様　式　Ｃ－１９、Ｆ－１９－１、Ｚ－１９　（共通）

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研究課題名（和文）オンラインコース教材におけるメディアストリームの部分検索のための量子論適用の研究

研究課題名（英文）Application of Quantum Theory to Partial Retrieval of Online Course Materials

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研究成果の概要（和文）：本研究では、オンラインコース教材を管理するために3つの異なるデータモデルの開発を行った。 また、これまで開発してきたクエリ演算に加えて、検索結果をより効率的に計算するために新しい演算も定義した。さらに、検索結果をより効果的に提示するために量子に基づいた確率順位付けモデルの提案を行った。特に、量子論に基づくinterferenceの概念は、検索結果のランク付けの不確実性を反映するために導入した。

研究成果の学術的意義や社会的意義
The results obtained from this research are believed to pave a way for a better ranking mechanism, especially in the field of Online Learning Material Retrieval Systems. This can be considered as a major academic contribution of this research.

研究成果の概要（英文）：In this research, three different data models were developed to organize and manage Online Course Materials. In addition to our previous query operations, new ones were defined to compute search results more efficiently. Moreover, quantum based probability ranking principle was proposed to present the search results more effectively. In particular, the notion of interference based on quantum theory was introduced to reflect the uncertainty of ranking of search results.

研究分野：データベース

キーワード：Online Course Materials　Query Model　Data Model　Quantum Theory　Information Retrieval　Ranking Principles

様　式　Ｃ－１９、Ｆ－１９－１、Ｚ－１９、ＣＫ－１９（共通）

## １．研究開始当初の背景

**In information retrieval (IR), quantum theory has been gaining a wide interest to be used to generalize the geometric, probabilistic, and logical-based IR models within a single mathematical formalism in complex Hilbert spaces. Various key concepts from quantum mechanics find their analogy in the IR field.**

**On the other hand, in recent years, prestigious universities such as Massachusetts University of the United States, Stanford University and the University of Tokyo of Japan, are offering Online Courses by providing teaching materials in various media formats such as presentation (slides), electronic textbooks and even lecture videos. However, there are yet no available tools to search for specific units of these media. Neither are there any means to guide a user to suggest and navigate through related media units. As the volume of these Online Course Materials is expected to keep growing, retrieval of specific information units will ultimately become essential.**

## ２．研究の目的

**Online Course Materials generally consist of media in various forms such as digital textbooks, slides, audios and even videos. In addition, information contained in each media may not be complete in itself. Usually, information in a particular part of a certain media is semantically related to a certain part of another media. These related parts of media complement each other and when they are presented to users as an organic unit, the users are expected to acquire a better understanding of the learning contents. The issue then is, given a set of keywords as search criteria, how to compute these organic units effectively that would satisfy the user's information need. The main objective of this research is to develop a formal framework for retrieving such organic units of Online Course Materials by adopting certain principles of quantum mechanics.**

## ３．研究の方法

**Given a user's information need, one of the important tasks in a typical IR system is to develop a formal theory to estimate the probability of relevance of a document. Rankings based on Probability Ranking Principles (PRP) are often implemented to present search results in decreasing order of their relevance probability, which would achieve an optimal retrieval performance. However, it is generally assumed that the relevance of a document to a user's information need is independent of other documents. And this is where conventional rankings based on PRP often fail. This is because the judgment of relevance of a document by a particular user, in most cases, is influenced by his or her recent activity. Moreover, in certain cases, a user's perception about a document is affected by his or her knowledge about that particular information as well.**

**This research is an attempt to implement a quantum based probability ranking principle in an Online Course Materials Retrieval System (OCMRS). The key difference of this approach is that this principle makes no assumption that the relevance of an information unit is to a user is completely independent of other information units.**

**We first considered three different models to represent information units of various media that can be available in an OCMRS. An information unit is defined as the smallest physical unit of a media that can be automatically identified such a slide of a presentation file, a page of a digital textbook, or a shot of a video. Usually, users expect to retrieve a meaningful organic unit which consists of consecutive information units. These information units may be extracted either from a single media or they may even consist of units from different related media.**

1. **Two Dimensional Data Model**
   **This model has been adopted from our earlier research. In this model, all related media are mapped in a 2 dimensional space. Each media has its own temporal dimension. Related units of cross media are mapped using a special algorithm beforehand. Given a set of keywords as a query, operations are first performed to compute a meaningful portion of this 2d space. Quantum based probability ranking principle is then applied to rank the result.**

2. **Graph-based Data Model**
   **In this model, each information unit is represented a node of a graph. Related information units are joined by edges of the graph. Given a set of keywords as a query, algebraic operations are performed to compute a meaningful subgraph. Quantum based probability ranking principle is then applied to rank the result.**

3. **Quantum-based Data Model**
   **In this model, each unit of media is represented on its own temporal dimension. However, unlike in 2d Model, no semantic mappings are performed beforehand. Given a set of keywords as a query, operations are performed to compute a meaningful portion of each media stream.** The concept of '**interference**' ba**sed on quantum mechanics is then applied during the rankings of the result. The topmost candidate is calculated as in a conventional one based on probability ranking principle. However, the rest of the candidates are calculated according the following two criteria.**

1. **The interference is negative if the following candidate is from a different media stream. This is based on the assumption that materials in different media streams usually complement each other.**
2. **The interference is positive if the following candidate is of the same media type. This is based on the assumptions that users would have a better understanding by getting more similar types of information regarding the query.**

**These models are still at early stages and experiments using real world data are to be carried out to verify the effectiveness of these approaches.**

## ４．研究成果

**The main contributions of this research are:**

1. **Different data models were developed to organize and manage Online Course Materials**
2. **Various new query operations were defined to compute search results efficiently.**
3. **Quantum based Probability Ranking Principle was proposed to present the search results more effectively.**

## ５．主な発表論文等

〔雑誌論文〕（計　**0**　件）

〔学会発表〕（計　**0**　件）

〔図書〕（計　**0**　件）

〔産業財産権〕
○出願状況（計　**0**　件）

名称：
発明者：
権利者：
種類：
番号：
出願年：
国内外の別：

○取得状況（計　**0**　件）

名称：
発明者：
権利者：
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番号：
取得年：
国内外の別：

〔その他〕
ホームページ等

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