MICROMULTIPROCESSING OF A SINGLE INSTRUCTION STREAM

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It is often desirable to increase both flexibility and speed of the processing of a stream of machine language instructions. Additional hardware can be added, but after a certain point loss of flexibility and added complexity make it undesirable. Microprogramming offers a means of achieving high flexibility and low complexity. Combining microprogramming and multiprocessing (micromultiprocessing) offers possibilities of increase in speed with moderate increase in cost over uniprocessing. Leapfrogging[1], balanced pipelining[2], and queued graphing(new) are examples of some approaches to micromultiprocessing that have been explored. In each approach, different tradeoffs are involved and many questions need further investigation.

[1]Rosenfeld, Jack et al,"Micromultiprocessing",IEEE Transactions on Computers, February, 1973, 149-153.
[2]Kurtzberg, Jerome et al,"A Balanced Pipelining Approach", Ibid, 143-148.

COMPUTER DATA COMMUNICATION: PACKET SWITCHING IN A SLOTTED SATELLITE CHANNEL

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Methods for data communication using a packet switching technology over a slotted satellite channel are proposed and studied. The basic model assumes an input source from many independent low-rate stations which use the channel in a multiple random access mode. When simultaneous transmissions interfere with one another, all of the conflicting packets are destroyed and must be retransmitted after some random delay. The message delay vs. channel throughput tradeoff is studied for various random delay policies. The dynamic behavior and stability of the model is analyzed. The channel is locally stable if the traffic rate is less than 1. Control policies are studied to return the channel from an unstable state to a stable state. The maximum channel throughput for this model (corresponding to a channel traffic rate of 1) is limited to below 1/e. Two other models are studied in which the channel throughput exceeds 1/e. The first consists of the addition of one or more high-rate buffered stations to the previous model. In this case the increase in overall channel throughput is at the expense of degraded performance for the low-rate stations. The second involves using a fraction of the channel capacity for the stations to make reservations. In this case, the increase in channel throughput is at the expense of longer message delays.

ONE-STEP METHODS FOR NONLINEAR N-TH ORDER INTEGRO-DIFFERENTIAL EQUATIONS

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The general n-th order integro-differential equation

$$(1)\quad y^{(n)}(x) = f(x,\bar{y}(x)) + \int_{x_o}^{x} K(x,\bar{y}(x);s,\bar{y}(s))\,ds$$

where the vector $\bar{y}(x)$ represents the vector of $y(x)$ and its n-1 derivatives

$$(2)\quad \bar{y}(x) = [y(x),y'(x),y''(x), \ldots,y^{(n-1)}(x)]$$

has a unique family of solutions $y(x)$, with one solution for each initial condition $\bar{y}(x_o) = \bar{y}_o$. One-step methods for numerically approximating these solutions are defined as satisfying

$$(3)\quad \bar{y}_{n+1} = \bar{y}_n + h\phi(x_n,y_n;h) + h^2 \sum_{i=0}^{n-1} \psi(x_n,y_n;x_i,y_i;h)$$

These methods are shown to converge to $\bar{y}(x)$ iff ϕ and ψ are consistent with the integro-differential equation (1), and several numerical examples are developed as demonstrations. The rate of convergence for $y(x)$ is $O[h^{2n-\min(p,q-1,r-1)}]$; where p, q, r are the orders of the highest derivatives actually used in f, K(x), and K(s) respectively.

A GENETIC THEORY OF SCIENTIFIC DEVELOPMENT

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A theory is presented to account for some aspects of information and knowledge dissemination. Information and knowledge phenomena seem to involve the transmission of many factors which may be linked, may compete for the attention of the receivers, and may be subject to different environmental pressures. Furthermore, it is apparent that new knowledge and information may be introduced into a population quite independently of the processes of dissemination. These features of information processes suggest that techniques similar to those employed in genetics may be adaptable to the study of information processes and in particular to the growth of science. Analysis is performed by the application of suitably designed PL/1 programs that identify the analogues of two factor crosses among stable markers of the scientific literature. The hypothesis to be tested is whether there exists maps of the literature which have the salient properties of genetic maps.

AN ALL CYCLE ALGORITHM FOR UNDIRECTED GRAPHS

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An algorithm is presented which generates, without duplication, all the simple cycles of an undirected graph. The algorithm employs the concept of a fundamental cycle set and is based on a more efficient branching procedure than was used previously.[1,2] As a consequence both execution time and storage requirements are greatly reduced. Also included is an improved method for finding the fundamental cycle set from a spanning tree, and a branch and bound option which will find the longest cycle in a graph.

[1]J. T. Welch, A mechanical analysis of the cyclic structure of undirected linear graphs. J. ACM 13, 2 (April 1966), 205-210.
[2]N. E. Gibbs, A cycle generation algorithm for finite undirected linear graphs. J. ACM 16, 4 (Oct. 1969), 564-568.

A PARADIGM FOR SEMANTIC PICTURE RECOGNITION

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I. Syntactic Picture Recognition.

Current syntactic (linguistic, grammar-based) approaches to picture recognition are found to have two basic limitations: (1) An inability to utilize contextual information to resolve ambiguities. For example, a "circle" may represent an eye, the sun, a ball, etc., and only through an analysis of the context (scene) in which the object is found can such ambiguities be resolved. (2) An inability to adequately describe a class of pictures in which non-pictorial paraphrase arises. That is, an inability to describe the possibly infinite variety of shapes of objects in a class, where each object is recognizable, completely out of context. Thus, while the human recognition of pictures is based on a combination of context analysis and analysis of shape (internal structure), syntactic recognition is based only on an incomplete ability to analyze simple shapes.

II. Semantic Picture Recognition.

A paradigm for picture recognition has been developed and evaluated which overcomes some of the limitations of syntactic techniques. Because the paradigm permits the exhibition of properties and relations of a non-pictorial kind it is termed a semantic paradigm. Explicit use is made of contextual information in the form of "rules of inference", and recognition is based on intensional class descriptions. Thus, cases of non-pictorial paraphrase, for which syntactic extensional descriptions are often inadequate, are now subject to analysis through the use of the semantic paradigm.

Evaluation of the semantic paradigm has been based on its application to problems involving ambiguity of shape, non-pictorial paraphrase, non-ideal (tv scan) data, and multistability in perception.
