

博 士 学 位 論 文

Doctoral Dissertation

内容の要旨

及び

審査結果の要旨

Dissertation Abstracts

and

Summaries of the Dissertation Review Results

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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 is 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 CI 博第 39 号
The Date of Conferment 学位授与日	March 20, 2014 平成 26 年 3 月 20 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
Dissertation Title 論文題目	平面配置スピーカによる 3D サウンドシステムの開発 3D Sound System with Horizontally Arranged Loudspeakers
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Abstract

Imaging technology has improved recently, and televisions can express the depth of vision with only a flat panel. Surround loudspeaker system provides a sound field on the horizontal plane. One of the next generation of virtual reality expression is real 3D image and sound.

There are various kinds of methods to make precise sound fields, including transfer function composition methods, solid angle division methods, direct synthesis, and composite sound field methods. However these methods have some limitations, such as small listening position and requirement of large-scale equipment. These problems prevent such systems from popularizing. On the other hand, 5.1 channel loudspeaker system has been popularized. Therefore, if the five loudspeaker systems have the capacity of playing spatial sound, many people can experience next generation sound.

This dissertation explains a panning algorithm to display spatial sound for horizontally arranged five loudspeakers. Principal cues for human perceiving the location of a sound image are interaural time difference (ITD), the interaural level difference (ILD), and the spectral cues provided by the pinnae. Stereophonic loudspeakers, one of the most popular loudspeaker systems, can make a sound image between the two loudspeakers because the system can control ILD using a panning algorithm based on a trigonometric function. Five loudspeaker systems cannot use the panning algorithm because the human has nonlinear auditory characteristics. Human auditory sense has different sensitivities in different directions, therefore a new panning algorithm was proposed. The panning algorithm has some control points and energy distribution ratio. When a system received a direction of a sound image, the panning algorithm calculates each loudspeaker's amplitude using the control points. The panning method accounts for problems of asymmetrical loudspeaker arrangement and human auditory characteristics. If the system uses only the panning algorithm, a listener perceives a sound image only on the loudspeaker plane. The system uses a set of head-related transfer functions (HRTF) for a sound image to be perceived above the plane. The reason why HRTF is used is HRTF contains a lot useful information for spatial localization. The combination of the panning algorithm and HRTF provides spatial sound localization. A listener can perceive a sound image spatially on the horizontally arranged five loudspeakers. Moreover, the new system can be used not only in an anechoic chamber, but also in an ordinary echoic room.

Then, this dissertation explains a new reverberation reconstruction method. Almost all the sound we hear contains reverberation. Reverberation gives a lot of cues for sound perception such as early reflections, reverberation time, and so on. To enhance listener envelopment, many sound sources were added reverberation. The method for adding reverberation to the sound source is convolving an impulse response (IR) and the sound source. Convolving an IR and the sound source is not enough because reverberation contains a lot of reflections, in other

words, each reflection has a room transfer function and an HRTF.

Impulse response does not contain directional information. To obtain the directional information of each reflection, a closely located four Omni-directional microphone array that forms three dimensional rectangular coordinates was used. Four impulse responses were analyzed by the sound intensity method and transformed into image sound sources (ISS). A new reverberation was reconstructed using all ISSs. Every delay, attenuation, direction and head-related effect of ISS was calculated and summed. Therefore, a new reverberation could contain directional information. The new reverberation reconstruction method and a conventional reverberation method were compared in a headphone-based system and the loudspeaker-based 3D sound system. From the results, the new reverberation reconstruction method improved the sound impression such as Spatiality, Clarity, and Naturalness in the both systems.

The relation between an audio content and a listener was usually a passive relation. A listener starts a content, and then the only thing the listener does is watching or listening to the contents. A positive relationship to a content is very important cue to provide a sense of immersion into a virtual reality. A real-time system named RISSICS (Real-time and Intuitive Spatial Sound Image Creation System) was developed. A Nintendo Wii Remote controller that has a three-axis motion sensor was adopted as a direction input device. A user can intuitively indicate the direction of a sound image. RISSICS immediately calculates all signal processing, and distributes the calculated signal to five loudspeaker. The refresh rate of RISSICS is shorter than the human's time resolution. A user can perceive a smoothly moving sound image. An experiment that evaluates how easy a user indicates a sound image position was conducted. Ten motions were requested to be evaluated, and the results show Wii Remote can be used as the input device.

Conventional horizontally arranged multi-channel loudspeaker system could not provide a spatial sound image. However, the combination of the five channel panning algorithm using the control points and HRTF can provide a spatial sound image. Moreover, the new reverberation reconstruction method can make a reverberation with directional information. The new reverberation improved the sound impression. Furthermore, the real-time 3D sound system with an intuitive input device provides new experience that listeners have the positive relation to the sound image. These results contribute to the development of multi-channel audio and virtual reality.

Summaries of the Dissertation Review Results

In this dissertation, the candidate proposed a new algorithm for spatial sound reproduction with horizontally arranged five loudspeakers that is being popularized as standard home theater systems. The system convolves head-related transfer functions of desired directions (azimuths and elevations) with

non-directional sound sources, and pans the amplitudes of the five loudspeakers according to the azimuths of the sound sources using an extended amplitude-panning method.

The processing is simple and not time consuming. Since this method using the current standard home theater systems, it is easy to be widely popularized. Also the method need to be more analyzed theoretically, the effect has been evaluated in both anechoic chamber and an ordinary reverberant environment by psycho-acoustical listening tests and the results are proved by statistic method.

For a 3D sound system, it is also important to create the reverberations of real or simulated environments. The candidate also proposed a new method to create binaural room reverberations by a measurement-and-reconstruction method using four microphones. This method firstly analyzes the image sound sources of the measurement position by the impulse responses of the four microphones and then reconstructs the room reverberation for the loudspeaker system not only for the measured position but also other different positions. The effectiveness of the method is also evaluation by psycho-acoustical listening tests. A useful GUI user interface using pointing devices is also developed and can be used for real-time 3D sound creation.

The dissertation and presentation were well organized and candidate has done enough things for the dissertation and obtained good results. He published 1 major journal paper, 4 major conference papers, and 2 non-major conference papers related the dissertation. He has demonstrated excellent skill in computer programming and showed sufficient knowledge about his research topic and related field. His English ability is also sufficient and can communicate with the referees fluently without problems.

Name 氏名	MADAAN, Aastha マダン アスタ
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 40 号
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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
Dissertation Title 論文題目	Relational Database Query Languages for Instances of Medical Information Repositories 医療情報リポジトリのインスタンスの為のリレーショナルデータベースクエリー言語
Dissertation Review Committee Members 論文審査委員	University of Aizu, Prof. BHALLA, Subhash (Chief Referee) University of Aizu, Prof. TEI, Shigaku University of Aizu, Senior Associate Prof. KLYUEV, Vitaly University of Aizu, Senior Associate Prof. PAIK, Incheon 会津大学教授 バーラ サバシュ(主査) 会津大学教授 程 子学 会津大学上級准教授 クリュエフ ヴィタリー 会津大学上級准教授 白 寅天

Abstract

The medical information includes both knowledge-based information (scientific papers and other literature) and patient-specific information (electronic health records, EHRs). The former is available on the Web through Web document repositories (such as, MedlinePlus, medical literature- PubMed, Medline). Querying these resources is required by a variety of end-users for improved quality of patient-care. These users include practitioners, specialists, researchers who are well versed with the medical knowledge and terminologies. They vary in their background, experience and interact with the system in various contexts. They pose precise queries and expect complete results within time limits (almost real-time). As a result, it is a complex task to query these resources. A search engine returns a large list of documents for a user search. A physician has to go over each of these documents to find the one that (exactly) matches his expectations. This task is time-consuming and may be abandoned. The study considers the medical domain experts in contrast with the database users, Web users, IR users and others. The medical experts are well versed with the schema (terminologies and medical processes) in comparison to the other users in terms of schema knowledge and ability to query. The study considers that enabling a database style query language over these resources may allow the domain experts to formulate exact queries and receive precise results within time constraints.

The patient-specific resources are available as standardized electronic health records repository. The earlier paper-based patient records have evolved from Electronic Medical Records (EMRs), to Personal Health Records (PHRs) to now available EHRs (Electronic health records). The EHRs interact with different departments and subjects in a health-care organization. As a result huge amount of heterogeneous data is generated. Recently, several standards such as HL7, CEN 13606 and openEHR have been proposed. The aim of these standards is to develop semantic interoperability. The study considers the electronic health records based on the openEHR standard.

Due to the huge amount of user-data and usage-data generated in case of the standardized EHRs database system there is need to support querying and enhance its usability. The standardized health records have complex structure and may be queried at single-patient level or population-level by a variety of medical domain-experts during the process of patient-care and for research purposes. This makes querying the EHRs databases complex. Moreover, a variety of end-users, varying in demographics and characteristics interact with the standardized EHRs systems for everyday tasks. Hence, the interaction data generated is large in volume and diverse in nature. Pattern mining tools can help in discovering knowledge from this data for usability and learnability studies. Using the discovered knowledge, the standardized EHRs database system can be improved on a continuous basis over its lifetime.

The goal of this study is to provide "ability to query" to the medical domain experts. For this, it provides database support to the medical domain experts for web-user level activity over the Web document repositories. It aims to support their everyday querying needs (over the Web document repositories and EHRs repository) through relational query languages. It also aims to enhance the usability of the

standardized EHRs database system. The main contributions of the study can be listed as:

- (1) The study models a Web based document repository as a three-dimensional cube that can be mapped to an XML-based hierarchical structure (XML schema). It proposes a two-step framework to create user-level schema corresponding to the Web document repository using the concept of "Web document segmentation" (as an off-line process) and enable existing XQuery query language (for XML) over it. This transformation makes the document repository query-able. Further, a new high-level query language interface, QBT (Query-by-Segment tag) is developed over it (on-line process).
- (2) Next, the study adapts the existing graphical, high-level query language XQBE (XQuery-By-Example) over the transformed schema for enhanced querying over the on-line medical document repositories. It provides a drag and drop query interface over an on-line medical document repository.
- (3) The study proposes a NoSQL, cloud-based persistence mechanism for the archetype-based EHRs. It further, proposes a high-level, graphical, relational-like query language Archetype By Example (AQBE) similar to the existing Query-By-Example (QBE) query language to support the user-queries over the standardized EHRs repository. It enables the medical concepts such as, blood-pressure or heart-rate to be queried independent of the system implementation and application environment.
- (4) To address the usability concerns for these databases and system enhancement purposes, the study proposes an automated usability enhancement framework. It makes use of pattern mining tools and user-centered design (UCD) guidelines to understand the heterogeneous end-users and user-system interactions. Further, the framework is adapted to provide an e-Learning framework for the end-users for improved usability, learnability and ease-of adoption of the system. Such a system is capable to provide lifetime continuous feedback to the EHR system designer for system enhancement.

Through the experiments and user-studies, it can be concluded that the study provides easy-to-use high-level query languages for the domain-experts as well as the novice medical users to query the knowledge-based and patient-specific medical information repositories. The use of query languages allows the users to frame exact queries and receive results within the desired context. The experiments exhibit the strengths of the query-languages compared to the existing methods of search/query.

Limitations of the study include evaluation of the proposed systems (QBT, MXQBE - XQBE on MedlinePlus medical encyclopedia) over similar medical document repositories. For the proposed AQBE query language, more query functions (for population and epidemiological queries) need to be implemented to make it a complete database query language for the standardized EHRs database (using a NoSQL store). Implementation in real world setting and a usability study of the proposed query interfaces with actual physicians and clinicians will help to improve the system.

Summaries of the Dissertation Review Results

The candidate proposes relational database query languages for two instances of medical information repositories. The first instance considers the online medical document repository, MedlinePlus (knowledge-based medical information repository). For this, a mathematical model is proposed that maps

the repository on an XML schema. Over this, a graphical query language interface Query by segment tag (QBT) and existing XQBE graphical query language has been adapted. For the second instance, standardized EHRs databases are considered and an Archetype-By-Query Example (AQBE) query language has been proposed over them. The experiments and evaluation show the usability of the proposed languages for the healthcare experts.

During the final doctoral dissertation review, the committee examined the response to questions of the preliminary dissertation review and new contents included by the candidate, in detail. The questions that were not answered or partially addressed were few and did not form a major exclusion of detail. Overall, the review committee members expressed a favorable opinion that the candidate has acquired an ability to do independent research activity and pass the applicant for doctoral degree. There were some minor modifications to be made before submission of final draft of the thesis.

The candidate Ms. Aastha Madaan (d8131102) has completed the changes in the draft of the thesis report as per the guidelines. The report containing item-by-item description of changes as per suggestions during final review has been submitted. The candidate has implemented the entire set of recommendations satisfactorily.

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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 CI 博第 41 号
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Dissertation Title 論文題目	Global Social Service Network Construction and Application to Service Composition and Recommendation グローバル・ソーシャル・サービスネットワーク構築ならびにサービス合成と推薦手法への応用
Dissertation Review Committee Members 論文審査委員	University of Aizu, Senior Associate Prof. PAIK, Incheon (Chief Referee) University of Aizu, Prof. BHALLA, Subhash University of Aizu, Prof. VAZHENIN, Alexander University of Aizu, Senior Associate Prof. NARUSE Keitaro 会津大学上級准教授 白 寅天(主査) 会津大学教授 バーラ サバシュ 会津大学教授 ヴァジェニン アレンクサンダー 会津大学上級准教授 成瀬 継太郎

Abstract

Web services have had a tremendous impact on the Web as a potential silver bullet for supporting a distributed service-based economy on a global scale. However, despite the outstanding progress, their uptake on a Web scale has been significantly less than initially anticipated. The isolation of services, the lack of social relationships among related services, inadequate trade-offs between the expressivity and semantics of the service descriptions, and poor scalability, exponentially expanded search time in large search spaces, have been identified as reasons for the poor uptake.

In this thesis, we propose connecting the isolated service islands into a global social service network to enhance the services' sociability for service discovery, recommendation and composition on a global scale. First, linked social service-specific principles is proposed based on linked data principles for publishing services on the open Web as linked social services; then, social link is proposed for linking distributed services according to the quality of social link. Next, a new framework is suggested for constructing the global social service network following linked social service-specific principles based on complex network theories; then some approaches are proposed to enable the exploitation of the global social service network, providing new value-added applications: Link-as-you-go, Workflow-as-a-Service, Recommendation-as-a-Service. Finally, experimental results show that Our approach can solve the quality of service discovery, recommendation and composition problem, improving both the scalability issue, sociability issue and the success rate by exploring service-to-service based on the global social service network.

Summaries of the Dissertation Review Results

Study of the candidate proposes a novel method to locate, compose, and recommend services to new service developers with global service network. The thesis is suggesting the new concept of service network to link service though four attributes: functionality, non-functionality, past social interactions and popularity. When a user (i.e. service developer) tries to seek a service, the user can get it by traveling the network. A new workflow can be obtained by travelling with objective function on service clusters of the network (GSSN in the thesis).

The approach is contrasted with the existing approaches such as semantic-based or QoS-based approaches. Experimental result shows the proposed approach is outperformed the existing approaches. The thesis is very excellent in the points of novelty, originality, theory, and experimental evaluation.

The first version of presentation was in short of research motivation details and has some minor mistakes. The applicant has improved the points very well in the final review.

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