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BESÖK PÅ BROWN UNIVERSITY

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BESÖK PÅ BROWN UNIVERSITY

K J Åström

INSTITUTIONEN FÖR REGLERTEKNIK
Lunds Tekniska Högskola
Maj 1982

BESÖK PÅ BROWN UNIVERSITY

Diskussioner med Alan Pearson

Alan Pearson arbetar för närvarande med identifiering av system med tidsfördröjningar, analys av "chattering", problem för numeriskt styrda verktygsmaskiner och adaptiv reglering baserad på deterministiska idéer. Arbetet med numeriskt styrda verktygsmaskiner genomförs i samarbete med Brown & Sharp, som är en tillverkare av stora numeriskt styrda maskiner. Problemet är att om man kör med hög produktion, börjar det arbetande verktyget att vibrera och man tvingas att sänka hastigheten. Med det givna materialet och dylika bristförhållanden kan man på förhand experimentera ut var den bästa hastigheten finns, men det vore önskvärt att ha ett analytiskt system för att göra detta. Det finns många avancerade förslag till att styra dessa med hydraulik på verktygen, men Alan tänker sig att använda maskinhastigheten och matningshastigheten som styrvariabler. Problemet är olinjärt och ganska svårt att förstå sig på.

LEMS

På Brown har man nyligen slagit ihop ett laboratorium för tekniska man-maskin system. Laboratoriet leds av Harvey Silverman. Han doktorerade på Brown på den tiden jag undervisade där och han har sedan dess varit verksam vid IBM's forskningslaboratorium i tio år. En beskrivning på laboratoriet bifogas som appendix. Idén är att bygga upp ett mikroprocessorlaboratorium där det finns möjligheter att göra digital signalbehandling och digital reglering. För närvarande har man satsat på att bygga upp ett laboratorium för undergraduates baserat på Motorolas 68 000. Man hade en arbetsstation bestående av ett färdigt Motorola-kort, en vanlig terminal och möjligheter att ansluta flera olika yttre komponenter. Till den mer avancerade forskningen hade man också ett Motorola-system. Detta system var mera ambitiöst och där fanns också en speciell signalbehandlingsprocessor APS-2, som Silverman hade designat vid IBM. Den anslöts via versabus till Motorola systemet. Man tänker sig att på sikt, och när signalbehandlingsdatorer blir tillgängliga, skulle man även kunna ansluta sådana till systemet. Man har också beställt ett grafiskt datasystem av fabrikat Lexi-data.

I projektet ingick, förutom professor Silverman, även professor David Cooper, Alan Pearson och Bill Wolowich. Speciellt intressant för oss var projektet Visual servoing, som går ut på att utveckla lämpliga modeller, algoritmer och reglerteknik för flervariabla reglersystem, som styres från komplexa bildbehandlingsgivare, eller från långa rader av optiska detektorer. I digital reglering koncentrerar man sig framför allt på ett projekt att styra en intressant hydraulmotor, som hade utvecklats vid IBM's forskningslaboratorium. Motorn fungerade så att hydraulkolvar tryckte på en sinusformad kam. Mycket stora dragkrafter och ett mycket snabbt servo kunde erhållas.

Diskussioner med Tom Banks

Tom Banks, som är verksam för Centre for Dynamical Systems (CDS), arbetar för närvarande intensivt med identifiering av dynamiska system med tidsfördröjningar.

Slutsatser

Det kan vara mycket intressant för oss att ha närmare kontakt med gruppen på Brown University. Det är av speciellt intresse för Lars Nielsen att följa verksamheten beträffande Visual Servoing. Vi kan säkert också ha glädje av deras erfarenheter att bygga upp mikroprocessorklaboratorier. Det kunde även vara intressant att få hit Harvey Silverman att gästföreläsa i Lund inom ramen för datalogiprogrammet.

**The Laboratory For
Engineering Man/Machine Systems**

L E M S

SPRING, 1981

**Electrical Sciences Division of Engineering
Brown University
Providence, RI 02912**

What is the Laboratory?

The Laboratory for Engineering Man/Machine Systems (LEMS) is a new laboratory within the Electrical Sciences activity of the Division of Engineering at Brown University for collaborative research on the analysis and design of intelligent systems involving sensing, decision making and control. The principal investigators have expertise and interest in theoretical and practical problems in the areas of computer vision and image processing, modeling and control of complex dynamical systems, speech processing, signal processing, high-speed computer architecture, and visual servoing. The activity spans the range from providing theoretical-mathematical "frameworks", to the construction and use of original, advanced, hardware and software systems for new product prototypes. Collaborative efforts are not only across disciplines among principal and associated investigators, but also with various other departments at the University, and especially with cooperating industry.

The Electrical Sciences faculty of the Division of Engineering at Brown has long been recognized for its theoretical achievements in the areas of dynamical systems analysis, pattern recognition and computer vision. Recently, two new faculty positions were allocated to develop a program in Computer Engineering, the senior level position having been filled by one of the principal investigators. The new emphasis was the catalyst for the development of the theory-to-practice laboratory, and four senior faculty have cooperated in forming LEMS. Also associated with LEMS are two junior engineering faculty members. One of three positions for proposed permanent support personnel is currently being filled. Faculty from other disciplines at Brown, such as Computer Sciences, Cognitive Science, Linguistics, etc. are associated with LEMS in a peripheral manner.

An important goal of LEMS is to develop a cadre of graduate and undergraduate students who are well-rounded in the above disciplines and who are experienced in bridging the gap between mathematical theory and real-world development.

Laboratory Facilities

LEMS is currently in a stage of early development. A laboratory facility has been constructed at the Barus-Holley Engineering building for accomodating LEMS equipment. Currently, a full-color, Grinell, 512x512 image processing systems is resident in the new laboratory. It is supposed, at the present, by a DEC PDP 11/03 systems, but will be connected, shortly, to a VAX 11/780. Two ports from the University IBM 370/158 are in use, tied to Motorola 68000 VERSABUS systems. These are being developed into real-time, speech and signal processing facilities. Real-time capability, in both cases is being made feasible by our current development of a high-speed, single board, programmable processor which can be placed on the VERSABUS as single or multiple attached processors. With the addition of BRUNET, a coaxial network throughout the campus for terminal and computer communication, LEMS will make extensive use of a VAX 11/780 at the Brown University Cognitive Sciences Center, and other campus systems. Also, it is expected that in the near future a large minicomputer will be housed in the Laboratory.

Current Research and Development

Speech Processing

- Design, implementation and testing of a high-quality inexpensive speech recognition front-end
- Comparison of human versus machine performance for several difficult discrete utterance recognition vocabularies
- Development of algorithms for connected speech recognition
- FIR filter speech synthesizer

Computer Vision

- Maximum likelihood boundary estimation -- parallel processing for real-time estimation; mathematical analysis of estimation accuracy
- 3-D scene analysis and recognition using estimation and decision theory -- 3-D parameterized structure modeling; image intensity formation; a general approach to image modeling and recognition; local shape estimation from image shading
- Texture recognition and analysis using random field models -- 2-D Markov process models and analysis; other stochastic models; the combination of random fields and geometric structure; boundary estimation between textured regions

High-Speed System Architecture and Development

- Development of a unified microprocessor/attached processor approach for real-time processing of speech data and/or imagery
- Design and development of a second-generation, monoboard, attached processor

Nonlinear Systems

- Investigation into an underlying nonlinear model for the speech production system

Visual Servoing

- The development of appropriate models, algorithms and control techniques for multivariable dynamical systems which are to be controlled from complex, visual or sensor array input

Signal Processing

- New approaches for the application of Winograd Fourier Transform Algorithms

Digital Control

- The integration of microprocessors for the control of complex multivariable systems

- Investigation into linear and nonlinear models for a new, high-speed, high-torque linear, hydraulic motor and its control using a 68000 microprocessor

Seminar Series

During the academic year 1980-81, LEMS has sponsored a seminar series which has focused on the topics of speech processing, computer vision, and robotics. Some twelve eminent scientists from Bell Laboratories, IBM T.J. Watson Research Center, and leading university research centers in the US and Europe have each spent a day interacting with LEMS faculty, and have presented topical seminars. This series is for the benefit of the Brown community and nearby industry, and is going to be continued in the next academic year.

LEMS - The People

Four, full-professors have joined to form LEMS. Two junior engineering faculty are associated with the new facility. Importance is placed on interactions with other interested faculty in the Electrical Sciences, and in other departments, such as Computer Science, Applied Mathematics, Psychology etc.

Given a successful Industrial Liaison Program, LEMS will have three permanent staff - a technician, a hardware design engineer, and a systems programmer. It is crucial that permanent staff be in place to ensure continuity in systems support, development, experimentation, and maintenance of hardware and software libraries. Also, these personnel are to be responsible for any duplication of hardware/software systems for supporting agencies and/or Industrial Liaison participants.

At present, the number of graduate students in the Electrical Sciences in the Division of Engineering, who are doing research in areas pertinent to the activity of the Laboratory, is roughly 20. Seven of these students have Master's degrees and are working toward their PhD. We anticipate a steady-state level of about 15 PhD. students, and an equivalent number of Master's degree students. Also, a number of outstanding undergraduate Computer Engineers will do Honors Theses at LEMS.

Principal Investigators

Prof. David B. Cooper
(Computer Vision, Applied Stochastic Processes, Pattern Recognition)

Prof. Allan E. Pearson
(Nonlinear Modeling, Adaptive Systems, Visual Servoing)

Prof. Harvey F. Silverman
(Speech Processing, Signal Processing, Computer Architecture)

Prof. William A. Wolovich
(Large Dynamical System Analysis and Synthesis, Digital Control)

Industrial Liaison Program

Strong, two-way, ties with industry are an important part of the LEMS program. Thus, all such ties are being actively encouraged, and participation is most welcome. Cooperating industry will profit from the LEMS program through LEMS research results, as influenced by the needs of the participating organizations, faculty consulting, the duplication of LEMS hardware and software, LEMS patents, the visiting scientist program, and the LEMS seminar series. LEMS will benefit from the collaborative research activity, graduate student support through fellowships and cooperative programs, direct grants, and equipment support.

The LEMS Industrial Liaison Program for undergraduate Computer Engineering will put participating industry in contact with some outstanding, Brown Electrical and Computer Engineering majors. Participants will work with industrial sponsors for one or more summers and do associated Honors Theses at LEMS. The conjunction of the Computer Engineering coursework, LEMS project activity, and Industrial Liaison summer work should result in a uniquely trained engineer at the BSE level, both for industry and graduate school.

For Industrial Liaison or Student information, please write:

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