Faculty of

Engineering

RESEARCH PROJECTS

A Theoretical Study on Two New Types of Reliable Networks

- ✍ CAI Leizhen
- ❑ 1 September 1996
- ❖ Research Grants Council

In the era of information revolution, high speed communication networks have become a back-bone of the modern society, and the reliability of such networks is ultimately important to accomplish this role. With the possibility of hardware failure, it is inevitable that some sites and lines in a network may become unavailable from time to time, owing to hardware breakdown or routine maintenance. To avoid catastrophic effects on the rest of the network, one should pay a special attention to the topology of the network while improving the reliability of the supporting hardware.
In this project, the researchers will introduce two new types of network topologies to cope with site and line failures. The first one deals with isolated failures of sites and lines and guarantees effective communications amongst operative sites in the event of such failures. The second one deals with a small number of site and line failures and guarantees not only effective but also efficient communications amongst operative sites.
The researchers will investigate the underlying structures of these two types of networks, and design efficient algorithms to recognize and construct these networks. This research will certainly enhance our understanding of the relationship between the topology and reliability of a network, and hopefully will also provide us with useful guidelines in designing reliable networks in practice.
(CU96537)

Improving Generalization of Recurrent Networks in Time Series Prediction

- ✍ CHAN Lai Wan ● MOODY John*
- ❑ 15 September 1996
- ❖ Research Grants Council

Many real life data are evolving in time, for example, the spectrum of a speech signal, stock prices, national GNP, electricity usage and tourist arrival patterns etc. A good representation that accurately describes the behavior of a given system is needed in order to do forecasting. Often, real life data are too complex to be described by one single model or just a few deterministic equations. The researchers propose to use a number of recurrent networks to model temporally dynamic systems and integrate the results together to form mixture models.
The theoretical aspect of this project will be to improve the generalization ability of recurrent models and to investigate the mixture model of recurrent networks. The researchers will apply their new techniques to time series prediction problems, such as financial market data series and macroeconomic data.
Writing software from scratch repeatly to simulate recurrent networks is a somewhat tedious task, and programming errors are difficult to trace. Thus, the researchers plan to develop a versatile development toolkit for recurrent networks. This toolkit will serve two purposes. Firstly, it will enable the visualization of the internal states of recurrent networks and the design and study of properties of new recurrent models. Secondly, it will provide a programming environment to construct systems containing modules of recurrent networks.
(CU96529)

Abstraction, Association and Clustering in Data Mining

- ✍ FU Wai Chee, Ada ● WONG Man Hon
- ❑ 1 October 1996
- ❖ CUHK Research Committee Funding

Over the past ten to twenty years, huge amounts of data have been collected and managed in relational databases by industrial, commercial or public organizations in Hong Kong. The growth in size and number of existing databases has far exceeded the human abilities to analyze such data with available technologies. This has created a need and challenge for extracting knowledge from these databases.
The researchers will study the relationship among three methods: abstraction, association rule mining, and clustering. They propose to develop a knowledge discovery system that will help local industries to extract or "mine" useful information from their databases, which in the long run, shall lead to enhancements in the operations and productivities of the industries of Hong Kong.
(CS96004)

A Virtual Environment for Real-time Exploratory Scientific Visualization

- ✍ HENG Pheng Ann
- ❑ 1 October 1996
- ❖ CUHK Research Committee Funding

Scientific visualization is about using computer-generated graphics to help us understand and visually clarify the relationship inherent in scientific data. We can use visualization techniques to extract useful and important information from very large and complex data sets. Virtual reality techniques can be used to further enhance a researcher's ability to explore more rapidly and easily in many complex data

environments. However, it is important to maintain a very high frame rate of the graphics update (at least 15 frames per second) and provide feedback of real-time interaction in a virtual environment, regardless how complex the environment is.
In this research, the investigators will develop a virtual environment consists of original time-critical visualization techniques and novel 3D user interface techniques for real-time exploration of time-varying volumetric data generated from different scientific applications, such as medical imaging, molecular modeling, computational fluid dynamic, super-computer computations and simulations.
(CS96005)

Min/Max Entropy Principles for Unsupervised Visual Processing via Constrained Sigmoidal Neural Networks

- ✍ KING Kuo Chin Irwin
- ❑ 1 December 1996
- ❖ CUHK Research Committee Funding

This research project aims to use the Minimum/Maximum Entropy Principle (MMEP), an information theoretic based principle, to explain unsupervised color and motion processing of visual information.
This research involves (1) theoretical formulation of several adaptive rules specifically derived from the MMEP; and (2) experimental simulations to verify our theoretical formulation.
The researchers expect their research to form a consistent global framework to account for the self-organization involved in processing visual information based on the MMEP. The final result may find practical applications in adaptive histogram equalization for automatic contrast adjustment and as a pre-processing step for image understanding, pattern recognition, and motion analysis tasks.
(CS96007)

Multiparadigm Programming Language Implementation and Applications

- ✍ LEE Ho Man Jimmy ● LEUNG Ho Fung
- ❑ 1 November 1996
- ❖ CUHK Research Committee Funding

In this project, the researchers propose to investigate the implementation of a multiparadigm programming language that supports both the logic programming and the object-oriented paradigms and the language's applications.
(CS96008)

The Design and Analysis of Asynchronous Arithmetic Units

- ✍ LEE Tak Kwan
- ❑ 1 September 1996
- ❖ Research Grants Council

The aim of this project is the design and implementation of asynchronous arithmetic units that will, the researchers hope, achieve high performance while consuming very small amount of energy. They will also investigate ways to analyze these circuits so that we can produce efficient circuits in a systematic and cost-effective manner.
(CU96520)

Real-time Separation of Multineuron Recordings

- ✍ LEONG Heng Wai
- ❑ 6 January 1997
- ❖ CUHK Research Committee Funding

The majority of neurophysiological experiments measure spikes recorded from individual neurons in response to a stimulus. This project will develop digital signal processing techniques to archive automated spike sorting of extracellular recordings so that many neurons can be recorded from a single probe. Previous work in the field required special purpose hardware and did not adapt to changes in spike morphology over time. These problems will be addressed in the research.
(EE96014)

Object-oriented Real-time Rule-based Programming for Intelligent Control

- ✍ LEUNG Ho Fung ● LEE Ho Man Jimmy
- ❑ 1 November 1996
- ❖ CUHK Research Committee Funding

A real-time system usually consists of a collection of autonomous and communicating processes that collaborate to perform some high level behaviour, having to satisfy stringent timing constraints. Programming of real-time systems inherits all traditional software engineering issues and poses significant problems of its own. The desire to incorporate intelligence into real-time systems introduces further complication into the software design and development process. In this project, the researchers propose to design and implement an object-oriented real-time rule-based programming language. Objects are synonymous to processes. Object-orientation, in addition to facilitating the design and decomposition of large and complex software, couples well with Gentleman's anthropomorphic server viewpoint of process structuring for concurrent systems. The language should be rule-based for programming intelligent decision making systems. The researchers use Hoare's CSP, which has influenced the design and

evolution of concurrent logic programming languages, as a starting point for the language. Each object in the language thus encapsulates, among others, a set of rules written in the style of CSP. In the design of the language, the researchers plan to concentrate on devising appropriate abstractions to model essential features, such as event, synchronisation, and alarm, of a real-time programming language. Implementation issues include execution timeliness, task scheduling, and resource management. To demonstrate the feasibility of the proposal, the researchers plan to develop a real-time control program using the proposed language. The project helps to the design and programming of robust and reliable intelligent real-time control systems. The project also represents the first attempt to establish a link between object-orientation and process structuring.
(CS96006)

Optimal Mappings Between Problem Models and Parallel Genetic Algorithms

- ✍ LEUNG Kwong Sak ● WONG Chak Kuen ● LEUNG Yee (Geography)
- ❑ 1 September 1996
- ❖ Research Grants Council

Genetic algorithms (GAs) are stochastic global search and optimization techniques inspired by nature's evolution process and population genetics. They have been demonstrated to be effective and robust in solving many difficult and complex problems such as design and planning, network optimizations and knowledge acquisition. Due to its global search approach, it is not particularly efficient. However, the GAs have extremely strong implicit parallelism which can be exploited to substantially speed up the computation. A lot of work has been done in the field of parallel GAs (PGAs). In some cases, even superlinear speedups can be achieved. However, the importance of classifying a problem and finding an optimal PGA for it has not been addressed adequately and formally.
Therefore, the project is to formalize the mappings and relationships between the problems to be solved and the PGAs used, so that the researchers could find an optimal PGA for a problem easily. With the thorough understanding of the relationships, they should also be able to further improve and accelerate the PGAs. The researchers will develop a generic software tool for PGAs in appropriate environments; establish and formalize the relationships between the problems, their models, the potential accelerators and the PGAs; and evaluate and apply the system to large scale real-life problems related to Hong Kong industry. The contribution to the theory and applicability of PGAs will be significant.
(CU96535)

Parallel Numerical Solution Methods and Bounding Techniques in Solving Large Markovian Models: Applications to Computer & Communications

- ✍ LUI Chi Shing John
- ❑ 1 September 1996
- ❖ CUHK Research Committee Funding

With today complex computer system, it is important to evaluate different design options and their performance implications during the early design phase. Often times, mathematical model is used to represent the system under study. The most widely used mathematical model is the Markovian stochastic model. But to represent a realistic system, the Markovian model has a very large state space and we are confronted with the *state space explosion problem* in which the traditional numerical approach class of problem of interest and suggest ways to (1) understand the properties of a large class of system that permit computation of *light bounds* on solution of the models; and (2) parallel numerical solution methods of solving the large or infinite state space Markovian models under a high performance workstation cluster. The class of application we will focus in this research is from current issues in parallel/distributed computer systems and distributed multimedia communication networks. The result of this research will provide both specific methods on this set of important class of application and contribute to the general body of performance analysis techniques.
(CS96018)

Operating System and Network Support for Distributed Multimedia Services

- ✍ LUI Chi Shing John
- ❑ 1 January 1997
- ❖ CUHK Mainline Research Scheme

The goal of this research is to investigate the requirement and system supports for distributed multimedia data types on packet switching network and computer systems. The researchers plan to investigate the design and implementation of operating system techniques, transport protocols and network switches to enable various distributed multimedia services with different performance guarantee.
(CS96016)

3D Motion Specification in the Virtual Space

- ✍ SUN Hanqiu
- ❑ 1 December 1996
- ❖ CUHK Research Committee Funding

Computer technology has replaced traditional hand-drawn manual interface to various motion control techniques, which are mainly specified in two interfaces: keyframing and coding. Both interfaces are essentially based on predefined sequential paths, and have limited ability creating variable behaviors in interactive environments in real time.
This research aims at investigating the potential use of newly emerged 3D input/output devices for direct 3D motion specification in the real-time virtual spaces. Its primary objective focuses on two important aspects: the 3D specification of typical motion types and context-dependent parameters mapping. The basic specification functions, spatial references, multiple DOF interaction, and physical constraints using the spatial input devices will be theoretically and experimentally investigated. This research is one amongst the first in this direction. The outcomes of the research serve as the basic software layer for developing higher-level 3D user interfaces and interactive applications in virtual environments. Its efforts will reduce the cost developing the applications and in turn increase the productivity and creativity of the work, for a wide range of VR user community of Hong Kong.
(CS96021)

Optimal Arrangements of Flexible Objects

- ✍ WONG Chak Kuen
- ❑ 1 September 1996
- ❖ Research Grants Council

In this project we plan to investigate a brand new class of optimization problems involving the optimal arrangements of flexible (elastic or deformable) objects. The first task is to model the deformation of objects under external forces. Based on preliminary results for the case of a single flexible material, we plan to derive approximate formulas for the relationship between deformation and force for packing of objects which are made from different materials. These approximated deformation/force relationships will then be used for the design of new algorithms optimizing the packing of flexible objects with different coefficients of elasticity. The emphasis will be on the computation of equilibrium states, satisfying desired optimality criteria. To find optimal arrangements, we plan to utilize the special structure of the underlying configuration space to develop new stochastic algorithms, including theoretical studies about the convergence rate of our specific algorithmic solutions and the speed-up in run-time of various parallelization schemes. The optimal arrangement of flexible objects will be analyzed in close relationship to potential applications, including the design of new amorphous polymeric and related materials as well as that of package cushioning systems.
(CU96502)

Time-multiplexing FPGA Routing for Efficient Logic Block Sharing

- ✍ WU Yu Liang
- ❑ 1 October 1996
- ❖ CUHK Research Committee Funding

To alleviate the on-chip routing bottleneck and to increase the range of circuit sizes which can be accommodated on a single chip, we propose a time-mutiplexed routing architecture for SRAM based FPGAs. This can be implemented by having multiple programmable SRAMs for each routing switch so as to implement a multiple-phase clocking scheme on chip resources. For example, with two SRAMs per switch, we can route the interconnects in two different phases. As a result, a better circuit density is achieved by using more clock cycles, however with a smaller cycle time. The preliminary results considering only the sharing of routing resources between different clocking phases have shown that the routing channel density is averagely reduced by 30%. In this project, the researchers propose to also make use of the logic resources sharing and explore the various pin-permutation equivalent properties of Look-Up-Tables (P equivalent, NPN equivalent, etc.). This technique should be able to further increase the range of circuit sizes accommodable within a same chip.
(EE96003)

From Mixture Model to Ying-Yang Machine: New Methods for Nonlinear Time Series Modeling and Its Application to Financial and Trading Data Analyses

- ✍ XU Lei
- ❑ 1 December 1996
- ❖ Research Grants Council

We encounter time series almost everywhere. It modeling and analyses can help us to understand the physical events (e.g. weather, earthquake), control engineering systems, monitor industrial process, predict financial and trading markets, as well as guide management and planning in enterprises or governments. The existing classical methods for time series modeling belong to basically two classes. One is the linear ARMA or ARIMA models that targets generally at any time series, but is only applicable to time series which is stationary at least after some specific preprocessing. The other class consists of those problem-dependent approaches, based on trends fitting, seasonal factor removing, and segmentation. However, they work only for some specific non-stationary time series, for which we have enough a *priori* knowledge or heuristics. In recent years, promising improvements have been obtained on time

series modeling by neural networks, which provide general nonlinear and nonparametric tools suitable for various situations. However, currently a neural network is considered globally as a black-box, and is only appropriate to problems with a single underlying regime. However, many nonstationary real world time series switch between different regimes (e.g. the behavior of Hong Kong Heng-Seng Index depends on whether there is an influential political message from mainland or USA; the need of electricity depends on seasons, etc.). This project targets to develop tools for nonlinear modeling of nonstationary time series, based on the latest frontier study of neural networks, which has been moving towards to networks with modular, hierarchical or even graphical structure that can automatically divide time series into local regions with smooth transition and that can assign, via a probabilistic engine, each region to each component that forms the structure. More specifically, this project will systematically investigate the theoretical and practical problems on extending two latest such models-*Mixture of Experts* and *Ying-Yang Machine* from modeling a set of independently and identically distributed samples to a nonstationary time series. Based on the results, the researchers plan to develop a new practically applicable software with several new tools for financial and trading data analyses.
(CU96515)

Please refer to previous issues of *Research Projects Summary* for more details of the following ongoing research at the department:

Edition — Title/Investigators

1994-95 Efficient Algorithms for Fixed-Parameter Problems Concerning Cycles (CS94008)
✍ CAI Leizhen

1995-96 Uniformly Polynomial-time Algorithms for Parameterized Families of Graphs (CU95510)
✍ CAI Leizhen

1995-96 Sequential Signal Processing Using Mixture Recurrent Networks (CS95018)
✍ CHAN Lai Wan

1995-96 Performance Analysis and Theoretical Studies for Replicated Databases (CU95531)
✍ FU Wai Chee, Ada ● WONG Man Hon ● CHEUNG David W. L.*

1995-96 Interactive Volume Visualization in a Virtual Environment (CS95024)
✍ HENG Pheng Ann

1994-95 Facial Expression Animation and Lip-Synchronization Using Anatomical Models in Reading Text in Cantonese and Mandarin (CS94011)
✍ KING Kuo Chin Irwin

1995-96 Development of An Image Database for Hong Kong's Fashion Industry Supporting Content-Based Retrieval (CS95009)
✍ KING Kuo Chin Irwin ● CHAN Lai Wan ● FU Wai Chee, Ada ● XU Lei

1995-96 FACE: A Face Analysis and Computing Environment (CU95513)
✍ KING Kuo Chin Irwin ● XU Lei ● CHAN Lai Wan

1995-96 Towards an AI Architecture for Very Large-Scale Constraint Satisfaction (CS95019)
✍ LEE Ho Man Jimmy ● LEUNG Ho Fung ● CHAN Lai Wan

1994-95 A Chinese Multimedia Presentation Authoring System (CS94012)
✍ LEE Moon Chuen

1995-96 The Design of a High-Performance, Low-Energy Asynchronous ALU (EE95014)
✍ LEE Tak Kwan

1995-96 Real-time Logic Programming for Intelligent Control (CS95020)
✍ LEUNG Ho Fung ● LEE Ho Man Jimmy

1995-96 Binary Fuzzy Constraint Satisfaction Problems: Properties and Solutions (CS95025)
✍ LEUNG Ho Fung ● LEE Ho Man Jimmy

1995-96 Automatic Knowledge Acquisition in an Inexact Environment Based on Genetic Techniques (CU95514)
✍ LEUNG Kwong Sak ● WONG Man Leung (Systems Engineering & Engineering Management)

1995-96 An Intelligent Database for Standard Chinese Computer Terminology (CS95026)
✍ LEUNG Kwong Sak ● YUNG K. T.*

1992-93 HANZIX (CS91012)
✍ LU Qin ● LEE Kin Hong ● HSU Siu Chi

1995-96 A Comprehensive Chinese Thesaurus and Its Application Programme Interface (CU94528)
✍ LU Qin ● LEE Kin Hong

1995-96 A Chinese Internet Information Server and the Server Access Software (CS95013)
✍ LU Qin ● LEE Kin Hong ● WONG Chak Kuen

1994-95 Methodologies in Minimizing I/O Bandwidth Demands of Multimedia Servers (CS94010)
✍ LUI Chi Shing John

1995-96 Parallel Simulation Methods for Continuous Time Markov Chain on Maspar with Applications in Computer/Communication Systems (CS94021)
✍ LUI Chi Shing John

1995-96 Resource Management and Performance Analysis for Cost-effective Multi-media Storage Server (CU95509)
✍ LUI Chi Shing John

1994-95 Research on a New Class of Optimization Problems Related to the Handling of Elastic 3-D Objects by Robots and Its Application in Industry (CS95008)
✍ WONG Chak Kuen ● LEUNG Kwong Sak ● HUI Kin Chuen (Mechanical & Automation Engineering) ● LEUNG Yee (Geography) ● ALBRECHT Andreas*

1995-96 On a New Class of Stochastic Processes (CS95021)
✍ WONG Chak Kuen

1995-96 Performance Analysis of Semantics Based Concurrency Control Protocols for Databases (CU94525)
✍ WONG Man Hon

1995-96 An Unsupervised Pattern Recognition Approach Based on Multi-Models Least Squares Learning Aided by Iterative Relabelling: Theories, Algorithms, and Engineering Applications (CU94503)
✍ XU Lei

1995-96 Theoretical and Experimental Studies on the EM and EM Algorithms for Mixture Architectures with Supervised and Unsupervised Learning (CS95010)
✍ XU Lei

1995-96 Distributed and Hierarchically Structured Nonlinear Hebbian Learnings and Their Applications to Image Compression, Pattern Discrimination, Signal Blind Separation and Visual Processing (CU95512)
✍ XU Lei

1994-95 Complexity of Deterministic Scheduling Problems (CS95003)
✍ YOUNG Ho Fai Gilbert

1995-96 Applications of Scheduling Problems (CS95015)
✍ YOUNG Ho Fai Gilbert

RESEARCH OUTPUTS AND PUBLICATIONS

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RESEARCH PROJECTS

A DC Coefficient Restoration Scheme for Image Coding

- ✍ CHAM Wai Kuen
- ❑ 1 November 1996
- ❖ CUHK Research Committee Funding

DC coefficient restoration scheme is a technique which can be used to increase the compression ability of block-based transform image coding techniques by not transmitting the DC coefficients but instead estimating them form the transmitted AC component. In this project, the researchers propose to investigate a global minimum approach which estimates all the DC coefficients by minimizing the mean-square magnitudes of all the edge difference vectors.
(EE96005)

Numerical Modelling and Experimental Studies of the Fiber Ring Laser for the Generation of Ultrashort Optical Pulses for Soliton Communication

- ✍ CHAN Kam Tai
- ❑ 1 November 1996
- ❖ CUHK Research Committee Funding

An optical soliton is a special class of optical pulses that will not change its pulse shape after travelling long distances despite the presence of relatively large dispersion in the optical fiber. An attractive method of generating solitons makes use of a fiber ring laser in which the gain is provided by a laser diode pumped erbium-doped silica fiber. This proposal will attempt to build for the first time a numerical model to analyze the mechanism of pulse generation in a fiber ring laser. In particular, the researchers will investigate the effects of different laser parameters on the pulse width of the soliton pulses, which is one of the most important design variables for real applications. In addition, the researchers also aim at building an experimental fiber ring laser not only for the purpose of testing their numerical model, but also for searching for new phenomena not predicted by the model.
(EE96006)

Study of Intermodulation Distortion in MMIC Active Filters

- ✍ CHENG Kwok Keung
- ❑ 1 December 1996
- ❖ CUHK Research Committee Funding

Conventional passive filters based upon distributed elements normally require large substrate area which is undesirable, as high integration is necessary for a cost-effective communication system. A number of high performance and compact active filters implemented by both hybrid and MMIC technology has been demonstrated recently. The objective of this study is to examine the limitations of different configurations of active filters, and if possible, to derive methods to improve them. These limitations include linearity, intermodulation distortion, noise figure and stability.
(EE96004)

Blind Signal Estimation Using High Order Cumulants

- ✍ CHING Pak Chung
- ❑ 1 April 1996
- ❖ CUHK Departmental Funding

In many practical applications, we need to extract information, either the transmission gain or a particular source, from a mixture of signals received by a sensor array. Very often, both the source signals and the channel characteristic have to be estimated in the absence of a priori knowledge of their properties. Two major classes of algorithms had been developed to tackle this type of blind estimation problem, viz. the nonlinear optimization method and the eigendecomposition method. The optimization method achieves statically optimal estimates by minimizing some prescribed cost functions iteratively. This method is computation intensive but can be used under adverse situation such as coherent signals in colored noise. On the contrary, the eigen method although computationally efficient only provides suboptimal estimates sometimes. This is achieved by imposing a number of assumptions which might not be practical or realistic.
Motivated by the linearity of cumulant and its Gaussian rejection, we attempt to design a blind channel estimator that requires the least squares solution of a linear system only. Three mild assumptions are needed, namely, the non-Gaussianity of the source signals, the Gaussianity of the noise, and the statistical independence of the signals and noise. Apart from these assumptions, the channel matrix has to satisfy an identifiable condition that is different from the full column rank condition. This makes the proposed estimator particularly useful when the number of sources is greater than the number of sensors, and source extraction can be performed, if required.
(EE96016)

Development of an Automatic Recognition System for Continuous Cantonese Speech

- ✍ CHING Pak Chung
- ❑ 1 August 1996

❖ Research Grants Council

Recently, the researchers have pioneered frontier research on speech recognition of isolated Cantonese syllables. Cantonese is the most commonly used Chinese dialect in Southern China, specifically in Hong Kong. It has a number of distinct linguistic/acoustic features which are very different from other languages, and there is very little published work on this dialect. Although a greater degree of success has been achieved in recognition of isolated words from a fixed vocabulary, the goal of machine recognition for real continuous speech remains elusive. The difficulties mainly come from the presence of variant co-articulation phenomena and the consequent contextual effects on the acoustic properties of a continuous speech signal. In this project, the researchers will extend their knowledge to develop an automatic recognition system for continuous speech of Cantonese. The proposed recognition system will be based on the recurrent neural networks (RNN) approach. The system design methodology will also incorporate multi-level linguistic properties of Cantonese, such as tone variations, constrained syllabic structures, segmental duration, prosodic rules, special oral grammar, etc. In addition, a large scale speech database of Cantonese will be constructed to provide appropriate acoustic data for the training and testing of recognition algorithms.
(CU96509)

Articulatory Controlled Speech Synthesis using Neural Networks

✍ CHING Pak Chung ● GOODYEAR C. C.*

❑ 1 January 1997

❖ UK/Hong Kong Joint Research Scheme, the British Council

Recently, in work at The Chinese University of Hong Kong, neural nets have been successfully trained to classify the nine different lexical tones of Cantonese and a fully recurrent neural network has also been designed to model both static and dynamic features of the various phonetic constituents in the Cantonese syllabary. On the other hand, a model of the vocal tract has been developed at Liverpool that allows the complete area function to be expressed efficiently in terms of the quasi-articulatory parameters. Segments of speech consisting of vowel-vowel diphones are then synthesized using format tracks to determine the best selection of vocal tract parameters. It is envisaged that articulatory control parameters need to drive a neural network based synthesis for Cantonese can be obtained more accurately if phonetic features of the utterances are known. This idea is to be explored using the above techniques with an ultimate goal to produce high quality and natural synthesized Cantonese speech.
(EE96002)

Strained-layers Growth for Semiconductor Laser Applications

✍ HSU Chung Chi ● XU Jianbin ● HARK Sui Kong (Physics)

❑ 1 August 1996

❖ Research Grants Council

The researchers plan to fabricate the following semiconductor lasers incorporating the strain effect:
(1) 0.98 micron GaInAsN/GaAs lasers for fiber amplifiers,
(2) 1.3 micron GaInAsN/GaAs lasers for optical communications,
(3) 1.55 micron InAsPN/InP lasers for optical communications, and
(4) 2.0 micron GaInAsN/InP lasers for medical applications.
(CU96551)

Mobile Radio Propagation Characterization and Prediction: A Neural Network Approach

✍ LAI Kin Yue Albert

❑ 1 October 1996

❖ CUHK Research Committee Funding

The application of a neural network to characterize mobile radio propagation and predict performance is a new topic of great interest to mobile radio service providers for practical reasons. Initial data shows that neural network techniques is quite capable of learning and predicting various propagation characteristics. Such neural network experiments by Stocker, et. al. [1] and the authors [2] were taken using measured data in real environment, namely the German cities of Mannheim and Darmstadt, and also the California cities of San Francisco, Oakland and Berkeley. Building on that foundation, this project will develop a Learning, Predicting and Real-time Adaptive (LEPRA) system in an urban area for automatic Personal Communication System (PCS) cell planning and site placement, real-time transmit power adjustment, real-time antenna beam re-direction and pattern selection with smart antennas, etc. The only thing the mobile radio service provider has to do is to install a certain number of signal generation and monitoring devices at various points in the service providing area. Using that data, the LEPRA system will automatically "learn" the environment, predict coverage patterns, assign cell sites, and issue commands to the cell sites to generate an optimal coverage pattern. Furthermore, this signal generation/monitoring system may, if the service provider elects to, stay in that area and provide on-going service quality monitoring, optimization and real-time adaptive adjustment. Both software

simulation and hardware implementation on off-the-shelf components will be attempted, using the complicated urban environment of Hong Kong as our test sites.

[1] K.E. Stocker, B.E. Gschwendtner, F.M. Landstorfer, "Neural Network Approach to Prediction of Terrestrial Wave Propagation for Mobile Radio", IEE Proceedings-H, Vol.140, No.4 August 1993.

[2] Qin Zhou and A.K.Y. Lai, "Empirical Prediction of Mutipath Propagation by Neural Network", Proceedings of the World Congress on Neural Networks, pp.II-84 to II-87, Vol.2, July, 1995, Washington, D.C., USA.

(EE96008)

Analysis and Transcription Tool for Speech Research

- ✍ LEUNG Hong Chung
- ❑ 1 October 1996
- ❖ CUHK Research Committee Funding

The successful development of speech recognition and synthesis systems relies on the availability of a strong research infrastructure. In particular, there is an urgent need for tools that will enable researchers to conveniently collect and analyze large amounts of speech data. In this research project, the investigator proposes to develop a set of software tool to enable the speech researcher to interactively record, transcribe, analyze, store, and retrieve speech utterances at ease. Once such a set of tools is developed, the speech researcher will be able to examine the acoustic properties of speech sounds, develop speech recognition and synthesis algorithms, compute vital statistics about the structural constraints of a language, among other benefits.

The development of such interactive tools from scratch is a project of great magnitude, and will require a long period of time to perfect every aspect of the tools. The investigator plan to bootstrap their effort by making use of tools that have been developed overseas. The investigators will extend such existing tools, developed primarily for English and other Roman languages, to facilitate our speech research program in Chinese. The speech researcher will be able to interactively record speech utterances in Chinese. Multi-level transcription procedure will also be developed so that utterances can be annotated in several levels of symbolic descriptions, including orthographic transcription in Chinese characters and phonetic transcription using a set of phonetic symbols for Chinese.

(EE96007)

Compact Ultrafast Semiconductor All-optical Switches and the Diode Laser and Erbium Doped Fiber Sources for Pumping Them

- ✍ TSANG Hon Ki
- ❑ 1 November 1996
- ❖ CUHK Research Committee Funding

The switching of optical signals at sub-picosecond timescales have potentially very important applications in high-bitrate time-division-multiplexed optical communications. Conventional electronic technology is incapable of attaining the high switching speeds needed because of fundamental RC limitations. Ultrafast femtosecond optical switching has already been demonstrated in III-V integrated optical devices using large laboratory-based laser sources. The proposed research seeks to transfer ultrafast switching technology to more practical configurations using compact light sources. The project will involve research on the generation of high-power high bit-rate ultrashort pulses from systems using only diode-lasers and optical fibers. The project will research novel configurations of nonlinear III-V semiconductor waveguides and attempt to demonstrate ultrafast all-optical switching which can be used in practical systems.

(EE96009)

Formation and Properties of Granular Structures by MEVVA Implantation

- ✍ WONG Sai Peng Joseph ● WILSON Ian Howard ● WONG Hong Kuen (Physics)
- ❑ 1 December 1996
- ❖ Research Grants Council

In this project, the researchers propose a new approach to form granular structures of nanometer-sized metal and compound crystallites by ion beam synthesis (IBS) with a metal vapor vacuum arc (MEVVA) ion source. The resulting structures and their properties will be studied using Rutherford backscattering spectrometry (RBS) and channelling RBS, secondary ion mass spectrometry (SIMS), x-ray diffraction (XRD), cross-sectional transmission electron microscopy (XTEM), scanning tunnelling microscopy (STM) and atomic force microscopy (AFM), optical absorption, spectroscopic ellipsometry, electrical and magnetic characterization techniques.

(CU96534)

Development of Scanning Near Field Optical Microscopy and its Applications in Electronic Engineering

- ✍ XU Jianbin ● WONG Sai Peng Joseph ● WILSON Ian Howard
- ❑ 1 November 1996
- ❖ Research Grants Council

In this project, the researchers propose to develop a scanning near field optical microscope and to study electronic and optoelectronic devices with the microscope.
The specific aims of the project include:
(1) The development of a scanning near field optical microscope in combination with a shear force microscope.
(2) The application of the microscope to characterization of (a) electronic materials and devices; and (b) opto-electronic materials and devices. (CU96512)

Please refer to previous issues of *Research Projects Summary* for more details of the following ongoing research at the department:

Edition — Title/Investigators

1994-95 Estimation of DC Coefficients from AC Coefficients of Its Application in Image Coding (EE94008)
✍ CHAM Wai Kuen

1995-96 On-line Handwritten Chinese Character Recognition (OHCCR) Systems (CU92506)
✍ CHAM Wai Kuen ● CHANG Michael (Information Engineering)

1995-96 Fractal Image Coding with Adjacent Block Parameter Estimation (EE95019)
✍ CHAM Wai Kuen

1995-96 Injection Oscillator Phase-locked Loop (CU94510)
✍ CHAN Cheong Fat ● CHOY Chiu Sing Oliver

1995-96 A High Performance Microwave-to-Lightwave Modulator for Microwave Subcarrier Multiplexed Broadband Integrated Services Digital Networks (CU93506)
✍ CHAN Kam Tai ● LAI Kin Yue Albert ● HSU Chung Chi ● YANG Shuwen*

1995-96 Theoretical Modelling and Experimental Study of Multisection Distributed Feedback Lasers for Advanced Lightwave Communications (EE94007)
✍ CHAN Kam Tai ● LIEW So Kuen ● WANG Wei* ● WANG Qi Ming* ● EVANS Gary A.* ● BUTLER Jerome*

1995-96 A Preamplified Acousto-Optic Tunable Filter for Dense Wavelength Division Multiplexed Networks (EE95015)
✍ CHAN Kam Tai

1995-96 Time-Domain Characterization, Modelling and Simulation of Nonuniform VLSI Interconnects (CU94539)
✍ CHANG Fung Yuel ● WING Omar (Information Engineering)

1995-96 Geolocation by Satellites (CU93508)
✍ CHING Pak Chung ● CHAN Yiu Tong*

1995-96 Speech Analysis by Visualized Representations Using Time-frequency Distributions (CU95505)
✍ CHING Pak Chung ● ZHANG Bilin

1993-94 Finding the Optimum Probe Points to Generate a Minimum Test Set (EE94013)
✍ CHOY Chiu Sing Oliver ● CHAN Cheong Fat

1994-95 Architecture Synthesis (EE95004)
✍ CHOY Chiu Sing Oliver ● CHAN Cheong Fat

1995-96 A Study on Contactless Integrated Circuit (IC) Testing (EE92031)
✍ CHOY Chiu Sing Oliver

1995-96 An ICT Image Processing Chip based on Fast Computation Algorithm and Self-timed Circuit Technique (CU94507)
✍ CHOY Chiu Sing Oliver ● CHAM Wai Kuen ● CHAN Cheong Fat

1995-96 An Adaptive Circuit Design Technique to Suppress Power Noise in a High Speed Output Driver (CU95526)
✍ CHOY Chiu Sing Oliver ● CHAN Cheong Fat

1992-93 A Fundamental Study of Crystal and Epitaxial Growth Processes and Their Application to Optoelectronic Devices (EE93019)
✍ HSU Chung Chi ● WILSON Ian Howard ● MING N. B.*

1995-96 Metalorganic Vapor Phase Epitaxy (MOVPE) for High Speed Optoelectronics (CU93509)
✍ HSU Chung Chi

1995-96 Metalorganic Vapor Phase Epitaxy Growth Mechanism (CU94501)
✍ HSU Chung Chi ● WILSON Ian Howard

1995-96 A Millimeter Wave Wireless Network (WAN) for Medical Imaging Services in Hong Kong and Guangdong (CU92502)
✍ LAI Kin Yue Albert ● WONG Po Choi (Information Engineering) ● LUK Kwai Man*

1995-96 A Novel Meandering Inverted F Antenna (MIFA) for Mobile Communications (CU95506)
✍ LAI Kin Yue Albert

1994-95 An Optimized Configuration to Generate Wavelength-Tunable Optical Pulses (EE94009)
✍ SHU Ching Tat C.

1995-96 III-V Based Ultrafast Meta-semiconductor-metal Photodetectors (CU95528)
✍ SHU Ching Tat C. ● HSU Chung Chi ● CHAN Kam Tai

1995-96 A Novel Scheme of Wavelength-Multiplexing Using Self-Injection Locked Lasers (EE95005)
✍ SHU Ching Tat C. ● TSANG Hon Ki ● ZHAO Yang*

1995-96 Optoelectronic Waveguide Components for the Next Generation of Communication Systems (CU94511)
✍ TSANG Hon Ki ● CHAN Kam Tai

1995-96 Tapered Diode Lasers for the Generation of Long-Wavelength High-Power Optical Pulses (EE95016)
✍ TSANG Hon Ki

1995-96 Fabrication and Characterisation of Magnetic Thin Films on III-V Semiconductors (EE95006)
✍ TSANG Hon Ki ● SCHWARZACHER Walther*

1995-96 A Vision System for Autonomous Guidance of Indoor Mobile Robots (CU94523)
✍ TSUI Hung Tat ● CHAN Chack Kuen

1995-96 3-D Object Recognition by Active Vision Systems Using Belief Networks for Information Fusion (CU95518)
✍ TSUI Hung Tat

1993-94 Photoelectronic Materials and Structures - Fundamental Properties and Device Applications of Porous Silicon and Similar Materials (EE93018)
✍ WILSON Ian Howard ● WONG Sai Peng Joseph ● HARK Sui Kong (Physics) ● CAI S.* ● LIU Z.* ● LI J.* ● ZHANG S.*

1995-96 Scanning Probe Microscopy Applied to High Speed Electronic Devices (CU92501)
✍ WILSON Ian Howard

1995-96 Photoelectronic Materials and Structures - Fundamental Properties and Device Applications of Porous Silicon and Similar Materials (CU94504)
✍ WILSON Ian Howard ● WONG Sai Peng Joseph ● HARK Sui Kong (Physics) ● CAI S.* ● LIU Zhong Fan* ● LI J.* ● ZHANG S.*

1995-96 Epitaxial Growth of Compound Semiconductor Layers (EE95007)
✍ WILSON Ian Howard ● BANGERT U.*

1995-96 Ion Implantation of Advanced Thin Film Materials (EE90003)
✍ WONG Sai Peng Joseph ● LIANG W. W. P.* ● PENG S. Q.*

1995-96 Metal Silicides by Ion Implantation with a MEVVA Ion Source (CU94520)
✍ WONG Sai Peng Joseph ● WILSON Ian Howard

1995-96 Ion Beam Synthesis and Modification of SiC/Si Heterostructures for Electronic Device Applications (CU95535)
✍ WONG Sai Peng Joseph ● WILSON Ian Howard

1994-95 Two Dimensional Dopant Profile Studied by Scanning Probe Microscopy (EE94010)
✍ XU Jianbin ● WONG Sai Peng Joseph ● WILSON Ian Howard

1995-96 Investigation of Metal-oxide-semiconductor by Modified Scanning Probe Microscopy (EE95009)
✍ XU Jianbin

1995-96 Investigations of Inorganic Ferroelectric Films by Scanning Probe Microscopy (CU95504)
✍ XU Jianbin ● WONG Hong Kuen (Physics) ● WILSON Ian Howard

1994-95 Adaptive Modelling and High-Order Spectrum Analysis of Nonstationary and Non-Gaussian Vibroarthrographic

Signals for Noninvasive Diagnosis of Knee Joint Disorders (EE95003)
✍ ZHANG Yuanting ● CHOY Thomas T. C.

1995-96 Electrical Bio-impedance Technique and Rheopneumography - Validation of the Modelling Method and Clinical Application (CU94545)
✍ ZHANG Yuanting ● CHOY Thomas T. C. ● CHAN Hok Sum (Medicine) ● XIONG J. F.*

1995-96 Processing of Otoacoustic Emission Signals and Establishment of Its Homomorphic Simulation Model (EE95017)
✍ ZHANG Yuanting ● YANG Fu Sheng* ● YE Datien*

RESEARCH OUTPUTS AND PUBLICATIONS

<P953485> **Yang, Y.F.; C.C. Hsu and E.S. Yang.** "Carbon-Doped GaInP/GaAs Double Heterostructure-Emitter Bipolar Transistors with High Current Gain". *IEEE Transactions on Electron Devices* vol.42 no.7, pp.1383-1386. USA, 1995.07.

<P953486> **Yang, Yue-Fei; Chung-Chi Hsu; Edward S. Yang and Y.K. Chen.** "Comparison of GaInP/GaAs Heterostructure-Emitter Bipolar Transistors and Heterojunction Bipolar Transistors". *IEEE Transactions on Electron Devices* vol.42 no.7, pp.1210-1214. 1995.07.

<P953487> **Chan, P.T.; H.S. Choy; C. Shu and C.C. Hsu.** "High-Performance InP/$Ga_{0.47}$ $In_{0.53}$ As/InP Metal-Semiconductor-Metal Photodetectors with a Strained $Al_{0.1}In_{0.9}P$ Barrier Enhancement Layer". *Applied Physics Letters* vol.67 no.12, pp.1715-1717. USA, 1995.09.18.

<P953511> **Ma, Ning; Didier Vray; Philippe Delachartre and Gerard Gimenez.** "Sea-Bottom Backscattering Modeling with a Wideband Constant Beamwidth Sonar at Normal Incidence". *IEEE International Ultrasonics Symposium* vol.2, pp.1077-1080. Seattle, USA, 1995.11.07.

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<P961688> **Hsu, C.C.; Y.F. Yang; H.J. Ou and E.S. Yang.** "CCI_4-Doped Semi-Insulating InP as a Buffer Layer in GaInAs/InP High Electron Mobility Transistors". *Applied Physics Letters* vol.69 no.8, pp.1143-1144. USA, 1996.08.19.

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<P962235> **Chu, Qing-Xin and Fung-Yuel Chang.** "Time-Domain Model Synthesis of Microstrip Discontinuity by FDTD and Digital Signal Processing Methods". *Proceedings of Asian-Pacific Conference on Environmental Electromagnetics CEEM* pp.91-94. Xi'an, China, 1996.11.05.

<P962236> **Chang, Fung-Yuel.** "The Unified Nodal Analysis of Electronic Circuits". *Proceedings of the IEEE Midwest Symposium on Circuits and Systems* Iowa, USA: IEEE, 1996.08.

<P962379> **Jia, L.; S.L. Zang; S.P. Wong; I. H. Wilson; S.K. Hark; Z.F. Liu and S.M. Cai.** "Further Evidence for the Quantum Confined Electrochemistry Model of the Formation Mechanism of *p*-Type Porous Silicon". *Applied Physics Letters* vol.69 no.22, pp.3399-3401. USA, 1996.11.25.

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<P962438> **Ding, A.L.; J.B. Xu; W.G. Luo; X.P. Qu; P.S. Qiu; H.K. Wong and I.H. Wilson.** "Highly-oriented PNZT Ferroelectric Thin Films on Pt/Ti/SiO2/Si Substrate". *Proceedings of the 10th IEEE International Symposium on Applications of Ferroelectrics* vol.2, pp.833-836. USA: IEEE, UFFC, 1996.08.18.

<P962439> **Wilson, I.H.; J.B. Xu; R.A.B. Devine and R.P. Webb.** "Energetic Ion Impacts on Quartz Surfaces: A Study by Atomic Force Microscopy". *Nuclear Instruments and Methods in Physics Research B* vol.118, pp.473-477. Holland, 1996.

<P962516> **Ng, H.H. and Albert K.Y. Lai.** "An Ultra High Conversion Gain Regenerative Mixer Utilizing Injection-Locking Technique". *Proceedings of Asia Pacific Microwave Conference* vol.4, pp.1519-1522. New Delhi, India, 1996.12.17.

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<P962574> **Zhou, Qin and A.K.Y. Lai.** "The Dependence of Single Room Indoor Radio Propagation on Frequency". *Proceedings of IEEE Antenna & Propagation Symposium* vol.2, pp.1502-1503. Baltimore, USA: IEEE, 1996.07.21.

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<P962730> **Wilson, I.H.; Y.J. Chen; J.B. Xu; R.A.B. Devine and C. Jeynes.** "Ion Impacts and Nanostructures on Ge(111), $In_{0.22}Ga_{0.78}As$/GaAs(100) and Alpha Quartz Surfaces Observed by Atomic Force Microscopy". *Surface and Interface Analysis* vol.24, pp.881-886. USA, 1996.12.

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<P962765> **Ho, H.L. and W.K. Cham.** "Fractal Image Compression with Adjacent Block Parameter Estimation". *Proceedings of 1996 IEEE TENCON - Digital Signal Processing Applications* Perth, West Australia, 1996.11.

<P962789> **Chan, W.K. and F.W. Tse.** "Restoration of Low Frequency Coefficients". *Proceedings of ICSP'96* pp.1082-1085. Beijing: IEEE, 1996.10.14.

<P962795> **Pang, Tin-Chak Johnson; Chiu-Sing Choy; Cheong-Fat Chan and Wai-Kuen Cham.** "Self-Timed Booth's Multiplier". *Proceedings of the 1996 2nd International Conference on ASIC* pp.280-283. Shanghai: Shanghai Scientific & Technological Literature Publishing House, 1996.10.

<P962831> **Zhang, Haiyan; Dengyu Wong; Baoqiong Chen; Shaoqi Peng; S.P. Wong and Ning Ke.** "Thermal Analysis of Helium Pressure Effect on the Formation of Nanotubes". *Abstracts of the Materials Research Society 1996 Fall Meeting.* Paper no.D15.5, p.162. Boston, USA, 1996.12.

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<P962835> **Ke, N.; W.Y. Cheung; S.P. Wong and S.Q. Peng.** "Electrical and Defect Properties of Sn-Doped C_{60} Thin Films". *Abstracts of the 2nd International Interdisciplinary Colloquium on the Science and Technology of the Fullerenes* p.146. Oxford, UK: Elsevier Science, 1996.07.

<P962836> **Ke, N.; S.P. Wong; Shaoqi Peng and Shunhui Lin.** "Electrical Characteristics of Fluorine Implanted a-Si:H Thin Films at High Fields". *Materials Chemistry and Physics* vol.46, pp.93-95. Switzerland, 1996.10.

<P962845> **Wong, S.P.; Qicai Peng; W.Y. Cheung; W.S. Guo; J.B. Xu; I.H. Wilson; Sui-Kong Hark; R. Morton and S.S. Lau.** "Formation and Characteristics of $CoSi_2$ Layers Synthesized by MEVVA Implantation". *Abstracts of the Materials Research Society 1996 Fall Meeting* Paper no. A3.24/B3.24, p.17. Boston, USA, 1996.12.

<P962846> **Wong, S.P.; L.C. Ho; W.S. Guo; H. Yan and W.M. Kwok.** "Ion Beam Synthesis of SiC/Si Heterostructures by MEVVA Implantation". *Abstracts of the Materials Research Society 1996 Full Meeting.* Paper A3.25/B3.25, pp.17-18. Boston, USA, 1996.12.

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<P962854> **Ng, Y.P.; Tan Lee; P.C. Ching and L.W. Chan.** "Recent Advances in Cantonese Speech Recognition". *Proceedings of International Symposium on Multi-Technology Information Processing* pp.139-144. Hsinchu, Taiwan: National Tsing Hua University, 1996.12.16.

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<P962857> **Lee, Tan and P.C. Ching.** "On Improving Discrimination Capability of an RNN Based Recognizer". *Proceedings of the International Conference on Spoken Language Processing* vol.1, pp.526-529. USA: University of Delaware and Alfred I du Pont Institute, 1996.10.03.

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see also <P962190>, <P962213>, <P962889>, <P962966>, <P970588>, <P970600>, <P970964>, <P971047>, <P972050>

RESEARCH PROJECTS

Fiber-based Components for Ultra-high Speed Optical Networks

- ✍ CHEN Lian Kuan ● CHEUNG Kwok Wai ● JIAN Shuisheng*
- ❑ 15 September 1996
- ❖ Research Grants Council

The project is to investigate and implement two new fiber-based components that are suitable for high speed optical time-division multiplexing (TDM) networks. The first is an optical gating device that will feature polarization-insensitive and sub-picosecond response time. This device is very suitable as an ultra-high speed modulator. The polarization-insensitive feature makes it a viable component for future field deployment. The second is a low cost pulse multiplier in which the pulse separation time can be adjusted with an accuracy of a few picoseconds. This device can be used to produce high repetition rate pulses from a lower repetition rate source that has higher power and lower jitters. The proposed devices will be employed in the ELITE (the Experimental Lightwave Testbed) where high speed lightwave TDM and WDM experiments will be performed.
(CU96525)

Path Switching - A Quasi-Static Routing Scheme for Large-Scale ATM Packet Switches

- ✍ LEE Tony Tong
- ❑ 1 September 1996
- ❖ Research Grants Council

The challenge of modern broadband digital networks is to provide multirate and multicast virtual-circuit connections for supporting high-speed multimedia services, which generate much less predictable traffic statistics than the traditional telephone network or low-speed data networks. To achieve this goal, the researchers propose a quasi-static routing scheme called path switching in the three-stage Clos network. It uses a predetermined periodical connection pattern in the central stage, look-ahead selection in the input stage, and output concentration in the last stage. The scheduling of path switching consists of capacity assignment and route assignment. The capacity assignment is constrained by the quality of services of connection requests. The route assignment is based on the time-space interleaving of the coloring of bipartite graphs. The routing in the switch fabric is totally distributed and can be performed individually in each switch module according to local information only. In future research, the researchers intend to develop more efficient algorithms for capacity assignments and route scheduling, determine the appropriate fabrics used in each component, and enhance the architecture to be capable of performing multicast switching and accommodating the traffic with different priorities. The research will show that the path switching in Clos networks is the most cost-effective method to handle multirate, multicast and multimedia traffic in the broadband network.
(CU96523)

Control-Theoretic Approach to Adaptation of VBR Compressed Video for Transport over a CBR Communications Channel

- ✍ LIEW Soung Chang
- ❑ 1 January 1997
- ❖ Research Grants Council

This project concerns the adaptation (rate-control) of VBR-compressed video to CBR traffic for network transport. Adaptation schemes previously proposed were *ad hoc* and not readily analyzable. This makes systematic design of the adaptation controller difficult: a large set of video programs may need to be fed to a simulated controller to test and set control parameters, and even then the robustness of the system against instability is by no means guaranteed. To allow systematic design and to limit the amount of simulation needed, the researchers propose an analyzable control-theoretic adaptation framework. Preliminary study indicates that the systematic investigation of many important issues (such as controller's stability, robustness aganist scene changes in video, robustness against image-quality oscillations, etc.) can be investigated in a quantifiable manner.
(CU96506)

Design and Analysis of Multicarrier CDMA Systems for Wireless Communications

- ✍ LOK Tat Ming
- ❑ 1 October 1996
- ❖ CUHK Research Committee Funding

Recently, there have been interests in designing multicarrier code division multiple access (CDMA) systems for wireless communications. In this project, issues on designing and analyzing multicarrier CDMA systems for wireless communications will be investigated. In particular, similarities and differences between multicarrier CDMA systems and others CDMA systems, such as direct sequence CDMA (DS-CDMA) systems and frequency hopped CDMA (FH-CDMA) systems, will be explored. It is expected that some of the well established techniques for designing and analyzing DS-CDMA or FH-CDMA systems can also be applied to multicarrier CDMA systems, while others may not be applicable

and further investigation would be required. Special attention will be paid to the design of efficient receivers with interference suppression capabilities under fading channels. The performance of these receivers under different channel conditions would be studied both analytically and through computer simulation.
(EE96017)

Reducing the Pre-Switching Processing Complexity in Multistage ATM Switching Networks

- ✍ TO Pak Tung
- ❑ 15 June 1997
- ❖ CUHK Research Committee Funding

Most existing non-blocking and self-routing multistage packet switches are based on the sort-banyan principle. In these switches, the majority of the switch complexity comes from the sorting networks, which has a complexity of O ($N \log^2 N$) where N is the switch size. The researchers refer to the complexity (both time and hardware) of the sorting network and the associated contention resolution algorithm performed on it as the *pre-switching processing* complexity of the switch. In this project, the researchers investigate how the overall complexity of the switch can be reduced by trading off the pre-switching processing complexity and the complexity of the routing network. The switch architectures under investigation will be based on the sort-Clos principle, which is the generalization of the sort-banyan principle. Usually, pre-switching processing complexity can be reduced by partitioning the inputs into smaller subsets so that a smaller sorting can be used for each of these subsets of inputs. At the same time, however, the researchers must guarantee that the non-blocking and self-routing properties of the network are not compromised. In this regard, they will investigate how the complexity of the sorting network in a sort-Clos network can be reduced by varying the number of middle-stage modules in the Clos network, while preserving the non-blocking and self-routing properties. Performance of the resulting networks will be evaluated by means of mathematical analysis and simulations.
(CS96022)

Information Security in Communication and Computing Networks

- ✍ WEI Keh Wei Victor
- ❑ 1 September 1996
- ❖ Research Grants Council

Due to the phenomenal rise of Internet popularity, a tremendous amount of multimedia data are transmitted over the World Wide Web. Previously distinct fields of study, such as text compression, speech/audio compression, and image/video compression become increasingly interwined. There is an increasing need to combine these research fields, to interbreed their coding techniques, and to study the tradeoffs when different components of multimedia data compete for bandwidth.
In text compression, the researchers aim to study two new breakthrough general text compression algorithms: the block sorting algorithm of Wheeler and the context sorting algorithm of Yakoo. They intend to try to achieve a thorough theoretic understanding of this pair, and to extend their results.
In speech compression, the researchers aim to implement a speech-compressed international direct dial telephone prototype. By using existing speech compression techniques such as CELP or its variants, and existing moderns, they can compress 3 to 6 voice conversations into one IDD telephone line. They intend to add the necessary switching protocols to make this a working prototype.
In image/video compression, the researchers aim to study the new and on-going MPEG-4 video coding standard. They intend to study the general outline of this "vast" standard, and to focus on one or two specific aspects for in-depth studies, such as embedded zerotree wavelet coding and video object plane coding.
(CU96526)

Integrating Data Services on DECT Systems

- ✍ WONG Wing Shing ● CHAN Kam Tai (Electronic Engineering) ● YUM Peter Tak Shing
- ❑ 1 August 1996
- ❖ Industrial Support Fund, Industry & Technology Development Council

DECT (Digital European Cordless Telecommunications) is a standard for digital mobile telecommunication that has gained a lot of popularity. A substantial number of Hong Kong companies are in the business of manufacturing DECT telephones. In addition, the possibility of the introducing the DECT system to Hong Kong is being actively considered by the Office of Telecommunication Authority.
Most of the research and development efforts on DECT are currently concentrated on voice applications. The objective of this project is to advance the local base of the DECT technology by pioneering the prototyping of a DECT network with data services.
To avoid duplication of efforts, the lower protocol layers of our prototype will be built on commercially available DECT solutions. The researchers'efforts will be focused on providing the hardware and software interface to these solutions and on

developing the network and application level solutions.
(EE96001)

New Approaches to Mobility Management and Multiple Access Protocol for Cellular Systems

- ✍ WONG Wing Shing
- ❑ 1 September 1996
- ❖ Research Grants Council

The overall objective of this project is to investigate new algorithms and protocol for managing terminal mobility and multiple access in cellular communication systems. More specifically, there are three major tasks in the project. The goal of the first task is to design new location registration algorithms to manage terminal mobility for cellular communication systems. Performance of these new algorithms, measured by communication complexity, will be analyzed and compared with traditional approaches in the second task. The objective of the final task is to investigate how the information provided by these new user location algorithms can be utilized to design new multiple access protocols.
(CU96524)

Multilevel Diversity Coding

- ✍ YEUNG Wai Ho Raymond ● ZHANG Zhen*
- ❑ 1 September 1996
- ❖ Research Grants Council

In a multilevel diversity coding system, the information source $\{(X_{1k}, ..., X_{Lk}), k=1,2, ...\}$ consists of L independent data streams, $\{X_{1k}\}$, ... $\{X_{Lk}\}$ in decreasing order of importance. The information source is encoded by a number of encoders. There are a number of decoders, each with access to a certain subset of the encoders. The decoders are partitioned into L levels, where decoders belonging to Level i are required to reconstruct $\{X_{1k}\}, ..., \{X_{ik}\}$.
Up to now, the coding rate region of certain special cases are determined. The goal of this project is to generalize the existing results.
(CU96501)

Please refer to previous issues of *Research Projects Summary* for more details of the following ongoing research at the department:

Edition	Title/Investigators
1995-96	A Novel and Feasible Approach to Realize a High Speed Optical TDM Network (CU95541) ✍ CHEN Lian Kuan ● CHEUNG Kwok Wai
1995-96	Study of Extinction Ratio Penalty in NOLM and NALM for Ultrahigh Speed Lightwave Networks (CS95023) ✍ CHEN Lian Kuan
1993-94	Lightwave Network and Technologies Research (EE94006) ✍ CHEUNG Kwok Wai ● CHAN Kam Tai (Electronic Engineering) ● CHEN Lian Kuan ● HSU Chung Chi (Electronic Engineering) ● SHU Ching Tat C. (Electronic Engineering) ● TSANG Hon Ki (Electronic Engineering)
1995-96	Electronic News Media and Publishing Consortium (CS95011) ✍ CHEUNG Kwok Wai ● CHI Chi Hung (Computer Science & Engineering)
1995-96	Burst-mode Receiver Design, Analysis and Applications (CU95540) ✍ CHEUNG Kwok Wai ● CHEN Lian Kuan
1995-96	High Capacity Network Infrastructures for Internet Service Providers and Multimedia Applications (CS95027) ✍ HUI Yu Ngai ● CHEUNG Kwok Wai ● CHENG Che Hoo (Information Technology Service Unit)
1995-96	The Fundamental Issues of Design and Analysis of High-speed Packet Switched Networks (CU94541) ✍ LEE Tony Tong ● LIEW Soung Chang
1994-95	Intelligent Multimedia System (EE94011) ✍ LI Shuo-yen Robert
1995-96	Self-Route Switching - A Theoretic Foundation and New Architectures (CU94540) ✍ LI Shuo-yen Robert
1995-96	Prototyping Large ATM Switches of a 3-CMOS-chip Design (CU95508) ✍ LI Shuo-yen Robert ● CHAN Cheong Fat (Electronic Engineering)
1993-94	Throughput Optimization in Multistage ATM Switches (EE93010) ✍ LIEW Soung Chang
1994-95	A General Packet Replication Scheme for Multicasting in Interconnection Networks (CS94014)

✍ LIEW Soung Chang

1995-96 Conceptual Study and Implementation of a Parallel Routing Scheme on an ATM Network Testbed (CU94533)
✍ LIEW Soung Chang ● LEE Tony Tong

1995-96 Video Aggregation: Integration of Video Data Compression and Multiplexing for Transport in Broadband Communication Networks (CU95502)
✍ LIEW Soung Chang

1995-96 Interactive Visualization and Analysis of 3-D Digital Images (CU93524)
✍ NG Wai Yin ● CHANG Michael ● HSU Siu Chi (Computer Science & Engineering)

1995-96 Network Dimensioning in WDM-Based Lightwave Networks (CS95017)
✍ TONG Fuk Kay ● YUM Peter Tak Shing

1994-95 Data Compression: Theory, General Algorithms, and Specific Algorithms for Chinese-Language Applications (CS94015)
✍ WEI Keh Wei Victor

1995-96 Data Compression: Theory, General Applications, and Chinese Applications (CU95524)
✍ WEI Keh Wei Victor

1995-96 Circuit Simulation on an SIMD Massively Parallel Computer (CU94514)
✍ WING Omar

1995-96 Information Coding in Decision and Control Systems (CU95507)
✍ WONG Wing Shing

1995-96 Matrix-Analytic Methods in Queueing Analysis (CU94535)
✍ YEUNG Wai Ho Raymond ● SENGUPTA Bhaskar*

1995-96 Multi-Star Realization of Expandable ShuffleNet (CU94537)
✍ YUM Peter Tak Shing

1995-96 Design, Implementation, and Performance Evaluation of a Mobile Metropolitan Area Network (CU95537)
✍ YUM Peter Tak Shing ● WONG Wing Shing

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see also <P962747>, <P970530>, <P971097>, <P971412>, <P972028>

RESEARCH PROJECTS

Three-Dimensional Reconstruction from Stereo-Motion

- ✍ CHUNG Chi Kit Ronald
- ❑ 1 October 1996
- ❖ CUHK Research Committee Funding

This research studies how the advantages of two vision cues: stereo vision and visual motion analysis, can be combined when we have two cameras that move through the scene while taking pictures repeatedly. In contrast with the previous work, the researchers emphasize the following in constructing such a stereo-motion cue:
(1) it should work with short image sequences;
(2) it should work with sparsely sampled image sequences;
(3) it should take into account possible disturbances and uncertainty to the camera motion; and
(4) most importantly, it should have an explicit mechanism to combine the advantages of the motion and stereo cues to provide easy correspondence as well as easy reconstruction.
(CS96009)

Robust Control of Nonminimum Phase Nonlinear Systems

- ✍ HUANG Jie
- ❑ 1 October 1996
- ❖ Research Grants Council

This research project aims to develop the robust nonlinear servomechanism approach to the control of uncertain nonlinear systems. Almost all practical control problems reduce to the design of a control law for a plant such that the output of the closed-loop system asymptotically tracks a class of reference inputs and rejects a class of disturbances in the presence of plant uncertainties. The typical linear robust control approaches such as H_2, $H\infty$, and linear servomechanism theory, though effective for linear systems, are not capable of controlling uncertain nonlinear systems. Most of the existing nonlinear approaches such as input-output feedback linearization and the sliding mode method rely on the invertibility of the plant, thus being applicable only to minimum phase systems. Unlike previous approaches, the researchers' proposed approach is only based on the steady state behavior of the nonlinear plant, thus capable of achieving asymptotic tracking and disturbance rejection for a broad class of uncertain nonlinear systems. The success of the research will not only resolve a longstanding nonlinear control problem, but also lead to an effective approach to controlling highly uncertain nonlinear systems such as high performance missile and/or aircraft systems, high accuracy robot manipulators, and large maneuvering spacecraft.
(CU96518)

Decentralized Adaptive Control for Multiple Manipulators in Cooperation

- ✍ LIU Yun Hui
- ❑ 1 October 1996
- ❖ CUHK Research Committee Funding

This research aims to develop a decentralized adaptive controller for multi-manipulator systems in the presence of model uncertainties. The complicated control architecture and model uncertainties have been two of major obstacles to applications of multi-manipulator systems in industries. The existing cooperation systems adopt centralized control architectures whose complexities depend on the numbers of degrees of freedom (DOF) of the systems, and thus they are not able to yield real-time response when many robots are involved. Furthermore, since most existing controllers require accurate robotic models, various uncertainties regarding the models will decline their performance. To solve the problems the researchers will propose a decentralized cooperation controller with the ability of coping with model uncertainties. In the proposed method, individual manipulators will be under control of their own controllers designed in state spaces of the individuals. Since the number of robots involved does not affect the dimension of such an individual state space, the controller will have a simpler architecture and be easy to implement. A model-based adaptive algorithm will also be introduced to cope with any uncertainties regarding robotics models. This research includes not only theoretical analysis but also experimental verifications.
(EE96012)

Recurrent Neural Networks for Solving Combinatorial Optimization Problems with Time-Varying Parameters and Their Applications for En-Route Vehicle Guidance in Intelligent Transportation Systems

- ✍ WANG Jun
- ❑ 1 December 1996
- ❖ Research Grants Council

The ability to solve large-scale combinatorial optimization problems in real time is essential in many planning and control applications. The NP-completeness of many combinatorial optimization problems make it challenging to develop such solution procedures. The complexity of the task is compounded when a combinatorial optimization problem has time-varying parameters. This is a

research project for analysis and design of recurrent neural networks for solving combinatorial optimization problems with time-varying parameters. The research is to investigate the applications of the recurrent neural networks for en-route vehicle guidance in intelligent transportation systems. Based on the previous results on the recurrent neural networks for convex programming obtained by the prospective principal investigator, the proposed research will involve the analysis and design of recurrent neural networks for solving general combinatorial optimization problems by deterministic annealing. The proposed research will focus on the recurrent neural networks for specific combinatorial optimization problems such as the shortest path problem, the Chinese postman problem, and the traveling salesman problem for vehicle guidance application. The first objective of the proposed study is to develop recurrent neural network models capable of generating real-time solutions to general combinatorial optimization problems. The second objective is to apply the proposed recurrent neural networks to specific combinatorial optimization problems related to en-route vehicle guidance. Five major tasks are identified for the proposed research:
(1) the reformulation of combinatorial optimization problems;
(2) the analysis of neural network dynamics;
(3) the enhancement of the recurrent neural networks for convex programming developed by the proposer to solve specific combinatorial optimization problems and the development of new recurrent neural networks for solving general combinatorial optimization problems;
(4) the formulation of the vehicle routing and guidance problems as combinatorial optimization problems;
(5) the applications of the proposed neural networks to solve specific combinatorial optimization problems related to en-route vehicle routing and guidance in intelligent transportation systems.
(CU96521)

Hidden Markov Model Approach to Monitoring Spot Welding Quality

- ✍ XU Yangsheng ● ZHANG Jiong*
- ❑ 1 February 1997
- ❖ CUHK Research Committee Funding

The inconsistency of the spot welding quality is a major problem in welding industries and it has limited the application of welding robots in automotive and shipbuilding industries where zinc coated steel and other materials are increasingly used. It is necessary to develop an on-line monitoring system to observe, classify, and predict the welding quality and potential problems. The researchers propose a hidden Markov model approach to monitoring spot welding quality and the working conditions, and detecting potential failures. The hidden Markov model (HMM) is a computational paradigm for modeling and representing a doubly stochastical process that is hidden in an observable process. The HMM is appropriate for welding quality monitoring, because the welding process is stochastic and strongly nonlinear with respect to welding action input and environmental variations. The failures or poor quality is the result of failure and malfunction of certain welding tools or inconsistency of welding process, and thus can be modeled by the transition probability matrices and output distribution matrices. At Carnegie Mellon Robotics Institute, the PI has developed the HMM-based real-time learning and recognizing system for classifying the patterns of human gestures, robot actions, and machinery processes. It is significant to implement the scheme to the welding industries for high performance, high quality, and high productivity of automatic welding processes.
(EE96013)

Identification of Fuzzy System via Singular Value-based Methods

- ✍ YAM Yeung
- ❑ 1 November 1996
- ❖ CUHK Research Committee Funding

A singular value-based method has been proposed recently for fuzzy approximation of general functions. Unlike other approaches, the method generates membership functions and rule consequents simultaneously and readily yields a fuzzy system with product-sum-gravity inference. The present project studies a particular extension to this methodology, which is to tailor the technique for fuzzy identification using input/output sample data. The study shows, with samplings over a set of rectangular grid points and that the data set is noiseless and is indeed generated by a system of product-sum-gravity inference, exact recovery of the original fuzzy system is possible. Under the present framework, issues such as similarity transformation, model reduction, irreducible representation, etc., can be addressed for fuzzy identification. The technique as developed can be applied to fuzzy system with a general number of inputs. The results obtained so far have been documented in a conference paper. In the coming months, the project will focus on using randomly sampled I/O data for identification.
(EE96011)

Haptic Device for Virtual Reality Application

- ✍ YEUNG Siu Kau
- ❑ 1 January 1997
- ❖ CUHK Research Committee Funding

The proposed project consists of two parts: (1) the development of a force feedback haptic device (a parallel bar electro-mechanical mechanism with force reflection) and (2) the software development of collision detection response for sculpting virtual objects using this proposed haptic device.
After the completion of the project, a piece of original design haptic mechanism and associate collision detection software for virtual reality will be a useful tool, which is not available from any source, for other related research in robotics and virtual reality.
(EE96010)

Please refer to previous issues of *Research Projects Summary* for more details of the following ongoing research at the department:

Edition Title/Investigators

1995-96 Using 2-D Invariants for 3-D Object Recognition (CU94506)
✍ CHUNG Chi Kit Ronald

1995-96 Numerical Approach to Computing Non-linear H∞ Control Laws (EE95013)
✍ HUANG Jie

1995-96 Development of a Knowledge-based Geometric Modeller for Industrial Design (CU93501)
✍ HUI Kin Chuen

1994-95 Geometric and Topological Theory of Creativity (CS94017)
✍ KWONG Chung Ping

1995-96 Decentralized Hybrid Cooperation Control of Multiple Manipulators (EE95018)
✍ LIU Yun Hui

1995-96 Recurrent Neural Networks for Manipulator Inverse Kinematics Computation of Redundant Robots (EE95012)
✍ WANG Jun

1993-94 A Next-Generation Intelligent Robot with Creativity (EE94001)
✍ YAM Yeung ● SHI Xiaolun ● HUI Kin Chuen ● CHUNG Chi Kit Ronald ● KWONG Chung Ping

1995-96 Integrated Approach for Robust Control Design (CU93511)
✍ YAM Yeung

1995-96 Manipulator Control for Soft Contact Applications Using Neuro-fuzzy Techniques and Non-parametric Models (CU95539)
✍ YAM Yeung ● KWONG Chung Ping

RESEARCH OUTPUTS AND PUBLICATIONS

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RESEARCH PROJECTS

New Scheduling Models with Applications to Berth Allocation

- ✍ CAI Xiaoqiang ● LEE Chung Yee
- ❑ 1 December 1996
- ❖ Research Grants Council

The researchers plan to introduce a class of new scheduling models, in which a big job must occupy a full machine, whereas a small job may share a machine with some other jobs at a time. In addition, the processing rate of a machine is reduced as the number of jobs processed increases. These models differ largely from traditional problems which assume that one machine processes exactly one job at a time. This project is motivated by real-world problems such as berth allocation, where a physically small vessel (job) may share, with other vessels, a berth (machine) equipped with certain processing (loading/unloading) capacity, although a physically large vessel must occupy a whole berth. The researchers will consider the situation where jobs may arrive at different times. Different performance measures will be examined, including mean flow time, maximum lateness, total earliness and tardiness, etc., in order to reflect the need of decision making in different environments. Topics to be addressed will include basic issues, such as optimality properties and scheduling rules, complexity analysis, well-solvable cases, and heuristics and their performance analysis, as well as methodological studies, which are to explore algorithms to find solutions effectively. As an application, the problem of berth allocation in container terminals will be examined.
(CU96543)

Performance Evaluation Without Asset Pricing Model

- ✍ HE Jia
- ❑ 1 October 1996
- ❖ CUHK Research Committee Funding

Mutual fund industry is a rapid growing industry world-wide. The evaluation of mutual fund performance has been a widely-studied problem in financial engineering. The central question is whether mutual fund managers demonstrate superior performance. Superior performance arises from superior information active portfolio managers obtain to help select assets which yield higher average returns than passive portfolios with equivalent risk. Many traditional evaluation techniques generally measure abnormal performance of actively managed portfolios as deviations from that predicted by an asset pricing model. Conceivably, any performance evaluation that is determined relative to an asset pricing model which assumes efficiency of a benchmark index or of a set of benchmark indexes inevitably contains some model misspecification errors.
This project presents two methods for constructing performance measures that alleviate the problem associated with specification errors due to inefficient benchmarks used in asset pricing models. In the first method, the researchers construct a proxy for stochastic discount factors (representing a general asset pricing specification) that has the minimal specification error with respect to all passive assets. While in the second method, the researchers construct upper and lower bounds for the performance of each mutual fund. The upper and lower bounds are constructed based on a given set of passive assets and mutual fund. The bounds will be sharpened if more assets are included.
(CS96010)

Intelligent Investigation Support System - An Application to Computer-Aided Crime Investigation

- ✍ LAM Kai Pui ● BRAHAN J. W.*
- ❑ 1 December 1996
- ❖ CUHK Mainline Research Scheme

This project aims at using both knowledge based systems (KBS) and neural-network (NN) based techniques for computer-aided crime investigation. The operation of a police service is an information and knowledge intensive operation requiring a repository of heuristic skills or expertise of experienced police investigators. In addition to its traditional use for crime analysis, computer technology further permits continuous monitoring of rapidly changing data for the possible detection of complicated crime patterns as they emerge, thus providing an effective means for crime prevention. Realizing the high volume of crimes in a heavily populated city like Hong Kong, and retirements and the requirement for periodic internal transfers of police officers may result in a possible lack of adequate training and experience, there is an urgent need for knowledge based systems to embed individual's skill for efficient police operation. However, technology transfer of KBS and NN for police operation is not a trivial task. It requires a systematic approach of situation analysis, requirement analysis, knowledge acquisition, data acquisition, implementation, and the development and evaluation of field test prototypes with close cooperation from the police. Encouraging results have been reported on the "AI-Police" Project (a joint work of the National Research Council of Canada and the Ottawa Police Service) on the use of KBS for handling break and enter incidents. Further potential remains to be explored. The present project is to

initiate a collaborative work which draws upon the expertise developed on "AI-Police", and the experience of the investigators in their previous research in KBS and NN. On-going dialog with the Hong Kong Police indicates a promising sign of interest and user's support, and would eventually lead to further support and collaboration.
(CS96017)

Neural-Network Based Multiple Models for Adaptive Control Applications

- ✍ LAM Kai Pui ● CLARKE D. W.*
- ❑ 1 January 1997
- ❖ UK/Hong Kong Joint Research Scheme, the British Council

To initiate a collaborative research effort between Hong Kong and two leading United Kingdom universities (Oxford and Glasgow) in developing new theory and applications based on neural networks and adaptive control technologies.
The following objectives are planned for achieving the aim:
(1) To enhance the research basis on neural networks for adaptive control applications in Hong Kong based on the extensive experience of the Oxford and Glasgow groups.
(2) To visit the Oxford and Glasgow groups to gain an understanding of their recent research focus, to discuss with active researchers in related fields, and to define new direction and details for collaboration through direct discussion.
(3) To visit Hong Kong to give advice on research progress, to understand the current status and discuss with active researchers in related fields, and to help in defining new research directions.
(4) To summarise and report on major achievements obtained during the project year, and to suggest plans for future collaboration.
(CS96002)

Knowledge Engineering Laboratory - Applying Artificial Intelligence Research to Industrial Applications

- ✍ LAM Kai Pui ● LOW Boon Toh ● LAM Wai
- ❑ 25 May 1997
- ❖ CUHK Strategic Research Program

The main objectives of the Knowledge Engineering Laboratory are:
(1) To focus on the application and deployment of knowledge-based technologies for systems engineering and management problems which involve substantial industrial participation.
(2) To establish a laboratory which fosters collaboration between faculty members in areas of common interest in knowledge systems research.
(3) To perform basic research in key scientific areas of knowledge engineering for supporting applications development.
There are 6 projects to be undertaken including Artificial Intelligence Crime Analysis and Management Systems, Intelligent Agents and Applications, Automatic Pattern and Rule Discovery System for Product Marketing, Knowledge-based Chaotic Prediction for Financial Engineering Applications, A Hybrid Inference Network for Knowledge Representation and Reasoning, and Logic-based Intelligent Information Filtering.
(CS96014)

Distributed Learning of Bayesian Inference Networks

- ✍ LAM Wai
- ❑ 1 December 1996
- ❖ CUHK Research Committee Funding

This proposal aims at investigating a distributed model for the Bayesian inference network learning problem. Bayesian inference networks are a relatively new paradigm for representing and reasoning knowledge under uncertainty. This learning problem has been shown to be NP-complete. Hence enormous computational resource is required for large networks. The proposed research is to design a distributed algorithm for this problem so that the researcher can take advantage of the existing networked workstations. By exploring this direction, the researcher can extend the size of the largest learning problem which can be solved in reasonable time. In the researcher's previous work, he has developed a serial algorithm for this problem. Central to this algorithm is a score metric based on the Minimum Description Length (MDL) principle. This MDL score metric offers a formalism to balance the accuracy and simplicity of learned networks. The researcher intends to exploit the properties of this MDL metric. This facilitates an efficient parallel asynchronous search mechanism upon which the distributed algorithm is based. This distributed model has a number of features. It is intrinsically fault tolerant in that the algorithm can still terminate and return correct solution even some communication links are broken or some workstations are down during the learning process. The distributed solution has dynamic load balancing feature which can adjust its processor allocation depending on the current load of the processors. It also scales well. Preliminary experiments using networked workstations in the Department will be conducted to demonstrate the viability, effectiveness, and scalability of this approach empirically.
(CS96011)

Saddle Point Generation in Nonconvex Optimization

- LI Duan
- 1 September 1996
- Research Grants Council

The concept of saddle point plays a fundamental role in optimization. The saddle-point condition is a sufficient condition for the optimality. Many nonconvex optimization problems, however, do not possess a saddle point. Recent research breakthroughs have revealed that the existence of a saddle point is not an inherent property in optimization problems. It is rather a characteristic associated with a given representation space. A saddle point can be generated in an equivalent representation space for a general class of nonconvex optimization problems through the pth-power transformation and zero duality gap can be thus achieved. The initial results by the principal investigator in this new research direction of saddle-point generation for nonconvex optimization are extremely promising.
Two major research tasks will be pursued in this project. The first research task is to characterize and classify a general class of convexification transformations for generating a saddle point in nonconvex optimization. The second major task is to derive decomposition solution schemes for large-scale problems when a convexification transformation introduces nonseparability. The outcomes from investigation in this proposed project would enhance our understanding of the fundamental nature in nonconvex optimization and improve efficiency of the solution algorithms for nonconvex optimization. Various applications will be pursued.
(CU96545)

An Empirical Analysis of Stochastic Volatility Model

- LIU Ming
- 1 September 1996
- CUHK Research Committee Funding

Stochastic Volatility (SV) model together with its associated informational flow story has been accepted as one of the most predominant benchmark for stock price movement, yet very few empirical studies have been conducted to assess the goodness-of-fit of the model. The only exception is Gallant, Hsieh and Tauchen (1994), using the efficient method of moment (EMM) framework, they have yielded some very critical conclusions regarding the goodness-of-fit of the SV model. Given the important status of the stochastic volatility model infinance, their result deserves to be reassessed. A preliminary study the researcher conducted has shown that in the presence of long memory in the volatility, which has been identified as one key property of volatility, neither the AIC nor the Schwartz criterion gives a good selection of auxiliary model. Furthermore, the EMM estimation with the selection usually results in inference biased towards the rejection of the maintained model. In this project, the same technique of EMM will be employed on the same data set used by Gallant, Hsieh and Tauchen (1994), the only distinction of this study is that the researchers will incorporate the long memory consideration when they choose their auxiliary model. The method of selection will be based on a multi-dimensional extension of the KPSS test and the researchers will accept the best Schwartz selected model conditional on this model pass the KPSS test. This will allow them to select an auxiliary model which matches well even with the long memory property of the volatility and to yield more positive conclusion on the empirical validity of stochastic volatility model. Besides the long memory consideration in both the auxiliary model and the maintained model, the researchers will also empirically assess the importance of many other features of stochastic volatility models.
The result of this project is of great interest to financial economists, both theoretical and empirical, given the huge volume of works done with the SV model. With the local interest in financial innovations, this study will be of great interest to Hong Kong society as well.
(CS96012)

Linguistic Knowledge Acquisition for a Chinese Noun Phrase Parser

- WONG Kam Fai
- 1 October 1996
- CUHK Research Committee Funding

The objective of this project is to design and develop an automatic knowledge acquisition methology for extracting language knowledge for a Chinese noun phrase parser.
(CS96013)

A Machine Tractable Chinese Thesaurus and its Application to Natural Language Processing

- WONG Kam Fai ● LUM Vincent Yu-Sun
- 1 October 1996
- CUHK Research Committee Funding

There are two camps in Natural Language Processing (NLP) research, namely, linguistics- and corpus-based. The main difference between the two is the way in which language knowledge is acquired. In the former, it is extracted from linguistics resources, i.e. dictionary and/or thesaurus; and the latter from a

large set of text by training. At present, linguistics-based Chinese NLP applications are simple due to the lack of a comprehensive electronic thesaurus. A comprehensive thesaurus is one with broad coverage, rich in semantics as well as widely accepted. But, current electronic Chinese thesauri fail to fulfill these requirements.

CILIN, 同義詞詞林, is a comprehensive contemporary Chinese thesaurus easily accessible in China. For this reason, it will be a good knowledge source for Chinese NLP. However, at present, the CILIN is only available in hard copies and is, therefore, applicable only to manual linguistics applications. Manual processing is too restrictive. It severely limits the size of the applications and also underutilizes the potential of the CILIN. To circumvent these predicaments, we propose to develop a machine tractable CILIN and further apply it to various Chinese computing applications, including information retrieval, compound noun detection and words disambiguation. These are classical applications in natural language processing. Effective application of the electronic CILIN to them will verify the practicality of the thesaurus.
(CS96019)

Robust Production Scheduling in High Tech Manufacturing

- ✍ YAN Houmin ● SETHI Suresh P.*
- ❑ 1 September 1996
- ❖ Research Grants Council

This project is concerned with the development of robust production planning and scheduling policies in high tech manufacturing. Certain features of high tech manufacturing make the problem of planning and scheduling an extremely difficult one. Past research suggests that the problem can be simplified by a hierarchical decomposition into simpler problems without much loss in optimality. The characterization will allow us to express nearly optimal policies in terms of a number of parameters such as threshold levels or hedging points depending on the states of the system and its environment.

The project is particularly important to Hong Kong as there are many high tech companies in the territory, such as Hua Ko Semiconductors, RCL Semiconductors, and Motorola Semiconductors Hong Kong Ltd. The research would take local characteristics of the high tech industry in the region in the development of methods for cost reduction and improvement of operations. The use of these methods would provide strategic benefits to the regional companies.
(CU96532)

Managing Manufacturing/Marketing Interface: An Empirical Study of Chinese Manufacturing Enterprises

- ✍ YANG Shitao
- ❑ 1 December 1996
- ❖ CUHK Research Committee Funding

This project focuses on the issues related to interfaces between manufacturing and marketing and explores how Chinese managers adjust their manufacturing practices as they become more familiar with both materials and consumer markets. The first phase of the project will use interviews with approximately 50 different manufacturing enterprises in China while the second phase will use mail surveys sent to 1000 managers in both interior and coastal areas.

The purposes of this research are to identify areas of manufacturing practice where Chinese enterprises are facing difficulty as a result of economic reforms and to suggest ways of improving the processes of change at the enterprise level through better managing manufacturing/marketing interfaces.
(EE96018)

Please refer to previous issues of *Research Projects Summary* for more details of the following ongoing research at the department:

Edition	Title/Investigators
1995-96	Manpower Planning and Scheduling with Staff of Mixed Skills (CU94543) ✍ CAI Xiaoqiang ● LUM Vincent Yu-Sun ● ZHOU Xunyu ● YAN Houmin
1995-96	Implementation and Application of Binary Relation Inference Networks (CU93510) ✍ LAM Kai Pui
1995-96	Real-time Systems Diagnosis with Microprocessor Applications (CU95517) ✍ LAM Kai Pui
1994-95	Advancement in Nonconvex and Nonseparable Optimization and Its Application in Reliability Networks (CS95004) ✍ LI Duan
1994-95	Reasoning About Knowledge Bases Using Hybrid Symbolic-Connectionist Approach (CS94019) ✍ LOW Boon Toh
1995-96	An Integrated System for Resource Planning and Scheduling of Large Scale Organizations (CS94022)

✍ LUM Vincent Yu-Sun ● CAI Xiaoqiang ● YAN Houmin ● ZHOU Xunyu ● YEE Lim Chun

1994-95 Retrieval-By-Sense — a Novice Scheme for Information Retrieval (CS95001)
✍ WONG Kam Fai ● LUM Vincent Yu-Sun ● PAN Haihua

1995-96 A Chinese Database Management System Interface (CU94517)
✍ WONG Kam Fai

1995-96 Towards a Natural Language-oriented Chinese Information Retrieval System (CU94519)
✍ WONG Kam Fai

1995-96 Dynamic Near-Optimization and Applications (CU94502)
✍ ZHOU Xunyu

1995-96 Asymptotic Optimality of Hierarchical Production Policies in Discrete Event Manufacturing Systems (CU95520)
✍ ZHOU Xunyu

1995-96 Maximum Principle for Singular Controls in Finance (CS95012)
✍ ZHOU Xunyu

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