Multimedia and Decision-Making Process

Ovidiu-Alin DOBRICAN
West University of Timişoara, Romania
ovidiu.dobrican@feaa.uvt.ro

Multimedia technology has changed the way we use computers. Multimedia transforms computers into a second person. Multimedia technology has made it possible for us to see, hear, read, feel, and talk to computers. Multimedia technology has transformed our use and understanding of computers. On the other hand, multimedia presentation is one of the fastest-growing sectors of the computer industry. Applications have appeared in many areas, such as training, education, business presentation, merchandising, and communications.
Keywords: *multimedia, decision, studies, mining, architecture*

1 Introduction

The term multimedia has diverse meaning, depending on their use. It can mean the deployment of computers to deliver information as text, image, audio or video, but it could be also the capacity to manipulate and distribute content that includes image, audio or video via a communication device. By definition, multimedia includes the design, implementation, manipulation, storing, and delivering of various types of media to interested users [1].

Many of the business decisions require information displayed in a various presentation formats. Initially studies focused only on visual formats, such as text, tables, and graphics. Little attention was paid to non-traditional presentation formats, such as multimedia [2].

On the other hand computer feedback messages are usual texts. Such messages are impersonal and do not capture the user's attention. Multimedia technology represent then an opportunity to enrich the feedback. On the other hand, the rich information transmitted using multimedia and the smart aspect of the presentation might distract user's attention from the main message, thus decreasing the efficiency of the feedback [3].

Multimedia is divided into three major types:

- interactive multimedia - users control the delivery of the integrated elements;
- hypermedia - users can navigate through linked elements;
- liner multimedia such as TV where users haven't control over the flow of information.

Multimedia influences many aspects of our lives, so, we have [4]:

- Multimedia in business - presentations, training, marketing, advertising, product demos, simulations, catalogues, messages, network communications, video-conferencing. All these elements allow businesses to run smoothly and efficiency.
- Multimedia in schools - it switches the teaching process. The teacher will become a facilitator of learning, rather than the traditional role of provider of information and understanding.
- Multimedia at home - increasing convergence or melding of computer-based multimedia with entertainment and games.
- Multimedia in public places - in hotels, trains, malls, museums, multimedia is available as kiosk providing information and help to the consumers.
- Virtual reality - it is placed between technology and creative invention in multimedia.

On the other hand, Lim and Benbasat in [5] emphasize three characteristics of multimedia:

- there must be two or more representation modes or formats (text, graphics, video and sound) integrated into a single presentation;
- the user interacts with the multimedia presentation for some purpose (to solve a task or problem) and is not a passive viewer;

- the different representation formats must be used as sources of cognitive information.

In this paper we will introduce first the basic elements of multimedia and later we will emphasize some aspects of using multimedia elements in decision-making process.

2 Multimedia Elements

Text includes letters, words, sentences, and paragraphs to tell a story, state a fact, report an event, or convey an idea. It contains also numbers, punctuation, symbols, and special characters. It is the most used form of communication and is considered a basic element of visual multimedia [6]. The text appears in any form of multimedia presentation. Any page or picture label includes text that gives details to users on the information of such content. Text is still the dominant form for explaining what the application is or how to use it. Also, text use is more evident in the design of the GUI. So, the designers of multimedia projects have to choose carefully the few words that convey the idea, and they can also use other properties such as size, colour, and effects [7].

Image, from a multimedia point of view, is made up of picture elements called pixels with brightness and colour. It is a collection of dots (black-white or coloured), each with a value, and when they are placed next to each other, they form the entire image. Images are stored and exchanged in many standard formats such as the JPEG, GIF, BMP, PNG, TIFF, etc. [7].

Images are represented as a two-dimensional matrix of pixels where each pixel has a different representation (pixel depth), depending on the image type.

- Monochrome images or 1-Bit images - each pixel is represented by a single bit and a value (0 or 1), displayed with the colours white or black.
- Grey-level images or 8-Bit images - each pixel is stored as a single byte and has a value between 0 (black) and 255 (white) of grey colours.
- Colour images or 8-Bit colour images - each pixel is represented by 8-bit value with colours ranging from 0 to 255. These colours are a combination of the three basic colours: red, green, and blue (RGB). The main difference with the grey level image is that the pixel value is not a colour, but it is an address to the index of colours called LUT (look-up table) that is stored in the machine displaying the image.
- Colour image or 24-Bit colour images - each pixel is stored as three bytes of colour yielding large combinations of colours (16,777,216). Each image is represented as three two-dimensional arrays, one array for each of the three colour components (red, green, and blue).
- *Sound* is used in multimedia product: presentations, videoconferences, computer games, home theatre, etc. It consists of differences in pressure that produce waves that travel in all directions. Depending on its pressure and frequency level, if it reaches the ears, it is experienced as sound. An important step forward was made when the sound was digitalized. Digitizing is the process of converting a sound from the continuous form (analogue) into digital (discrete form) by taking a sample of the sound at a given time interval and storing it as an 8-bit or 16-bit data. The frequency of taking samples (sampling rate) affects the quality of the digitized. The most three common frequencies are: 11.025 kHz, 22.05 kHz, and 44.1 kHz. Sound files exist in many formats such as MIDI, MP3, WAV, WMA, MPEG audio. These formats require a media player that is capable of recognizing such formats. Another main advantage of digital sound is the ability to edit such files using digital audio editors [8].

Video is defined as a series of images (frames) put together and displayed one after the other to create the illusion of motion. The illusion of motion is created by displaying a number of frames per second where each frame contains a slight difference from the previous one, utilizing the vision persistence of the human eye, thus creating the feeling that the object is actually moving. Video is the most demanding multimedia elements in terms of storage and transmission, because of the large size of files [9]. Some of the most popular video standards include NTSC, PAL, SECAM.

With advancements in video use in computers, mobile phones, and the Internet, digital video become more and more popular. It has many advantages over analogue video, including:

- direct access;
- storage on reusable digital memory, which makes it easier to be edited and integrated into multimedia applications.

High Definition is the new standard in digital video, in which wider screens would give viewers an enhanced sense of vision and a better viewing pleasure.

A final aspect of multimedia components is how they can be delivered to the potentially users.

Multimedia products can be delivered using several types of portable devices such as CD (max. 900 MB), DVD (max. 8GB), or BD (max. 50 GB), or online, using communication networks and the Internet. A major problem of multimedia is then, the delivery of large amounts of data within the limitations of networks and storage capabilities. A solution to this problem is compression, which is a process of obtaining a significant reduction in data size in order to reduce storage requirements and bandwidth limitations.

Compression algorithms are based on reducing redundancies that exist in all multimedia data and on exploiting the limitations of the human visual and hearing system.

Compression techniques can be lossless compression (reconstructed data after decompression is the same as the data before compression) and lossy (reconstructed data is not equal to the original data) [9].

Redundancy reduction types are:

- symbol-level redundancy and block-level redundancy - used for text lossless compression;
- inter-pixel spatial redundancy and inter-pixel temporal redundancy - used in image and video lossy compression.

Some examples of compression formats are: MP3, WMA, MPEG audio, JPEG and GIF standard image, MOV, WMV, MPEG1, 2 video, and newly H264/AVC adopted as compression scheme for MPEG-4 video [10].

3 Multimedia in business

Advances in information technologies made it possible for organizations to present relevant information using multimedia elements. In the last few years, multimedia applications like short clips have become standard in the business world, supplementing classical text reports. Multimedia formats are being used not only in personal communications, but also in business-to-employee, business-to-business, and business-to-consumer communications.

We will analyze three different aspects of using multimedia in DSS:

- for designing a DSS
- as an “ingredient” of decision
- as a feedback method of decision.

3.1 Multimedia in DSS design

According to Ramesh and Sengupta, given the variety of information and support needs of various stakeholders, a successful DSS design should support capture, representation and reasoning with both informal and formal design rationale knowledge. In order to facilitate easy, and complete capture of knowledge, a design rationale DSS should use a variety of media that are best suited for capturing different aspects of design rationale, ranging from textual representations through multimedia capabilities.[11]

Design rationale can be represented in a variety of ways, from formal representations to informal representations. An advantage of formal representation is that it facilitates automated reasoning. The formal representation is necessary in domains that have formal domain models. In the design of large scale systems where the size and complexity of design rationale knowledge can grow, automated reasoning can be useful.

But, in design situations without well defined domain models, the acquisition of design rationale knowledge often occurs through informal means, like records of meetings. On the other hand, superficial representations may lose useful detail, while detailed representations may create trivial knowledge. [11]

Since design is a collaborative process, informal design rationale knowledge often consists of discussions among individuals engaged in the process and they communicate through multiple channels. Informal representations enable the retention of information in its most complete form, thereby facilitating the creation of thick descriptions. Recording human interaction in such forms allows access to the richness and complexity of social behaviour. Formal representations can only be used by individuals who are familiar with such rigor, while informal representations can be used by a wide type of users.

But, the main problem of informal representations is the classification, indexing, retrieval and use. Given the volume of knowledge generated in large projects, the problem of access and navigation is a significant impediment to the use of design rationale. [11]

We can say then, that formal and informal representations of design rationale are complementary, so the design rationale should combine the advantages of both forms of representations.

According to the same authors, the multimedia use in capturing informal knowledge provides three advantages:

- Multimedia (graphics, animation, and sound) are more effective than text in transmitting information like behaviours and evolution of systems. Also, multimedia is useful in capturing physical gestures, body language and other forms of implicit communication among members in design groups. The recorders are non-intrusive and allowing an uninterrupted design process while design rationale is recorded.
- The capture of knowledge though multimedia facilitates the creation of contextualized narratives. Once captured, these narratives can then be used by different individuals for different purposes. For example, if a user wants to know about evolution of a particular product he can use the record of the design session while another user could be interested in learning about the various points of view of the stakeholders.
- The availability of such information in an unprocessed descriptive form provides a powerful context for ascertaining the semantics of communication, and thus, the interpretation of meaning. Meanings do not exist in artefacts, symbols and practices, but rather are assigned by people who perceive and interpret their content and context. Also, design decisions are often characterized by assumptions that are not stated explicitly, but must be inferred from the context of the discussion. The analysis of representations, then, is an interpretive exercise in search of meaning. A richer context for understanding the collaboration mechanisms, process and culture in design groups can enable the user to interpret the rationale behind the creation of artefacts.

The use of multimedia is critical to any effective scheme for representing informal knowledge. The usefulness of such information is enhanced when he's linked to formal information that is relevant to given context.

3.2 Multimedia as an element of decision

Organizations may use multimedia elements:

- for affective purposes (entertainment and persuasion) [12], [13];
- for cognitive purposes when film clips are used to communicate useful information to decision-makers and especially to consumers [14].

Cognitive aspect is defined in terms of thoughts and cognitive factors in decision-making are beliefs about the state of the world (representations of events, circumstances, and entities), while affective aspect is defined in terms of feelings or emotions related to the goals of the individual. So, it is necessary for organizations to consider carefully the cognitive effect of multimedia elements in addition to the affective effect.

On the other hand, the effects of different types of media on decision-making will depending on information overload and task

familiarity. Task performance may be negatively affected by overly rich multimedia presentations or by lack of task familiarity.
Regarding to these affective and cognitive aspects, we emphasize three important studies about multimedia influences on these plans.

3.2.1 Affective plan

The affective effect of multimedia on decision-makers is based on the assumption that organizations use multimedia presentations, especially film clips, almost exclusively for entertainment and affective persuasion.
Rose realized two studies regarding the influence of multimedia on affective plan to financial decision-making.
First study
In 2001, he realized a study where he included multimedia elements that are intended to affect the decision-making on an emotive or affective level. He didn't transmit any cognitive information about the decision task. [12]
The decision-makers had to take a financial decision based on textual financial information in conjunction with these multimedia presentations.
The multimedia film clips used by author:

- not content any task (financial) information;
- were taken from commercial movies (Liar Liar, Pretty Woman);
- were used to affect participants' moods.

He examined the effects of multimedia presentations on information overload aspect.
As a result, the author found that multimedia presentations in conjunction with textual financial information can affect memory and decision-making by means of the affective state induced by the multimedia. The decision makers reconstructed memories of financial data to match media-induced affective responses and also they made investment choices according with affective responses to video media, even when the financial data clearly indicated the superiority of another choice. Also they indicate that the effects of multimedia presentations on decision-making (positive or negative) may interact with information overload so that overload conditions enhance multimedia effects.
Second study
In 2004, Rose et al. made another study when they studied the effects of reducing the information and cognitive loads. They considered following hypothesis: [13]
1) Recall of financial information will increase as information load is decreased.
2) Information load interferes more with the recall of numerical financial data than with the recall of affective responses.
3) Recall of financial information will increase as cognitive load is decreased.
4) Cognitive load interferes more with the recall of numerical financial data than with the recall of affective responses.
5) Reconstruction of financial data to match the affective response to the data will decrease as information load decreases.
6) Reconstruction of financial data to match the affective response to the data will decrease as cognitive load decreases.
7) Media-induced affective states will have less influence on investment decisions when information load is low relative to when information load is high.
8) Media-induced affective states will have less influence on investment decisions when cognitive load is low relative to when cognitive load is high.
They made three experiment for the hypothesis (1, 2, 3, 4), (5, 6), (7, 8) accordingly. They had 253 students and each of them was randomly assigned only in one experiment. All participants had completed at least two courses in the principles of accounting, an intermediate accounting course, a cost accounting course, an accounting information systems course, and a finance course. The authors considered that the students are good substitutes for individual investors because they have more domain-specific knowledge in comparative financial analysis than the average individual investor has.
The results of the first experiment indicate the validity of hypothesis 1, 2, 3, 4. The recall of financial data increases substantially when information or cognitive load is reduced and the recall of affective responses

was unaffected by changes in information or cognitive load. These aspects suggest that affective responses were durable in memory, regardless of the levels of information or cognitive load. The participants' memories for financial data improve rapidly as the quantity of information to be analyzed was reduced.

The results of the second experiment indicate the validity of hypothesis 5, 6. Reconstruction is problematic because decision makers actually recreate memories of financial data and the decisions are made based on false memories.

The results of the third experiment indicate the validity of hypothesis 7, 8. The authors demonstrated that financial decision makers rely on affective responses to multimedia much more in high information/cognitive load environments than in low information/cognitive load environments. [13]

3.2.2 Cognitive plan

Wheeler and Arunachalam realized in [14] a complementary study where they used multimedia representation modes only for transmitting "task indication" as cognitively defined. Presentations combining both film and text were considered multimedia presentations only if relevant task information is communicated through both media.

To avoid any conflict with study of Rose, the authors didn't include emotive or non-cognitive elements in the different presentation modes that might significantly affect participants' decision-making.

The authors considered three categories of hypotheses for this study [14].

1) *Hypotheses on unwillingness to apply externally provided instructions to task solutions.*

1a) Decision-makers are less willing to conform to externally provided information processing rules when task familiarity is high, than when task familiarity is low.

1b) Decision-makers are less willing to conform to externally provided information processing rules when task information is communicated through a single medium, than when communicated through multimedia.

1c) Decision-makers are less willing to conform to externally provided information processing rules when the amount of task information is below the information overload threshold, than when above the information overload threshold.

2) *Hypotheses on inconsistencies between task solutions and self-reports.*

2a) Decision-makers are less likely to be consistent with the information processing rules adopted for solving tasks when task familiarity is low, than when familiarity is high.

2b) Decision-makers are less likely to be consistent with the information processing rules adopted for solving tasks when task information is communicated through multimedia, than when communicated through a single medium.

2c) Decision-makers are less likely to be consistent with the information processing rules adopted for solving tasks when the amount of task information is above the information overload threshold, than when below the information overload threshold.

3) *Hypotheses on non-compliance of task solutions with externally provided instructions.*

3a) Decision-makers are less likely to comply with externally provided information processing rules when task familiarity is high, than when task familiarity is low.

3b) Decision-makers are less likely to comply with externally provided information processing rules when task information is communicated through a single medium, than when communicated through multimedia.

3c) Decision-makers are less likely to comply with externally provided information processing rules when the amount of task information is below the information overload threshold, than when it is above the information overload threshold.

Each participant performed four different tasks: selecting an apartment, purchasing a used car, predicting bankruptcy and buying stock. These four tasks represent two types of tasks: familiar (apartment selection and used car purchase) and unfamiliar (bankruptcy

prediction and stock purchase). Before performing the main experiment, participants executed one instance of each task type for practice (with tasks and software).
The participants were 109 students who had completed introductory financial accounting courses. It was considered that accounting students are appropriate participants for this study because it is reasonable to assume that they are familiar with apartment shopping and used car purchases but unfamiliar (or less familiar) with bankruptcy predictions and stock purchases.
Participants were provided either 6 (marked with "*") or 12 indications to perform each task. These elements are presented in Table 1.

Table 1. Task information [14]

Cue	Tasks			
	Apt. selection	**Used car purchase**	**Bankruptcy prediction**	**Stock purchase**
1	Discount for renting	Condition of tires	* Firm size	* Management's ranking
2	* Utility bill	Cost of insurance	* Sales-to-total assets Ratio	Gross national product projection
3	* Size of apartment	* Condition of engine	* Assets-to-current liabilities ratio	Industry's strength relative to foreign competition
4	Fitness centre and pool	* Payments versus participant's budget	Net income-to-total assets ratio	* Total equity-to-total liabilities ratio
5	High speed Internet connection included	* Condition of interior	Retained earnings-to-total assets ratio	* Industry's growth in sales
6	* Private parking	* History of prior accidents	Working capital-to-total assets ratio	Unemployment rate
7	* Washer and dryer included	Results of test drive	Common stockholder's equity-to-total debt ratio	Interest rates
8	Distance -university	Condition - exterior	* Management's ranking	* Firm size
9	Management's ranking	Air-conditioning	* Cash flow-to-total debt ratio	* Net income-to-net worth ratio
10	* Age of apartments	Availability of financing	Quick assets-to-total liabilities ratio	Cash-to-total assets ratio
11	* Rent relative to participant's budget	* Car style relative to preference	Customer satisfaction	* Earnings before interest and tax to sales ratio
12	Safety deposit	* Miles per gallon	* Return on stock	Sales-to-fixed assets ratio

The task indications were provided via computer interfaces in text and/or film clip formats. Participants received the information through a single medium / presentation mode (using text-only or film-clip only formats) or a multimedia presentation mode (using both a text-only and film clip format). All tasks were equivalent in the amount of information provided to participants (length of task descriptions and number of indications) and in the types of information provided (a mix to both financial and non-financial cues). Participants were instructed to apply equal decision weights to the 6 or 12 cues provided.
For each task, participants were asked to estimate a probability on a scale of 0 to 100. They estimated the probability that they would rent the apartment, buy the used car, purchase the stock or the company would declare bankruptcy, given the information from the 6 or 12 cues.
The results indicate a fully support for 1a, 1c, 2c, and 3a, partial support for 1b, 2a, 2b, and 3c and no support for 3b, so the multimedia presentations have influence in all three variables discussed. On the other hand, results provide the strongest support for task familiarity affecting the three dependent variables examined (unwillingness, inconsistency, and non-compliance): 1a fully supported, 2a partially supported and 3a fully supported. Slightly less support is provided for hypotheses relating to information overload (full support for 1c, full to partial support for 2c, and partial to mixed support for 3c and medium type (partial support for 1b and 2b and none for 3b. Even in relation to medium type, there is, nonetheless, some degree of support

for two or the three hypotheses.

3.3 Multimedia as a feedback method of decision

Kai et al. realize a study in [3], where they analyzed if the multimedia elements improve the feedback of the business decisions. It is known that the feedback is a very important ingredient of the tasks' improvement.

They started from the following aspects:

- the people desire to eliminate or reduce the feedback-internal standard discrepancy by attempting to attain the standard; when a negative feedback is received (performance below the standard), the effort will be increased in order to attain the standard; on the other hand, when positive feedback is received (performance exceeds the standard), the effort is reduced or maintained
- "vividness effect" increases the effectiveness of the messages
- multimedia elements have different capabilities to present information vividly
- multimedia is attractive also because vivid information required less cognitive effort.

Based on these assumptions, the authors elaborated three hypotheses to study:

1) Negative feedback leads to a higher level of subsequent task performance than positive feedback.

2a) For negative feedback, non-vivid messages are more effective than vivid messages.

2b) For positive feedback, non-vivid messages are as effective as vivid messages.

The participants in the experiment were 72 business students. The research focused on two dimensions: feedback sign (positive or negative) and the vividness of the feedback messages (high vividness - multimedia) and low vividness (text). The participants were also randomly assigned to receive the feedback in different media and the video and textual messages used identical words.

The results indicate a fully support for hypothesis 2a and 2b and no support for hypothesis 1.

The participants who received initially a negative feedback, text messages (non-vivid) were more effective than multimedia messages (vivid), according to hypothesis 2a.

The participants who received initially a positive feedback, text messages were as effective as multimedia messages, according to hypothesis 2b.

The hypothesis 1 was not verified because the effect of a negative feedback has two aspects:

- informational – increase the performance level
- motivational – could decrease the desire of attaining the standard.

The hypothesis 1 considered only informational aspects.

This study emphasized that, despite the attraction of multimedia elements, they could be useless so the DSS designers should be careful in using it as feedback elements.

4 Multimedia data-mining

Another aspect of multimedia implication in decision-making is multimedia data-mining that includes both multimedia and data mining in order to discover knowledge in multimedia data.

Due to development of the computer and digital technologies in early '90s, multimedia emerged as a research area, refers to the study and development of an effective and efficient multimedia system targeting a specific application [15]. The research in multimedia covers a very wide spectrum of subjects, ranging from multimedia indexing and retrieval, multimedia databases, multimedia networks, multimedia presentation, multimedia quality of services, multimedia usage and user study, to multimedia standards. Today, it is known that multimedia information is ubiquitous, required, and even essential, in many applications. This phenomenon has made multimedia repositories widespread and large [16]. There are tools for managing these collections, but the need for tools to extract hidden useful knowledge from multimedia collections is becoming pressing and essential for many decision-making situations. For example, it is necessary to develop the tools for discovering relationships between objects within images, classifying images based on their content, extracting patterns in sound, categorizing speech and music, recognizing and tracking objects in video streams. Also, researchers in multimedia information systems, in order to improve the indexing and retrieval of multimedia information, are looking for new methods for discovering indexing possibilities [16].

On the other hand, data mining is also a very diverse, interdisciplinary, and multidisciplinary research area. The terminology data mining refers to knowledge discovery. Originally, this area began with knowledge discovery in databases. However, data mining research today has been advanced far beyond the area of databases, due to the following reasons [17]:

- today's knowledge discovery research requires more than ever the advanced tools and theory beyond the traditional database area, like mathematics, statistics and pattern recognition
- with the increase of the data storage scale and the presence of multimedia data almost everywhere, it isn't enough for today's knowledge discovery to focus only on the structured data; the traditional databases have evolved into data warehouses, and the traditional structured data have evolved into more non-structured data such as imagery data, time-series data, spatial data, video data, audio data, and general multimedia data. In applications, these non-structured data do not exist in a traditional "database" anymore; they are just simply a collection of the data, even though they are called databases (image database, video database).

Also, there is an increasing interest in the analysis of multimedia data generated by different distributed applications, such as collaborative virtual environments, virtual communities, and multi-agent systems. The data collected from such environments include a variety of documents that are part of the business process, asynchronous discussions, transcripts from synchronous communications, and other data records. These heterogeneous multimedia data records require transformation procedures before analysing. Consequently, multimedia data-mining is a combination between multimedia and data mining, and an application in this domain refers to the synergistic application of knowledge discovery theory and techniques in a multimedia database or collection.

While we have a definition of multimedia data mining, it is useful to clarify some aspects:

- In a classic database system (structured data in the traditional databases), there is always a DBMS to manage all the data in the database. When the data become non-structured data, like multimedia data, often we don't have such a management system for all the data in the collection. Typically, there exists a collection of multimedia data, and it is necessary to develop an indexing/retrieval system or other data mining system for this collection. In many literature references, it is used the terminology of "database" to refer to a multimedia data collection, even though this is different from the traditional, structured database.
- Although "multimedia" refers to the multiple modalities and/or multiple media types of data, conventionally in the area of multimedia, multimedia indexing and retrieval also includes the indexing and retrieval of a single modality of data, such as image indexing and retrieval, video indexing and retrieval, audio indexing and retrieval. Therefore, studies in image data mining, video data mining, and audio data mining alone are considered as part of the multimedia data mining area.

A possible architecture for a multimedia mining system is shown in the Figure 1.

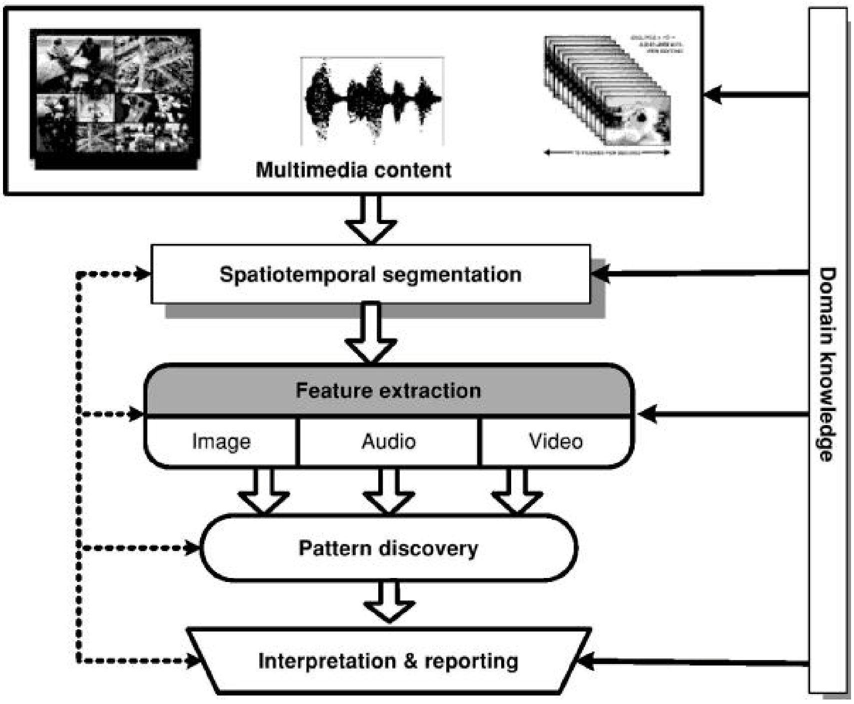

Fig. 1. Multimedia DM architecture [18]

In a multimedia data mining system, it could also exist a special user interfaces to facilitate the communications between the users and the mining system, because, the quality of the final mining results can only be analyzed by the users. So, if the quality is not acceptable, the users may use this special interface to adjust different parameter values, to change different components, in order to obtain better results.

4.1 Image mining

A good example in multimedia data mining is offered by Perner regarding image mining [19].

He considers the example of a medical doctor who inspects the irregular tissues visible on X-ray image. He will make the decision about malignant or benign nodule based on some morphological features of the nodule that appeared in the image. He accumulated his knowledge over years in practice. He considers that a nodule will be malignant if the following rule is satisfied: *the structure inside the nodule is irregular and areas of calcifications appear and there are sharp margins*.

Returning to multimedia-mining, an automatic image interpretation based on such a rule would be possible only after the image has passed through various processing steps. These steps include:

- automatically image segmentation into objects and background
- objects obtained must be labelled and described by features
- these features must be grouped into symbolic representations in order to obtained a similar result with that based human knowledge.

But, we do not know in advance our important features of a collection of images. Mining an image data base containing only images and no image descriptions require to extract automatically the useful information from the image.

We observe that is a contradiction here.

There exist more categories of features:

- low-level features such as blobs, regions, ribbons, lines, and edges can be extracted from images
- on the base of low-level features it can calculate some high-level features but it is not possible to obtain all such features in this way
- features like an “irregular structure inside the nodule” it can’t be obtained even in this way; are not so called low-level fea-

tures. Therefore, it is necessary to input experts descriptions into an image database

- all these aspects are depicted in figure 2.

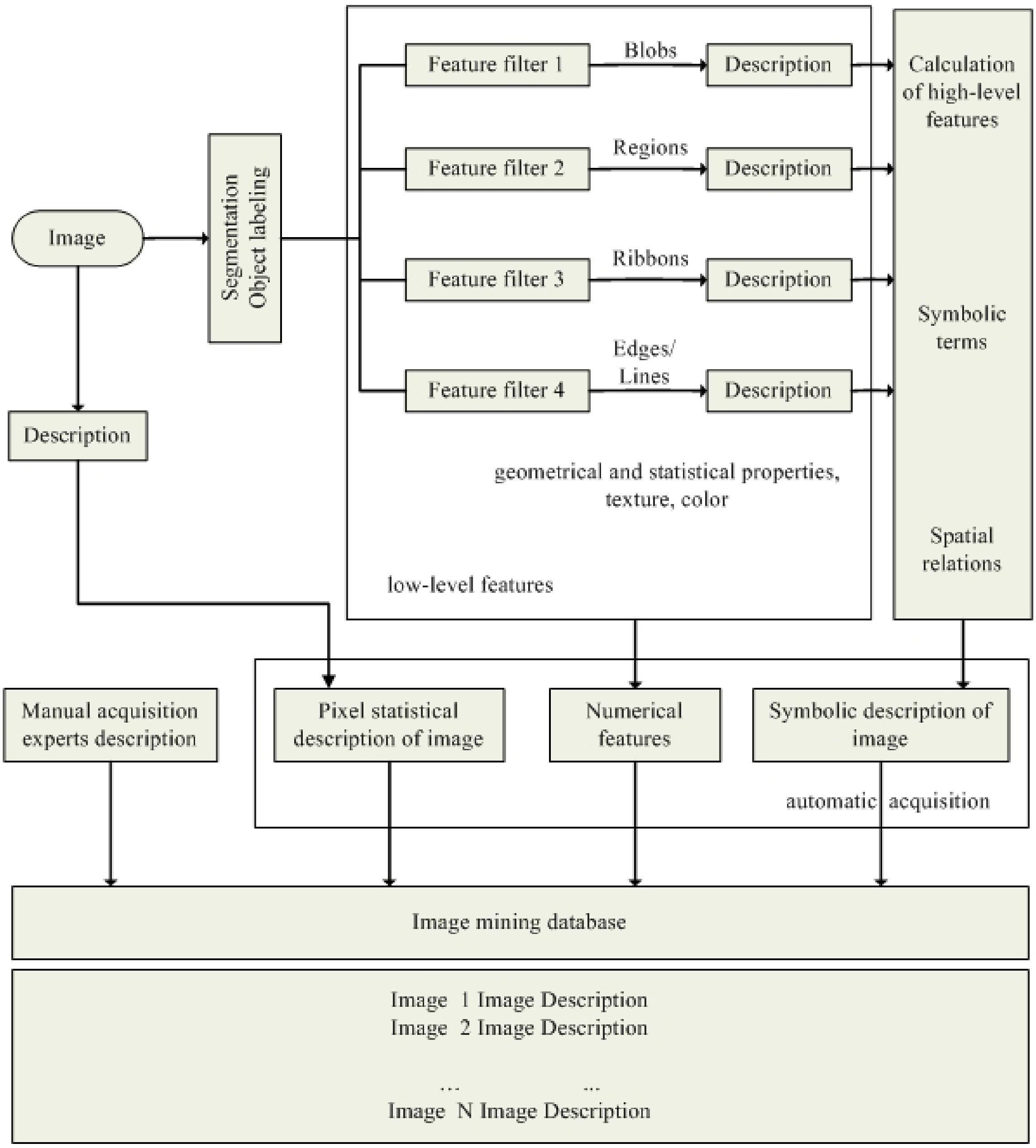

Fig. 2. Image mining [19]

We can observe that different abstraction levels to represent an image exist. The higher abstraction level is the more useful the derived information with data mining.

We can describe an image: [19]

- by statistical properties that is the lowest abstraction level,
- by low-level features and their statistical properties such as regions, blobs, ribbons, edges and lines, which is the next higher abstraction level
- by high-level or symbolic features that can be obtained from low-level features
- by experts symbolic description which is the highest abstraction level.

In multimedia domain, useful results can only be obtained by data mining when the data are carefully prepared. The influence of unnecessary, noisy data affects the result of the data mining. That fact should be avoided by applying proper data preparation techniques. The raw data of a multimedia source such as images or video cannot be used as it is. Usually these data need to be transformed into a proper abstraction level. For example from an object in an image features should be calculated that describe the properties of the object. Each image will then have an entry in the data table containing the features of the objects extracted from the image.

5 Conclusions

This is due to the fact that in today's society almost all the real-world applications often have data with multiple modalities, from multiple sources, and in multiple formats [16]. For example, in the manufacturing domains, business processes can be improved if, for example, part drawings, part descriptions, and part flow can be mined in an integrated way instead of separately.

On the other hand, multimedia mining is a direct outgrowth of progress in data storage and processing speeds. When it became possible to store large volumes of multimedia data and run different statistical computations to explore all possible correlations among them, the multimedia mining domain was born. Mining allowed people to hypothesize relationships among data entities and explore support for those. This field has been applied to applications in many diverse domains and keeps getting more applications. Considering the volume of multimedia data and difficulty in analyze the semantic aspect, multimedia and data mining will come closer and be applied to some of the most challenging problems. Some of the important challenges for data mining are posed by multimedia systems. Similarly, the most rewarding applications of data mining may come from multimedia data.

Sheu and Ismail have observed how multimedia technology has changed our lives and "has forever changed the way we live, work, entertain, and learn. With wide access to the Internet, kids can spend more time online experimenting with and learning from computers through the Information Superhighway than on the TV. Once the power of image, video, and graphic through high-speed fibre-optic transmission or wireless communication is enjoyed, the old-fashioned approach of using plain text as a main source of information will be a thing of the past"[20].

References

[1] T. Vaughan, *Multimedia: Making it work (7th Ed.)*, McGraw Hill, 2007.

[2] H. A. Huang and J. C. Windsorb, "An empirical assessment of a multimedia executive support system," *Information & Management*, Vol. 33, No. 5, pp. 251-262, 1998.

[3] H. L. Kai, M. J. O'Connor and W. E. Remus, "The impact of presentation media on decision making: does multimedia improve the effectiveness of feedback?", *Information & Management*, Vol. 42, No. 2, pp. 305–316, 2005.

[4] R. Lewis and J. Luciana, *Digital media: An Introduction*, Pearson Prentice Hall, 2004.

[5] K Lim and I. Benbasat, "The influence of multimedia on improving the comprehension of organizational information", *Journal of Management Information Systems*, Vol. 19, No. 1, pp. 99-127, 2002.

[6] B. A. Khasawneh, "Multimedia essentials and challenges", *Multimedia transcoding in mobile and wireless networks, Information Science Reference*, pp. 1-13, 2008, Available at: http://www.igi-global.com/downloads/excerpts/7780.pdf.

[7] Z. N. Li and M. S. Drew, *Fundamentals of multimedia*, Pearson Prentice Hall, 2004.

[8] K.C. Pohlmann, *Principles of digital audio (5th Ed.)*, New York: McGraw-Hill, 2005.

[9] A. Bovik, *Handbook of image and video processing*, Academic Press, 2000.

[10] A. Bovik, *The Essential Guide to Video Processing, 2nd Edition*, Academic Press, pp. 310-328, 2009.

[11] B. Ramesh and K. Sengupta, "Multimedia in a design rationale decision support system", *Decision Support Systems*, Vol. 15, No. 3, pp. 181-196, 1995.

[12] J. Rose, "The effects of multi-media in-

duced affective states on recall and decision-making by individual investors", *International Journal of Accounting Information Systems*, vol. 2, no. 1, pp.22–40, January 2001.
[13] J. Rose, F. Roberts and A. Rose, "Affective responses to financial data and multimedia: the effects of information load and cognitive overload", *International Journal of Accounting Information Systems*, Vol. 5, No. 1, pp. 5-24, May 2004.
[14] P. Wheeler and V. Arunachalam, "The effects of multimedia on cognitive aspects of decision-making", *International Journal of Accounting Information Systems*, vol. 10, no. 2, pp.97-116, June 2009.
[15] B. Furht, *Multimedia Systems and Techniques*, Kluwer Academic Publishers, 1996.
[16] Z. Zhang, F. Masseglia, R. Jain and A. Del Bimbo, "KDD/MDM 2006: The 7th KDD Multimedia Data Mining workshop report", *ACM SIGKDD Explorations Newsletter*, Vol. 8, No. 2, pp. 92-96, December 2006, Available at: http://www.sigkdd.org/explorations/issues/8-2-2006-12/15-MDM.pdf.
[17] J. Han and M. Kamber, *Data Mining - Concepts and Techniques*, Morgan Kaufmann, 2nd edition, 2006.
[18] V. A. Petrushin and L. Khan, *Multimedia data mining and knowledge discovery*, Springer, pp. 16, 2007.
[19] P. Perner, *Data Mining on Multimedia Data*, Springer-Verlag Berlin Heidelberg, 2002.
[20] G. Ditsa, *Information Management: Support Systems & Multimedia Technology*, IRM Press, pp. viii, 2003.

Ovidiu DOBRICAN is Teaching Assistant at Faculty of Economics and Business Administration at the West University of Timişoara and a PhD student in Business Information Systems at Babeş-Bolyai University of Cluj-Napoca. His main research areas are DSS domain and collaborative systems.