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Multimedia Data Mining and its Relevance Today - An Overview

Sujata Kundu[1], Anirban Bhar[2], Shyamapriya Chatterjee[3], Soumya Bhattacharyya[4]
[1,2,3,4]*Assistant Professor, Department of Information Technology, Narula Institute of Technology, Kolkata, India*

***Abstract*: Nowadays, multimedia technology is widely applied in everywhere. Data quarrying or mining is an effective and powerful approach for extracting hidden information from enormous collections of synchronized digital data stored in databases. In digital library Data mining is the key technology. It is required to retrieve the information of text and manage and also retrieve the video information. Multimedia Data Mining is the technique to be used to discover the implicit, effective, valuable and intelligible pattern from a large amount of multimedia data by analyzing the feature of seeing and hearing and then to discover knowledge and obtain the tendency and association among the events. And it can also provide us the ability of decision supporting to resolve the problem. This paper discusses the basic theories of Data Mining and its current approaches.**

***Keywords*: Data Mining, Multimedia Mining, Architectures, Applications, Models.**

1. Introduction

Data mining refers to the process of finding interesting patterns in data that are not ordinarily accessible by rudimentary queries and associated results with the objective of using discovered patterns to improve decision making. Multimedia data mining is helps to extract knowledge from multimedia data sets like audio, video, images, graphics, speech, text and combination of several types of data sets. Text data can be used in web browsers, messages like MMS and SMS. Image data can be used in art work and pictures with text still images taken by a digital camera. Audio data contains sound, MP3 songs, speech and music. Video data include time aligned sequence of frames, MPEG videos from desktops, cell phones, video cameras etc.

2. What is Multimedia Data Mining

Data mining is the analysis step of the "Knowledge Discovery in Databases" process, or KDD. Extraction of information is not the only process we need to perform; data mining also involves other processes such as Data Cleaning, Data Integration, Data Transformation, Data Mining, Pattern Evaluation and Data Presentation. Figure 1 illustrates multimedia data mining

3. Categories of multimedia data mining

The multimedia data mining is classified into two broad categories as static media and dynamic media. Static media contains text and images. Dynamic media contains Audio and Video. Multimedia mining refers to analysis of large amount of multimedia information in order to extract patterns based on their statistical relationships. Figure 2 shows the categories of multimedia data mining.

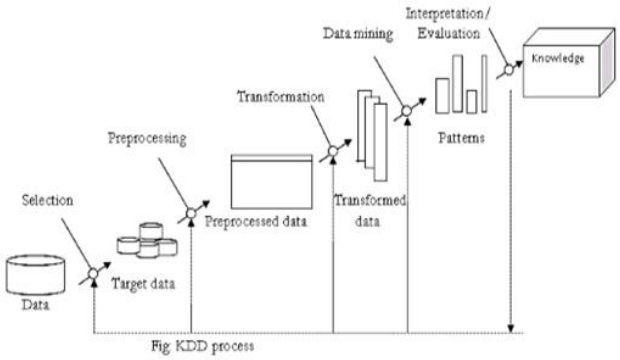

Fig. 1. KDD process

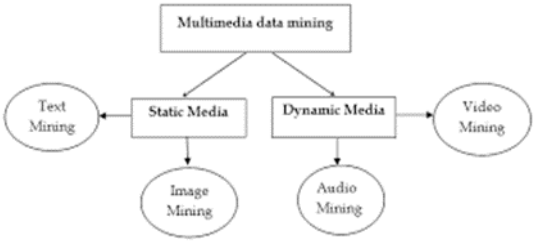

Fig. 2. Categories of multimedia data mining

Text mining: Text Mining also referred as text data mining and it is used to find meaningful information from the unstructured texts that are from various sources. Text is the foremost general medium for the proper exchange of information [3]. Text Mining is to evaluate huge amount of usual language text and it detects exact patterns to find useful information.

Image mining: Image mining systems can discover meaningful information or image patterns from a huge collection of images. Image mining determines how low level pixel representation consists of a raw image or image sequence can be handled to recognize high-level spatial objects and relationship [14]. It includes digital image processing, image understanding, database, AI and so on.

Video Mining: Video mining is unsubstantiated to find the interesting patterns from large amount of video data; multimedia data is video data such as text, image, and metadata,

visual and audio. The processing are indexing, automatic segmentation, content-based retrieval, classification and detecting triggers. It is commonly used in various applications like security and surveillance, entertainment, medicine, sports and education programs [15].

Audio mining: Audio mining plays an important role in multimedia applications, is a technique by which the content of an audio signal can be automatically searched, analyzed and rotten with wavelet transformation. Band energy, zero crossing rate, pitch period and band-width are often used features for audio processing [2]. It is generally used in the field of automatic speech recognition, where the analysis efforts to find any speech within the audio [11].

4. Multimedia databases

It includes video, images, audio and text media. It can be stored on extended object-relational or object-oriented databases, or simply on a file system. Multimedia is becoming increasingly available on the World Wide Web which can be viewed as a large and distributed multimedia database.

5. Multimedia data mining process

Figure-3 shows present architecture which includes the types of multimedia mining process [19]. Data Collection is the initial stage of the learning system; Pre-processing is to extract significant features from raw data, it includes data cleaning, transformation, normalization, feature extraction, etc. Learning can be direct, if informative types can be recognized at pre-processing stage. Complete process depends extremely on the nature of raw data and difficulty's field. The product of pre-processing is the training set. Specified training set, a learning model has to be selected to learn from it and make multimedia model is more constant.

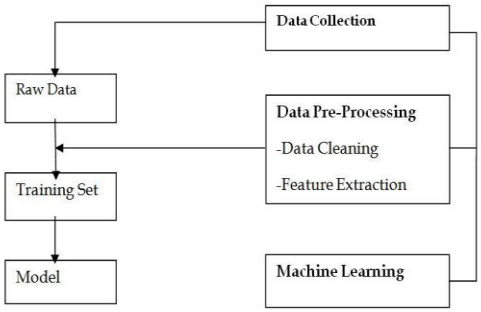

Fig. 3. Multimedia data mining process

6. Data Warehousing

A data warehouse is constructed by integrating the data from multiple heterogeneous sources. An enterprise data warehouse is a database used for reporting and data analysis. Integrating data from one or more disparate sources creates a central repository of data, a data warehouse. It supports analytical reporting, structured and/or ad hoc queries, and decision making. Data warehousing involves data cleaning, data integration, and data consolidations. The typical extract-transform-load based data warehouse uses staging, data integration, and access layers to house its key functions. The staging layer or staging database stores raw data extracted from each of the disparate source data systems. The integration layer integrates the disparate data sets by transforming the data from the staging layer often storing this transformed data in an operational data store database. The integrated data are then moved to yet another database, often called the data warehouse database, where the data is arranged into hierarchical groups often called dimensions and into facts and aggregate facts.

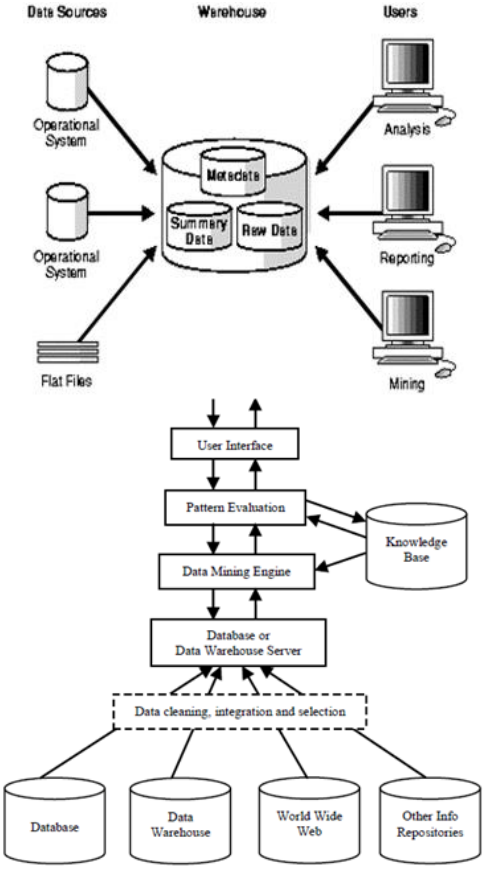

Fig. 4. Data warehouse

7. Multimedia data mining goals and methods

Dissecting a set of objects, uncovering rules, decision trees, pattern recognition, trend prediction, and dimensionality reduction are some goals in Multimedia data mining [3].

A. Dissecting a Set of objects

The most popular goal in data mining is dissecting a set of objects which is described by high-dimensional data into small comprehensive units, classes, substructures, or parts. These substructures give better understanding and control, and based on suitable information can assign a new situation to one of these classes, which can be classified as supervised or unsupervised. Each object originates from one of the predefined classes and is described by a data vector. But it is unknown to which class the object belongs, and this class must be reconstructed from the data vector. In unsupervised classification (clustering), according to the object content

without a priori knowledge a new object is classified into a cluster of objects. It used in multimedia data mining early processes.

B. Uncovering rules

An association rule method is used if goal of multimedia data mining is to be expressed as uncovering interesting rules [3]. An association rule takes a form of an implication X→Y, where X and Y denote antecedent and consequent of the rules respectively. X and Y belong to set of objects I, X ∩ Y = Φ, and D denotes a set of cases. We describe support s and confidence c as two parameters. The rule X→Y has support s in D, where s% of the data cases in D contains both X and Y and the rule holds confidence c in D, where c% of the data cases in D that support X also support Y. Association rule mining selects rules which have support greater than user-specified minimum support threshold. Confidence of the rule is at least from 0 to 1 confidence threshold. An association rule mining algorithm works in two steps:

1. Finds all large item sets that meet the minimum support constraint
2. It generates rules from all large item sets that satisfy the minimum confidence constraints.

8. Data mining versus multimedia data mining

Current data mining tools operate on structured data, resides in large relational databases whereas data in multimedia databases are semi structured or unstructured. Compared with data mining, multimedia mining reaches much higher complexity resulting from the huge volume of data, the variability and heterogeneity of the multimedia data such as diversity of sensors, time or conditions of acquisition the content meaning of multimedia is subjective.

Unstructured data: It is simply a bit stream. For example, pixel level representation of images, video and audio, and character level representation for text. To extract semantics from this data substantial processing and interpretation are required. It is difficult to interpret the database as this kind of data is not broken down into smaller logical structures.

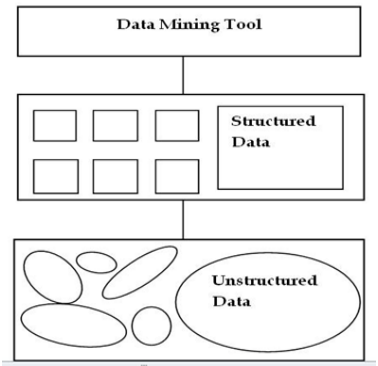

Fig. 5. Unstructured Data to Structured Data Conversion

9. Architectures for multimedia data mining

The architecture of multimedia data mining has several components like input, multimedia content, spatiotemporal segmentation, feature extraction, finding the similar patterns and evaluation of results.

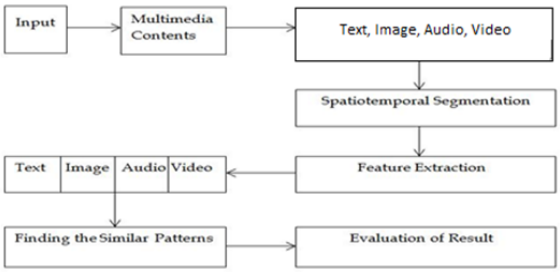

Fig. 6. Multimedia data mining architecture

Data collection is the starting point of a learning system, as the quality of raw data determines the overall achievable performance. Then, the goal of data pre-processing is to discover important features from raw data. Data pre-processing includes data cleaning, normalization, transformation, feature selection, etc.

1. Input stage comprises which multimedia database is used for finding the patterns and to perform data mining process.
2. Multimedia Content is the data selection stage which requires the user to select the databases, subset of fields or data to be used for data mining.
3. Spatio-temporal segmentation is nothing but moving objects in image sequences in the videos and it is useful for object segmentation.
4. Feature extraction is the pre-processing step that involves integrating data from various sources and making choices regarding characterizing or coding certain data fields to serve when inputs to the pattern finding stage. Such representation of choices is required because certain fields could include data at various levels and not considered for finding the similar pattern stage. In multimedia data mining the preprocessing stage is significant since the unstructured nature of multimedia records.
5. Finding the similar pattern stage is the heart of the whole data mining process. The hidden patterns and trends in the data are basically uncovered in this stage. Some approaches of finding similar pattern stage contain association, classification, clustering, regression, time-series analysis and visualization.
6. Evaluation of Results is a data mining process used to evaluate the results and this is important to determine whether prior stage must be revisited or not. This stage consists of reporting and makes use of the extracted knowledge to produce new actions or products and services or marketing strategies [8].

10. Issues in multimedia data mining

Before multimedia data mining develops into a conventional, mature and trusted discipline some issues have to be addressed. These issues pertain to be the multimedia data mining approaches and their limitations. Major Issues in multimedia data mining includes content based retrieval and similarity search which are integrated with mining methods,

generalization and multidimensional analysis, classification and prediction analysis, and mining associations in multimedia data [6]. Content based retrieval in multimedia is a challenging problem [7]. To gain insight into the meaning contained in databases is objective of multi-dimensional analysis. The multi-dimensional approach makes navigating the database easier, screening for a particular subset of data, or asking for data in a particular way, and being able to define analytical calculations. The speed of these operations is much quicker and more consistent than in other database structures as the data is physically stored in a multi-dimensional structure [8].

With features extracted from multimedia data an important issue is how features should be integrated for mining and other applications. On each modality most of the multimedia analysis is performed separately, and to arrive at the final decision about input data results are brought together at a later stage. This approach is called late fusion or decision-level fusion. This is a simple approach; we lose valuable information about the multimedia events or objects present in the date.

11. Approaches to multimedia data mining

The integration of storage and search techniques with standard data mining methods is required for multimedia database mining. Promising approaches [4] includes Construction of multimedia data cubes, the extraction of multiple features from multimedia data, and similarity based pattern searching.

Multimedia data cube: Primarily on the basis of visual content this facilitates multiple dimensional analyses of multimedia data. Multimedia Miner as a multimedia data mining system prototype has been designed and developed which includes the construction of a multimedia data cube that facilitates multiple dimensional analysis of multimedia data. The mining of multiple kinds of knowledge includes characterization (summarization), discrimination (comparison), classification, association and clustering, in image and video databases.

Feature extraction: To extract patterns and derive knowledge from large collections of images, audio and video it takes the information contained in multimedia data. Some features that are used include short-time energy, pause rate, zero-crossing rate, normalized harmonicity, fundamental frequency, frequency spectrum, bandwidth, spectral centroid, spectral roll-off frequency and band energy ratio [9].

Similarity based pattern searching: In multimedia retrieval and data mining Similarity search is a crucial task. It can be defined as searching for a set of similar objects to a given query object.

Database approach: This approach views multimedia data as structured. Manually or semi-automatically features are extracted. The features or attributes on unstructured data, entail a high level of abstraction. In the features the higher the level of abstraction, the lower the scope for ad-hoc queries.

12. Techniques of multimedia data mining

A. Multimedia data mining process using classification rules

In this approach, main focus is on discovering the semantic structures. We use the classification rule approaches to perform data mining process because this approach only induces absolutely accurate rules. Examples of this work are:

1. The hidden markov model.
2. Detection of soccer goal shots using decision tree.

B. Multimedia data mining process using clustering

Clustering is a process of organizing objects into groups whose members are similar in some way. It is one of the unsupervised learning data mining technique. In unsupervised classification, the problem is to group a given collection of unlabeled multimedia files into meaningful clusters according to the multimedia content without a prior knowledge. Recent works in this area are:

1. Unsupervised neural nets & staff organizing maps
2. Incremental clustering at various resolutions, using Haar Wavelet transforms and K- means

C. Multimedia data mining process using association rules

For discovering interesting relations between variables in large databases Association rule learning is a popular and well researched method. There are different types of associations which are association between image content and non image content features. Some early examples are:

- Image classification method by using multiple level association rules based on image objects.
- A multi relational extension to FP-tree algorithm to accomplish association rule mining task effectively.

D. Multimedia data mining through statistical modeling:

In this approach, a collection of annoted images is used to build models for joint distribution of probabilities that link image features and keywords [4]. An early example of this work is:

A simple occurrence model to establish links between words and partitioned image regions.

13. Applications of multimedia data mining

There are various applications [2] [9] of multimedia data mining some of which are as follows:

In digital libraries: The retrieval collection storage and preservation of digital data is performed in the digital library. To fulfill this purpose, there is a need to convert different formats of information such as text, images, video, audio, etc. While conversion of the multimedia files into the libraries data mining techniques are popular.

For traffic video sequences: To discover important but previously unknown knowledge the analysis and mining of traffic video sequences such as vehicle identification, traffic flow, queue temporal relations of the vehicle at intersection, provides an economic approach for daily traffic monitoring operations.

For automated event analysis of suspicious movements: Surveillance system to monitor movements of employees, visitors and machines are used in many government organizations, multi-nationals companies, shopping malls, banks. Which has an ultimate objective to detect suspicious person based on their movements to maintain security and avoid any casualty.

In medical analysis: Application of Data Mining techniques for Medical Image Classification is used.

Media production and broadcasting: Proliferation of radio stations and TV channels makes broadcasting companies to search for more efficient approaches for creating programs and monitoring their content.

Customer insight: It includes collecting and summarizing information about customers opinions, products or services, customers complains, customer‘s preferences, and the level of customer‘s satisfaction of products or services. Many companies have help desks or call centers that accept telephone calls from the customers. The audio data serve as an input for data mining to pursue the following goals are topic detection resource assignment and evaluation of quality of service.

Surveillance: Surveillance consists of collecting, analyzing, and summarizing audio, video, or audiovisual information about a particular area, such as battlefields, forests, agricultural areas, highways, parking lots, buildings, workshops, malls, retail stores, offices, homes, etc. [10]. Which is associated with intelligence, security, and law enforcement and the major uses of this technology are military, police, and private companies that provide security services. There are several goals of surveillance data mining like objector event detection or recognition, summarization and monitoring.

Intelligent content service: The Intelligent Content is a semantically smart content centric set of software services that enhance the relationship between information workers and computing systems by making sense of content, recognizing context, and understanding the end user’s requests for information‖ The multimedia data mining techniques can help to achieve the following goals are indexing web media and using advanced media search advanced web based services.

I. Knowledge Management: Many companies consider their archives of documents as a valuable asset. They spend a lot of money to maintain and provide access to their archives to employees. Besides text documents, these archives can contain drawings of designs, photos and other images, audio and video recording of meetings and multimedia data for training.

14. Conclusion

Multimedia data mining techniques are active and growing area of research now, in this paper we discussed data mining multimedia. We first described the motivation for multimedia-data mining with applications and then discussed different approaches for mining multimedia mining. This paper also describes well known applications for multimedia mining.

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