Listed are abstracts from recent papers by IBM authors. Inquiries should be directed to the publications cited.

Abstracts

Coupled Film Memory Elements, H. Chang, *Journal of Applied Physics* **38,** 3, 1203–1204 (March 1967). Coupled-film arrays have been fabricated on insulated Cu ground plane with .004″ wide bit lines on .006″ centers and .007″ wide word lines on .014″ centers, resulting in an unusually high packing density of 12,000 bits/in. Sense signal of 2 mv under worst case testing conditions has been measured at 200 ma word current (6 ns risetime) and 15 ma bit current. The low word and bit currents have been achieved by miniaturizing the devices while providing flux closures. The etched permalloy-Cu-permalloy bit/sense lines are plated with permalloy at the edges. The word lines are embedded in ferrite. Permalloy backing on word line and permalloy embedded in ground further improve flux closure. Available permalloy materials have intrinsic limitations on the obtainable H_k, $H_c\,\alpha$ and the ratio $H_c/\alpha H_k$ (a measure of disturb immunity). The device operating margin can be extended by using doublet word and/or bit currents. The doublet bit current increases the bit disturb threshold while the doublet word current decreases the bit write threshold. With both doublet bit and word currents, both beneficial effects are achieved.

Designing Combinatorial and Sequential Adaptive Logic Networks, R. J. Barbetta, *Computer Design* **6,** No. 6, 44–48 (June 1967). Synthesis of combinatorial and sequential adaptive logic networks described in this article, uses a technique which partitions the logic into two sub-networks. The first sub-network contains the logic necessary to perform the functions to which the network adapts; the second sub-network is a sequential logic network which controls the adaptive process, and employs binary encoding to minimize the number of memory cells needed. A specific implementation of a memory cell is given to illustrate the application of the technique to network examples.

Digital Accelerometer Built Around Crystals, R. A. Watson, *Space/Aeronautics* **47,** No. 6, 111–118 (June 1967). The increasing use of digital computers in aerospace vehicles has been accompanied by a similar increase in the use of analog-digital conversion equipment, simply because much of the sensor hardware that provides the inputs to the computers consists of analog designs that, over the years, have been developed to a high degree of perfection. Getting rid of the analog-digital converters obviously would yield improvements in reliability and reductions in weight and power requirements but is feasible only if the cost penalty of replacing an analog sensor with a digital design is acceptably small and the new sensor is superior in performance. An example of a digital sensor of acceptably low cost is the digital accelerometer that has emerged from recent work at IBM's Electronic Systems Center on the conversion of sensed quantities into pulse format without analog-digital conversion. This accelerometer is an open-loop device that requires neither precision zener diodes nor timing circuits and has no magnets or moving coils and no flotation fluid. It is thus a much simpler device than the familiar pulse-balance loop used in analog-digital conversion, in which a summation of analog forces is balanced by a series of high-precision unit pulses in a magnetic movement or torquer coil.

Digital Determination of Third-Octave and Full-Octave Spectra of Acoustical Noise, G. C. Maling, W. T. Morrey,* and W. W. Lang, *IEEE Transactions on Audio and Electroacoustics* **AU-15,** 45–55 (June 1967). The spectrum of the acoustical noise produced by typical sources such as business machines is usually measured with analog filter banks. The objective of this study was to perform spectral analysis using digital rather than analog methods. The Cooley-Tukey algorithm has been used to compute the Fourier coefficients of noise samples obtained with the aid of a digital recording system described previously. The resulting coefficients have been used to compute octave band and third-octave band spectra of the noise samples. The digital spectral estimates are in good agreement with analog measurements. Emphasis is placed on the filter characteristic or "window" used for the analysis, and the spectral fluctuations which occur in short (65–250 ms) samples of the noise. For one machine studied, the spectral fluctuations are larger than would be expected for samples of random noise. Spectral analysis of impulsive noise produced by a second machine (a manual, key-entry card punch) indicates that spectral fluctuations occur even when the envelope of the pressure-time pattern is observed to be repetitive.

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Handprinting Input Device for Computer Systems, J. G. Simek and C. J. Tunis, *IEEE Spectrum 4,* No. 7, 72–81 (July 1967). A novel, low-cost handprinting transducer intended for use as an input device to digital systems has been developed and is described in this article. Recognition of sensed handprinted characters is accomplished by means of adaptively derived linear decision functions. This provides flexibility of the character set and permits the system to be tailored for a variety of users.

Historical Notes on the Fast Fourier Transform, J. W. Cooley, P. A. W. Lewis, and P. D. Welch, *IEEE Transactions on Audio and Electroacoustics* **AU-15,** 2, 76–84 (June 1967). The fast Fourier transform algorithm has a long and interesting history that has only recently been appreciated. In this note, the contributions of many investigators are described and placed in historical perspective.

Improvements in the Design of Retransmission Systems, R. J. Benice and A. H. Frey, Jr., *IEEE Transactions on Communications Technology* **COM-15,** No. 3, 463–467 (June 1967). Two improvements in the design of retransmission (ARQ) systems are described which lead to simpler implementation and improved performance. One change simplifies the procedure for handling erroneous messages; the other simplifies the procedure for requesting retransmissions. The consequences of these modifications and the results of a comparative analysis with previous techniques are summarized.

An Instructional Display Terminal, R. A. Aziz, *Proceedings of the Eighth National Symposium on Information Display* **83,** (May 24–26, 1967). As a low-cost tool for Computer-Assisted Instruction (CAI), the IBM 1510 Instructional Display provides a CRT display surface, with keyboard and light pen as input devices, all program controlled. The course material to be displayed is stored initially in computer coding in the Central Processing Unit, which serves as many as 32 stations via co-axial cable (up from 2000 feet). As the material is needed, it is translated to dot matrix form by dictionary lookup, from core dictionaries of standard or user-defined symbols, and limited graphics. Typically, images include numbers and other mathematical symbols, and upper- and lower-case letters from various alphabets. Converted to video form by software and circuitry, the image content is stored on a disk video buffer which supplies 32 displays simultaneously. The NRZ magnetic recording (non-return-to-zero) allows for discrete updating of lines or single words. The display unit circuitry amplifies the video signals and separates their timing and data components. The timing signals operate television-type deflection circuitry at a low horizontal scan rate. The refresh rate is 30 frames per second, with two-to-one interlace. The image is displayed as a matrix of white dots and lines. The viewing surface is logically divided into 40 columns and 32 half lines, with each

character allotted an addressable position formed by one column and two half lines. Since the available array consists of 61,440 dots (192 visible scan lines of 320 visible dots each), each character is formed by a dot matrix 8 x 12. Addressable locations are joined as needed to form graphics. To enter a response via the light pen, the student depresses the pen against the CRT faceplate, and the pen control registers as his "answer" the word or character in that position. To accomplish this, sync signals from a clock track are combined with the detect pulse. The P-7 phosphor has two layers—blue for maximum light change each frame time (for light-pen detection) and yellow-green for long persistence. The latter helps reduce flicker, as does the neutral-density glass filter bonded to the faceplate.

A Mathematical Model of Fibrinolysis, W. Liniger and P. Tuegsegger, *Mathematical Biosciences* **1,** 263–285 (1967). In the present paper we discuss a mathematical model of fibrinolysis and show that it agrees with experimental evidence. We hope such a model might ultimately serve as a basis for simplifying and speeding up certain clinical assays.

Mathematical Theory of Automobile Traffic, D. C. Gazis, *Science* **157,** 3786, 273–281 (July 21, 1967). During the past ten years, significant advances have been made toward the quantitative, mathematical description of traffic flow and the solution of traffic control problems. A survey of these advances is given in this article.

A Model for a Multifunctional Teaching System, K. J. Engvold and J. L. Hughes, *Communications of the ACM* **10,** No. 6, 339–342 (June 1967). This paper describes a teaching system model that was incorporated into an operating system of a large computer, transferred control to the operating system to execute functions other than teaching, and then recovered control in order to resume teaching. The teaching system (ABAC-II) was written to run under the operating system (IBSYS) for the IBM 7044 Graphic System. Because the teaching system automatically terminated and rescheduled itself, a student studying a course presented at a cathode-ray display terminal could switch readily between student mode and programmer mode. During the latter, the full resources of the operating system (language processors, compilers, library and user's programs) were at his disposal. He could, for example, write, assemble, debug, and execute at the terminal a program written in any language processed by the operating system. A course could therefore include text material interleaved with programming problems which the student could solve without leaving the terminal. Exercises in simulation and gaming could also be provided. The implications of a teaching system with this degree of flexibility for industrial and executive training as well as academic education are discussed. In addition, the advantages of this type of system for computer programming and operation are also considered.

Parallel Methods for the Numerical Integration of Ordinary Differential Equations, W. L. Miranker and W. Liniger, *Mathematics of Computation* **21,** 99, 303–320 (July 1967). In this paper we derive a class of numerical integration formulas of a parallel type for ordinary differential equations. These formulas may be used simultaneously on a set of arithmetic processors to increase the integration speed. Conditions for the convergence of such formulas are formulated. Explicit examples for two and four processor cases are derived. Results of numerical experiments are given which show an effective improvement in computation speed.

PL/I List Processing, H. W. Lawson, Jr., *Communications of the ACM* **10,** No. 6, 358–367 (June 1967). The concepts of list processing have been introduced into the PL/I language. With these new facilities, it is possible to write PL/I procedures that operate on simple and complex data list organizations. Most list processing languages have suffered from their inability to deal with complex data structures and/or from their inability to perform the complete range of programming language operations upon the data list structures. These two problems have been eliminated in the list processing facilities of PL/I. The basic concepts of list processing and the philosophy of the PL/I language extensions are discussed. In addition, several detailed list processing examples are provided.

Reverse Monte Carlo for Computer-Aided Circuit Analysis, A. R. Berding and T. W. Collins, *EEE* **15,** No. 6, 68–72 (June 1967). Even the most comprehensive analysis techniques have not proved adequate in analyzing the sense amplifier, the most critical circuit in a memory system. The Monte Carlo method of analysis (which randomly selects component values from a given set of distributions and analyzes the performance of the circuit for these values) has had limited effectiveness since the traditional application of the Monte Carlo technique results in excessive iterations within each of the many thousands of problem solutions and greatly extends computer running time while yielding only limited output data. An application of the Monte Carlo method has been developed which minimizes the iterations and at the same time yields more useful output.

Roster of Programming Languages, J. E. Sammet, *Directory of Computers and Automation* **16,** No. 6, 80–82 (June 1967). A listing of existing higher-level languages developed or reported in the United States which have been implemented on at least one computer is given.

Route Control at Critical Intersections, D. H. Gazis and R. B. Potts,* *Proceedings of the Third Conference of the Australian Road Research Board* **3,** 1, 354–363 (1966). The capacity of a road network is often limited by the capacity of critical intersections which rapidly become bottlenecks in peak traffic conditions. The authors suggest a method of relieving traffic congestion at critical intersections by route control of traffic platoons. By using adjacent streets the simple intersection is replaced by an intersection complex and the control of platoons through the complex is achieved by properly offsetted interconnected traffic lights.

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Some Explicit Polynomial Approximations in the Plane, T. J. Rivlin and B. Weiss, *Bulletin of the American Mathematical Society* **73,** 3, 467–469 (May 1967). Our main object here is to present several classes of examples of both analytic and nonanalytic functions where the best approximation can be determined explicitly for all n.

What is the Fast Fourier Transform?, W. T. Cochran,* J. W. Cooley, D. L. Favin,* H. D. Helms,** R. A. Kaenel,* W. W. Lang, G. C. Maling, Jr., D. E. Nelson,*** C. M. Radar,**** and P. D. Welch, *IEEE Transactions on Audio and Electroacoustics* **AU-15,** 45–65 (June 1967). The fast Fourier transform is a computational tool which facilitates signal analysis such as power spectrum analysis and filter simulation by means of digital computers. It is a method for efficiently computing the discrete Fourier transform of a series of data samples (referred to as time series). In this paper, the discrete Fourier transform of a time series is defined, some of its properties are discussed, the associated fast method (fast Fourier transform) for computing this transform is derived, and some of the computational aspects of the method are presented. Examples are included to demonstrate the concepts involved.

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