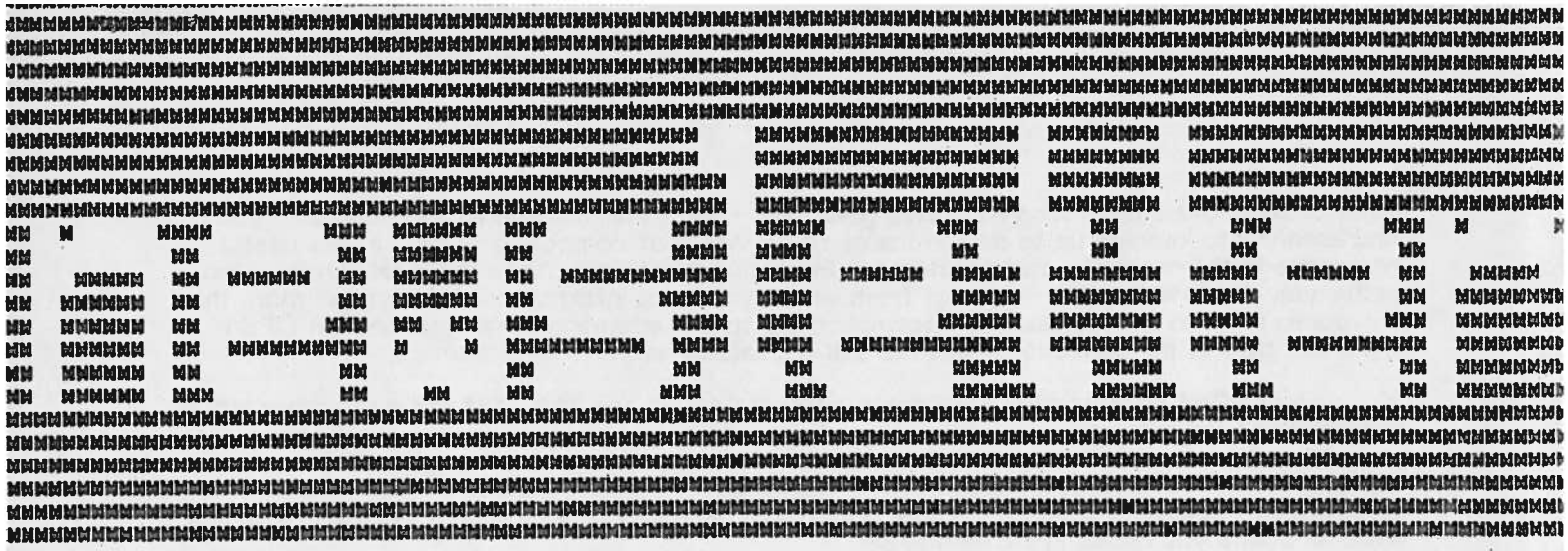

CSCSI/SCEIO CMCCS/ACCHO CIPPRS

Vol. 1, Number 4 March 1982

EDITORIAL

It is difficult to explain, but every once in a while a revelation occurs and we suddenly realize the truth. Looking back on it, one asks oneself "Why did it take so long?", It should have been obvious. Well, whether we like it or not this could be the last issue of this newsletter. Unless there is a sudden infusion of interest, effort and material this newsletter won't continue. That doesn't mean, of course, that something else won't take its place, and it could be a big improvment, which some will say that it won't be difficult. In any event, things will change and let's hope for the better.

Thank you, and it's been good talking to you.

W. A. Davis
March 8, 1982

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Letter to the Editor, dated December 1, 1981:

I would like the opportunity to respond to your article entitled The CIPS Connection in the Sept./81 Newsletter.

As a past president of CIPS, Wayne, I know you are well aware of our strengths and weaknesses. We not only want to be a technical society, we want to be the Professional Society for Computing in Canada, with all that that implies. We are, for example, very keen on the work that the Accreditation Council for Computing in Canada is doing, and for your very valuable personal contribution to that committee. We would like the INFOR Journal to be the publication outlet for researchers in Computing in Canada, but our biggest problem is in getting research papers. We would like to make our National Conference even more meaningful, and I'm sure it will be this year in Saskatoon (May 19-21).

I think that you are a little unfair when you say that "CIPS is ... a club interested in dinner meetings and non-technical talks". A very important thing that CIPS does is to hold dinner meetings. Sometimes the talks after the dinner meeting are non-technical. Does that make us a club? I personaliy find the dinner meeting most useful, as it gives me a unique chance to meet

other professionals from whom I learn a great deal – technical, managerial and political – that I find essential to keeping up to date in the complex world of computing. I find it a very useful alternative to the more structural lectures at Educational Institutes. As to the meal format, what better way of cornering the specialist from whom you want information? I always get more than my money's worth in very valuable information. So to me, attending dinner meetings at CIPS is an important part of my education – and I've still got lots to learn.

As to CIPS relationship with Special Interest Groups, we, like ACM and many other similar organizations, have some fundamental issues to resolve – and ours are greatly enhanced by the presence of our big brother south of the border. You are aware of my thoughts on this whole subject from a pre-release version of a position paper I wrote. It is close enough to be a final version that you may circulate it if you wish. I would, however, like to answer here a few of the specific points you raised in the newsletter.

Membership was and remains a real problem. A Special Interest Group, by definition, is a subgroup of some larger group. It would seem appropriate that that larger group be involved in general computing, and that is precisely what CIPS is. The parent body is responsible for the SIG's including their debts, etc. On discussion with our Constitutional lawyers, it wasn't clear how that responsibility could be met if a significant fraction of the members of SIG were not members of CIPS.

Although we very much wish that the SIG's remain as SIG's we recognized that there should be an escape route for those groups who desire complete freedom over all else. Thus we built into the new constitution a mechanism for dealing with such an "Association" in a reasonable, business-like manner. We hope it won't happen, but it may, and if so, we can handle it. I regret that the term "Profit" appeared in a draft position paper relating to SIG's. What was being addressed was the fact that CIPS was and is greatly subsidizing the SIG members and that that subsidization should cease. Recall, SIG members who were also CIPS members were charged nothing for the service provided and non-CIPS members only $5.00, whereas it costs close to $20.00 per CIPS member to run the National Office. "At Cost" would have been a better term to use than "at a profit".

What I don't understand in general is why anyone would not be prepared to pay $50.00 to belong to the National Society associated with the field of work from which one gains one's living. Surely it is a very small price to pay to know that someone is attempting to look after your livelihood, and further, if you don't like the way it is being looked after there is a ready-made springboard from which to jump into the fray and do it better!

I'm not quite sure what you meant by the "doubtful services" CIPS provides. When there have been any problems, they have, in my experience, been due to a lack of communication between the two groups or two individuals. This is one of the very strong reasons for getting a nice clear agreement, so as the players change, as they invariably do in volunteer societies, a clear understanding will still be in place. Your SIG representative to the national board has, on a number of occasions, remarked how helpful and efficient was the service provided by the National Office of CIPS.

Finally, CIPS, to fill its role in society, needs many members from all specialties in Computing – and we need SIG's and so my plea is that we not fragment things further, but that we join forces to make what Computing in Canada should be – a calling in which all Computing Professionals in all areas of computing can be proud to work and develop their skills. Let's not let small sums like $50.00 per year be the difference between having a unified or an uncoordinated voice for computing in Canada.

Sincerely,
A. G. Fowler, President, CIPS

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Editor's Reply (to A. G. Fowler)

Thank you for taking the time to respond, and I agree that I should be well aware of the strengths and weaknesses of CIPS. I find it very frustrating, however, that some members of the current CIPS board are not aware of the weaknesses of CIPS and are not willing to listen to any attempts to correct them.

CIPS is in a very unique position, in my opinion, since they should be able to provide a forum for academics and others working in the forefront of the computer field to interchange ideas with the practitioners. Unfortunately, because of the many factors, not all of which I understand, this has never really come about. One of the major failures of CIPS has been its inability to come to grips with the needs of the academic and research communities. Admittedly, CIPS is supporting INFOR and holds annual conferences; however, neither is adequate to meet current requirements. I am concerned that you feel it is necessary to defend the dinner meetings. You shouldn't have to, since they serve a real urpose and I attend quite a few of them myself. The trouble is, not everyone wants to be saddled with dinner meetings, but CIPS does not want to recognize those people. Therefore the club image. Why can't they be an option like most other things?

Your statements about the $50.00 bother me. It is about time that CIPS tried to understand why people are concerned about their $50.00. In the first instance it is not $50.00, because section dues are added on top. In Toronto this comes to $90.00, with free meals too, but remember it's (not) a club. Furthermore, what has CIPS done to look after the livelihood of academics? The honest answer has to be very little, and for the most part doesn't seem to be trying. Now I know that some in CIPS are, since you and I are both trying; however, sometimes it seems that for every positive step there are at least twenty negative ones.

While I admit that the academic and research communities have not supported CIPS to the extent that they should have, I don't think that should be reason for CIPS to ignore their needs. Surely what CIPS needs to do is swallow its pride and attempt to reverse its image while it still has a chance to do so, although by now the bitterness and rancor on both sides may be too deeply ingrained to have much effect. If positive steps are not taken soon, then the outcome, unfortunately, will be that CIPS will become just another DPMA. After all, if the inititive has to come from this other group of people, then they will opt for an organization over which they have some influence.

Lastly, some note should be made as to why this discussion occurs here in the open and not between individuals. Well, I tried the other and it failed. I wrote long letters about the constitution revisions; however, I received no replies, and no action was ever taken. In adition, I even went to the board meetings in Elora, at my own expense, to present the views of some of the SIGs. At that time, neither Paul Tremblay nor myself were permitted to attend the meeting, let alone listened to. That's how much interest there is in the CIPS board about the viewpoints of the current SIGs.

W. A. Davis

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Fourth National Conference
of
Canadian Society for Computational Studies of Intelligence/
Societe Canadienne pour Etudes d'Intelligence par Ordinateur

University of Saskatchewan
Saskatoon, Saskatchewan
17, 18, 19 May 1982

In conjunction with:
The 1982 National Conference of the
Canadian Information Processing Society

Topics of interest include: all areas of artificial intelligence, expert systems, natural language unerstanding, knowledge representation, heuristic problem solving, automatic proramming, computer perception and vision, image analysis and understanding, robotics, programming systems for AI, psychological aspects of AI, automatic theorem proving, learning, social implications of AI, and advanced applications.

Proceedings will be distributed at the conference and will be subsequently available for purchase from CIPS. Invited speakers:
Ron Brachman, B. Chadrasekaran, Scott Fahlman, Roger Schank, Bonnie Lynn Webber, Bob Woodham.

Address for information:
Gordon McCalla
CSCSI/SCEIO Conference
Dept. of Computational Science
University of Saskatchewan
Saskatoon, Saskatchewan S7N 0W0

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CSCSI/SCEIO Annual Meeting
August 28, 1981

The Annual Meeting for 1981 was held at the University of British Columbia, Friday, August 28, 1981. Alan Mackworth chaired the meeting which began at 12:30.

1. *Minutes.* The minutes of the last meeting were approved on a motion of N. Cercone seconded by W. Havens.

2. *Next Meeting.* The 1982 meeting of the Society will be held at the University of Saskatchewan in Saskatoon, May 17–19, 1982. G. McCalla is the General Chairman and Local Arrangements Chairman, and N. Cercone is Program Chairman. The meeting will be held immediately preceding the CIPS meeting. Several invited speakers have already agreed to participate. An application has been made to NSERC for travel funds for these people. Abstracts are due December 7, 1981. Suggestions for a logo for the meeting (and for the society) should be sent to N. Cercone. The Chairman moved thanks to the conference organizers.

3. *Constitution.* J. Mylopoulos reported that the Society's letters patent had been granted in Ontario. A. Mackworth raised the issue of the affiliation with CIPS. CIPS now requires every member of an affiliated society to also be a member of CIPS, a fairly expensive proposition as far as we are concerned. CIPS is considering replacing its affiliated society system by one of Associated Societies, an arrangement which would be considered by them on a case by case basis. There was the feeling that CIPS has not been serving us particularly well. There were complaints about the slowness of their central office. CIPS is also in financial difficulty, which will probably mean an increase in our costs. A. Mackworth will look into the new Associate Society status. T. Marsland suggested we might consider membership in the Learned Societies of Canada. It was not clear whether this would solve our office problem.

4. *Finances.* Wayne Davis was not present, so no Treasurer's Report was presented. A. Mackworth had spoken to the Treasurer and reported that things were generally going well.

5. *Newsletter.* Our joint newsletter with CIPPR and CMCCS is as always looking for contributions. Send them to the Editor, G. McCalla.

6. *Other Societies.* A. Mackworth expressed his concern at the fact that the first day of IJCAI had been taken over by AAAI. The possibility of some joint membership or affiliation scheme with AAAI was raised and will be investigated by the Chairman.

7. *New Officers.* The Nominating Committee was encouraged to submit more than one candidacy per position, if at all possible. Any members willing to serve as officers should make themselves known to the Chairman.

8. *AI in Canada.* In 1973, Ted Elcock and Zenon Pylyshyn suggested to NRC that a study be made of AI in Canada. This offer was declined. A. Mackworth suggested resurrecting the idea, along the lines of the COSERS study in the U.S.
Z. Pylyshyn agreed to assist. The size, coverage, and intended audience of the proposed report were discussed. The audience should include NSERC, NRC, Science Council, and the Ministeries of Supplies and Services, Energy, Mines and Resources, Communications, and Science and Technology. The press would of course be sent the report as well. The consensus of the meeting was that the Executive should look into the detailed coverage of the report and approach individuals to do the work.

The meeting adjourned at 2 p.m.

C. Raymond Perrault, Secretary.

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GRAPHICS INTERFACE '82 TENTATIVE TECHNICAL PROGRAM
Constellation Hotel, Toronto
19, 20 and 21 May 1982

Wednesday, May 19th
I. Human/Computer Interaction (I)

Invited Speakers:
James D. Foley, George Washington U.
Michael Mills, U. of Montreal
Tom Moran, XEROX Palo Alto Res. Cen.

Human/Computer Interaction (II)

FLAIR: User Interface Design Tool.
P.C.S. Wong & Eric R. Reid, TRW Defence and Space Research Group.

Software for Device-Independent Graphical Input. G. Hamlin, Los Alamos Scientific Laboratory.

A. Graphics Interchange Protocol, Format and Systems Tool.
Weiler & G. Glass, General Electric CR&D.

Towards a User Interface Prototyping System. M. Green, McMaster U.

Graphics Algorithms

Invited Speaker: Frank Crow, Ohio State U.

Hierarchical Approaches to Hidden Surface Intersection Testing.
N. Dadoun, D. Kirkpatrick & J. Walsh, U.B.C.

Computational Techniques for Parametric Curves and Surfaces.
B. Barsky, UC Berkeley & A. Fournier, U. of T.

Efficient Polyhedron Intersection and Union. W. R. Franklin, Renssellaer Polytechnic Institute.

Speech Synthesis and Understanding.

Invited Speakers:
Ron Cole, Carnegie Mellon U.
Joseph Olive, Bell Labs, Murray Hill.
Computer Recognition of Plosives in Running Speech. B. Tang & C. Y. Suen, Concordia University.

A Computational Model of Music Listening. M. Piszczalski & B. Galler, U. of Michigan.

Graphics Systems

Graphical Display of the Structural Composition of Chemical Compounds.
W. M. Verbestel & C. Y. Suen, Computer Systems Director, Revenue Canada.

GRAFLIB – A High Level Graphics System Built on the CORE Implementation.
K. O'Hair, Lawrence Livermore Lab.

New Techniques for Teaching Musical Performance Skills. M. R. Lamb, U. of T.

SSA/AIDS: A Graphic Interactive System for Structured System Analysis.
R. Hoffman, B. W. Bickham & L. S. Harris, Exxon Corp.

Pattern Recognition & Image Processing.

Invited Speaker: Jerome Feldman, U. of Rochester.

Global Analysis and Description of the Observable Changes of a Moving Cell.
M. D. Levine & Y. M. Youssef, McGill U,

Linear, Quad and Oct-trees: Their use in Generating Simple Algorithms for Image Processing.
I. Gargantini & Z. Tabakman, U. of Western Ontario.

Curves for Modelling Chromosome Shape. C. M. Merritt, NRC, Ottawa.

Thursday, May 20th

CAD/CAM (I)

Invited Speakers:
Pierre Bezier, Regie Renault (ret.)
Donald Greenberg, Cornell U.
Graham Whitehead, Vadeko International

CAD/CAM (II)

GRIMBI – A Combination of Interactive Methods and CAD Database Techniques for Functional Modelling. K. Leinemann, Inst. fur Reaktorenwicklung, Karlsruhe, BRD.

A Low-cost CAD System for Manufactured Housing. C. M. Coupal, Saskatoon, Sask.

Case Study: an Interactive Design Program for Modular Building Elevations Using Microprocessors. D. W. Collins, Computer Aided Building Design Laboratory, Concordia U.

Mapping and Spatial Information (I)

Spatial Information Management – A Survey. M. Turoi, DCIEM.

A Microcomputer Based Spatial Information System.
G. Moon & T. Lehan, Collins and Moon, Guelph.

Some Problems Associated with the Use of Colour in Cartographic Displays.
M. W. Dobson, SUNY, Albany.

Automated Polygon Creation from Dime Network Files.
Jean-Margret Hynes, U. of Illinois at Chicago Circle.

CAD/CAM(III)

DSG: A CAM-oriented Solid Modelling Interface. F. Arbab, L. Lichten & M. A. Melkanoff, UCLA.

CAD Specification for Gate Arrays. D. S. Herrmann, DEC.

The Computer Simulation of Meta-structures, D. W. Collins, Concordia U.

MDM-1: A Computer-aided Mold Design and Manufacturing System.
A. Yajima, H. Jonishi, J. Tsuda & N. Osada, Arch. Machine Group, MIT.

Mapping & Spatial Information (II)

Research into an Interactive Spatial Information System.
G. Blair & G. Moon, Collins & Moon, Guelph.

A Graphics Interface to Large, Shared Databases.
M. Friedell, J. Barnett & D. Kramlich, Computer Corp. of America.

A Videodisc-based Terrain Map Display System. R. D. Rhode, The MITRE Corp.

On the Use of Fractals for Efficient Map Generation. F. S. Hill & S. Walker, U. of Mass., Amherst.

Business Graphics.

Invited Speaker: David Friend, Computer Pictures Corp.

Business Graphics. Maxine Brown, Integrated Software Systems Corp.

DPICT/B – A Menu-driven Business Graphics Package. Dennis Crabtree, Data Plotting Services.

Friday, May 21st
Human Factors (I)

Artistic Reflections on Man-Machine Interfactes. D. M. Palyka, NYIT.

TINKER: Interleaving Program Testing with Program Design. Henry Lieberman, AI Lab, MIT.

Towards an Art of Program Illustration.
R. Baecker & A. Marcus, Human Computing Resources Corp.

A Testbed for Experimenting with Colour Perception and Use.
J. Beatty, S. Goetz & D. J. Rasquinha, U. of Waterloo.

Graphics Hardware

A High Performance Raster Display System. R. Batos *et al.*, Tektronix Corp. & U. of Waterloo.

A Dynamically Alterable Vieodisc Display. D. S. Backer, Architecture Machine Group, MIT.

VLSI-Based Architecture for Real-time Raster Display of Shaded Polygons.
D. Fussell, U. of Texas at Austin.

Considerations for the Design of a Laster Graphics System. K. Deaton, Toronto.

Human Factors (II)

An Information Study of Selection Positioning Tasks. W. Buxton, H. Ray & A. Kroll. U. of Toronto.

Communicating with Computers in Human Terms. J. Scully, Polhemus Nagivation Sciences.

Visual Thinking Reconsidered: Some Implications for Computer Graphics.
M. Mills, U. of Montreal.

Evaluation of Graphics on Videotex by Inexperienced Users.
J. W. Tombaugh, R. Dillon & N. Carboni, Carleton U.

The Use of Object Oriented Languages in Graphics Programming. M. Green, McMaster U.

Animation & Modelling (I)

Invited Speaker: Judson Rosebush, Digital Effects Inc.

An Advanced Data Generation System for Use in Complex Object Synthesis for Computer Display. W. Carlson, Ohio State U.

Representation and Control of Complex Animation Figures. D. Zeltzer, Ohio State U.

Animation and Modelling (II)

Techniques in Frame Buffer Animation. K. S. Booth & S. MacKay, U. of Waterloo.

An Object Editor for a Real-time Animation Processor. S. Ressler, Bell Labs, Murray Hill.

Computer Assisted Analysis of Human Movement. T. W. Calvert, J. Chapman & A. Patla, Simon Fraser U.

Development of a Low-cost 3-dimensional Computer Graphics Training Device.
L. S. Finegold & A. J. Ash, U.S.A.F. Human Resources Lab.

For further information:

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Tel: (416)447-8518

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Some thoughts on Formats for DATA transfer

W. A. Davis

There is a need for standard format(s) for the transfer of images for image processing and graphics. There have been several proposals made, but in my opnion, none are sufficiently broad to satisfy the significant needs. It is felt by many that the data format is more important than standards for manipulation as proposed by GSPC. After giving the problem some thought, although maybe not enough, the following characteristics and ideas have surfaced. In order to ensure that these are relevant, they are presented here for your consideration and response. It would also be interesting to know if anyone has any opinions as to how useful the exercise is, i.e., how necessary are standards?

The format should be capable of accommodating a number of different file types, including: pixel data, polygon or line data, text for both documentation and overlays of other files, plus other modification or auxiliary files such as windows, grey level transforms and histograms. In addition, a capability for an adequate directory and facilities for indexing should be available.

One question occurs: How much variation in individual file types can or should be

accommodated? I think that considerable flexibility should be available. To illustrate, consider the case of pixel data. If a user has binary pixel data, will a format be permitted to pack the data 8 pixels per byte? I think the user should be able to pack the data anyway that is convenient up to and including 16 bits per pixel.

Flexibility for text is easily provided by allowing documentation files in ASCII and any reasonable format: name-value pairs, formatted descriptions with page control characters in column 1, and even source programs in any language.

One area which is in need of extensive study is the definition and need for header files. While header files are used extensively, it would be difficult to establish (I think) a header that would serve everyone's needs. At least, preserving the requirement that the header be of a manageable size. One alternative would be to provide a facility for either a self describing header for magnetic tape usage or no header at all.

Comments should be sent to either W. A. Davis or M. Wein whose addresses appear on the last page.

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McGill University

Electrical Engineering Department

Computer Vision and Graphics Laboratory

RESEARCH PROJECTS: COMPUTER VISION

Cooperative and Competitive Computation in Vision Systems

This continuing algorithmic research has primarily been centered around the study of networks of cooperating and competing computational processes. These processes, called relaxation labeling processes, are particularly useful in reducing local ambiguities which arise during the processing of visual information. For example, when an original intensity array (i.e. picture) is interpreted into a low level, symbolic vocabulary, local feature detectors do not respond only to the selected pattern feature; they also respond to various noise configurations. The relaxation labeling processes reduce these kinds of local ambiguities by making use of constraint or compatibility relationships between pairs of neighbouring response interpretations (or labels). They work in a parallel and iterative manner, thus allowing local certainties to exert a more global influence. Formally, relaxation labeling is a class of computational processes that manipulate labels on graphs. The underlying graph structure denotes both the picture parts or abstract objects to be labeled and the neighbour relations over these projects. If the relaxation process operates discretely, then it discards labels that are inconsistant with the label sets attached to neighbouring nodes. If it operates continuously, then it updates a measure of certainty attached to each label. The initial certainties are obtained, e.g., on the basis of the feature detector responses.

A theory of continuous relaxation founded on a definition of consistency in labelings that was motivated by discrete relaxation, has been developed in two directions. The first direction led to an explicit functional that could be maximized to guide the search for consistent labelings from inconsistent ones. The functional is similar to others that have recently been suggested from results in optimization theory. It only exists under restricted circumstances, however, and is mainly used to derive a new relaxation operator that is valid under these restrictions. The second direction, based on variational calculus, provides the real core of the theory. The problem of finding consistent labelings is shown to be equivalent to solving a variational inequality. A procedure for accomplishing this is derived which is very similar to the above restricted relaxation operator. Surprisingly, this new relaxation operator can be approximated, under certain conditions, by the more standard ones. The circumstances under which the original operator functioned well are similar to these conditions, which suggests practical confidence in the new theory, and leads us to conjecture that the successful applications of the standard operators are explainable by the current theory. Most recent work is centered on additional convergence properties of this new operator, on its relationships to established theories of (partial) differential equations, and on its extension to multiple-level systems.

Robert Hummel (Courant Institute, NYU), Steven Zucker

A Projection Operator for Relaxation Labeling

The new relaxation theory is an extension of a form of gradient ascent on a domain bounded by constraints, and thus has the problem of determining the optimal updating direction when one of these constraints is encountered. We have formulated this as a closest point problem, and have obtained a solution which is iterative, finite, and faster than other algorithms in the optimization literature. A convergence proof is included.

John L. Mohammed, Robert Hummel (Courant Institute), Steven Zucker

Optimal Interpretation of Local Operator Responses

The feature detection process is often composted of two essentially different stages. The first of these is the convolution of a local operator, such as an elongated "line detector", over an image. The second stage is an evaluation, or interpretation, of the response of this operator. If it were possible to build perfectly accurate feature operators, then the above process would be trivial. One could, for example, evaluate a line operator at several orientations around a point, and then simply take the maximal response as a certain indication of the presence of a line (with a given orientation) at that point. The response of real line operators is ambiguous, however, and requires a more serious interpretation effort.

There are two premises underlying our interpretation system. The first is that the interpretation should be an optimal one, so that, e.g., it could be computed by a relaxation network. The second is the sense in which it should be optimal, we are taking an explication of the (contextual) constraints that should exist between operator responses. The general idea is illustrated by the following example.

Consider the problem of interpreting a binary image of thin curves into local oriented segments. (This is really the line finding problem alluded to above as it could arise, e.g. in the interpretation of the zero-crossings of a differential operator.) A local line operator evaluated over such an image would give a particular response characteristic, say as a function of the underlying segment's orientation. Given that there was a unique, straight segment with no noise, it would be maximal when they were oriented identically, and would drop off as one was rotated. Such expected response characteristics could be measured or computed for more general situations as well. It is these expected responses that are the basis for our constraints: the interpretation system should find the line most likely to give the response characteristics observed for the image under analysis. Or, in other words, the answer is the line pattern L for those that would be expected, given L. While this could be done for operator responses of one size, the constraintsto which it gives rise are weak ones. Much stronger constraints arise when operators of different size are considered simultaneously. The larger ones then restrict the context within which the smaller ones are to be interpreted.

Pierre Parent, Peter Sander, Steven Zucker

Texture Discrimination Using Multiple Image Representations

The co-occurrence based approach to texture discrimination can be viewed as one of finding summary statistical representations for the information in textural patterns. Functions of these statistics then provide the feature vectors for standard pattern classifiers. In an empirical study we found that, for certain classes of patterns, features of intensity and edge co-occurrences, taken together, were more powerful (for discrimination) than features of either one individually. And, in other studies, we found that more "abstract" edge features could pollute the classificiation process. The reason for this, we believe, is based on the amount of texture structure captured by the texture representation. The purpose of this project is to determine useful measures of texture structure, so that they can be applied to real discrimination tasks.

Kamal Gupta, Steven Zucker

A Rule-Based Low Level Image Segmentation System

A new paradigm for a modular computer vision system has been proposed and implemented. The system is capable of segmenting and interpreting images of natural scenes. Both the low level segmentation and high level interpretation processes are meant to interact in a bottom-up as well as a top-down manner. In order to accomplish this, the system is designed to consist of two associative memories and serveral independent processes. The input image data, the segmentation and interpretation data, and at the end of processing, the output are stored in a short term memory (STM). A long term memory (LTM), embodies the model representing the system knowledge at both the low level and high level stages. The latter employs the concept of competition and cooperation as its basic processing strategy. This implements a relaxation labelling process to iterate into a set of object interpretations corresponding to the regions segmented by the low level stage.

Recent work is primarily concerned with the development of the low level image analysis stage. This is implemented as a production system in which general knowledge about low level properties of an image is formulated into condition - action rules and stored in the LTM. The low level processes employ these rules to segment the image into uniform regins separated by connected lines. In addition to regions and lines, which are maintained separately during the analysis, a third data type is used to direct the attention of the system to the more interesting and worthwhile areas in the image. These focus of attention areas correspond to regions or groups of regions and lines and can be large smooth areas, textured areas or areas bounded by long connected lines. The strategy of the segmentation is defined by a set of rules that embody knowledge about the other rules in the system. These are termed meta rules are stored in the LTM. The low level processes match the rules in the LTM against the image data in the STM and whenever a rule fires, it triggers a low level action to perform an operation on the image data. These include merging and splitting regions, detecting lines, detecting textured areas, and connecting line segments. Such operations and others are handled by the three main processes in the system: the region, line and area analysers. The latter interact by changing the contents of the STM in order to achieve the final goal of creating a segmentation of the image into regions separated by strongly contrasting lines.

The system described above is both data-directed and knowledge-based. It is highly modular and extensible, and the model is easily accessed and modified since it is completely separate from the processing modules. Experiments are currently underway to test the system capabilities and construct the low level model.

M. D. Levine, A. Nazif, S. Shaheen

The Computation of a Depth-Map from Texture and Occlusion

There are a number of depth cues in a single image: texture, occlusion, perspective, shading, size-constancy. Perspective and size-constancy tests require knowledge about the visual world. Texture and occlusion cues, however, may be used in a general vision system without a priori knowledge about the visual world. The present research involves a feasibility study on co-operative processes which uses image texture and occlusion cues in a parallel fashion to derive a relative depth-map for the given image. These processes take as their input the signals from the multichannel data believed to reside in the human visual system.

M. D. Levine, N. Partovi

Picture Processing in Man and Machine

A comprehensive literature study is being carried out to isolate those models of human vision which could be incorporated into a computer vision system. Only so-called low level computational processes are under investigation at this time. A book on picture processing in man and machine is in preparation.

M. D. Levine

Applications of Robotics to the Inspection and Assembly of Electronic Systems

A survey of the literature on the application of computer vision methods to the electronics industry has been carried out. Such areas as wire bonding, PCB inspection, IC inspection, photomark inspection, hybrid circuit inspection, PCB drilling and other miscellaneous probems have been studied. There appears to be very little evidence of the use of sensor–based robots in these fields. Various practical applications of robots which are capable of visually sensing their environment are under investigation.

V. Agarwal, M. D. Levine, S. W. Zucker

A Computer Vision System for the Inspection of Integrated Circuit Chips

The design of a computer system for visually inspecting integrated circuit ships during manufacturing is being considered. The most generally encountered IC defects are misregistration, aluminum corrosion, conductor narrow–down and open–circuit defects, too–small and short–circuits between conductors, chip crack defects, diffusion defects, no probe mark defects, and edge cut by scribing. The main issues are considered to be (1) the symbolic representation of the latter defects, (2) the generality of the system, i.e. to what extent should particular information on a chip be used as opposed to a general information structure valid for all chips.

C. Eskenazi, M. D. Levine

RESEARCH PROJECTS: BIOMEDICAL IMAGE PROCESSING

Quantification and Characterization of the Morphology of Moving Cells

Cell Movement is a fundamental process of some importance to aspects of cell biology as diverse as migration of cells in embryological development and to host defense mechanisms. This study is promarily concerned with the interaction between external factors and cell internal processes that occur at or within the cell membrane. However, there is no existing method to quantify the observable changes in nucleus and membrane shape that occur in locomotion. To achieve this objective using automatic techniques of digital image processing, this research is aimed at developing an image interpretation system capable of analyzing the structural changes in the shape of moving objects from sequences of pictures. To do this, the system would have to be able to: recognize the various image patterns, segment and interpret the desired object, and detect significant changes in the location of the moving object as well as in its shape. Of particular interest is the symbolic description and numerical quantification of the cell shape and movement patterns. Using a relational database we have developed a rule–based biomedical image processing system capable of analyzing a cine film of a moving cell(s). The system provides a quantification and symbolic description of the cell's geometry, thereby characterizing the changes in shape of the cell membrane.

The system consists of two main analysis stages: static scene analysis and dynamic motion analysis. First, we designed and tested the first stage which provides a numeric and symbolic description of the cell morphology and location in each frame. Recently, we have completed the second stage of the system, that is, the dynamic motion analysis. The latter was implemented in two parts: incremental change detection to detect and describe changes in both location and shape of the cell between successive frames, and global analysis to provide the overall description of the cell location and morphology. The results are then characterized by a high level processor which summarizes the global characteristics of the cell behaviour. All results are described both numerically and symbolically in terminology which is meaningful to a physiologist. Currently, we are testing the system and will examine the behaviour of different types of cells under different environmental conditions.

M. D. Levine, Y. M. Youssef

Experiments in Tracking the Morphology of Proliferating Cell Cultures by Automatic Picture Processing

Two years ago, a project was initiated with the overall goal of developing a system capable of automatic cell analysis of data recorded on film. The system was to have the ability to track the morphologies of individual cells, maintaining correspondence over time. Such problems as cell collision, mitosis, and imaging process artifacts were viewed as potential sources of difficulty from a computer vision point of view. At this point, two generations of the cell tracking system have been developed. The initial work focused on a minimization-based approach, in which the task was viewed as a correspondence problem based on feature vector selection. Changes in the appearance of the cells being tracked are represented as transformations over feature vectors. A rule-guided selection strategy was developed in which temporal variation in feature changes was used to hypothesize the appearance of cells which had undergone change. This allows the system to maintain correspondence even when cells undergo change in the interframe interval.

The second generation of our system is an attempt to deal more directly with the problems associated with the imaging process, in particular, with artifacts in phase-contrast microscopy. Whereas previously we were able to formulate sufficiently precise dynamic model descriptions of cell appearance and behaviour, in the latter case this was not possible. As a result, a second inference mechanism was added to provide so-called expert knowledge in deciding the current appearance of cells being tracked. We have just completed the new version of our system in a flexible test-bed environment. Current plants call for experimentation with our database, and refinement of the rule-based descriptions.

F. Ferrie, M. D. Levine, P. Noble (Faculty of Dentistry)

A Real-Time System for Tracking and Quantifying Blood Cell Movement

White blood cells play an important part in the protection of the body, and can in some cases lead to the elimination of tumour cells. The research described here is aimed at designing a system for tracking defensive blood cells and quantifying the dynamics of their motion in order to define those parameters which are important for tumour cell elimination. In the first stage of the project, the feasibility of carrying out the analysis using automatic digital picture processing techniques was established. Results obtained compared favorably with visual and manual computations performed on data derived from 16 mm movie films of cell motion using time-lapse photography. In the next stage, the system was modified and upgraded to allow for real-time image capture and cell tracking. At present, the system is being reprogrammed to allow for distribution to other interested laboratories.

F. Ferrie, M. D. Levine, P. Noble (Faculty of Dentistry), Y. M. Youssef

Spatial Pattern in Section of Human Muscle

One feature of certain types of abnormal human muscle is the presence of large clusters of fibres of the same type. Such 'type grouping' in a sample of muscle biopsy is important because it indicates a history of damage to the nerves supplying the individual muscle fibres. It is required to measure the degree of fibre type grouping in a given section of muscle biopsy. The 'distance' between two fibres is defined as the minimum number of fibre-fibre boundaries in any path between them. Informally, a section of muscle biopsy may be said to show 'type grouping' if fibres which are 'close' are more likely to be of the same type than two fibres chosen at random. In this project we are developing methods for assessing fibre type grouping statistically. A second-order representation is used, and a chi-square statistic provides the measure. Preliminary experimental results show that the measure discriminates strongly between grouped and non-grouped fibres.

Keith Paton, Steven Zucker

Dynamic Computer Assisted Tomography

In computer assisted tomography (CAT) the cross-sectional image of the patient is computed from radiation data of X-ray or radionuclides. An underlying assumption in existing methods is that the tissues and organs in the cross section are essentially stationary during data collection which may take from about 1 second to over 60 seconds in the commercially available scanners

at present. This assumption is violated particularly in imaging relatively fast moving objects such as the heart, and consequently the resulting images are severely blurred. Further, there is increasing interest in clinical rsearch and practice to use CAT to investigate the dynamic functions of organs, metabolism and transport phenomena. This project is concerned generally with the problems of imaging moving objects from their projections. Current emphasis is on imaging the beating heart and regional blood flow. To date a package of computer programs has been developed to simulate and reconstruct images of various moving phantoms. By using an interpolation procedure we have shown that clear images can be computed from a small set of data obtained at relatively slow scanning speed which would otherwise yield completely blurred images.

H. C. Lee, C. H. Leung, H. Ibisoglu

The Application of Texture Analysis to Discover the Spatial Distribution of Rat Incisor Ameloblasts

In this project, an attempt is being made to use conventional image processing techniques to characterize the spatial distribution of rat incisor ameloblasts at various stages in their life cycle. Emphasis is placed on early times in the life cycle when ameloblast differentiate and become organized into three-dimensional rows of cells. Initially texture analysis is being used to discover the underlying texture patterns in two dimensions. It is hoped this data will serve as one basis for a better understanding of the process of amelogenesis (enamel formation), since the mineralized, extra cellular matrix which these cells form (the enamel) typically is organized by the cells into three-dimensional rows.

M. D. Levine, R. Levy, C. E. Smith (Dept. of Anatomy and Histology), Y. Youssef

RESEARCH PROJECTS: COMPUTER GRAPHICS

Microcoding the 2900 Microprocessor Module

This project involves developing microcode software for operating the 2900 Microprocessor Module in the GRADS system. The main objectives are the realization of high level graphic primitives such as point, line, and polygon. In addition the real-time operating system requirements associated with the management of input/output buffers and interrupts are supported. The software is being developed using GPMA - General Purpose MacroAssembler. For testing, the M2900 SIMULATOR program, written in FORTRAN, is used. A 2900 microcode trace facility is also available (described below).

D. Chau, A. S. Malowany

An 8086 Microprocessor Module

The project involves the design and evaluation of a 16 bit microprocessor module for supporting 256 x 256 resolution displays. The local memory has been expanded to 128K bytes using 16K dynamic RAM's. Three access ports are maintained just as in the 2900 microprocessor version. Interrupt capabilities are supported. A ROM monitor and a serial interface for a terminal are included to permit stand-alone operation when desired.

R. Ampudia, A. S. Malowany

Programming the 8086 Microprocessor for GRADS

This project involves developing software associated with operating an Intel 8086 microprocessor as one of the paralleled modules in GRADS. The main objectives are the realization of high level graphic primitives and operating system services previously described for the 2900 microprocessor. These are currently being developed in 8086 assembler using cross assembler and debugging facilities of a CP/M system provided with dual CPUS (8085/8088). The 16 bit word size can efficiently support 256 x 256 resolution displays in single precision arithmetic. High level languages will be available.

R. Haag, A. S. Malowany

A Z8000 Microprocessor Module

This design of the GRADS microprocessor module uses the Zilog Z8000 16 bit microprocessor and is provided with 32K of program/stack memory and 32K of data segment memory. The memories are multiported to support DMA transactions to the HCI and graphics controler as in the other module versions. Interrupt capabilities are supported. A ROM monitor and a serial interface for a terminal are included to permit stand-alone operation when desired.

R. Robert, A. S. Malowany

Programming the Z8000 Module for GRADS

This project parallels the implementations previously described for the 2900 and 8086. It is curently being implemented directly in machine code and debugging is performed using a Z2800 CPU card which is compatible with the S100 bus.

The Host Computer Interface

This module is responsible for efficiently linking up the S100, Unibus, and the paralleled microprocessor computers in GRADS. It realizes a DMA facility, linking all computer memories. Packing and unpacking facilities accommodate the 8, 16, 20 or 40 bit word sizes. Any computer in the GRADS system may request the DMA machine and command transfers between any of the memories once the arbitration has granted its use. The HCI also supports the interrupt system and the Status/Contrtol registers of the microprocessor network. These are used to co-ordinate the operation of the GRADS system.

R. Pancholy, A. S. Malowany

Computer Generated Animations on the GRADS System

The objective is the real-time execution of computer generated images using the GRADS system. Three-dimensional models for aircraft simulator daylight visual systems are envisaged.

G. Carayannis, S. Chong, A. S. Malowany

Frame-to-Frame Coherence in Graphics Animation

One of the computationally most expensive aspect of graphics animation algorithms is the exhaustive elimination of hidden surfaces. In certain domains, however, there is a large amount of object coherence, or, in other terms, continuity in active occlusion relationships. The purpose of this project is to develop algorithms that take advantage of these relationships, so that animation can take place at a pace more acceptable to human observers. Our research is concentrated on a characterization of the constraints that exist between convex objects in stationary spatial relationship, and on how to embed these constraints in algorithms for run-time application.

Harold Hubschman, Steven Zucker

Axons Alive: An Animated Display of Action Potentials

Certain neurological diseases, such as muscular sclerosis, have physiological causes in the breakdown of the myelin sheath surrounding axons. Consequences of this breakdown may be drastic alteration of conduction velocity, ephaptic excitation, or the spontaneous generation of action potentials at an intermediate point along an axon. All of these phenomena have been observed by researchers at the Montreal General Hospital, and the goal of this project is to produce a graphics animated film depicting them.

M. Rasminsky (MGH), M. de Payrebrune, Y. LeClerc, Steven Zucker

Parallel Hidden-Surface Elimination

Determination of the visible (or hidden) surfaces in a 3-D scene is computationally the most expensive process of any 3-D image generation system. In order to reduce the total computing time per image, it has been suggested to distribute the processing load of the hidden-surface elimination (HSE) algorithm amongst an array of processors; i.e., distribute the scene data amongst the various processors which are executing the HSE algorithm. The present research investigates a distribution scheme with three goals: minimum coherence losses, minimum interprocessor communication, and minimum on-line overhead. To this end, the scene, rather than the screen data, is partitioned into smaller scenes, and each new partition is processed by one processor.

N. Partovi, V. Agarwal

RESEARCH PROJECTS: HUMAN PERCEPTION AND PSYCHOPHYSICS

Quantification of the Gestalt Laws of Organization

Early visual information processing involves an essential decomposition of the visual array into local pieces. Such decompositions underly our edge-finding processes, for example, and create the subsequent necessity for recomposition, or grouping. Such grouping processes were studied qualitatively by the Gestalt psychologists fifty years ago; we are now repeating many of those explorations within an experimental paradigm that leads to quantitative data. The stimuli consist largely of dot and line patterns, and the data are empirical estimates of the affinity, or compatability, between tokens in these patterns.

Peter Sander, Kent Stevens (MIT), Steven Zucker

Constraints on Grouping

The empirical affinities measured in the above project require explanation, and this project is aimed at developing such an explanation from within the computational paradigm. Constraints have been determined that are intrinsic to the grouping process, such as those arising from the use of hierarchies of "simple cells" in the orientation selection process, as well as those extrinsic to the grouping process, such as the differential geometry of surfaces. Constraints also exist with motion, which can be viewed as grouping in time rather than grouping in space.

Steven Zucker

RESEARCH PROJECTS: FAULT-TOLERANT COMPUTING

An Efficient Algorithm for Data Flow Anomaly Detection

The occurence of a data flow anomaly is often an indication of the existence of a programming error. The detection of such anomalies can be used for detecting errors, and to upgrade software quality. This paper introduces a new, efficient algorithm capable of detecting the anomalous data flow patterns in a program represented by a graph. The algorithm based on a static analysis scans the paths entering and leaving each mode of the graph to reveal anomalous data action combinations. An algorithm implementing this type of approach was proposed by Fosdick and Osterwell. Our approach not only corrects an error in the previous algorithm, it also provides time and space improvements over that algorithm. Current work in this project is directed towards solving some inherent problems associated with the static approach.

J. Jackner, V. K. Agarwal.

Store and Generate Built-In-Testing Approach

Various approaches to built-in-testing (BIT) have recently been proposed as a solution to the complicated problem of testing LSI and VLSI chips. These approaches, however, show extreme limits in their requirements for additional hardware and testing time. A new class of BIT schemes, called Store and Generate, is being developed in this project which will not only span the existing schemes but also allow the designer to develop one most suited to a particular application. The main tenet of the new approach is that it will provide a balance to all aspects of testing, namely, test data generation, test data storage, output data, generation and compression, output data storage, and fault coverage.

E. Cerny (Universite de Montreal), M. Arditi, V. K. Agarwal

A Unified Approach to Testing LSI/VLSI

Current methods of testing LSI/VLSI and fault modeling are very inadequate. With the growing use of such devices it is very essential that newer and advanced techniques be used in fault modeling and testing. In this project, we plan to develop a multilevel fault model which will enable the representation of each physical failure of interest in a chip at the most abstract level possible. A multi-level fault model so created wil not only ease the task of test generation and test verification, but also enable one to test the chip in a hierarchical manner, thus leading itself to a structured way achieving the required fault coverage.

R. Chandramouli (JPL), V. K. Agarwal

Test Set Generation for Non-Stuck-At Fault

An important class of failures in MOS logic comprises shorts and opens which cannot be modeled as classical stuck-at faults. It has also been observed that various stuck-at faults in the equivalent logic circuit of a MOS realization cannot be accounted for by any physical failures at all. These observations strongly indicate the need to generate test sets for MOS logic which have more relevance to actual physical failures than can be incorporated by the classical generation procedures. We have developed a procedure to generate such tests for fanout-free MOS logic by using the concept of L-expressions. Extensions of this work to logic containing fanout are being worked out.

P. Lamoureux, M. Furst, V. K. Agarwal

RESEARCH PROJECTS: COMPUTER SYSTEMS

A Browsing Approach to Documenting Documentation

A dedicated research facility, such as ours, contains a wealth of system programs, research software, user information, and documentation that needs to be accessable to all users. However, the extent and variability of this information makes hard-copy lisings an inappropriate medium, and burdens a small core of expert users with the task of information dissemination. To relieve this burden, an on-line system has been developed in which any user can browse through all of the above information quickly and easily. The system is based on keyword matching and graph traversal, and attempts to allow for both novel and experienced users. It has recently been re-implemented to run within the EMACS editor, thus placing documentation where the user most often requires it.

Yvan Leclerc, Mike Parker, Steven Zucker

McGILL REPORTS
(Some copies of reports are available. Write to: Att. Fran Lew, Admin. Secy.)

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4. Agarwal, V. K., Fung, A. S., Multiple Fault Coverage Predictions, TR-80-3R

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6. Haralick, R., Mohammed, J., and Zucker, S. W., Compatibilities and the Fixed Points of Arithmetic Relaxation Processes, TR-79-16R.

7. Hubschman, H. and Zucker, S. W., Frame to Frame Coherence and the Hidden Surface Computation: Constraints for a Convex World, TR-80-12.

8. Hummel, R. A., and Zucker, S. W., On the Foundations of Relaxation Labeling Processes, TR-80-7R.

9. Jackner, J., Agarwal, V.K., Data Flow Anomaly Detection, TR-81-12.

10. Knoll, A., A Real-Time System for Tracking and Quantifying Blood Cell Motion, TR-79-12R.

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12. Levine, M. D., A Knowledge-based Computer Vision System, TR-77-3R.

13. Levine, M. D., Ferrie, F., Cell Tracking by Inference. TR-81-11R.

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20. Rosenberg, D., Levine, M. D., and Zucker, S .W., Using Heuristic Occlusion Cues to Compute Relative Depth Relationships, TR-79-3.

21. Shaheen, S. I., An Implementation of a Relational Database and An Algebraic Sublanguage for Computer Vision System, TR-78-12R.

22. Terzopoulos, D., and Zucker, S. W., Detection of Osteogenesis Imperfecta by Automated Texture Analysis, TR-80-8R.

23. Zucker, S. W., Leclerc, Y. G., and Mohammed, J. L., Continuous Relaxation and Local Maxima Selection: Conditions for Equivalence, TR-78-15R.

24. Zucker, S. W., and Hummel, R. A., An Optimal 3-dimensional Edge Operator, TR-79-10R.

25. Zucker, S. W., and Terzopouos, D., Finding Structure in Co-Occurrence Matrices for Texture Analysis, TR-79-13R.

26. Zucker, S. W., Motion and the Mueller-Lyer Illusion, TR-80-2R.

27. Zucker, S. W., Labeling Lines and Links: An Experiment in Cooperative Computation, TR-80-3R.

28. Zucker, S. W., and Cavanagh, P., Constructive Texture Perception: Orientation Anisotropies in Discrimination, TR-80-9R.

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