博　士　学　位　論　文

Doctoral Thesis

内容の要旨

及び

審査結果の要旨

Thesis Abstracts

and

Summaries of the Thesis Review Results

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The University of Aizu

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博士の学位を授与したので、学位規則（昭和28年4月1日文部省令第9号）第8条の規定に基づき、その論文の内容の要旨及び論文審査の結果の要旨をここに公表する。

学位記番号に付した「甲」は学位規則第4条第1項（いわゆる課程博士）によるものであることを示す。

Preface

On granting the Doctoral Degree to the individuals mentioned below, abstracts of their theses and the theses review results are herewith publicly announced, in according to the provisions provided for in Article 8 of the Ruling of Degrees (Ministry Of Education Ordinance No.9, enacted on April 1, 1953)

The Chinese character, “甲”, at the beginning of the diploma number represents that an individual has been granted the degree in accordance with the provisions provided for in Paragraph 4-1 of the Ruling Of Degrees (what in called “Katei Hakase,” or the Doctoral Degree granted by the University at which the grantee was enrolled.)

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Name 氏名	Hirotomo Hayashi 林　博友
The relevant degree 学位の種類	Doctoral degree (in Computer Science and Engineering) 博士(コンピュータ理工学)
Number of the diploma of the Doctoral Degree 学位記番号	甲 CI 博第 10 号
The Date of Conferment 学位授与日	September 17, 2010 平成 22 年 9 月 17 日
Requirements for Degree Conferment 学位授与の要件	Please refer to the article five of “University Regulation on University Degrees” 会津大学学位規程　第5条該当
Thesis Title 論文題目	Algorithms for Efficient and Effective Induction of Neural Network Trees ニューラルネットツリーの効率的かつ効果的構築アルゴリズム
Thesis Review Committee Members 論文審査委員	University of Aizu, Prof. Q. Zhao (Chief Referee) University of Aizu, Prof. R. Oka University of Aizu, Prof. M. Sugiyama University of Tsukuba, Prof. T. Onisawa University of Aizu, Associate Prof. Y. Liu 会津大学教授　趙　強福 会津大学教授　岡　隆一 会津大学教授　杉山　雅英 筑波大学教授　鬼沢　武久 会津大学上級准教授　Yong Liu

Algorithms for Efficient and Effective Induction of Neural Network Trees

Thesis Abstract

Neural network tree (NNTree) is a hybrid model for machine learning and pattern recognition. An NNTree is a special decision tree (DT) with a small neural network (NN) embedded in each internal node. The small NNs are used for local decisions, and the tree controls the whole decision making process.

In this thesis, I introduce mainly three induction algorithms for NNTrees. A problem of traditional induction algorithm of NNTrees is the computational cost for induction. It is too expensive for practical use. This problem is solved using a heuristic grouping algorithm and a supervised learning algorithm. The second contribution is model reduction of NNTrees through dimensionality reduction. Here, I propose a two-stage dimensionality reduction method called discriminant multiple centroid (DMC) approach. This approach is very efficient for solving problems with very high dimensionality and a large number of data. My third contribution of this thesis is to improve the performance of the NNTrees further through optimization of the thresholds of internal nodes. The performance of NNTree will be improved by preventing meaningless data partition.

The efficiency and efficacy of these approaches are evaluated through experiments with several public databases. Experimental results show that the performance of NNTrees obtained by new approaches is better or comparable with traditional induction approaches, and NNTrees are more useful than existing other methods.

Summaries of the Thesis Review Results

In this study, Mr. Hayashi proposed a fast algorithm for inducing NNTrees, an efficient algorithm for inducing compact NNTrees, and a simple method for improving the generalization ability of NNTrees.

For image recognition and text classification, the number of data is usually large, and the dimensionality of the feature space is often very high. To solve such kinds of problems, it is necessary to induce the NNTrees with a reasonable design cost. The fast algorithm proposed by Mr. Hayashi is relatively efficient and effective, and can be used as a baseline for further study.

NNTrees may not be useful if we have sufficient computing resources. In this case, support vector machines (SVMs) can be much better as long as accuracy is considered. However, if the computing resources are limited (e.g. if we apply NNTrees to portable systems such as cell phones and IC cards), NNTrees can be more efficient, although the

performance may not be the best. The problem is, even NNTrees are not compact enough for applications with high dimensionalities. To solve this problem, Mr. Hayashi proposed the DMC (discriminant multiple centroid) approach, which is comparable with LDA (linear discriminant analysis) in accuracy, but the design cost is much lower.

It is important to preserve the accuracy while reducing the design cost and the implementation cost. For this purpose, Mr. Hayashi proposed a method for improving the generalization ability of NNTrees. The method is very simple. Only the threshold of each node is adjusted during the recursive induction process. Results show that the proposed method can improve the NNTrees for most databases, but the improvement is often not very significant. We need further study in the future along this line.

As a result of the thesis review, the thesis has been recognized as qualified for conferment for an academic degree.

Name 氏名	Dang The Ngoc
The relevant degree 学位の種類	Doctoral degree (in Computer Science and Engineering) 博士(コンピュータ理工学)
Number of the diploma of the Doctoral Degree 学位記番号	甲 CI 博第 11 号
The Date of Conferment 学位授与日	September 17, 2010 平成 22 年 9 月 17 日
Requirements for Degree Conferment 学位授与の要件	Please refer to the article five of "University Regulation on University Degrees" 会津大学学位規程　第5条該当
Thesis Title 論文題目	Performance Evaluation and Improvement Methods for Multi-wavelength Optical Code-Division Multiple-Access Systems 多波長光符号分割多重接続システムの性能評価と改善方法
Thesis Review Committee Members 論文審査委員	University of Aizu, Assistant Prof. A. T. Pham (Chief Referee) University of Aizu, Prof. S. Tei University of Aizu, Prof. T. Tsukahara University of Aizu, Associate Prof. I. I. Khmyrova 会津大学准教授　Anh T. Pham 会津大学教授　程　子学 会津大学教授　束原　恒夫 会津大学上級准教授　Irina I. Khmyrova

Performance Evaluation and Improvement Methods for Multi-wavelength Optical Code-Division Multiple-Access Systems

Thesis Abstract

Optical code-division multiple-access (OCDMA) has been considered as a promising candidate for the next-generation broadband access networks. The OCDMA systems that use multiple wavelengths (MW-OCDMA) to encode the transmitted signal have recently received increasing attention thanks to its spectral efficiency that makes a better use of the vast optical fiber bandwidth. On the purpose of studying the feasibility of MW-OCDMA in the next-generation broadband access networks, this thesis focuses on two important issues: (1) performance evaluation and (2) improvement methods for MW-OCDMA systems under the impact of physical layer impairments.

In the first part of the thesis, a modified model of Gaussian pulse propagation over an optical fiber is proposed. The conventional model is used for single-wavelength or wavelength-independent systems hence cannot take into account all the effects of group velocity dispersion (GVD). The proposed pulse propagation model is then applied to evaluate the impact of GVD on the performance of MW-OCDMA systems, including one-dimensional (1-D) and two-dimensional (2-D) MW-OCDMA systems.

In the second part, the impact of four-wave mixing (FWM), a nonlinear effect in optical fibers, on the performance of MW-OCDMA systems is theoretically evaluated. Although FWM is a well-studied issue in multi-wavelength optical networks (such as wavelength-division multiplexing (WDM)), it however has not been considered in MW-OCDMA systems. Moreover, due to encoding and decoding processes, the impact of FWM on the performance of MW-OCDMA systems becomes more complex than that of wavelength-independent systems, such as WDM.

Finally, to improve the performance of the MW-OCDMA systems, several methods are proposed in this thesis. The first one is a new receiver structure using optical hard-limiter (OHL) array. The proposed receiver is able to reduce multiple-access interference (MAI) and cancel optical beating interference (OBI) hence reduce the bit-error rate (BER) and increase the number of supportable users. In addition, a new multi-code modulation (MCM) scheme is proposed for reducing GVD effects. The MW-OCDMA systems using MCM outperform the ones using the conventional modulation schemes such as on-off keying modulation and pulse-position modulation (PPM) in terms of required transmitted power, number of supportable users, and user bit rate. Moreover, MCM and PPM are combined to form a new scheme of multi-code pulse-position modulation (MCPPM). This scheme inherits the advantages from both MCM and PPM hence is an attractive candidate for performance improvement of OCDMA systems.

Summaries of the Thesis Review Results

The submitted doctoral thesis is good, both in term of content and presentation. There are two major original contributions of this thesis. First, it is the proposal of a novel optical signal propagation model considering time-skewing effect in multi-wavelength optical CDMA systems. This model is then used to comprehensively analyze the performance of multi-wavelength optical CDMA systems under the impact of physical layer impairments including dispersion and four-wave mixing. The second original contribution is the proposal of a new modulation technique (named "multi-code modulation") and a new receiver structure (using optical hard-limiter array) for improving the system performance.

The applicant has a strong background in the area of optical communications. In his research area of optical code-division multiple-access (OCDMA) and its applications, he proves, by publishing a lot of papers in highly regarded journals and conference proceedings, that he has ability and is ready to be an independent researcher. The applicant also has very good programming skills, especially with the Matlab© language and OptiSystem© simulation package.

During the review process, the applicant has clearly responded to each of comments, suggestions by the committee in the preliminary thesis review. The written reply is clear and in a satisfactory form. In addition, the applicant has good English proficiency both speaking, listening and writing skills. The presentation in English is smooth and well-organized. Also, the committee finds that there is no problem in the discussion between the applicant and the committee.

Considering the quality of the applicant research and his ability/skills shown during the Reviews, the Review Committee unanimously agrees to pass the applicant in the Final Review.

Name 氏名	沈 文枫
The relevant degree 学位の種類	Doctoral degree (in Computer Science and Engineering) 博士(コンピュータ理工学)
Number of the diploma of the Doctoral Degree 学位記番号	甲 CI 博第 12 号
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Thesis Title 論文題目	Parallelization for High Performance Computing in Computer Simulation of Electrocardiogram 心電図のコンピュータシミュレーションにおける並列化計算に関する研究
Thesis Review Committee Members 論文審査委員	University of Aizu, Prof. D. Wei (Chief Referee) University of Aizu, Prof. R. Oka Shanghai University, Prof. W. Xu University of Aizu, Associate Prof. W. Chen University of Sydney, Prof. G. Nikishkov 会津大学教授 魏 大名 会津大学教授 岡 嶸一 上海大学教授 Xu, Weimin 会津大学上級准教授 陳 文西 会津大学教授 Gennadiy Nikishkov

Parallelization for High Performance Computing in Computer Simulation of Electrocardiogram

Thesis Abstract

Biological computations like electrocardiological modeling and simulation usually require high-performance computing environments. Multi-core CPU and GPGPU technologies enhance computation power dramatically. A CPU-GPGPU PC has been called a personal supercomputer and a CPU-GPGPU PC cluster has become more powerful too. However, approaches to deal with scheduling and load balancing of the computation on a CPU-GPGPU hybrid structure computing platform have not been well studied yet. Various self-scheduling (SS) schemes, such as FSS, GSS and TSS, have been proven success for shared memory multiprocessor systems. But these algorithms can neither give full play to GPGPU computing performance nor effectively reduce the scheduling overhead. This thesis introduces an implementation of parallel computation for computer simulation of electrocardiograms (ECGs) in four parallelization device setups: (a) 4-core CPU, (b) GPGPU plus 1 core of CPU, (c) 4-core CPU plus GPGPU, and (d) CPU-GPGPU PC cluster. To effectively take advantage of the multi-core CPU and GPGPU, load-prediction dynamic scheduling and load-prediction scheduling were applied to setting (c) and setting (d) respectively. Our research extended the application of parallel computing to an ECG simulation on a CPU-GPGPU PC and a CPU-GPGPU PC cluster. Compared with the traditional static scheduling and dynamic scheduling, load-prediction dynamic scheduling and load-prediction scheduling achieve a better load balancing, reduction in scheduling overhead, maximum utilizing of GPGPU, and better scalability.

Summaries of the Thesis Review Results

Biological computations like electrocardiological modeling and simulation usually require high-performance computing environments. Multi-core CPU and GPGPU technologies enhance computation power dramatically. A CPU-GPGPU PC has been called a personal supercomputer and a CPU-GPGPU PC cluster has become more powerful too. However, the approaches to dealing with scheduling and load balancing of the computation on a CPU-GPGPU hybrid structure computing platform have not been well studied yet. Various self-scheduling (SS) schemes, such as FSS, GSS and TSS, have been proven success for shared memory multiprocessor systems. But these algorithms can neither give full play to GPGPU computing performance nor effectively reduce the scheduling overhead. This thesis introduces an implementation of parallel computation for computer simulation of electrocardiograms (ECGs) in four parallelization device setups: (a) 4-core CPU, (b) GPGPU plus 1 core of CPU, (c) 4-core CPU plus GPGPU, and (d) CPU-GPGPU PC cluster. To effectively take advantage of the multi-core CPU and GPGPU, load-prediction dynamic scheduling and load-prediction scheduling were

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