This paper describes an IBM PC/AT based system, running ASYST 2.0, that allows the user to mathematically input the desired waveforms. This system is used to control two experimental metal shaping stations in a laboratory production environment. One of these stations requires the coordination of three arbitrary waveforms with an absolute position encoder. The second station uses two waveforms that are synchronized by the PC/AT system. The user interface is menu driven and consists of approximately 25 different menus and was designed to accommodate users of diverse technical backgrounds.

Controlling Compumotor PC21 Indexer with ASYST

Michele Limon
Dipartimento di Fisica
Sezione Astrofisicia
Via Celoria, 16
20133 Milano
Italy

The PC21 indexer is one of the most diffuse controller for step-motor but, like many other diffuse card for the PC Bus, the software furnished with it is written in BASIC. On the trace of the original BASIC routines I wrote two simple ASYST routines that allow data to be transferred from the PC21 to the PC Bus and vice-versa, a third routine can reset the PC21. The output routine needs as input the address of the card in number stack and the PC21 commands string in the symbol stack. The input routine needs the address in the number stack and put its answer, if any, as a string in the symbol stack. The reset routine needs only the card address in the number stack. Using different address you can control as many PC21 indexer as you like (multiple axes motion). I use the faster `"ARRAY` and `UNPACK ASYST` commands for converting strings into the equivalent ASCII code number instead of using the standard ASCII ASYST command. I also use `PORT.IN` and `PORT.OUT` commands for accessing the PC Bus directly.

A High-Speed Data Acquisition and Diagnostic System for the NRL Super IBEX Electron Beam Generator

Jonathan Williams
Ressler Associates, Inc.
8419 Oak Stream Drive
Laurel, MD 20708

An ASYST based 64 channel high-speed transient data acquisition system is described. The system is designed to monitor the Naval Research Laboratory's Super IBEX Electron Beam Generator, a high current relativistic electron beam generator. The system measures the propagation parameters of the electron beam and the machine diagnostics of the electron beam generator. The hardware controlled consists of 8 LeCroy 8210 (1MHz) digitizers, with four channels per digitizer, 16 LeCroy TR8837F (32MHz) digitizers, and 16 Tektronix 7912 (750 MHz) digitizers. The data acquisition software is designed to allow fast and easy instrument setup, acquisition, processing, graphing, and filing of raw and post-processed data. Digitizer setup is simplified by using a spreadsheet format that groups 8 channels of a given digitizer onto a single screen along with all of the necessary function settings for that digitizer. The data file structure allows storing all 64 channels of raw data, plus provides the ability to add up to 100 additional post-processed data sets within a single file. Graphing and signal processing functions are integrated together by using the various signal processing and analysis functions. The entire data acquisition system is controlled with a menu driven user interface that allows easy access to all system functions.

Instruction

Linearity Problems of Standard Temperature Sensors - an example for using ASYST in the engineering education.

Hans-J. Gebhardt
priv. Langer Graben 23
Fachhochschule Lippe
D-4920 Lemgo

ASYST provides advantageous mathematical and graphical capabilities for solving of problems of the measurement and sensor technology in the industry and the engineering education. The use of ASYST in practical courses can cause its acceptance as an important support to disseration research. However, there is a high threshold entering into this language.

Problems of linearization and special amplifier technology are typical for applications of sensors. The paper will discuss the following points:

1. Sensor signal conditioning
2. Methods of linearization, linearity errors
3. Discussion of the mathematical sensor models

Special software support is necessary for getting these main points in the limited time of a practical course.

Materials Research

MOCVD Process Control

John P. Shepherd, F.T.J. Smith, and David Cronk
Corporate Research Laboratories
Eastman Kodak Company

A real-time control system for the Metal Organic Chemical Vapor Deposition of Gallium Arsenide compounds will be discussed. In MOCVD growth, gases are passed across a hot substrate where they react to form an epitactic layer of GaAs or AlGaAs. Precise real-time control of gas flow, system temperature, and pressure is necessary. These experiments can run for several hours. The decisions about control strategy, sampling intervals, data acquisition, and data storage will be discussed, and the resulting implementation in ASYST will be shown. Additionally, the strategy for implementing real-time graphics of critical control parameters will be described.

We will also discuss problems caused by the limited memory space in the PC/AT for EGA, expanded memory, and memory-mapped data acquisition devices, and those DAS speed problems encountered when moving from an IBM-PC to an IBM-AT.

Data Acquisition from a Crystal Growth Furnace

Glenn A. Woodell
NASA Langley Research Center
Hampton, Virginia 23665

The compound semiconductor, Lead Tin Telluride, has been grown in a Bridgman crystal growth furnace. The development of crystal growth parameters is vital to the understanding of the solidification process. The former method for the collection of temperature data from the furnace was limited. Position of the translating furnace was read from a steel scale attached to the side of the furnace assembly and temperature data had to be hand-logged then hand-typed into a computer for further analysis.

The present system consists of an IBM-compatible personal computer, a Keithley 14-bit data acquisition system, and Sony digital position measuring system. This system allows up to 16 thermocouples to be read as quickly as every 2 seconds along with the associated time and position. The program is written so that the user merely answers a few questions about the experiment and then presses a function key to begin logging data. The screen displays the time and date, the temperatures of all thermocouples, and the position and total travel of the furnace. All thermocouples are plotted as temperature versus time curves. All data are assigned into individual arrays for ready analysis after the experiment has concluded.

This system provides a more efficient method of acquiring data, frees the experimenter of the trivial task of "watching the gauges," and allows quick display of experimental data.

Calculation of Growth Rates for a Directionally Solidified Semiconductor Crystal

Glenn A. Woodell and Archibald L. Fripp
NASA Langley Research Center
Hampton, Virginia 23665
David J. Knuteson
Department of Chemical Engineering
University of Florida
Gainesville, Florida 32611

Growth rate calculations are important in the analysis of semiconductor crystal growth. During directional solidification, the rate of translation of the liquid-solid interface, or growth rate, varies with the temperature and composition of the melt. Growth rate calculations provide information about the predicted stability of the interface. A routine has been developed which calculates the growth rate versus position along the crystal sample from scanning electron microprobe determined composition data and furnace temperature profile data. Previously, only an average overall growth rate could be approximated.

Data Acquisition for the Thermal Study of Convention in a Liquid Metal During Crystal Growth

Glenn A. Woodell
NASA Langley Research Center
Hampton, Virginia 23665

David J. Knuteson
Department of Chemical Engineering
University of Florida
Gainesville, Florida 32611

Crystal quality is strongly dependent on the flow regime of the liquid phase during directional solidification of semiconductor melt. During directional solidification, the melt can undergo several transitions from one flow regime to another. The technique for identifying convective states involves using thermocouples and Fourier analysis to delineate the oscillatory and turbulent regions. Previously a waveform analyzer was used to monitor and record temperatures and perform Fast Fourier Transforms (FFT). The data was then transferred to an IBM-compatible personal computer for plotting. Because of the lengthy data transfer routine, only 1 thermocouple could be read effectively.

The present system consists of and IBM-compatible personal computer and a Keithley 14-bit data acquisition system. This system allows for up to 16 thermocouples to be read and plotted on the screen while the data is being assigned into arrays for plotting and FFT analysis. This system allows more thermocouples to be places on the test sample, allows display of the entire furnace run, yields data taken in phase, provides data with less noise, and renders a more accurate FFT.

Physics

A Real-Time Data Acquisition System for the NASA Airborne Laser Polarimeter Sensor (ALPS)

Gregory C. Elman
Ressler Associates, Inc.
8419 Oak Stream Drive
Laurel, MD 20708

An ASYST based real-time data acquisition system for measurement of the depolarization properties of various materials on the Earth's surface is described. The ALPS system is flown in a NASA P3 and uses a ND:YAG laser pulsed at 20 Hertz to irradiate the Earth's surface. The ALPS data acquisition system measures the multispectral reflected energy of the laser with 12 photomultiplier tubes (PMT) whose outputs are digitized with a LeCroy 2249W charge integrating A/D converter. The 2294W is located in a CAMAC crate and is controlled by a Kinetic Systems 3922 parallel bus CAMAC crate controller. A NASA custom-designed CAMAC card controls the PMT's power supply, and synchonizes data acquisition with the aircraft's systems. An IBM PC/AT configured with an Intel InBoard 386 and a Kinetic Systems 2926 PC interface w/DMA card serves as the system controller. Between each laser pulse (50ms) the software must read the reflected laser signal, a dark current background level, and various housekeeping information, and then store this data in RAM disk. The data is displayed for analysis and permanently stored on the AT's hard disk when the aircraft is turning for its next acquisition pass. The ALPS ASYST software is comletely menu-driven and controls all data acquisition, processing, analysis, and data base functions.

Measurements on Aerosols using Laser Light Scattering: Particle Size and Shape Classification

Dr. P.H. Kaye, Dr. I.K. Ludlow, N.A. Eyles, and W.J. Worthington
Hatfield Polytechnic
Electrical and Electronic Engineering
Hatfield, Hertfordshire England
United Kingdom

An instrument has been constructed to classify individual aerosol particles in terms of size and shape by laser light diffraction. High particle throughput to a limit of 10,000 particles sec^{-1} in a 600 mL min^{-1} air flow are achievable. Initial results are furnished to demonstrate the viability of the technique. The ASYST programming language has been used to provide menu driven control of the apparatus and analysis of results. The scope of this paper is limited to an overview.

Dielectric Processes in Acqueous Solutions

Pete Gissel and Jim McKee

Solid State Farms, Inc.

This paper presents a study of dielectric relaxation processes of acqueous solutions. ASYST was used as the software for both data acquisition and analysis. The research was conducted in two parts. First, the data was acquired from a TEK 7854 oscilloscope controlled via GPIB bus using and IBM PC compatible. Two separate time domain waveforms, a reference and a sample, were stored in the PC. They were manipulated into a duration limited, processable form, converted to the frequency domain, and used to calculate transmission and reflection coefficients. These coefficients were then used in both direct calculation and iterative calculation techniques to determine the permittivity. The second part of the study involved deconvolving the calculated permittivity into separate processes so the permittivity information of the individual substances could be determined. Two different approaches to this problem were used. The first approach involved interactively approximating separate gaussian curves for the permittivities of the individual substance which, when added together, gave back the initial calculated permittivity. The second approach used an iterative gaussian filter technique to determine the relaxation frequencies only. Using the information from both these techniques, the results were compared and corrected to obtain accurate permittivity information on the individual substances.

Turbulent Flow Data Acquisition and Analysis with ASYST

P.J. McKinney and J.H. Davidson

Civil Engineering Department
Colorado State University
Fort Collins, Colorado 80523

A menu-driven turbulent flow data acquisition and analysis program group, TURBDATA, which operates with the ASYST scientific software package on an IBM compatible microcomputer is presented. This set of programs provides a user oriented flexible structure for hot-wire anemometer measurements with the ability to easily acquire and analyze data while retaining the features of the host software. In its present configuration, TURBDATA calibrates a hot-wire probe, acquires one-dimensional time series velocity data, computes a complete spectral analysis and plots the results.

Using ASYST to Analyze the Temperature Dependence of Radiation

Robert Novak and Robert McCullough

Physics Department
Iona College
New Rochelle, NY 10801

ASYST was used to analyze the data taken from an emission spectrometer. A quartz halogen lamp was used as a black body source. The temperature of the lamp was determined by an optical pyrometer. The light was focused onto the input slit of a 0.3 m scanning monochromator. A scan between 400 and 1000 nm was taken with a lock-in amplifier and the output was sent to an A/D converter attached to an IBM PC. Data was stored in a file which gave light intensity as a function of wavelength and temperature.

ASYST was then used to graph and analyze this data. Using the black body relationships, the temperature functions of the wavelength intensity and of the integrated spectra were illustrated. After including a calibrated spectra, the program can be used to determine the temperature of a source by analyzing the emission spectra which is generated.

Automated Photovoltaic Characterization & Analyses Using ASYST, A Forth Based Scientific Language

A. Vaseashta, P. Johnson and L.C. Burton

College of Engineering
Bradely Department of Electrical Engineering
Virginia Polytechnic Institute and State University
Blacksburg, VA-24061, U.S.A.

We present in this paper advantages and limitations of using ASYST, a forth based scientific language in automating a Photovoltaic Materials & Devices Characterization and Analyses facility employing multi-vendor data acquisition boards. Synchronizing data acquisition in such a multi-vendor boards system environment, especially accepting different protocols, requires access time whcih can exceed the device response time restraining real time data acquisition. Single monolithic programs employing colon definitions to increase computer/board communication rate via multitasking are presented. It is usually tedious to draft benchmark programs to establish fairly the software overheads. Attempts are however made to empirically determine functional dependencies of execution speed. Benchmark programs are also written in other scientific languages such as Basic and C to compare execution speed differentials with ASYST. Flow charts of key

programs are presented. A brief discussion is presented on experience gained in the use of ASYST in Laboratory Automation.

Testing

DDAS: A Dynamometer Data Acquisition System

G.W. Andrews, L.I. Davis, Jr. and R.J. Pawlowicz

Ford Motor Company
Dearborn, Michigan

DDAS is an ASYST-based software package which allows IBM PC/AT computers to be used for dynamometer data acquisition and analysis from engines in engine test cells.

The DDAS system makes use of a Data Precision 6000 for fast sample rate (transient) cylinder pressure, and a Keithley 500 for slow sample rate (steady-state) engine data. Additional equipment required includes cylinder pressure sensors, a crankshaft angle encoder, and a hard copy output unit. The software allows menu-driven system setup, data acquisition, analysis, and filing. The analysis includes steady-state engine performance calculations and combustion analysis from cylinder pressure readings. The DDAS software package is an example of a large special-purpose data acquisition program that of necessity uses ASYST application overlays to manage memory.

A General Purpose Facility for Electro-Mechanical Testing

George R. Baker

Stanley Tools
600 Myrtle St
New Britain, CT 06050

Ladimer S. Nagurney[3]

Department of Electrical Engineering
University of Hartford
West Hartford, CT 06117

This paper describes a general purpose data acquisition and control system using ASYST, developed to support R&D and Quality Assurance at Stanley Tools in the testing of rechargeable battery powered hand tool products and components.

System components are: an IBM PC/AT, Data Translation DT2805 data acquisition board, National Instruments PC2A IEEE Interface, HP 6031A Power Supply, HP 3457A System Digital Voltmeter, and two Magtrol Dynamometers.

The System was designed to be readily software configurable, permitting a wide variety of measurements to be made. The initial usage of this System was the measurement of DC motor and cordless tool characteristics, including the measurement of torque, speed, voltage, and current, and the calculation of motor and motor/gear train efficiencies.

Other uses of the System have included determination of the performance of industrial Glue Guns, using thermocouple measurements. For this test, ASYST routines were written to take thermocouple and cold junction compensation voltages from the DT2805, convert the cold junction voltage into a correction term, and, finally, to calculate and store the temperature data.

Automated Hall Effect Testing and Analysis of Semiconductor (GaAs) Material

Jeffrey A. Cook and Daniel C. Abbas

Corporate Research Laboratories
Eastman Kodak Company
Rochester, New York 14650-2011

The Hall effect is used to characterize materials in the semiconductor industry, and by utilizing this effect, parameters such as sheet resistance, bulk resistivity, Hall coefficient, mobility, and carrier concentration can be accurately determined. To achieve these results from an automated test system, functions such as current selection, phase nulling, signal optimizing, ohmic behavior checks, and a magnetic field control must be carefully and consistently executed. The ASYST program discussed here accomplishes this by controlling a lock-in amplifier, function generator, and switching unit over the IEEE-488 bus as well as a DC magnet using analog and digital signals. In addition, the program provides an operator interface for data acquisition, analysis, display, storage, and system monitoring.

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[3] Supported by an affiliation of Stanley Works to the Engineering Applications Center of the University of Hartford, College of Engineering

Engineering Production Testing of Semiconductor Devices Using ASYST

Terry Lines
National Semiconductor Corp.
MS 1-69
Commerce Park
Danbury, CT 06810

During the production of semiconductor devices, the need arises to perform testing on an engineering basis which is very different from production testing. Production testing of semiconductor devices focuses on the separation of units which are in compliance with preestablished electrical limits, from units beyond those limits. Production testing is typically done using commercial test systems which, out of necessity, stress speed and accuracy far above flexibility and data analysis.

The flexibility provided by ASYST makes it an excellent environment for an engineer using IEEE-488 controllable instruments to quickly develop a test application specific to his needs. While providing a very robust environment for the development of such applications, careful planning of approach and structure are required. Even though carefully planned and well implemented the developer will find there are weaknesses and pitfalls to be encountered. This paper, while based upon a specific application, presents development considerations which are hopefully more universal in scope. The discussion centers upon partitioning, data files, device drivers, and translation tables, and is targeted to the user with 0 to 6 months experience.

A Cordless Drill Life Test System using ASYST

George R. Baker
Stanley Tools
600 Myrtle St.
New Britain, CT 06050
Ladimer S. Nagurney[4]
Department of Electrical Engineering
University of Hartford
West Hartford, CT 06117

Product life testing is generally performed to determine if a product can survive the usage expected during its' design life. While many products can readily be life tested under continuous operation conditions, products designed for intermittent, battery powered use present substantial problems in life cycle testing. This paper describes a computer controlled life cycle test systems, programmed in ASYST, used to perform life tests on Cordless Drills and Cordless Screwdrivers. In this System, the units under test are connected to magnetic torque brakes. Using ASYST, the brake loads are varied to simulate various operating conditions such as drilling hardwood, drilling softwood, driving screws, and extracting screws. Parameters such as motor temperature, voltage, and current can be saved in a data file on the hard drive. The units under test are powered by a large Lambda supply. The system computer is powered from a UPS, which allows orderly shutdown in case of power failure. One 100 clock hour test cycle can simulate the entire design life of a Cordless Drill.

ASYST-Oriented Semiconductor Laser Characterization Instrumentation for Evaluation and Selection of Lasers Used in Photonic Applications

Glenda J. Peters Do and Terry L. Mack
Planning Research Corporation, ASTD
Hampton, Virginia 23665
Herbert D. Hendricks
NASA Langley Research Center
Hampton, Virginia 23665

Single-longitudinal mode semiconductor lasers are key elements in many photonic applications. A versatile evaluation setup has been developed for analyzing the behavior of semiconductor lasers developed under R&D efforts, as well as those that are commercially available. The instrumentation allows for the characterization of lasers under static as well as dynamic conditions. Data collection is automated using ASYST 2.01 and the GPIB bus interface on the measurement instrumentation.

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[4]Supported by an affiliation of Stanley Works to the University of Hartford, Engineering Applications Center

Depending on the design and function of a photonic component or instrument, laser parameters such as mode structure, output power, chirp, linewidth, mode stability over laser lifetime and optical feedback susceptibility will ultimately determine the data rate and/or measurement resolution of the design.

The use of ASYST 2.01 on an IBM-AT has facilitated the acquisition of a variety of laser data. The experimental setup uses an all-fiber delayed self-homodyne configuration which incorporates the necessary measurement elements of most photonic applications. In addition to static measurements, this allows configuration characterization of the lasers as part of a photonic subsystem.

The semiconductor diode lasers of interest operate at the wavelengths of 800 nm, 1300 nm, and 1550 nm. The device longitudinal mode structure and series of PI curves are now being obtained using ASYST 2.01, with spectral linewidth, chirp and mode stability measurements currently being incorporated.

Automatic Pulsed Testing and Analysis of Laser Diodes

D.L Peterson and J.A. Cook
Corporate Research Laboratories
Eastman Kodak Company
Rochester, New York 14650-2011

The successful development of laser diodes depends on the ability to test device performance. The most fundamental performance criteria are given by the relationship of the light output power (L) to injected current (I). An effective test system must be able to measure LI curves under pulsed conditions to prevent excessive heating, provide high current pulse amplitudes, test several hundred devices per wafer in strip form, retain the spatial information in order to study the process, and eliminate opportunities for operator error. The ASYST program discussed here controls high and low current pulse generators, a switch control unit, and a boxcar averager using the IEEE-488 bus and analog signals. In addition, the program provides an operator interface for data acquisition, storage, and analysis, including the presentation of data for single devices, as well as maps of device parameters, as a function of location on the wafer.

BTDAS: Vehicle Body Bending and Torsion Test Data Acquisition System

D. Peterson, L.I. Davis, Jr. and J.L. Westerbur
Ford Motor Company
Dearborn, Michigan

BTDAS is an ASYST-based software package which is used with an industrial version IBM-PC/AT to acquire and reduce data from a vehicle body torsion and bending test. The system hardware was selected to be rugged enough to operate in a garage environment.The system includes a Fluke Datalogger 2280 which reads voltages from a grid of linear displacement potentiometers arrayed beneath a vehicle body. The potentiometers measure displacement of the vehicle body in response to bending and torsional loading. The Fluke also reads signals from a number of load cells and LVDTs. The data is transferred via RS232 to the industrial PC for reduction and Analysis.

The software is menu-driven. By selecting the appropriate function keys, the test operator is able to summon up each of the manual input screens, select and run the desired test, print and plot the test results, and save the data to a file. BTDAS is a large package which uses several application overlays, and uses tokens extensively.

ASYST Controlled Automated Laser Diode Testing Station

Scott B. Chase and Julie Petronio
Eastman Kodak Company, DTGRL
Heads & Systems Laboratory,
460 Buffalo Rd. Rochester NY 14650

A system that performs several automated tests for evaluating the operating properties of laser diodes has been developed using the ASYST programming language. ASYST provides the flexibility to test the laser properties of the wide variety of lasers on the market today.

Several of ASYST's many software capabilities have been utilized in developing this test station. GPIB interface software has been used to obtain computer control of a function generator, an optical spectrum analyzer, and a temperature controller. Analog to digital converter channels have been used to sample external pre-amplifier circuitry. Labelled, color plots of characteristic laser diode curves are generated using ASYST's graphics software. Lotus files are used to recall a listing of lasers and their parameters as well as to store pertinent test results for permanent record.

The system is completely menu-driven and has the capability of testing any laser at a specified temperature. Tests which the system can currently perform include CW and pulsed laser power vs. drive current curves and optical spectrum analysis. The completed system will be capable of performing laser polarization ratio vs. output power, far-field intensity analysis, and intensity noise analysis. Methods of performing the various tests and a description of the system's flexibility requirements will be discussed.

DAMP: A Data Acquisition and Modelling Program for the SPICE Circuit Simulator

J. Rodriguez
Dept. of Electrical & Electronic Engineering
University of Bradford
Bradford UK

It is well known that for the successful use of circuit simulation tools as an aid in the design of circuits, an accurate mathematical model for the semiconductor devices is vitally important if the simulation is to be accurate. For nonlinear device models such as the ones used in the SPICE circuit simulator, the acquisition of the parameters of the models present severe problems due to the vast amount of data which needs to be gathered from various sources and the complex procedures for the extraction and optimization of the parameters from the measured data. The high cost of capital equipment and the lack of an integrated system which combines the modelling and circuit simulation stages also introduces problems. In this article, we describe a Data Acquisition and Modelling Program (DAMP) which tackles some of these issues and which has been developed as part of the work for an Alvey-sponsored project.

ASYST in Hyperbaric Test Facility, in a Test Buoy Program and in Shocktests

L.J. Wevers
TNO-IWECO
H. Keers
All Marine, Rotterdam, The Netherlands

Three ASYST user made programs can be explained briefly:

A) A laboratory 70 bar pressure vessel control and data acquisition system

B) An offshore test buoy measurement system to measure pitch, roll, heave, pitch and anchor force

C) An onshore shock testing data control and data acquisition system for shock simulation.

A In the laboratory A 1.7 M diameter, 5 m high water filled pressure vessel is controlled by an ASYST made software program. Every pressure function versus time can be made. This time function is sent via RS232 to a programmable logic controller to control the pressure vessel. Also via RS232 the pressure in the vessel is measured and sent back to the input time history diagram. Both input and output are plotted in the same window on the EGA monitor. The second function of the ASYST software made is to measure up to 20 channel of signals coming from the object under test in the pressure vessel.

B The buoy test program makes records of pitch, roll, heave and force values during 200 secs twice an hour during a period of two months in the winter of 1987/1988.

Two obtain frequency information of the dynamic buoy behavior fourier transforms are made with the ASYST words fft, REAL.FFT, ZMAG ... Etc.

C Transients as shock signals need double integration to obtain displacement from an acceleration signal.

Hardware setting of amplification and anti aliasing filtering is part of the ASYST user program made. Digital filters are made available in the ASYST software for to get the best results possible.

Measurements on Aerosol Particles Using Laser Light Scattering: a Protype Particle Tracker

W.J. Worthington, Dr. I.K. Ludlow, Dr. P.H. Kaye, and N.A. Eyles
Hatfield Polytechnic
Division of Electrical and Electronic Engineering
P.O. Box 109, College Lane
Hatfield, Herts, AL10 9AB, U.K.

Laser Doppler Velocimetry is used to track the forced vibration of a 10 micron scattering source. The induced particle motion can be reconstructed from the Doppler profile. The Asyst environment is employed for acquisition, processing and presentation of data.

Miscellaneous/Unclassified

Creation, Acqusisition and Quantitative Examination of Frame-Grabber Images

Brian J. Higberg
Corporate Research Laboratories
Eastman Kodak Company
Rochester, New York 14650-2011

A PC based frame-grabber board with CCD camera and display monitor provide the means to acquire optical information, such as the radiation patterns of opto-electronic semiconductor devices. This hardware can also be used to display large amounts of data in visual form. An interface between necessary assembly language routines and the ASYST programming environment is discussed. Frame-grabber data and functions are made available for inclusion in a variety of ASYST application programs.

Executing DOS Programs from within the ASYST Environment

Nigel Lovell, Branko Celler and John Vogelsang[5]
Biomedical Engineering Laboratory
School of Electrical Engineering and Computer Science
University of NSW, Sydney, Australia, 2033

A method for running any DOS executable file from within ASYST is described. An assembly program callable from ASYST is used to shrink memory, prepare the necessary parameter block and execute the DOS file.

Major ASYST Applications in Australia

Nigel Lovell, Michael Smart[6]*, and Branko Celler*
Biomedical Engineering Laboratory
School of Electrical Engineering and Computer Science
University of NSW, Sydney, Australia, 2033

ASYST has been in use in Australia for the past three years. A number of interesting applications, ranging from data acquisition and test management to video imaging, have been developed in that time. The high level of programmer productivity in a language such as ASYST has made these projects viable. High productivity can be attributed to several features of ASYST, including the choice of interactive or compiled modes of operation, an extended set of acquisition drivers, powerful array-handling (including the auto-plot facility), and a large library of analysis routines.

In this paper we will describe eight appliations which we have developed using ASYST. We have grouped these applications into four main areas: road transport, fourier transforms, video image analysis, and biomedical engineering. In each case particular features of the ASYST environment proved useful in solving the engineering problems. In most cases the development time was much shorter than would be expected using more traditional third-generation languages.

[5] Science & Computing Applications, P.O. Box 251, Sydney, Australia, 2033
[6] Science & Computing Applications, P.O. Box 251, Sydney, Australia, 2033