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Implementation of Multimedia Search & Management System Based on Remote Education*

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Abstract. In order for remote education using multimedia to be effective, an efficient management technique for video information needs to be developed. Therefore, for real-time processing of moving images, it is necessary to manage and search image data in a compressed state. MPEG-4 is the most widely used video compression technology. In order to process video in real time in distance education using multimedia, it is very important to develop a technique for managing and retrieving video information compressed with MPEG-4. Therefore, in this paper, a multimedia information management system and search technology were developed using MPEG-4 compression technology used for real-time distance education.

Keywords: Multimedia, MPEG, Remote Education, Video search, Compressed video.

1. Introduction

With the recent development of the Internet and the Web, the demand for multimedia, especially video information, is rapidly increasing. As object-oriented database-based multimedia database systems are being developed, they are in the stage of utilizing them in various multimedia authoring systems. Among them, many studies are being conducted on the storage and retrieval of multimedia information, especially video information [1].

However, the management of moving picture information using such a multimedia DBMS is a method of managing the search target bitmap or wave pattern in an uncompressed state. However, due to the nature of video, it is difficult to store, retrieve, or transmit uncompressed natural video as it is [2].

Therefore, in order to solve these problems and put it into practice in the video management system, a technology that compresses and stores video information, and searches and transmits the video information in real time in a compressed state, is required [3].

In this paper, we develop a compressed video management system that compresses video information with MPEG-4 technology, stores it in a database system, and searches

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using query words or representative images (key frames). In addition, annotation-based search and content-based search for video information search were used. Content-based search can automatically extract shape, texture, and movement from data features. Annotation-based search uses natural language processing to extract and provide semantic information of video data. This technique is modeled in various ways by easily extracting various features of moving picture data [4-6].

In this paper, we propose an Integrated Video Data Model (IVDM) that can use both annotation-based search and content-based search by analyzing general video data for real-time video search. This study made it possible to search various real-time images. And to improve the real-time image processing capability, MPEG-4 technology was applied to improve the compression capability.

This paper designed and implemented Compressed Video Information Management System (CVIMS) using Mpeg-4 compression technology. CVIMS consists of 3 layers. Layer 1 consists of user interface and layer 2 consists of video processing. Video processing is classified into movie display, caption/figure description editor, and query processor. Layer 3 consists of DBMS to store data.

In Section 2 of this paper, a related study is proposed, and in Section 3, an improved video data model is proposed. In Section 4, we designed a compressed image data management system, and in Section 5, we implemented the system. In Section 6, an integrated data model system was proposed, and in Section 7, a new image scheme was designed. Finally, in Section 8, conclusions and future tasks are presented.

2. Related Studies

Methods for storing and retrieving video data can be broadly divided into content-based search and annotation-based search.

Content-based search is a method of searching for the meaning of video data by extracting color, shape, and movement from each frame of the video, and searching based on this. Although this method shows good search results for a specific domain, it is difficult to extract the general meaning contained in the video data, and in the case of a compressed map image, it is inefficient in terms of performance because it must be decompressed and searched for image extraction [7-10].

The video data is largely composed of image, audio, and writing data. The image is what allows the listener to see the instructor's face. In this case, the visual effect can be increased. Audio and image data processing uses a compressed file after compression using a multimedia compression tool. For other writing data, when the lecturer draws a line or draws a rectangle on the screen, the actions are expressed by objectifying them. The act of changing the currently active page is also made possible to be expressed as a single object.

Annotation-based search is a method in which a person first grasps the meaning of video data, expresses it using natural language, and searches based on this. This method makes it possible to easily model various meanings of video material that are difficult to find with an automated method, and make them available for search. On the other hand, it is easy to lose the consistency of the video material because annotations can be given or interpreted differently depending on the user's point of view. In particular, it becomes more and more difficult to maintain consistency when it is intended to give a very detailed comment rather than a comprehensive comment [11-14].

Therefore, it is necessary to find a way to integrate these two techniques. At this time, in order to support the two search methods in a form suitable for the user's needs, it is necessary to develop an integrated data model above all else.

Recently, a multi-layered video model (MLVD) has been proposed for a search that integrates these two techniques. The MLVM model maintains independence for each layer and implements a query processor that does not depend on a specific method of content-based or annotation-based search, and suggests a model related to video data search. However, this paper proposes an integrated model for video management, accepts a part of the MLVM model in the search, and presents a method to approach the user's needs even though it has a step-by-step dependency. In this paper, a general video data model is proposed for efficient management of video documents, and research has been conducted on the development of an MPEG-4 compressed video document management system that supports only annotation-based search based on this [15-18].

However, in this paper, an integrated video data model that supports and manages annotation-based search and content-based search at the same time is presented, and based on this model, a system for managing compressed video information using an object-relational database in a client/server environment is developed. do. In this case, a plug-in technique is also used for use on the web.

3. Extended Video Data Model

Movies are stored in a movie database as successive groups of frames called storage movie segments. Thus, a drawing image is represented by a video stream mapped into one or more stored video segments [19-22].

IVDM was created with the concept of structural components related to the semantic units of a moving picture document. The concept of structural component is subdivided into compound unit, sequence, scene and shot, and these subclasses are defined in a hierarchical relationship with each other. A shot consists of one or more consecutive frames, and appears as a temporal and spatial sequence of actions. A scene is made up of several sets, and a sequence is made up of these scenes. A collection of related sequences constitutes a compound unit again, and the compound unit can refer to itself at an arbitrary level. The video search structure is divided into two stages: a stage that supports annotation-based search and a stage that supports content-based search.

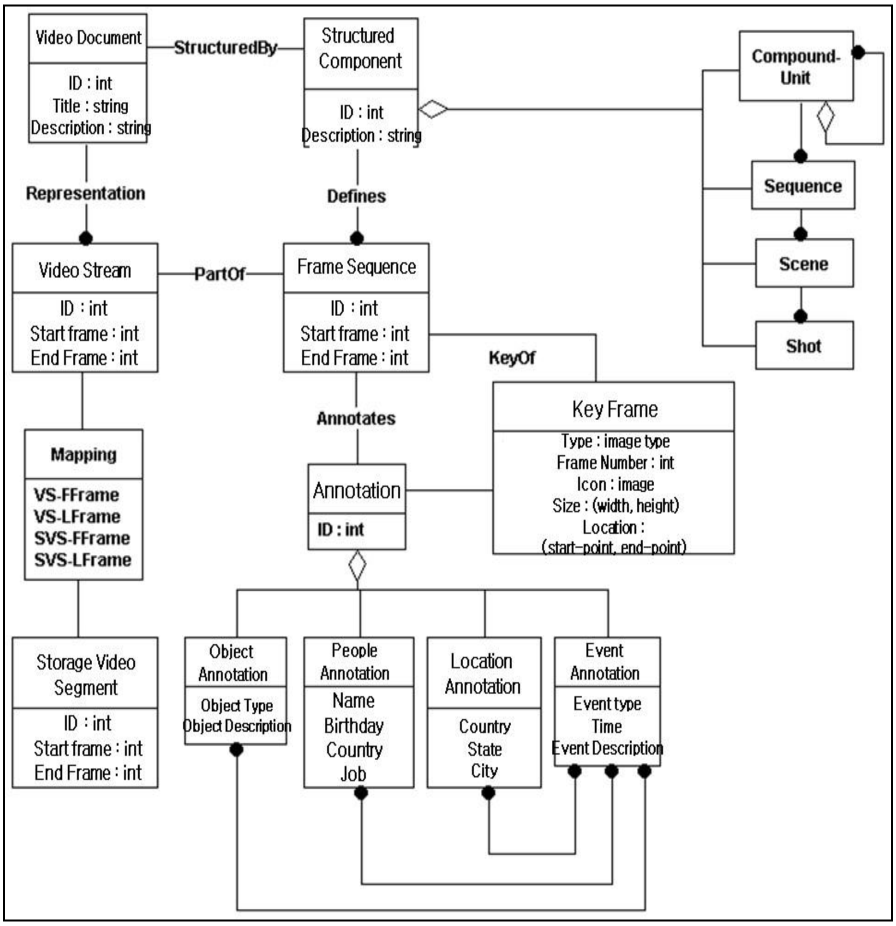

Fig. 1. Data Model of Video Information using Object Diagram

Fig. 1 shows a data model of moving picture information using an object diagram. The object diagram (OMT) shown in Fig. 1 was supplemented by adding a key frame management module and use of Dublin Core metadata [23].

(1) Key frame management module

(2) Utilize Dublin Core metadata for object annotation management

The Enhanced Generic Video Data Model (EGVDM) is a frame that provides functions for structuring video data, free annotation of video data, and sharing and reusing video data. it is work in EGVDM, moving picture data is a continuous group of frames called stored video segments.

The frame sequence in Fig. 1 is classified into an annotation object and a key frame object. A key frame object extracts a specific representative image from a frame sequence and consists of image, image type, frame number, size, and location information about it. Annotation objects include object annotation, person annotation, and location annotation. It consists of subclasses of location annotation and event annotation. Object annotation consists of object type and object description. In this paper, object annotation is defined using Dublin Core-based metadata. That is, an object annotation is defined by a title, a subject, an identifier, a relation, a right, a language, a document format, and the like [24].

4. Design of Compressed Video Information Management System (CVIMS)

Compressed video information management that extracts key frames from MPEG-4 compressed video data based on the video data model presented above, adds captions and picture descriptions, and stores them in the database in text format for management The system (CVIMS) was designed [25].

4.1. Index Structure for MPEG-4

MPEG-4 compressed video files are mainly composed of three types: I-frames, P-frames, and B-frames [26]. A double I-frame is a frame compressed using only a spatial compression technique without using a temporal compression technique. Therefore, since the I-frame can be independently decoded and can be accessed randomly, it can be a reference frame. Therefore, CVIMS assumes that all I-frames in the MPEG-4 compressed video file can be key frame candidates. Based on this assumption, CVIMS provides a way for users to directly select key frames by extracting I-frames from MPEG-4 compressed video. In addition, the search for each video is not performed by actual frame, but caption information for each key frame is created, structured together with the key frame, stored in the database, and then search is performed using the caption information [27].

Fig. 2 shows the relationship between the index structure and caption for MPEG-4 moving pictures. Technically, after extracting a key frame from a video, it was searched by attaching a caption that processes the contents of the key frame through image recognition.

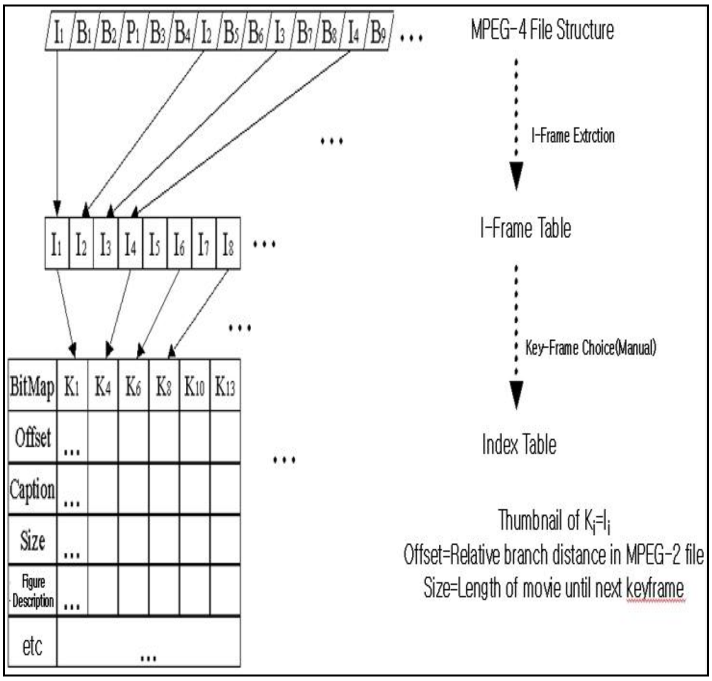

Fig. 2. Structure of MPEG-4 File and Index Information

4.2. Overall Structure of CVIMS

CVIMS includes a user interface and a caption and picture description editor that can index MPEG-4 video, a query processor that processes various user queries, a video display that displays query results, a database that manages index data and video data, and it is composed of a storage server that stores MPEG-4 video [28].

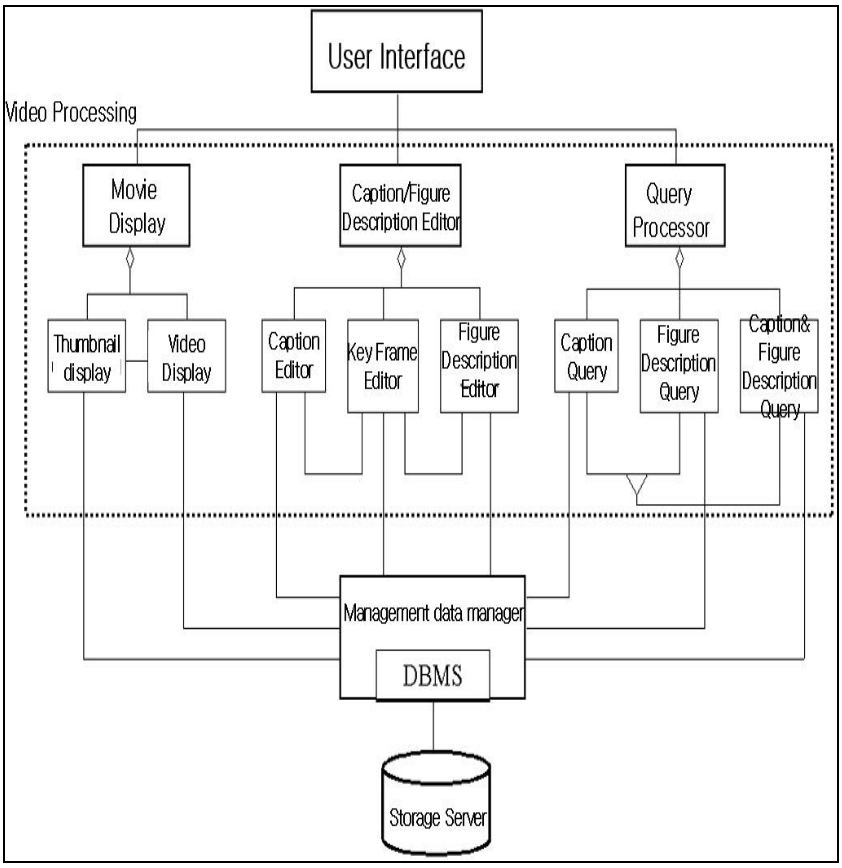

Fig. 3. CVIMS design diagram

Fig. 3 shows the components of CVIMS and subclasses and relationships of each component. VIMS is largely composed of user interface, video processor, and management data manager. The video processor again consists of a query processor, caption/picture description editor, and video display. According to the query type, the query processor consists of a caption query, a picture description query machine, and a query machine that combines captions and picture descriptions. It accepts the user's query, searches each object managed by the management data manager, and brings the desired result. The caption/picture description editor selects keyframes from the list of pre-decoded I-frames, writes caption information and picture description information for each keyframe, and stores them in the database. The video display is a part that displays the query result and is classified into a thumbnail display that outputs an icon in the form of a thumbnail picture and a video display that displays an actual video. Lastly, the management data manager manages the information stored in the database, and manages various index information and caption/picture description information created in the editor [29].

5. Implementation Result of CVIMS

Section 5 shows the implementation result of CVIMS designed in Section 4, focusing on the user interface screen.

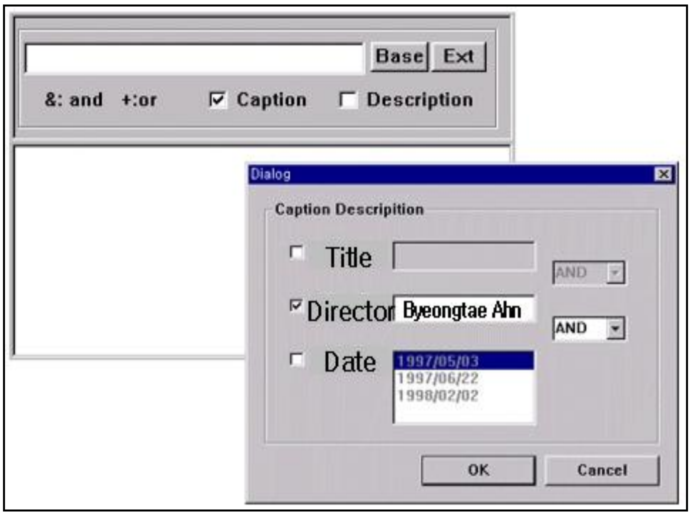

Fig. 4. Keyword Input Screen

Fig. 4 shows a screen in which search conditions and search keywords are entered after clicking basic search in the search window. In this window, set the items to be searched using check boxes and list boxes, and enter keywords for each selected item.

The user's query processing in the search window makes a query to the actual database through the following SQL statement [30].

▶ Simple query

```
  select * from caption_info
where title = search term [and(or) author = search term]
[and(or) madeday = search term]
    select * from picture_desc
where main1_content = search term [and(or)
main2_content = search term] [and(or) content = search word]
```

▶ Complex query

```
    Join Caption_info and Picture_desc tables
```

The results of query processing are shown in Fig. 5.

It appears in the form of a compressed picture as shown in Figure 5.

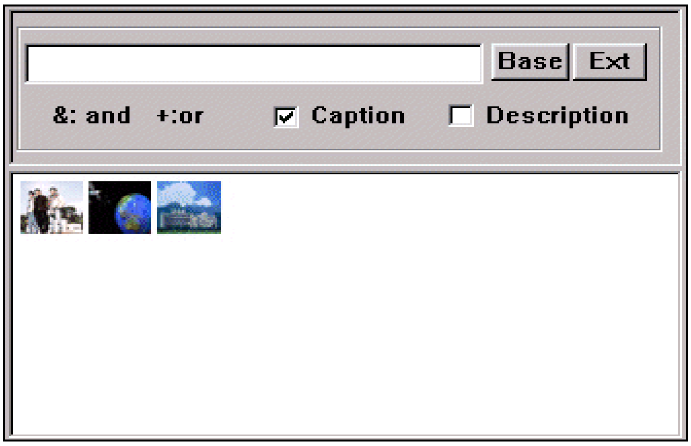

Fig. 5. Output Screen of Retrieval Result

Searching through the web also performs a search using caption information for a video, in the form of first selecting a desired item and then entering a search term for the selected item. At this time, the input search word is transmitted to the database in the form of a query word through the CGI program, and the search result is displayed on the web as an html document. If you click the compressed picture of the video you want here, the video with this thumbnail as a key frame is displayed, and the displayed video system is operated as a Netscape plug-in.

6. Unified Video Data Model (IVDM)

In order to search and manage videos efficiently, it is necessary to share the compressed video itself, related annotations, and image analysis results as an integrated database. To do this, it is necessary to create a general standard model and manage various and vast amounts of compressed video. Therefore, this section proposes an Integrated Video Data Model (IVDM) for video information management. By structuring video data, IVDM supports free annotation-based search for various video data at a high level and content-based search at a lower level.

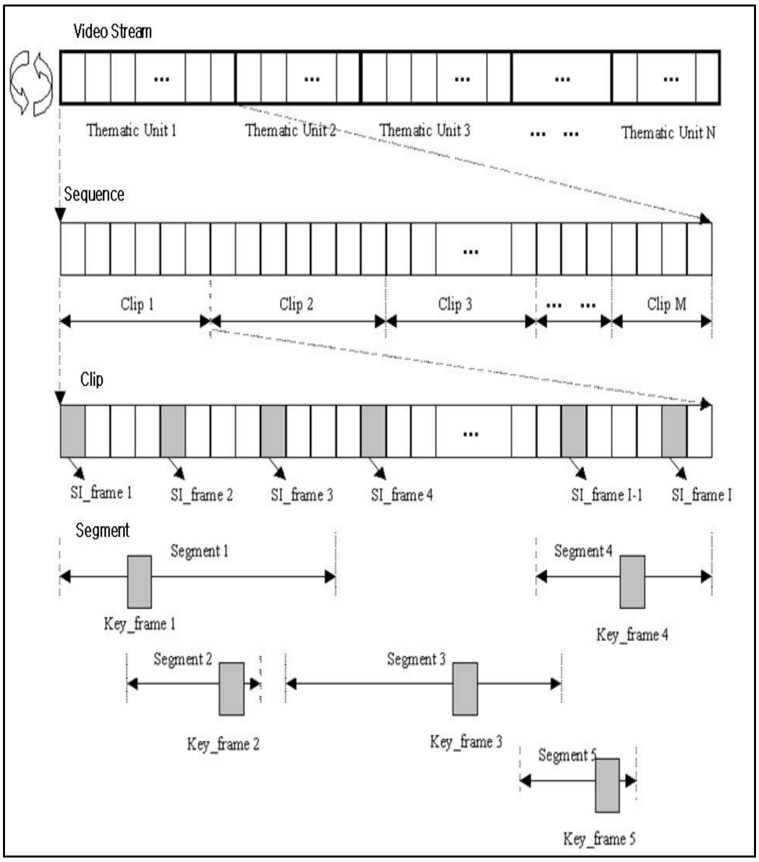

Fig. 6. Partition process for extraction characteristic of video

Fig. 6 shows the process of dividing a general video. The segmentation process is performed on the premise that the video stream belongs to one of these categories when moving pictures are classified into movies, news, dramas, video conferences, and the like. The whole news becomes a video stream, and sharing by topic, event, or reporter becomes a topic unit, and the circular arrow on the left can be repeatedly divided up to several levels. In this case, the number of repetitions may vary depending on the type of video, and the number or size of subject units may also vary depending on the type or subject of the video. In Figure 6, the smallest subject unit is expressed as a sequence. In connection with the previous example, the sequence becomes the content of a reporter's coverage. The sequence is again divided into scenes, where the scene corresponds to the part divided according to whether the reporter's coverage is a simple incident scene or an interview scene. Frames are extracted at regular intervals from this scene to search the flow order of moving pictures, that is, time dimension, and are called SI(Same Interval)_frames. For spatial-dimensional search, each scene is divided into segments where the target object exists, and the frame in which the target object appears most clearly is used as the key-frame. In the extracted SI_frame, the movement of the camera or object is analyzed, and in the key-frame, color, shape, texture, etc. are analyzed and used for search.

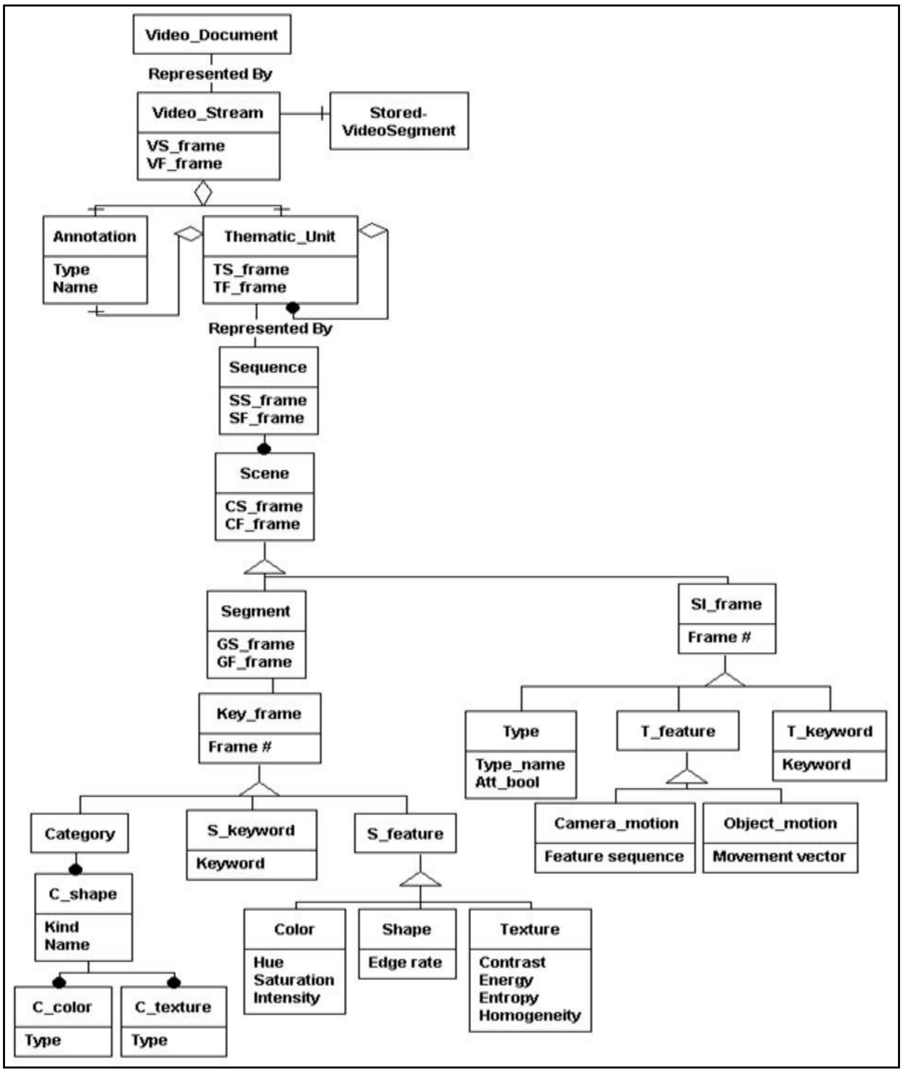

Fig. 7. OMT Object Diagram of IVDM

Through the process shown in Fig. 6, we propose an integrated video data model (IVDM) as shown in Fig. 7. Fig. 7 shows the OMT object diagram of the Integrated Video Data Model (IVDM). The OMT object diagram represents classes and their relationships, which is well suited to the design of databases.

Video_Document is expressed 1:1 again as Video_Stream, which is composed of one or more Stored_Video Streams and is stored in the database. In this case, Video_Stream has two attributes indicating the start frame and the end frame. As a part relationship (part_of) between Video_Steam and Annotation and Thematic_Unit, the set of one or more Annotation and Thematic_Unit becomes Video_Stream. Thematic_Unit may or may not contain a smaller Thematic_Unit again, and like Video_Stream, it is composed of one or more Annotations. As a generalization relationship (is_a) between a Scene and a Segment and SI_frame, the Scene can be expressed again as a Segment or SI_frame. SI_frame can be expressed as Type, T_feature, and T_keyword, respectively, and T_feature is generalized to Camera_Motion and Object_Motion again. Segment is in reference relationship with Key_frame, and this Key_frame can be expressed again as Category, S_keyword, and S_feature.

7. Schema Design for News Videos

In Section 7, we design the schema structure and query type of the news video based on the IVDM model and examine the processing process. In actual implementation, Informix, an object-relational DBMS, was used to manage index information, and the user interface was implemented using Visual C++ [15].

7.1. Schema Structure of News Videos

In Section 1, based on the IVDM model, a news video that can be a representative example of a video was designed to be implemented in an object-oriented database.

Fig. 8 shows the structure of the news video schema. The upper part of each square box is the class name of the database, and the lower part is the properties of each class. In the news video schema, each subclass inherits the properties of the top video class, such as start frame, end frame, and oid of actual video data. And news, theme, event, reporter, and scene classes are connected by properties with oid in order as classes for annotation-based search. Classes below scene are for content-based search. Key_frame and lower are for spatial search, and SI_frame and lower are classes for time dimension. The class for using the automated method through the actual image analysis algorithm is the class below s_feature or t_feature.

7.2. The Process of Searching for News Videos

Fig. 9 shows the actual processing process of news video search. Fig. 9 is a case of news video compressed with MPEG-4, and it is largely composed of a user interface, video processing module, and data storage. The user interface is again divided into index editor, video searcher and video player. The video processing module is the process from the user interface to accessing the actual video data or related information in the DBMS, the data storage, in order to respond to the user's request. The role of the index editor is to annotate each topic for content-based video search in later comments and I-frames, and extract SI_frame and Key_frame.

In the video searcher, there is a difference in the search method depending on whether the data input for the search is in the form of text, an image, or a video. When the search word is in the form of text, it is searched when the word exactly matches the data given in the form of a keyword, movement type, or category among annotation data assigned to each subject or content-based search. However, when image or video data is input as a query, color, shape, texture, and movement are analyzed in the query image as in the case of analyzing frames for content-based search and compared with the characteristic data stored in the database.

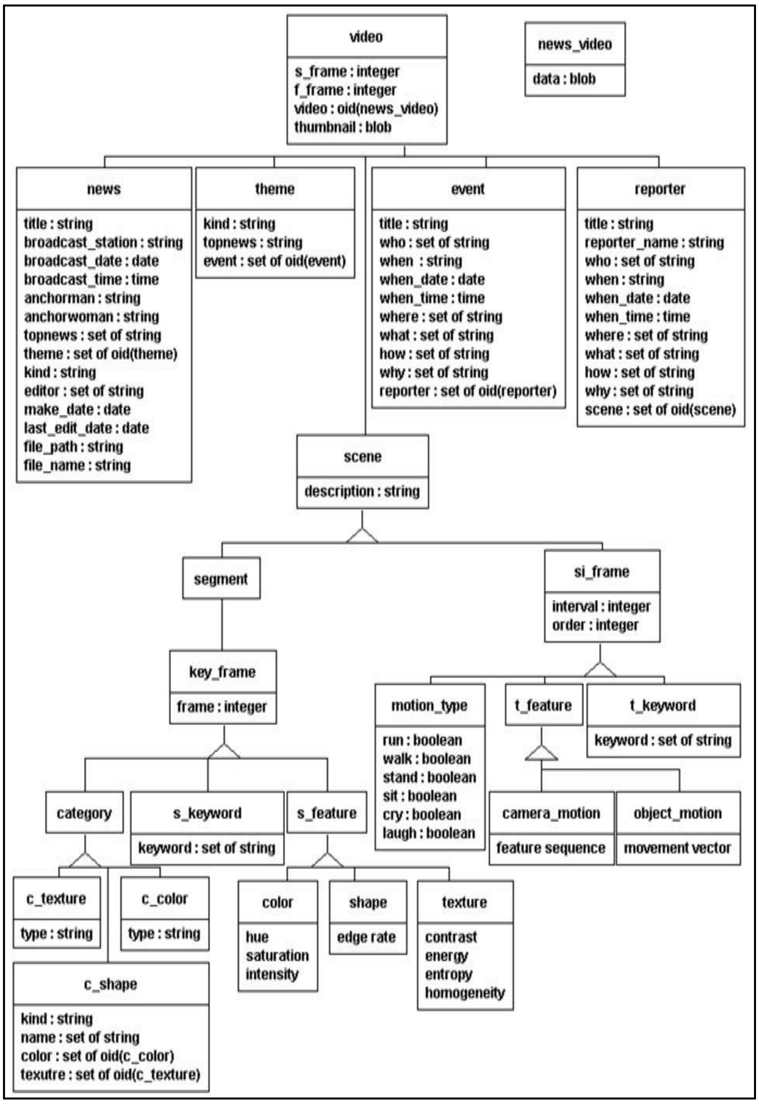

Fig. 8. Schema Structure of News Video

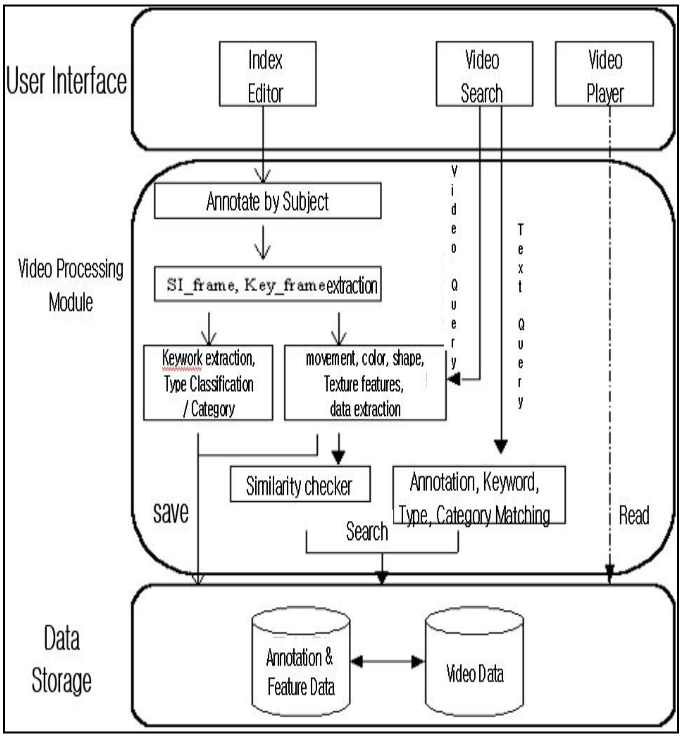

Fig. 9. News Video Search Process

The following shows the actual query, its processing process, and search results in order.

▶ Question: Among sports events that took place in December 1998, search for information about Se-ri Pak swinging and Chan-ho Park pitching.

▶ Query processing process:

```
 Ref1 := SELECT * FROM theme WHERE (when_date>='12/1/1998') AND
(when_date<='12/31/1998') AND (kind = 'sport');
 Ref2 := SELECT * FROM motion_type WHERE (swing = True) OR
(throw = True);
 Ref3 := SELECT * FROM c_shape WHERE (name IN 'Park Chan-ho') OR
(name IN 'Seri Pak');
Temp := Compare(Ref1, Ref2);
Result := Compare(Temp, Ref3);
```

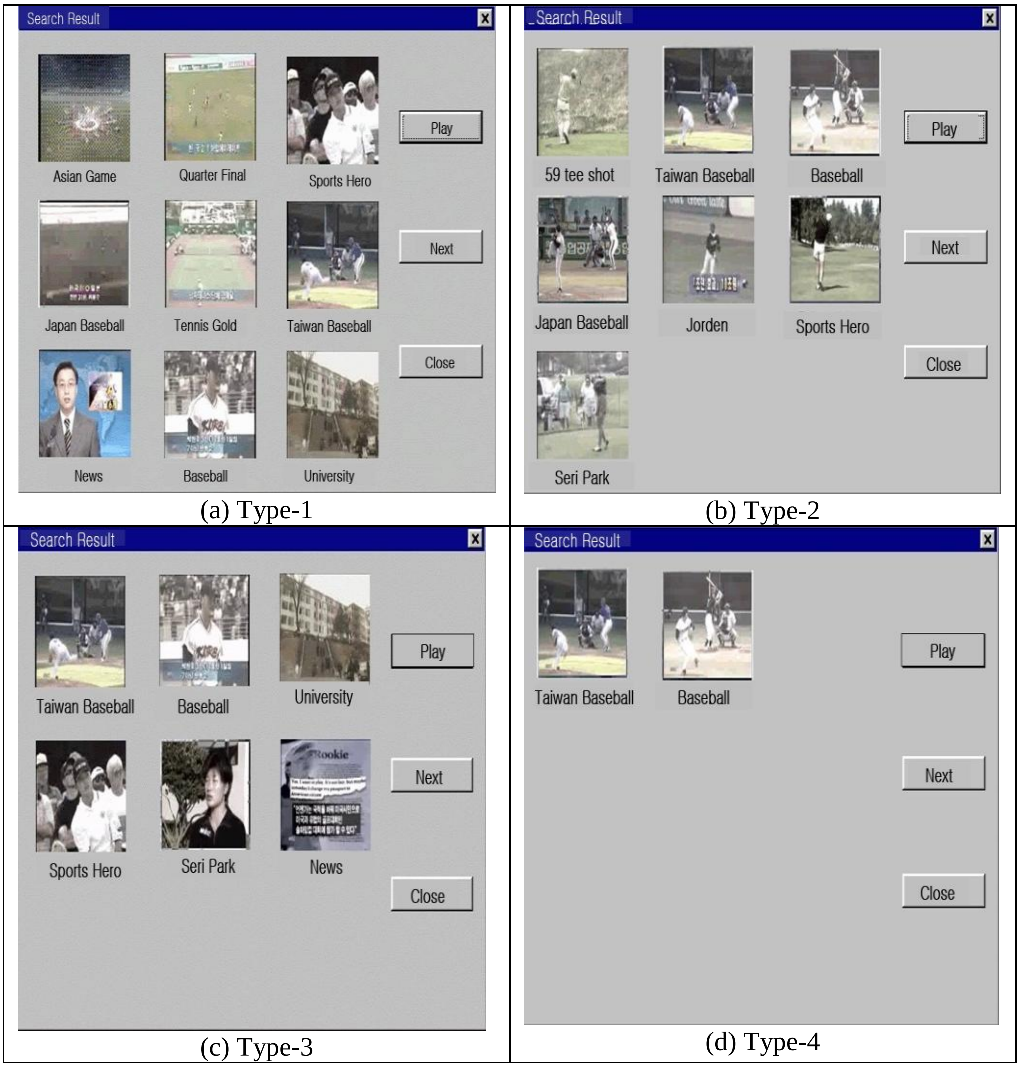

Fig. 10. Query Results for Videos

► Fig. 10(a) is the contents of Ref1, which is a Type-1(annotation-based) query result, and Fig. 10(b) is the contents of Ref2, which is a Type-2(SI_frame based) query result. Fig. 10(c) is the contents of Ref3 of Type-3(Key-frame based) query result. And Fig. 10(d) is the content of the final result of the Type-4 query that integrates the above three.

8. Conclusions and Future Challenges

In this paper, EGVDM (Enhanced Generic Video Data Model) is implemented by extending the video data model, and based on this, a prototype of compressed video information management system (CVIMS) that can manage MPEG-4 compressed video is designed and implemented. And based on this model, we designed an object-oriented database schema using news video as an example.

As a future task, not only index information but also image data itself should be structured and stored in the database. In order to structure the image data itself, the image data must be objectified, and an object-oriented database supporting objectification must be further developed. In addition, it is necessary to standardize the category of Key_frame and the type of SI_frame among the sub-scene structures for content-based search.

References

1. Mark Anthony Camilleri & Adriana Caterina Camilleri, The Acceptance of Learning Management Systems and Video Conferencing Technologies: Lessons Learned from COVID-19, Technology, Knowledge and learning 27, (2022) 1311-1333.
2. W. Zhu, et al., Evaluation of sino foreign cooperative education project using orthogonal sine cosine optimized kernel extreme learning machine, IEEE Access 8 (2020) 61107–61123, https://doi.org/10.1109/ACCESS.2020.2981968.
3. O Kuchai, K Skyba and A Demchenko, The importance of multimedia education in the information of society, IJCSNS VOL 22, No. 4, (2022) 797-803.
4. L.O. Seman, G. Gomes, R. Hausmann, CC-CCjs: a javascript web based application for education on basic converters, IEEE Latin Am. Trans. 13 (Aug. (8)) (2021) 2715–2722, https://doi.org/10.1109/TLA.2015.7332154.
5. Z. Gingl, G. Makan, J. Mellar, G. Vadai, R. Mingesz, Phonocardiography and photoplethysmography with simple arduino setups to support interdisciplinary STEM education, IEEE Access 7 (2019) 88970–88985, https://doi.org/10.1109/ACCESS.2019.2926519.
6. Y.A.M. Qasem, R. Abdullah, Y.Y. Jusoh, R. Atan, S. Asadi, Cloud computing adoption in higher education institutions: a systematic review, IEEE Access 7 (2019) 63722–63744, https://doi.org/10.1109/ACCESS.2019.2916234.
7. N.J. Martarelli, M.S. Nagano, Socioeconomic class of brazilian cities for health, education and employment & income IFDM: a clustering data analysis, IEEE Latin Am. Trans. 14 (3) (2016) 1513–1518, https://doi.org/10.1109/TLA.2016.7459643.
8. M.A. Cohen, G.O. Niemeyer, D.S. Callaway, Griddle: video gaming for power system education, IEEE Trans. Power Syst. 32 (July (4)) (2020) 3069–3077, https://doi.org/10.1109/TPWRS.2016.2618887.
9. J. Zheng, Q. Zhang, S. Xu, H. Peng, Q. Wu, Cognition-based context-aware cloud computing for intelligent robotic systems in mobile education, IEEE Access 6 (2018) 49103–49111, https://doi.org/10.1109/ACCESS.2018.2867880.
10. S.D. Assimonis, V. Fusco, RF energy harvesting with dense rectenna-arrays using electrically small rectennas suitable for IoT 5G embedded sensor nodes, in: 2018 IEEE MTT-S International Microwave Workshop Series on 5G Hardware and System Technologies (IMWS-5G), Dublin, 2018, pp. 1–3, https://doi.org/10.1109/IMWS-5G.2018.8484384.

11. Andreu Vaillo, Y., Murgui Perez, S., Martínez Lopez, P., Romero Retes, R., 2021. Mini-mental adjustment to cancer scale: construct validation in Spanish breast cancer patients. J. Psychosom. Res. 114, 38–44. https://doi.org/10.1016/j. jpsychores.2018.09.004.
12. Annunziata, M.A., Muzzatti, B., Bidoli, E., Flaiban, C., Bomben, F., Piccinin, M., Gipponi, K.M., Mariutti, G., Busato, S., Mella, S., 2022. Hospital Anxiety and Depression Scale (HADS) accuracy in cancer patients. Support. Care Canc 28, 3921–3926. https://doi.org/10.1007/s00520-019-05244-8.
13. K.T.D. Nguyen, C. Huang, An intelligent parallel algorithm for online virtual network embedding, in: 2019 International Conference on Computer, Information and Telecommunication Systems (CITS), Beijing, China, 2019, pp. 1–5, https://doi.org/10.1109/CITS.2019.8862072.
14. N. Ericsson, T. Lennvall, J. Åkerberg, M. Bj ¨orkman, A flexible communication stack design for time sensitive embedded systems, in: 2017 IEEE International Conference on Industrial Technology (ICIT), Toronto, ON, 2017, pp. 1112–1117, https://doi.org/10.1109/ICIT.2017.7915518.
15. D. Punia, B. Singh, Study of high-performance RFIC designs with efficient PA architectures for 5G networks, in: 2019 10th International Conference on Computing, Communication and Networking Technologies (ICCCNT), Kanpur, India, 2022, pp. 1–5, https://doi.org/10.1109/ICCCNT45670.2019.8944582.
16. J. Cui, X. Zhang, H. Zhong, Z. Ying, L. Liu, RSMA: reputation system-based lightweight message authentication framework and protocol for 5g-enabled vehicular networks, IEEE Internet Things J. 6 (4) (2019) 6417–6428, https://doi.org/10.1109/JIOT.2019.2895136. Aug.
17. A. Fendt, C. Mannweiler, L.C. Schmelz, B. Bauer, An efficient model for mobile network slice embedding under resource uncertainty, in: 2019 16th International Symposium on Wireless Communication Systems (ISWCS), Oulu, Finland, 2019, pp. 602–606, https://doi.org/10.1109/ISWCS.2019.8877372.
18. M. Dawson, F.G. Martinez, P. Taveras, Framework for the development of virtual labs for industrial internet of things and hyperconnected systems, in: 2019 IEEE Learning With MOOCS (LWMOOCS), Milwaukee, WI, USA, 2019, pp. 196–198, https://doi.org/10.1109/LWMOOCS47620.2019.8939660.
19. G. Chen, J. Tang, J.P. Coon, Optimal routing for multihop social-based D2D communications in the internet of things, IEEE Internet Things J. 5 (3) (2018) 1880–1889, https://doi.org/10.1109/JIOT.2018.2817024. June.
20. Z. Han, A. Xu, Ecological evolution path of smart education platform based on deep learning and image detection, Microprocess. Microsyst. (2020), 103343, ISSN 0141-9331.
21. C. Wei, 5G-oriented IOT coverage enhancement and physical education resource management, Microprocess. Microsyst. (2020), 103366. ISSN 0141-9331.
22. T. Yamakawa, M. Hashiba, T. Koyama, K. Akazawa, Amethod to convert HDTV videos of broadcast satellite to RealSystem multimedia contents, J. Med. Syst. 26 (2002) 439—444.
23. Golaghaie, F., Esmaeili-Kalantari, S., Sarzaeem, M., Rafiei, F., 2021. Adherence to lifestyle changes after coronary artery bypass graft: outcome of preoperative peer education. Patient Educ. Counsel. 102, 2231–2237. https://doi.org/10.1016/j. pec.2019.07.019.
24. M.T. Chou, P. McGinnis, R. Tello, A web-based video tool for MR arthrography, Comput. Biol. Med. 33 (2003) 113—117.
25. R. Friedl, M.B. Preisack, W. Klas, T. Rose, S. Stracke, K.J. Quast, A. Hannekum, O. Godje, Virtual reality and 3D vi-sualizations in heart surgery education, Heart Surg. Forum 5 (2002) E17—E21.
26. T. Boudier, D.M. Shotton, Video on the Internet: an intro-duction to the digital encoding, compression, and trans-mission of moving image data, J. Struct. Biol. 125 (1999) 133—155.
27. M.J. Garcia, J.D. Thomas, N. Greenberg, J. Sandelski, C.Herrera, C. Mudd, J. Wicks, K. Spencer, A. Neumann, B.Sankpal, J. Soble, Comparison of MPEG-1digital videotape with

digitized sVHS videotape for quantitative echocardio-graphic measurements, J. Am. Soc. Echocardiogr. 14 (2001) 114—121.

28. K. Spencer, L. Solomon, V. Mor-Avi, K. Dean, L. Weinert, M.Gulati, A. Herle, A. Spiegel, B. Balasia, T. Pionke, L. Sieb,R.M. Lang, Effects of MPEG compression on the quality and diagnostic accuracy of digital echocardiography studies, J.Am. Soc. Echocardiogr. 13 (2000) 51—57.
29. K. Spencer, L. Weinert, V. Mor-Avi, K. Dean, B. Bala-sia, L. Solomon, T. Pionke, L. Sieb, R.M. Lang, Electronic transmission of digital echocardiographic studies: effects of MPEG compression, Int. J. Cardiol. 15/75 (2000) 141—145.
30. J.S. Soble, G. Yurow, R. Brar, T. Stamos, A. Neumann, M. Garcia, M.F. Stoddard, P.K. Cherian, B. Bhamb, J.D. Thomas, Comparison of MPEG digital video with super VHS tape for diagnostic echocardiographic readings, J. Am. Soc. Echocardiogr. 11 (1998) 819—825.

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