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

第 9 号

The Ninth Issue

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The University of Aizu

はしがき

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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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Ⅰ博第 17 号**
The Date of Conferment **学位授与日**	March 23, 2007 **平成 19 年 3 月 23 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**	Algorithmic CyberFilm Language and Library of CyberFilm Algorithms **アルゴリズムサイバーフィルム言語とそのライブラリ**
Thesis Review Committee Members **論文審査委員**	University of Aizu, Prof. N. Mirenkov (Main Referee) University of Aizu, Prof. S. Tei University of Aizu, Prof. M. Osana University of Aizu, Associate Prof. A. Vazhenin **会津大学教授** N. Mirenkov **会津大学教授 程 子学** **会津大学教授 小佐野 峰忠** **会津大学助教授** A. Vazhenin

1. Thesis Abstract

The algorithmic cyberFilm language and the library of cyberFilm algorithms are presented. The algorithmic cyberFilm language is a visual (multimedia) modeling language for presentation, specification/programming, and consequent automatic code generation of computational algorithms. The library of cyberFilm algorithms is a collection of multimedia specifications related to a basic part of advanced algorithm course.

A programming paradigm based on the algorithmic cyberFilm language has been introduced by our research group of Active Knowledge Studio project. Within this paradigm, the general concept of the language, terminology, corresponding experimental subsystems, and some cyberFilm algorithms have been developed. Though, the considerable results have been obtained, still additional research steps should be taken in order to transform the innovative approach into a mature technology based on abstraction of a new type.

In this dissertation, based on a systematic analysis of the algorithmic cyberFilm language, the enhancement of its self-explanatory features and syntax/semantics representation has been developed. The originality of research includes:

1) Introducing new visual symbols and constructs, foreground/background images, multiple views, as well a set of rules defining meaning of the cyberFilm scenes and frames.

2) Developing the library of cyberFilm algorithms consisting of a variety of algorithms for sorting, string matching, dynamic programming, as well as algorithms on graphs, trees, etc. In this library, each item is represented by frames of algorithmic skeletons demonstrating dynamical features of algorithm, by frames of integrated views providing combined features in a compact format, and by corresponding template programs supporting the algorithmic code generation.

3) Creating educational materials of new type based on the extended studying and testing the cyberFilm language usability.

Chapter 1 (Introduction) begins with an overview of current situations in programming technologies and education, another overview of our approach and past results from our research group, and the objectives for developing the library and making definition of the algorithmic cyberFilm language, followed by a summary of contributions. The rest of the dissertation is organized as follows:

Chapter 2 (Related Works) presents related papers on visual languages, algorithm visualization, libraries and tools for developing and presenting algorithms, visual computing for education, definition approaches for visual languages, specification of software components, as well as filmification of methods. Considering these related works is a basis of what we pursue in the following chapters.

Chapter 3 (Algorithmic CyberFilm Concept) considers fundamentals of the multiple views, explanations of the algorithmic skeletons view and the integrated view, and the corresponding programming environment. Observation of computational algorithms features is also considered.

Chapter 4 (Definitions of the Algorithmic CyberFilm Language) provides the systematic presentation of the algorithmic cyberFilm language. First, a general overview of the language is provided, then syntax and semantics aspects of the language are defined more precisely.

Chapter 5 (Library of CyberFilm Algorithms) demonstrates the library items by presenting case studies. A number of cyberFilm algorithms are presented by the corresponding algorithmic skeleton frames and integrated views. This chapter also explains program generation from the algorithmic cyberFilm and presents characteristics of the library components and library usage.

Chapter 6 (A Language for Algorithmic Semantics) introduces a new view and language for algorithmic semantics. A concept of ``What'' and ``How'' problem descriptions is explained, and language constructs are presented. Practicality of the language is also considered.

Chapter 7 (Conclusion and Future Works) concludes the dissertation. It summarizes the contributions and shows the direction of future research.

2. Summary of the Thesis Review Results

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

A draft of dissertation of 217 pages has been presented. It consists of seven chapters and 117 items of references. In these chapters the algorithmic cyberFilm language and the library of cyberFilm algorithms are presented.

In this dissertation, based on a systematic analysis of the algorithmic cyberFilm language, the enhancement of its self-explanatory features and syntax/semantics representation has been developed. The originality of research includes:

1) Introducing new visual symbols and constructs, foreground/background images, multiple views, as well a set of rules defining meaning of the cyberFilm scenes and frames.

2) Developing the library of cyberFilm algorithms consisting of a variety of algorithms for sorting, string matching, dynamic programming, as well as algorithms on graphs, trees, etc. In this library, each item is represented by frames of algorithmic skeletons

demonstrating dynamical features of algorithm, by frames of integrated views providing combined features in a compact format, and by corresponding template programs supporting the algorithmic code generation.

3) Creating educational materials of new type based on the extended studying and testing the cyberFilm language usability.

Author's vision of future work has also been presented.

The overview of related work and results of his research were very well prepared and presented; answering questions was good and reasonable. The language of presentation was easy to understand and the language of answering questions was also good

The Review Committee unanimously recognized the thesis as qualified for conferment for an academic degree with necessity of minor modifications before submission of the final draft.

The main results obtained during the research and described in the dissertation are published in the following journals and conference proceedings:

1. **Yutaka Watanobe**, Nikolay N. Mirenkov, Rentaro Yoshioka, Oleg Monakhov, Filmification of methods: A visual language for graph algorithms, Journal of Visual Languages and Computing, Elsevier Publisher. (Accepted to be published)
2. **Yutaka Watanobe**, Rentaro Yoshioka, Nikolay N. Mirenkov, A Searching Method Based on Problem Description and Algorithmic Features, International Journal of Computational Science and Engineering (IJCSE), 2(5/6), 2007, 87—115, Inderscience Publisher.
3. **Yutaka Watanobe**, Rentaro Yoshioka, Nikolay N. Mirenkov, Self-Explanatory Components to Study Algorithms, The Journal of 3D images, 6(4), 2002, 231—236.
4. **Yutaka Watanobe**, Nikolay N. Mirenkov, Rentaro Yoshioka, Algorithmic CyberFilm Language, In: Proceedings of IEEE Japan-China Joint Workshop on Frontier of Computer Science and Technology (FCST 2006), Aizu-Wakamatsu, Japan, 2006, pp.178—185.
5. **Yutaka Watanobe**, Nikolay N. Mirenkov, Rentaro Yoshioka, CyberFilm specifications for generalized graph search algorithms, In: Proceedings of IASTED International Conference on Advances in Computer Science and Technology (ACST 2006), Puerto Vallarta, Mexico, 2006, pp.129—134.
6. **Yutaka Watanobe**, Nikolay N. Mirenkov, Rentaro Yoshioka, A visual language for the description of algorithmic semantics, In: Proceedings of IASTED International Conference on Software Engineering, Innsbruck, Austria, 2006, pp.91—96.
7. **Yutaka Watanobe**, Rentaro Yoshioka, Nikolay N. Mirenkov, A Searching

Method Based on Problem Description and Algorithmic Features, Lecture Notes in Computer Science 3433, 2005, pp.138—149.

8. **Yutaka Watanobe**, Rentaro Yoshioka, Nikolay N. Mirenkov, Library architecture for searching software components by their algorithmic features, In: Proceedings of 2004 International Conference on Distributed Multimedia Systems, San Francisco, California, USA, 2004, pp.190—195.
9. **Yutaka Watanobe**, Nikolay N. Mirenkov, Self-Explanatory Components for the Education of Algorithms, In: Proceedings of the Fifth International Conference on Human and Computer, Aizu-Wakamatsu, Japan, 2002, pp.283—288.
10. Rentaro Yoshioka, Nikolay Mirenkov, Yuho Tsuchida, **Yutaka Watanobe**, Visual Notation of Film Language System, In: Proceedings of 2002 International Conference on Distributed Multimedia Systems, San Francisco, California, USA, 2002, pp.648—655.

Name **氏名**	Hazem Mokhtar Mokhtar El-Bakry
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 I 博第 18 号**
The Date of Conferment **学位授与日**	March 23, 2007 **平成 19 年 3 月 23 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**	A Fast Searching Algorithm for Data Detection Using Neural Networks **ニューラルネットに基づくデータ検出のための高速探索アルゴリズム**
Thesis Review Committee Members **論文審査委員**	University of Aizu, Prof. Q. Zhao (Main Referee) University of Aizu, Prof. R. Oka University of Aizu, Prof. T. Hayashi Kyushu University, Associate Prof. H. Takagi 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 林 隆史** **九州大学助教授 高木 英行** **会津大学助教授 劉 勇**

1. Thesis Abstract

In this dissertation, faster neural networks for pattern detection are presented. Such processors are designed based on cross correlation in the frequency domain between the input matrix and the weights of neural networks. This approach is developed to reduce the computation steps required by these faster neural networks for the searching process. The principle of divide and conquer strategy is applied through matrix decomposition. Each input matrix is divided into small in size submatrices and then each one is tested separately by using a single faster neural processor. Furthermore, faster pattern detection is obtained by using parallel processing techniques to test the resulting submatrices at the same time using the same number of faster neural networks. In contrast to faster neural networks, the speed up ratio is increased with the size of the input matrix when using faster neural networks and

matrix decomposition. In addition, the problem of local subimage normalization in the frequency domain is solved. The effect of image normalization on the speed up ratio of pattern detection is discussed. Simulation results show that local subimage normalization through weight normalization is faster than subimage normalization in the spatial domain. The overall speed up ratio of the detection process is increased as the normalization of weights is done off line. Moreover, this dissertation presents a new approach to speed up the operation of time delay neural networks. The entire data are collected together in a long vector and then tested as a one input pattern. The proposed FTDNNs use cross correlation in the frequency domain between the tested data and the input weights of neural networks. It is proved mathematically and practically that the number of computation steps required for the presented time delay neural networks is less than that needed by CTDNNs. Simulation results using MATLAB confirm the theoretical computations.

2. Summary of the Thesis Review Results

So far, many researchers have verified that neural network (NN) is a very effective model for solving appearance based face detection problem, although it may not be the best. The main problem in NN-based approaches is that the computational complexity is very high during detection. The main concern in Mr. El-Bakry's doctor dissertation is to speedup the NN. The basic theory he used is to apply Fast Fourier Transform (FFT) in computing the cross correlation between the input image and the weight matrix of the NN. The NN implemented with this idea is called fast neural network (FNN). After came to Aizu, Mr. El-Bakry has made several new contributions. First of all, he corrected several important mistakes of existing papers. Second, he proposed a new way to improve the speedup ratio by decomposing the input image into many small blocks. Third, he proved that the centering operation can be done simply by centering the weight matrix. Fourth, he applied the FNN to solving several other problems, including implementation of time delay neural network, implementation of NNs with complex weights, and so on.

One comment on his dissertation is that he does not provide experimental results to support the effectiveness of the NN based face or object detection. However, since other researchers have already solved this problem, we cannot consider this is a big problem. Another comment is that he has not considered normalization and histogram equalization during face detection. He just considered a very simple pre-processing, namely centering. This alone may not be enough for obtaining good performance. However, since normalization and histogram equalization are not absolutely necessary when the input image is first transformed to an illumination insensitive feature space, we cannot say that this is a big deficiency of the dissertation. In fact, he has cited a paper written by other researchers who have used Mr. El-Bakry's method successfully to image detection.

Therefore, the work done by Mr. El-Bakry is original, and is considered to have certain impact in this area. In fact, as pointed out by him, the proposed method may be applied to solve many problems, and can be considered as a method widely useful.

The committee agreed that as a result of the thesis review, the thesis has been recognized as qualified for conferment for an academic degree.

Name **氏名**	Chuanfeng Lu **呂 伝峰**
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Ⅰ博第 19 号**
The Date of Conferment **学位授与日**	March 23, 2007 **平成 19 年 3 月 23 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**	Non-Linear PCA approaches for semi-universal image Compression **非線型PCAに基づく準汎用画像圧縮に関する研究**
Thesis Review Committee Members **論文審査委員**	University of Aizu, Prof. Q. Zhao (Main Referee) University of Aizu, Prof. M. Sugiyama University of Aizu, Prof. M. Cohen University of Aizu, Associate Prof. Y. Liu **会津大学教授 趙 強福** **会津大学教授 杉山 雅英** **会津大学教授** M. Cohen **会津大学助教授 劉 勇**

1. Thesis Abstract

PCA as an effective statistical analysis technique has been proposed for more than one hundred years. Theoretically, it is the optimal linear transform algorithm to de-correlate the input data. However, it becomes crippled when being adopted as an image encoder (like DCT transform encoder) due to the substantial property. Specifically, in PCA, the transform matrix is built based on the covariance matrix of a particular input image, thus it will lose the approximation ability when the input image changed. To resolve this problem, many improved PCA methods have been proposed in the literatures. However, very few proposals consider PCA as a universal image encoder; no reports show that PCA can produce a better performance than DCT.

Within all the current PCA-related approaches, non-linear PCA is believed as a potential approach to overcome the demerits of traditional PCA. First, non-linear methods are more close to the nature of image. Say, the characteristic distribution of a nature image is not linear or is not global linear. Therefore, theoretically non-linear methods are more appropriate for approximate image data. Currently a number of reports have proved that

non-linear PCA methods (when including auto-associative neural network with non-linear activating functions, Kernel PCA etc.) can surpass the traditional linear PCA in the sense of producing smaller fidelity distortion in some cases. However, these kinds of non-linear PCA suffers from other different shortcomings, the biggest problem is the generalization ability. The more accurate it can approximate one image, the larger distortion would be obtained when use it for compression another image. Beside this problem, neural networks methods need huge training time, Kernel PCA need storing all the training examples, as well as difficult to reconstruction. Also there is no sophisticated non-linear function could be used as a common one, still need code vector to determine which one is better.

In this study, attention has been focused on another kind of non-linear PCA, the local PCA approach. In other words, it is non-linear in global while linear in local. The main objective is to apply local PCA approaches as a semi-universal encoding to image compression. A number of characteristics of local PCA make it particularly well suited to this problem:

1. Different PCA can be used to approximate different image block with distinct characteristics. The data distribution of image maybe non-linear in global; however in most local areas they are linearly distributed.
2. Only linear PCA transform is needed for encoding and the coding, it is simple and fast.
3. or some special image databases, (for example, facial image, medical image and others), many similar or almost same characteristics exist. In other words, a small number of local PCA is enough to produce a good performance. As such, local PCA approach can be used as a universal encoder inside the database.

A new technique to obtain local PCA, called k-PCA, has been proposed. It is a combination of VQ and PCA, which can be retrained using training data to get an optimal performance, it can optimally determine the number of principal components for assigned error threshold, and it can optimally choose the important principal components to preserve to get high reconstruction fidelity.

The most important process for local PCA is how to divide the global space into a number of local spaces (or subspaces), k-PCA employs VQ approach do the clustering, and prior to VQ a pre-PCA is preformed to reduce the dimension number of VQ. After VQ, local PCA is implemented within different local spaces. A retraining process based on extended LBG algorithm has also been proposed to improve the performance of k-PCA. The performance of k-PCA as a universal image encoder is evaluated by means of cross-validation. The results of the experiments show that the k-PCA encoders, both before and after retraining, are better than DCT, PCA and other existing encoders. Further, the k-PCA encoders can

have very good generalization ability even if the training set is a small portion of the whole database.

To improve the performance of k-PCA as a practical application, a number of methods have been proposed as follow:

- A method to estimate MSE error using principal components without need of reconstruction. It is believed as a significant contribution to this field.
- An optimal PCA that can rearrange the principal components according to its contribution to reconstruction.
- An adaptive PCA with number-adjustable sub-spaces that enable the user to control the fidelity distortion easily.
- An adaptively optimal PCA.
- k-PCA-based on optimal PCA.
- k-PCA-based on adaptively optimal PCA.

2. Summary of the Thesis Review Results

In the doctor thesis of Mr. Lu, there are at least the following contributions:

1) Mr. Lu proposed a new type of non-linear PCA called k-PCA for image compression. Compared with existing neural network based approaches (e.g. MPC), k-PCA is more efficient and effective. Compared with existing sub-space approaches, the pre-compression used in Mr. Lu's approach can build k-PCA more efficiently.

2) To apply k-PCA as a semi-universal encoder, he proposed an extended LBG algorithm called e-LBG that can improve the performance of k-PCA significantly with a slight increase in computing time. Again, pre-compression is used, and this is the key point to reduce the computational cost of e-LBG.

3) To improve the performance further, Mr. Lu proposed an optimal k-PCA. Here, optimal means for any given image block, we can find the best PCA with the best combination of eigenvectors.

4) All the above proposed methods are verified with well-known images used by many researchers working in this field.

The proposed methods provide a new way for the next generation image compression. They might also be useful for compression of other types of data (e.g. speech compression). Further, since k-PCA is a data-dependent encoder, it may also be useful for improving the information security, if it is combined with some existing encryption algorithms.

State regarding responses to the issued pointed out at the preliminary and final thesis reviews

Mr. Lu has revised his thesis substantially based on the comments pointed out at the preliminary review and the final review. The current version is much better than before, although the English could be polished further.

【Opinions of the Review Committee】

The committee discussed the performance of the presentation and the thesis, and agreed that as a result of the thesis review, the thesis has been recognized as qualified for conferment for an academic degree.

Name **氏名**	Shengguo Sun **孫 勝国**
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 C 博第 14 号**
The Date of Conferment **学位授与日**	March 23, 2007 **平成 19 年 3 月 23 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**	A Personalized Support System Exploiting Learning Patterns Using Rule-based Reasoning **ルールベース推論を用いた学習者の学習パターンに基づく個人学習支援システムに関する研究**
Thesis Review Committee Members **論文審査委員**	University of Aizu, Prof. S. Tei University of Aizu, Prof. M. Osano University of Aizu, Associate Prof. S. Bhalla University of Aizu, Assistant Prof. H. Kurokawa **会津大学教授 程 子学** **会津大学教授 小佐野 峰忠** **会津大学助教授 S. Bhalla** **会津大学講師 黒川 弘国**

1. Thesis Abstract

In recent years, rapid developments have been made on using Web-based contents and learning support systems. More and more support methods have been proposed that are not only based on the level and ability of learners, but also consider learners' psychological states. But, to understand learners' psychological states becomes an important problem to be solved since the psychological states are very complicated. In this research, we provide a method to grasp learners' psychological states and the change of the psychological states by using two viewpoints of learning order patterns and the reaction patterns in learning process. We analyze the learner's learning habits by combining the two viewpoints. When a learner takes actions that are different from his/her normal learning habits, the system infers the reason to understand the change of learner's psychological states. Based on the proposed method, a Web-based support system is developed.

On the other hand, the learning in real world is the most important part in one's learning. Research studies on learning support methods in real world are possible and

necessary with the progress on the ubiquitous techniques. With the improvement of ubiquitous technology, more and more effective and natural supports for learning activities can be provided to learners in everyday life and skill learning.

The goal of this research study is to provide learners with personal supports based on learners' learning patterns and psychological states, in order to help learners learn effectively and make better learning rhythms. The methods on deciding and providing supports in Web-based environment have been mainly researched. As a further step, question of how to apply the methods in ubiquitous environment has also been researched. Moreover, we provide a support method to increase learning effect and modify learners' behaviors using behavior principles especially shaping principle. Shaping principle is applied in a ubiquitous gym system.

In this research, we propose support methods in ubiquitous environment to help learners modify their behaviors and behavior patterns in self-learning and skill learning process. Based on the methods, we design a support system of a learning room for self-learning support, and design a support system of a ubiquitous gym for skill learning support. In the self-learning room system, we propose a hierarchy of zones, by which the position information and learning actions of learners can be correctly caught, and the needed services can be easily provided to learners. This study proposes a method to analyze learners' learning patterns from learning histories based on learning orders and reactions in hierarchical zones, and we provide supports to learners by using Rule-Based Reasoning (RBR) in order to increase learning efficiency. This helps a learner to bring up good learning (life) rhythms. In the ubiquitous gym, the learner can have physical exercises to increase power and stamina. The system can grasp a learner's situations including training actions, training durations, and degree of difficulty, etc. The situations can be compared them with training plan and requirements, and help the learner improve/modify the behaviors and training plans. Shaping principle is an often part of the principles for behavior modification. Different support methods are decided based on the shaping principle and the learner's purposes.

The following issues have been examined.

(a) The methods on reasoning learning patterns and part of related psychological states based on learners' Web-based actions have been proposed.

(b) Methods about support to increase learners' learning effect and help learner grasp better learning methods and rhythms have also been proposed.

(c) A Web-based support system applying the methods in (a) and (b) has been developed, in order to provide learning contents to learners and collect their actions in learning process, then provide effective supports to them by reasoning their psychological states and learning patterns.

(d) In ubiquitous learning support topic, a model of hierarchy of zones is proposed, by which the position information and learning actions of learners can be correctly caught, and suitable services can be easily provided to learners.

(e) Ubiquitous learning support systems has been designed and developed, the methods in (a) and (b) are revised to fit the features of ubiquitous environment and ubiquitous learning.

The thesis is organized as follows:

Chapter 1

In this chapter, the background and purpose of this research are introduced.

Chapter 2

In this chapter, we survey the related researches. At first, researches on Web-based learning support systems are discussed. And then, researches on ubiquitous learning support systems are summarized. Regarding both Web-based learning support systems and ubiquitous learning support systems, researches on personalized support methods are extensively investigated.

Chapter 3

In this chapter, we present the Web-based learning support methods and the Web-based learning support system. The models and definitions are introduced. And the details of the methods are described. Then the implementation and evaluation of the system are also presented.

Chapter 4

In this chapter, we present the ubiquitous learning support system in self-learning environment. The methods on collecting learners' actions and reasoning learners' patterns are described. And then the implementation and evaluation of the system are presented.

Chapter 5

In this chapter, we present the ubiquitous gym system as a case study for skill learning in ubiquitous environment. The methods on collecting learners' actions and reasoning learners' patterns are described. And then the implementation and evaluation of the system are presented.

Chapter 6

In this chapter, we describe the conclusions and discuss the problems which should be solved in the future.

2. Summary of the Thesis Review Results

【Doctoral Thesis】

・Summary of content

The applicant has made good progress on his research.

The applicant investigated personalized support systems. At first a Web-based support system is proposed. A learner's situation is detected by observing the learner's actions (logs) to learn a subject. Learning order patterns and reaction patterns are detected and support is given to the learner based on the patterns. The web learning system is further extended to a ubiquitous learning environment, where learning not only through Web but also in real world is supported. A hieratical zone model is proposed to detect the learner's behaviors and provide support to the learner. As an example, a ubiquitous gym support system is proposed and developed. Moreover, a support method applying shaping principle is proposed.

【Scholastic Aptitude】

・Fundamental Scholastic Aptitude

The applicant has average background knowledge on the computer science and engineering.

・English Language Proficiency

English language proficiency of the applicant is good. The presentation in English is fluent. The discussion with reviewers (answer of reviewers' questions) in English is smoothly performed.

【Opinions of the Review Committee】

The committee discussed the performance of the presentation and the thesis, and agreed that as a result of the thesis review, the thesis has been recognized as qualified for conferment for an academic degree.

博 士 学 位 論 文
Doctoral Thesis

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