Multimedia Question Banks: Storage and Retrieval Techniques

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Abstract

Multimedia question banks consist of questions combined with multimedia features. The questions are often grouped and referred to a common object (i.e., images, graphics, video / audio recording). When only one or some of the questions are selected from a set of correlated questions, it will be ideal if only the parts relevant to the questions are presented. This arrangement can be very complex as some questions do not refer to a single segment of the object. Furthermore, some objects have their elements tightly coupled which gives an impact that they cannot be split but must be presented together. The storage and retrieval techniques are discussed in this paper.

Keywords

question banks, multimedia, data storage, information retrieval, object-oriented, message passing

1. Introduction

The idea of *question bank* has been attractive to educators, as time spent in preparation and marking examinations will be greatly reduced. Conventional question banks consist of structured questions, such as true / false or multiple choice questions, which are mainly independent of each other and represented in text. Since multimedia technology has become more available, a broader range of questions can be set. *Multimedia* is composed of different medium, including images, graphics, audio and video (Christodoulakis and Koveos, 1995). Adding these elements to questions makes handling multimedia question banks much more complicated.

It is common that a set of questions is grouped and refers to a particular object (i.e., image, graphics, text document, or audio / video). A major problem arises when only one or some of the questions on an object are selected at random. It may be confusing to the examinees if all parts of the object are displayed. It would be ideal if only the parts relevant to the questions listed are presented. This way it will be explicit to the examinees exactly what parts of the object the question is referring to. It will assist the examinees to focus their attention on the answers required. For example, there is an image with parts numbered for four questions. With random selection, only questions two and three may be displayed. The parts numbered for the other two questions will serve to confuse the students as they are not relevant to the questions. In this paper, we intend to investigate the storage and retrieval techniques to deal with these issues.

In *hypermedia*, links are used to join question text with objects (Elmasri and Navathe, 1994). This technique is insufficient as the object is represented as a unit. Our approach is to present an object as an *aggregate* of its components (Dillon and Tan, 1993). Consequently, each question within a group could just refer to the necessary object components. Additionally, inference rules must be occupied as selected questions within a group might not refer to neighbouring object components (e.g., extreme parts of a voice recording). As it is significant to show a global picture of the object, intermediate object components must also be included. However, one must be aware that the final object presented must display the minimum information necessary to enable the examinees to be clear about what is required. At the same time there must be enough information to cover all parts relevant to the questions.

There are two main techniques for question retrieval. The first is based on objects. The questions can be then selected manually. The second is based on questions, where the referred objects (or object parts) are *intelligently* retrieved by the system. Either way, examiners must be able to do content-based searching and complete database browsing. Content-based searching techniques for text can be based on keywords or topics, together with level of difficulty, whilst object searching must employ more sophisticated matching techniques.

The rest of this paper is organized as follows. Section 2 describes a type of multimedia questions which becomes a central problem to be solved in this paper. Section 3 explains the storage techniques, while section 4 presents the retrieval techniques. Finally, section 5 gives the conclusions and discusses potential future work.

2. Multimedia Questions

The two main parts of multimedia questions are *object* and *question parts.* An object can be in a form of image, recording, text, or any unstructured data. The object is the main focus in which questions in the question part are referring to. These objects can be either *time* or *spatial dimensional*. *Time dimensional* objects are objects that span on a linear dimension. An example of a time dimensional object is a recording of any type, such as audio, visual. These objects fill in a single dimensional space which is the duration of the play. A key feature of this kind of object is that there is a starting point and an ending point. To illustrate a time dimensional object, consider figure 1 as an example. As time dimension is not possible to be presented on paper, figure 1 shows a moment of an audio-visual recording only. The current time position within the recording duration is also shown.

Spatial dimensional objects are static. They can be presented on x and y axis, or columns and rows. Some examples include images, graphics, text, etc. Figure 2 shows an example of a spatial dimensional object, that is a picture of an engine. All questions in that section refer to the picture. When the object does not fit into the provided space, a scroll bar is shown to enable users to scroll the object.

The *question part* consists of a set of questions referring to an object. The questions can be either *point* or *multipoint* questions. A *point question* is a question which has a reference to a single segment of an object. If the object is a time dimensional object, point questions relate to a ‘moment’ of the play. The ‘moment’ can be interpreted as a section that cannot be divided into more sections. The question could be a question on what was said, or where it took place, etc. If the object is a spatial dimensional object, point questions refer to a section of an image / picture. For example, a question can be asked about a part of an engine, or a block of a landscape.

```
Questions 1 through 8 are based on the following video
recording.
```

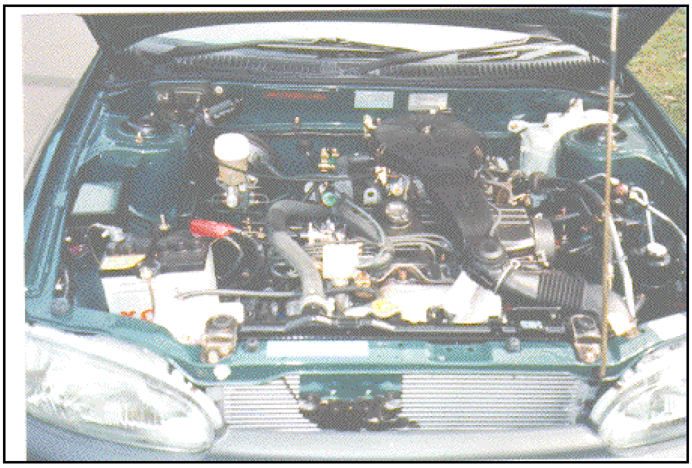
Time:

39%

*Questions:*1. ....
2. ....
....
8. ....

Figure 1. Questions with a time dimensional object.

Questions 1-10 refer to the following picture.



*Questions:*1. ....
2. ....
....
10. ....

Figure 2. Questions with a spatial dimensional object.

As opposed to point questions, *multipoint questions* have reference to several sections of an object. The referred sections can be in *serial* or at *random*. Serial multipoint questions associate with a series of adjacent sections. If it is in a time-dimensional object, the sections are contiguous.

However, in a spatial dimensional object, adjacent sections can be clustered based on columns or rows. On the other hand, random multipoint questions link with several sections of an object in random order. In an extreme case, a question refers to the starting point and ending point of a recording. Therefore, when this question is selected, all parts of the recording must be played. This similar technique applies to spatial dimensional objects as well.

3. Storage Techniques

Time dimensional objects can be stored using single dimensional arrays or object aggregation, whereas spatial dimensional objects are stored using two dimensional arrays or tree structures. The *question part* and the *object part* in the question bank are stored separately. Each *part* contains the *content* together with some *properties* and the necessary operations to communicate with each other. Figure 3 shows a graphical notation of the relationship between the question part and the object part. This type of notation is commonly used in the context of object-orientation (Taniar, 1992).

The object part is implemented as an *inheritance* hierarchy where specialization follows the path down the hierarchy. In this way, new types of multimedia objects can be easily added to the current schema. When an object is created or accessed, the control goes directly to the concerned *class*—video, audio, etc. This *polymorphic* feature is also a result of the inheritance feature.

The `Object_Part` is responsible for the following operations:

- *Creation of new objects*. Each time a new object is created, the `Object_Part` stores all important properties of the object (title, size, colour, etc) and creates an object identifier for that particular object. Depending on the type of the object, the content of the object will be stored into an appropriate class, i.e., `class video`, `class audio`, etc.

- *Set up linking between object's segments*. Each object in the question bank is divided into segments and the 'link' between segments is taken care of by the object. This implies that each question can relate to any particular parts of an object simply by calling the object identifier plus the boundary identifiers of the object segments as its parameters. The referred object is responsible for linking its segments. The boundary identifiers for both time and spatial dimensional objects can be represented by at least two points, i.e., the starting and the stopping points.

- *Display an object (based on the object identifier) and display some segments of an object (based on some boundary identifiers)***.** Each time a question is accessed, the associated object is also accessed. Each question sends a message to a particular object or to some particular segments of an object. The question does not have to know the linking process of the segments or the process of displaying the object, because all of these operations are handled by the object itself. The question calls the associated object / segments every time it is accessed, and the object part displays the called objects based on the parameters sent by the questions. If the question only sends an object identifier as a parameter, the whole object of that particular identifier will be displayed. If the parameters include an object identifier and some boundary identifiers, only some segments of the identified object will be displayed, in which the segments displayed are based on the boundary identifiers.

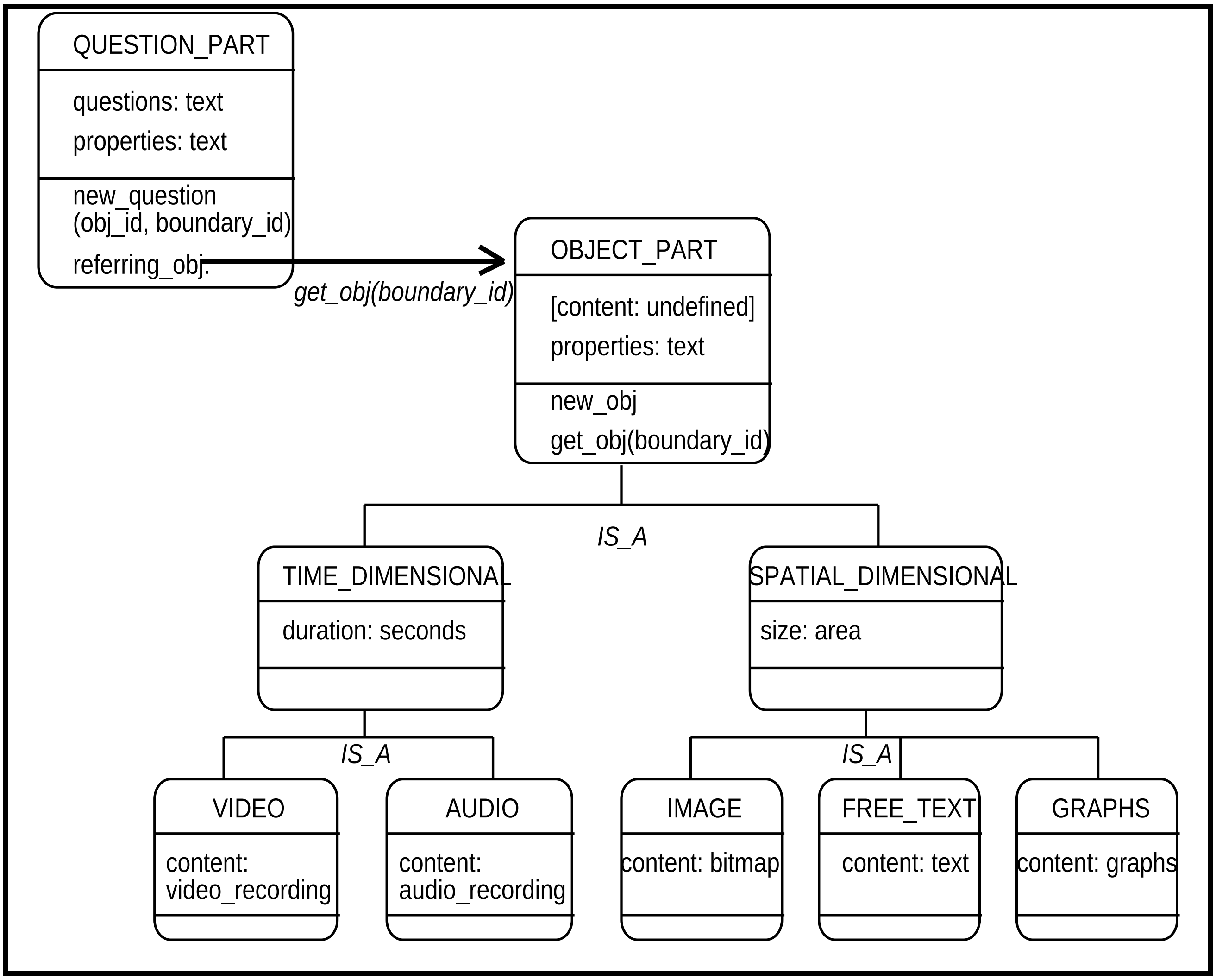


Figure 3. The relationship between the *question part* and the *object part*.

4. Retrieval Techniques

Question retrieval should be bi-directional, i.e., from the object parts or from the question parts. As a result, searching techniques should facilitate both object based and question-based.

4.1 Object-based retrieval techniques

Content-based searching of multimedia objects are considered immature as current video and audio management tools are based on pixel rather than the perceived contents (Smoliar and Zhang, 1994). Current research in the areas of image and pattern recognition is addressing this problem. As each object part consists of two attributes—`content` and other `properties`, in which the `content` attribute contains the body of object and the `properties` attribute consists of additional information about the object itself, e.g. title, topic—it is possible to search based on the properties of the objects. Therefore, users can do a search based on frame numbers, titles, time codes, etc., but not the content of the attribute objects. Another alternative is by applying the knowledge-based technology (Smoliar and Zhang, 1994), that is, to make the systems have some degrees of intelligence / knowledge about the objects, and these are stored together with the object itself.

If the number of objects in the database is small, searching can be done through a complete browsing of all objects. Once the objects are selected, the associated questions are then presented and chosen. Associated questions are implemented as an aggregate of its object parts. Therefore, each object has a number of corresponding questions.

4.2 Question-based retrieval techniques

Selecting questions from a question bank can be done through a query language which retrieves questions satisfying the selection criteria. This selection can be done through keywords or subject matching. Content-based searching is also possible for questions because they are stored in structured data organization.

Another retrieval technique is based on database browsing. Users are presented with a complete list of all questions in the database, and then the questions are chosen manually. This primitive filtering technique will be very useful when combined with content-based searching, as the content-based searching often lists more questions than needed. Therefore, an additional step is needed to further filter the questions. These techniques are similar to techniques used by most library electronic catalogues, where users can search on categories combined with complex Boolean operations.

Once the questions are selected, the accompanying objects are also retrieved. This mechanism is possible because each question is attached to an object. The question only needs to send a message `get_obj` with parameters, that is the boundary of the object. The object that is referred to will subsequently invoke its method to find out all its intermediate parts. Using this method, random multipoint questions will only need to select the necessary points of the required object, and they will construct a complete object to be presented together with the question. This *encapsulation* prevents each question from the complexity of forming the desired object.

5. Conclusions and Further Work

Multimedia has been gaining popularity among computer literates. In this paper, we aim at utilizing this technology to help educators in preparing and presenting questions for examinations. This paper concentrates on a type of multimedia questions where a set of correlated questions refer to an object. When an appropriate object storage technique is applied, data retrieval can be efficient, and furthermore, complex object retrieval can be made possible.

An implementation of a multimedia question bank is being planned at Swinburne in the near future. Some factors however are not mentioned in this paper, such as level of difficulty of each question; it would be ideal if the composition of the test ranges from the easiest to the hardest. We will also consider other types of multimedia questions, where the question itself is not text-based, but composed of other forms of medium, such as voice, graphs.

Research is underway to employ some techniques to search multimedia objects from a database. A neat query requirement must be formulated before advanced searching techniques can be developed.

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