REPOSITORY

technical papers covering the full range of computer system design

The following papers are available from the IEEE Computer Society Repository in either microfiche or photocopy form.

Prices are as follows:

Photocopy – Up to 25 pp. – $4
26 to 60 pp. – $6
60 to 100 pp. – $8

Over 100 pages – price is stated in the heading to the paper's abstract.

Microfiche – Up to 50 pp. – $2.50
50 to 100 pp. – $5.00

Over 100 pages – price is stated in the heading to the paper's abstract. It should be noted that Repository items, which are available strictly for the convenience of our readers, are accepted as submitted, and have not necessarily been subjected to the normal referee process.

All Repository items must be prepaid. Please make your check or money order payable to the IEEE Computer Society.

R74-48 — Hunt, B.R., and Andrews, H.C., "The Application of Different Filter Structures to Image Restoration by Digital Computer" (15 pp.; University of California, Los Alamos, NM).

The problem of image restoration has been approached by a number of different solutions. The methods of solution are enumerated and compared in terms of the frequency structure of the filter which generates the image restoration. An experiment was performed to compare the quality of image restorations produced by the different filters. Results of the experiment are discussed and samples of the images are presented. The experimental results show that the Wiener filter is not always optimal in image restoration problems and that other filters offer better results.

R74-49 — Vandewalle, J., "The Piecewise-Linear Approximation of Discrete Data Sets" (10 pp.; Catholic University of Louvain, Heverlee, Belgium).

The minimax error of the piecewise-linear approximation of discrete functions as a function of the values of the knots is unimodal. An easy implementable algorithm is described to calculate this minimum and then is compared to other methods.

R74-50 — Laski, J., "The Binary Realizable Approximation of a Probability Density" (11 pp.; Instytut Informatyliu, Gdansu, Poland).

The usefulness of an application of the spectral approach to the problem of approximation of an arbitrary probability density function is shown. The approximating function from the formal point of view is a probability density function on a given limited interval [a, b], and its values have finite binary expansions. These problems arise in the simulation of a given continuous process by a digital binary random variable.

R74-51 — Gaveilovic, M.M., "Optimal Approximation of Convex Curves by Functions Which Are Piecewise Linear" (38 pp.; Mihailo Pupin Institute, Belgrade, Yugoslavia).

An efficient method is presented for solving the problem of approximation of convex curves by functions that are piecewise linear, in such a manner that the maximum absolute value of the approximation error is minimized. The method requires the curves to be convex on the approximation interval only. The boundary values of the approximation function can be either free or specified. The method is based on the property of the optimal solution to be such that each linear segment approximates the curve on its interval optimally while the optimal error is uniformly distributed among the linear segments of the approximation function. Using this method the optimal solution can be determined analytically to the full extent in certain cases, as it is done for functions x^2 and $\sqrt{x}$. In general the optimal solution has to be computed numerically following the procedure suggested in the paper. Using this procedure, optimal solutions are computed for functions sin x, tg x, and arctg x. Optimal solutions to these functions have been in practical applications.

R74-52 — Chang, C.L., "Pattern Recognition by Nearest Neighbor Classifiers" (23 pp.; National Institute of Health, Bethesda, MD).

A nearest neighbor classifier is one which assigns a pattern to the class of the nearest prototype. An algorithm is given to find prototypes for a nearest neighbor classifier. Starting with every sample in a training set as a prototype, any two nearest prototypes of the same class are then successively merged so long as the recognition rate is not downgraded. The algorithm is very efficient. For example, when it was applied to a training set of 514 cases of liver disease, only 34 prototypes were found necessarily to achieve the same recognition rate as the one using the 514 samples of the training set as prototypes. Furthermore, the number of prototypes need not be specified beforehand in the algorithm.

R74-53 — Ramapriyan, H.K., "Multilevel Approach to Sequential Detection of Pictorial Features" (23 pp.; Aerospace Systems Center, Huntsville, AL).

The problem of detecting the local similarity between templates in a given class and a given image is considered. The problem is treated as a generalization of the sequential similarity detection algorithms recently published and illustrated with application to image registration by Barnea and Silverman. When the given set consists of a large number of templates and the number of locations in the image matching any of the templates is small, it is wasteful to examine each of the templates at every location in the image for a match. Instead, it is suggested that the set of templates be partitioned and a representative template be defined for each of the partitions. Several levels of partitioning are defined. Elimination of mismatching locations and termination of computation can take place at each level of detection. Each level of testing is over a more restrictive subset of the template class than the previous level. A general formulation of this approach is presented and criteria for selecting representative templates, the ordering of components of a template vector for error evaluation and the threshold sequences to be used in deciding about a match is given. Suboptimal solutions satisfying these criteria are given. Illustrative examples are provided showing recognition of linear features in test patterns and aerial photographs.

To order your repository papers use the Multipurpose Order Form inside back cover.

R74-54 — Cheung, C.C. and Ehrich, R.W., "On the Minimization of Tree Type Universal Logic Circuits" (19 pp.; University of Massachusetts, Amherst, MA).

The realization of arbitrary switching functions using the universal logic modules of Yau and Tang has the disadvantage of large trees of modules resulting. A decomposition theorem and an algorithm are given for reducing the size of such trees with what is called a chain decomposition.

R74-55 — Butler, J.T., "On the Number of Functions Realized by Cascades and Disjunctive Networks" (35 pp.; Wright-Patterson AFB, OH).

The number of functions realized by certain networks of two-input one-output gates are presented. Two networks are considered; one is the disjunctive network, which is characterized by the restriction that each gate output and each network input connect to exactly one gate output. The other network, the cascade, is the special case of the disjunctive networks in which each gate has at least one input which connects to a network input. For both networks, a recursion relation is derived for the number of realized switching functions dependent on exactly k variables. Both expressions have been solved by computer for k up to 15. Also, expressions are derived for the number of functions realized by cascades and disjunctive networks of two-input one-output cells, where each cell realizes any of the 16 functions on two variables.

R74-56 — Tabloski, T.F. and Mowle, F.J., "A Numerical Expansion Technique And Its Application to Minimal Multiplexer Logic Circuits" (76 pp.; Purdue University, Lafayette, IN).

A method of realizing arbitrary combinational switching functions with multiplexers is derived. These circuits are divided in two classes where the first allows only uncomplemented variables as control inputs and the second has unrestricted inputs. The selected inputs to each multiplexer in the first class of circuits called tree circuits are shown to be residue functions of the output function. The minimal multiplexer realization of a function's dual or complement can be derived from the function's minimal tree realization. The number of symmetric variables in any switching function reduces the number of multiplexers in the final tree realization. The relationship of the number of multiplexers and the amount of delay of a tree circuit realization to the unrestricted input or control function realization is derived and shown to be dependent on the number of single variable residue functions of the subfunctions.

R74-57 — Parker, K.P. and McCluskey, E.J., "Probabilistic Treatment of General Combinational Networks" (11 pp.; Stanford University, Stanford, CA).

A method is given for calculating the probability that the output of a general combinational network is 1 given the probabilities for each input being 1. The notions of the *probability of a signal* and *signal independence* are defined.Then several proofs are given to show the relationship between Boolean operations and algebraic operations upon probabilities. As a result of these a simple algorithm is presented for calculating output probabilities. An example of the usefulness of this result is given with respect to the generation of tests for the purpose of fault detection.

R74-58—Garon, G. and Krieger, M., "Address Driven Microprogramming" (14 pp.; University of Ottawa, Ottawa, Canada).

Address driven microprogramming is based upon the idea of separating the microinstruction definition (bit patterns) from actual programming effort (microinstruction sequencing) which is required in standard microprogramming. To do this the distinct and valid microinstructions, the control states of a machine, are stored in a fixed read-only memory and are referred to by their addresses. The microprograms with the proposed organization become listings of these addresses stored in a separate control memory, much smaller in size than the corresponding micro-store memory. The resulting control unit organization provides for economic dynamic microprogramming, additional reliability, and potentially greater user flexibility. An additional advantage of this organization is that it allows a better tailoring of the control unit to customer needs.

R74-59 — Kartashev, V.I., "The LSI-Modular Computing Systems" (54 pp.; University of Nebraska, Lincoln, NE).

Basic principles are considered for designing LSI-modular computing systems using only two basic modules: a logical module implemented as 8-bit parallel LSI-microprocessor placed on a single semiconductor MOS/LSI-chip; and a memory module implemented as a 16-bit standard memory used for construction control memory of the system. Various modifications of LSI-modular computing systems differ from each other by two parameters: the processor size (from 16 to 128 bits); and speed and size (no more than 65.5K) of control memory. A new control organization for the system is considered which implements the changeable instruction period Tp' – that is the time during which one program instruction is executed. For each instruction the Tp' – quantity is identified by three factors: the processor size in a system; the speed of the memory unit used in a system; and the type of operation implemented within an instruction. Introduction of changeable T_P permits accelerated computation of many computer operations. Also the hardware organization of the basic computer operations within LSI-modular computing system is given.

R74-60 — Yuen, C.K., "Function Approximation by Walsh Series" (34 pp.; Australian National University, Canberra, Australia).

Function approximation by the use of a finite Walsh series is considered. As Walsh functions form an orthonormal, complete set, any well behaved function can be represented exactly by an infinite Walsh series. The inclusion of only a finite number of terms in the series gives an approximation. The process of threshold sampling includes terms of largest magnitudes in the series and gives a least square error approximation. Error analysis for this selection procedure is unavailable; however, error analysis is possible if terms are selected according to degrees and subdegrees. Truncation is equivalent to dropping all terms with degrees greater than some amount. Because terms have been grouped by their degrees, the error caused is a weighted integral of the first derivative, and an upper bound on the expression can be derived. A truncated Walsh series corresponds to a simple function table. Similarly, data compression is equivalent to dropping terms with large enough subdegrees, with an estimable error. After a Walsh series has been selected, it is possible to modify the coefficients using Lawson's algorithm and to reduce the maximum error.

R74-61 — Krishan, G. and Sharma, K.D., "An Algorithm for Exponentiation to Fractional Powers and Rooting" (17 pp.; Indian Institute of Technology, Haus Khas, New Delhi-29, India).

An algorithm is described to raise a number to fractional powers and is applied to develop unified algorithm for division, square rooting, and cube rooting. A hardware implementation is also described which requires $\frac{T}{2}$, T, $\frac{3T}{2}$ timings, where T is the multiplication time, for division, square rooting, and cube rooting respectively. The method can also be used to find inverse product by applying division algorithm twice.

R74-62 — Friedman, J.H. and Tukey, J.W., "A Projection Pursuit Algorithm for Exploratory Data Analysis" (36 pp.; Stanford Linear Accelerator Center, Stanford, CA).

An algorithm for the analysis of multivariate data is presented and discussed in terms of specific examples. The algorithm seeks to find one- and two-dimensional linear projections of multivariate data that are relatively high revealing.

R74-63 — Pavlidis, T., "Optimal Piecewise Polynomial L_2 Approximation of Functions of One and Two Variables" (10 pp.; Princeton University, Princeton, NJ).

The problem of piecewise polynomial L_2 approximation with variable boundaries is considered. Necessary and sufficient conditions for local optima are derived. This allows the use of simple functional iteration algorithms for locating the boundaries.

R74-64 — Okuda, T., Tanaka, E. and Kasai, T., "Method for the Correction of Garbled Words" (29 pp.; University of Osaka Prefecture, Sakai, Japan).

A new correcting method for garbled words is proposed based on Levenshtein Distance and Weighted Levenshtein Distance. The method is powerful enough to correct not only substitution errors but also insertion and deletion errors. According to the results of the simulations on nearly 1000 high occurrence English words, the method achieves higher error correction rates than any other method has been able to attain. The hardware realization of the method is feasible, though rather complicated.

R74-65 — Franklin, M.A. and Gupta, R.K., "Stack Distance Density and Page Fault Probability in Virtual Memory Systems" (20 pp.; Washington University, St. Louis, MO).

An algorithm is given for calculating page fault probability in a virtual memory system operating under demand paging and LRU replacement rule. A first order Markov model of program behavior is assumed and procedure to obtain various moments of stack distance density function is given.

R74-66 — Franklin, M. and Sen, A., "An Analytic Response Time Model for Single and Dual Density Disk Systems" (34 pp.; Washington University, St. Louis, MO).

The question of replacing a single density, two-channel, two-controller disk system with a cheaper, plug-compatible, dual density, single channel system having the same capacity is considered. An analytical model is explored to examine the effect of such a replacement on average response time – the time between issuing an I/O request and completion of the request. Queueing theory is used to obtain curves of response time vs arrival rate and the results are compared with corresponding curves obtained by a simulation model.