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SUPPORTING INFORMATION VISUALIZATION THROUGH TOPIC MAPS

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We are living a phenomenon of accelerated information production with different accessing sources. Hence users are faced with a growing problem: accessing (navigation) and filtering specific information contained in large datasets, which are increasing in size. Procedures such as data filtering and gathering are now simplified through a new concept known as *Topic Maps*. The application of Virtual Reality technologies enables to present and interact with multidimensional information in a 3D space. In this paper we present INSPHERE, a new visual metaphor for information visualization, based on both, Virtual Reality techniques, and “geographical information maps” provided by Topic Maps.

1 Introduction

Multi-dimensional information structures are greatly concerned with the mapping of semantically related information in two-dimensional spaces. The use of semantic models and information visualization techniques in conjunction, contributes to faster and effective data exploration.

Topic Maps paradigms are based on the premise that information/knowledge may be described through the definition of topics and the links between them. As there is no universal technique for information visualization, we have developed INSPHERE, a new technique that can support data navigation in large data sets, based on Topic Maps and Virtual Environments. The use of an immersive virtual environment can provide the user with a new 3D perspective of the information, permitting to explore spatial correlations between the information. This enables the user to truly navigate through the information.

Our work intends to establish the basis for future information visualization techniques, taking advantages of the Virtual Immersive Environments.

In this paper we present our own experience on applying Topic Maps as a structuring information model for Information Visualization based on Topic Maps and three dimensional spaces. This aims to support the access to multimedia content in different scenarios such as e-Learning or Collaboration environments.

2 Topic Maps and Information Visualization

2.1 The Topic Maps Standard

Topic Maps are an ISO standard published as ISO/IEC 13250 in 2000 [1]. They enable structure information and give it meaning by adding semantic description of the relations between the information units. Topic Maps paradigm provide a solution for interchanging and finding information from different sources. The special characteristic of the Topic Maps model is the clear separation between the description of the information structure and the physical information resources (like web pages, multimedia content, books).

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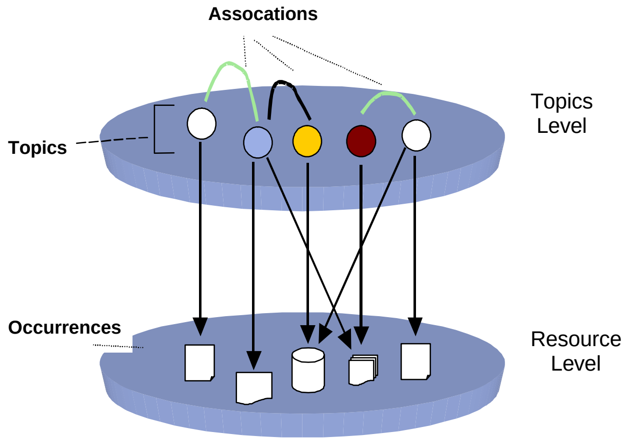

Figure 1: Topic Maps Concept

As shown in the above figure, topic maps enables to create an external index of information, making it findable. Topic Maps describe the information at the *Topic Level*, and maintains the information objects at the *Resource Level*.

A topic map consists of topics, association between topics and very little else [2]. A topic is multi-headed link that points to all its occurrences [3]. This "link" aggregates information about a given subject (the thing that the topic is about). Information objects that are external to a topic map are called occurrences. Topics can be categorized according to their kind (topic type) and may be seen like a typical *class-instance* relationship. They represent the classes in which topics are grouped in, i.e., the category of one topic instance. Topics can have names that can be used in different scenarios or contexts. Related topics can be "connected" making use of associations. A kind of topic tree can be built and described, enabling to create "virtual tables of contents", i.e. tables describing contents which do not reflect a sequential order within a specific document, but instead organises chunks of information as if they were presented in a classical, sequentially ordered document. In other words, the semantic containment for a topic association can serve to dynamically assemble fragments of information [3]. All these characteristics can be *scoped*, which means that it is possible to validate, within certain limits, any assignment of a topic characteristic. This concept is important in the sense that it avoids ambiguities between topics and their characteristics. A topic map is the whole document (one or more, either linked or not), which uses this grammar [4]. Note that in a topic map everything is defined as topic.

Topic Maps is often compared to RDF (Resource Description Framework). Although they have similarities with respects to their application, these two standards have also big differences. While Topic mapping is knowledge representation applied to information management from the perspective of humans, RDF is knowledge representation applied to information management from the perspective of machines [5].

2.2 Information Visualization

Information Visualization can be broadly defined as a computed-aided process that aims to reveal insights into an abstract phenomenon by transforming abstract data into visual spatial forms [6]. It is concerned with reducing or refining the cognitive overheads of understanding complex information structures through the use of visual representations and interactive elements. Information visualization traditionally focuses on finding meaningful and intuitive ways to represent non-spatial and non-numeric information to people. Currently much of the research and investigation in this field is concerned with the development of strategies and approaches in order to visualize information sources and data as a means toward helping people interpret and understand the information. Hyperbolic trees, spiral, cone tree, and others, are some of these developed approaches. The use of the third dimensional space starts to bring some emphases and contribution to this field, giving the information a more "look-and-feel" sensation. This extra dimension will offer the user the possibility to have better control over the information to be explored. We

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can look into Virtual Reality technologies in order to place the user inside a computer generated world of information, allowing interactive and navigation possibilities within the information space and its respective associations.

2.3 Virtual Reality

The term Virtual Reality (VR) is interpreted differently by people. There are some people to whom VR is a specific collection of technologies, like a Head Mounted Display, Glove Input Device and Audio. Some other people stretch the term to include conventional books, movies or pure fantasy and imagination.

The ultimate VR systems completely immerse the user's personal viewpoint inside the virtual world. These immersive VR systems are equipped with a Head Mounted Display (HMD). Another possible variation of the immersive systems is the use multiple large projection displays to create a 'Cave' or room in which the viewer(s) stand. So, VR technologies have considerable potential to extend the power of information visualization methods [7].

On the other hand, Virtual Environments (VE) offer a new human-computer interaction paradigm where users are no longer external observes of content in a computer display, but are active participants on a computer generated virtual world [8]. Thus, mixing these potentialities with semantic networks enables the user to access the desired information in a quicker, easier and intuitive way.

3 INSPHERE – Virtual Sphere for Information Visualization

As presented above, Topic Maps model creates an abstract level above the original information resources, without changing them. The use of metaphors, by means of making abstract representation of the information, enabled us to develop INSPHERE, a virtual representation of a sphere model to represent the topic maps concept. Therefore, INSPHERE explores Virtual Reality potentialities with respects to interactivity and navigation possibilities. The basic idea is to present a 3D sphere in a Virtual Environment where the user navigates immersively through the information. The required devices for this scenario are a HMD (Head Mount Display) and a pointer.

Figure 2: HMD and a paradigm for the virtual pointer (using a virtual glove)

The HMD provides the user with the immersive sensation of being in direct contact with the information space, whereas the virtual pointer is used as a tracking device enabling the selection of the topics presented by the sphere. In this context the user is able to navigate within the 3D spherically oriented structure by means of a multi-recursive interconnected topics network. The selection possibility is provided by the virtual pointer, used to "dive-into" and zoom-in on portions of interest.

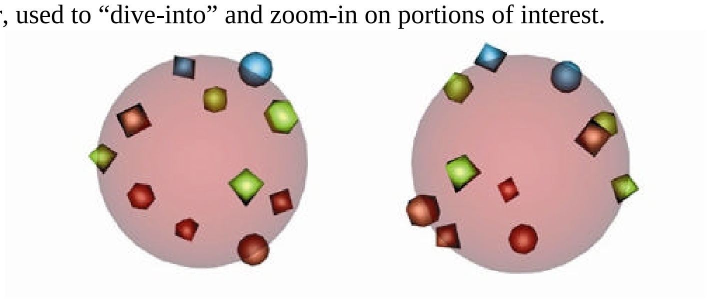

Figure 3: Sphere with topics (two perspectives)

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As showed in figure 3, only one of the sphere layers are displayed to the user as a 3D representation. Each topic is represented by a geometric shape in the surface of the sphere and the associations between topics are represented by interconnecting lines (figure 4).

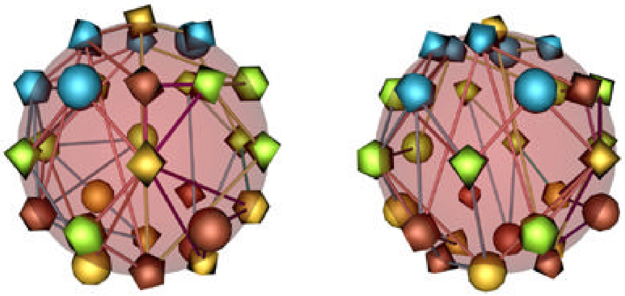

Figure 4: Sphere with topics (two perspectives)

The navigation between different layers is activated by the selection, done by the user, of the topic that represents such layer. By selecting a particular topic, the user can access the next hierarchical level, represented by a new topic map. Each sphere may have a new topic map instance or not. This leads us to say that the user may find and access many other topic maps in the interior of one specific topic. These topic maps may be interconnected or not, thus permitting, once more, an access to topics and their characteristics (including occurrences). In case the existence of various topic maps, occupying various hierarchical "sub-spheres", is not verified in the interior of the first sphere, the user would be faced with only occurrences of visualized topics referenced to the only and current topic map. With respects to topic map graphical representation, a variation in color (and/or icons, figures, etc.) may be used for the purpose of better defining and distinguishing different topic types. Furthermore, distinct line styles or colors may also be used for the purpose of graphically representing different association types. These lines, as well as spheres, may also have a small textual description, activated by a user-oriented event (i.e. dragging the virtual pointer over the object) [9].

When the transition between layers occurs, the user has the impression that the current sphere shrinks or grows, depending if the new topic is more or less important than the last one. Finally, the old sphere is replaced by the new, representing the actual topic map.

Each topic that contains linked information can be opened like a drawer, showing the linked documents inside (figure 5). At this point, the user is able to select and preview a document, without leaving the virtual environment. The user will determine whether the information is useful or not. If not, the user is permitted to work back on the hierarchical structure. A navigation log may be useful to determine this working back approach of the user navigation history. This will permit the user to recursively call the previous topic map, enabling search refinement.

Other functionalities, such as a project book (bookmark) help the user manage the searched information for future retrieval according to user expertise. The user does not necessarily need to use this functionality, but it will certainly help in processing the searched information to be included in personal projects.

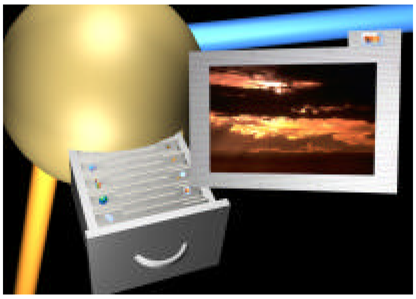

Figure 5: topic information resources (preview of a picture)

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4 CONCLUSIONS

It is commonly accepted that a book without an index is like a country without a map. For some people, tracing a path without a map may be considered a great challenge. Therefore, if the main objective is to trace the correct path as quick as possible, then a map is indispensable. Any user of great information repositories, like the World Wide Web, faces with a common scenario of having to go through various search strategies and information refinement techniques in order to find the desired information. Hence, it is vital to structure and organize information in a common and standard manner. Here we can apply Topic Maps as a new technology achieving, to some extent, the solution to this problem. Regarding this, the use of RDF should be considered as a complementary model for generating topic maps.

On the other hand, the visualization of complex and multidimensional data is a problem largely recognized. Graphical visualization continues to be one of the biggest challenges of computational science. Our aim is to represent information in a perceptible manner, making use of VR and its potentialities within the human sensorial system, by means of permitting a more intuitive and flexible manipulation of the information space; thus, giving the user the power of decision (according to the meta data received).

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