

A complete system of tridimensional graphical representation of information : “Crystal hy-map™”

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ABSTRACT

This document is a review of a recent project envisioning to implement a system breaking, once and for all, away from the traditional WIMP model and offering a better spatial hierarchical organisation of metadata. For this, it attempts quite particularly to create new description methods in regards to constraints of research space as well as to develop processes of information type assignment, both static and dynamic. Furthermore, it aims to elaborate original interfacing procedures dedicated to semi-immersive interactive display of hypermedia data.

Keywords

Semi-immersive interactive display, Informative space, Semantic analysis, Instinctive interface.

1. INTRODUCTION

Recent research projects carried out on the subject of data processing within a virtual context clearly show that the process that leads the user to adopt a certain strategy rather than another, primarily in the case of numerous situations where complex problems need to be solved, represents one of the fundamental parameters in the development of active principles on which Human-System interfaces depend [4]. These interfaces must allow both to communicate with the different system components and to ensure the control of the decision program in the most uniform manner. Consequently, a development study is necessary in order to highlight the essential role of man in its operation, a role which necessarily assumes a great level of adaptability of representation and display methods for pertinent information.

Currently, there are numerous visual systems capable of significantly improving the management and analysis of information through well-known gathering and processing procedures [9]. They allow both the understanding of certain common situations and a real anticipation of possible actions and trends.

However, these applications do not offer a great deal of perceptually rich information. They are neither capable of developing a complete spatial representation of information nor of favouring the implementation of new knowledge in complex environments.

Thus, it is of primordial importance to envisage new representation paradigms whose aim is to reach a level of communicational performance of clearly superior systems so as to allow the use of an extended metadata display, an intuitive interfacing system by direct handling as well as a procedure for the localisation and retrieval of multimodal information efficient in big corpora.

That is precisely what this software development project, “Crystal hy-map”, aims to do, by attempting to create a real tridimensional graphical representation to explore information. It implements a conceptual approach, resulting from the deformation of the object, which allows to correct the occlusion phenomenon and to build a spatial reality that would be close to the human perceptive system and therefore interpreted favourably as the network of links becomes more complex. In addition, it pioneers new methods for the distribution of information for multidimensional integration spaces (non-hierarchical organisation of metadata, use of original constraints related to positioning, etc.) as well as new procedures for the retrieval of knowledge from hypermedia data [3].

2. WORK HYPOTHESIS

This research project relies on the triple hypothesis that it is possible to:

- convey the structure of the information space through an interactive tridimensional modelling, subject to great constraints such as that of real time
- organise metadata according to their spatial correlation (relation of spatial positioning, closeness)
- imagine an ergonomic browsing space that would allow the user to isolate pertinent information in a precise manner while having an overall view of things.

3. OBJECTIVES

This project questions the current state of the art of displaying information and strives to propose new solutions for the representation of implicit information data.

It turns on five major axes:

- Display of the browsing structure
- Display of non-hierarchical data
- Display of complex operations on the client-system

- Display of multimodal information
- Display of multivariated data.

Development of the software environment relies therefore on certain research works dealing with the combination of display modules, the implementation of an object-oriented approach for tridimensional display, the creation of original datamining processes and procedures for the retrieval of knowledge from data, etc. [6].

4. OPERATING PRINCIPLES

“Crystal hy-map” is a complete representation system that uses a hypermedia structure designed to support a large network of links. It relies on a connectionist system capable of handling numerous data units where information is organised in directories and indexed by geo-semantic analysis. For this, the information is based on a hypermedia browsing repository structured from a “grid” (C.S. : X, Y, Z) for semantic positioning of information revealing new integration procedures mainly between various documentation models and ergonomic knowledge [2]. The main objective lies on the possibility of optimising parameters which constitute the workload for the human operator (e.g. number of objects handled, temporal constraints, parallelism of tasks, length of procedures, etc.) and setting-up a method to diagnose the cognitive workload for the interfaces [11].

Its aim is to highlight the obsolescence of traditional browsing and graphical search tools by insisting on the need to offer new strategies for the processing of information in virtual contexts that are suitable for complex situations. This leads to the implementation of new paradigms for prospective representation of space that make the elaboration of procedures for distribution and project evaluation useful.

Thus, it strives to offer, by way of an interactive feature for semantic distribution of information (“information space mapping”), new methods for the management and handling of nodes, links and annotations (“semantic network”) as well as new processes to discover specific knowledge [10].

4.1 Design of an explorer hypermedia

Hypermedia must have organised knowledge on the subject and a modelling of the reading task. It is therefore necessary to ensure a good distribution of skills between the user and the machine and to guarantee a true integration of both agents (HMD) in the decision process.

To do so, this project defines a visual organisation concept that would allow to observe and understand information more easily by way of a dynamic tridimensional cartographic display [12].

The original aspect of such an approach lies, beyond formal changes, on the fundamental modification both in terms of distribution, representation, use and production of specialised* information and in the elaboration of a new logic to help in the understanding of spatio-temporal processes [7].

The software design process involves the following aspects:

- usability (learning of functionalities only)
- representation of knowledge without logical, hierarchical or ensemblist constraints
- formalism of task description
- multimodal interaction
- vague goals.

Consequently, hypermedia are composed of two reading levels, that of the node and that of the network. In the first level, new browsing functions as well as new data structures are defined. There, information is decomposed into small elementary units that can act as the entry point (“ingress node”) or the exit point (“egress node”) for the subject. These units, which represent a unique idea and concept, are both syntactically and semantically discrete. They contain several types of information:

- the name that identifies the node
- its interaction data, types of media on which the user may work
- its browsing data, data from which the node function gets its information
- its informative data, data that the user gets via the function.

The second level offers the possibility of browsing the database in a non-predetermined order and of carrying out associative searches.

This idea presents several advantages. First of all, the adding of new data can be acknowledged immediately. Secondly, it is not necessary to plan in advance the way in which the different media will be arranged in the hyperbase, etc.

The latter has therefore no need to be structured or even indexed as what will guarantee the pertinence of information is first, the preprocessing of visual and textual descriptors and second, the semantic analysis of information and its location according to areas of influence. Thus, the idea is to consider bases of a large scale and to organise them in such a way that inquiries on flows may be tended to with a transmission rate of satisfying quality. The description schema will then be adapted to documents and their descriptions.

Raj Jain [8] suggests 3 types of characteristics that are indeed satisfying:

- type *Fu* contains “meta-characteristics” that can be automatically retrieved from information associated to documents (size, author, format, etc.)
- type *Fd* contains characteristics that are directly retrieved (derived) from documents at the moment they are entered into the base
- type *Fc* contains characteristics that are also retrieved from documents, but that are only done so at the useful moment.

4.2 “Polyhedral computation”

“Polyhedral computation” is a calculation on the evaluation and distribution of areas of semantic influence of one or several distant “objects” (cf. contextual semantics).

* Work on the notion of space by Klob, Moulthrop, Rosemberg etc.

This calculation is the keystone of the system for tridimensional representation of information. It allows for a perfect semantic distribution of information on the object and pioneers, by benefitting from computers' processing rate and graphical capacity, in a new approach for locating and retrieving information for big corpora as well as for searching documents in non-structured bases.

It is organised on an algorithm for geo-semantic location of information. The goal is to "encircle" the object in order to control all its deformations and allow for real time handling of metadata.

5. DEVELOPMENT PERSPECTIVE

So far, projects that have been undertaken have more directly dealt with the elaboration of the system (data display, environment for distributed parallel programming, etc.) as well as database management (modelling of data and multimedia inquiries). The designing of this elaborate operational system leads to the extending of the scope and the concept.

Indeed, "Crystal hy-map" is a very flexible data representation environment that is similar to both the semantic networks and the object orientation paradigm. It is perfectly capable of supporting the implementation of different knowledge representation formalisms [1].

Consequently, one of the short-term goals is to implement this structure in a diagnosis aid interactive system containing a hyperbase, a model base and a knowledge base.

5.1 Prototype for a knowledge base processing system (an expert system for aid in medical diagnosis)

The implementation of dedicated hypermedia, or in other words, the creation of autonomous knowledge entities, does not imply major difficulties. What represents a greater challenge is precisely the ability of making information search possible in a large hypermedia base from an external multi-inquiry processing process.

To accomplish this, we have decided to design an expert aid system for medical diagnosis. The idea is to focus particularly on the diagnosis and problem solving approach while allowing database queries for detailed cases in the hope of improving the doctor's smart workstation [5]. Inference processes (rule detection, selection and application of a learned rule) must be able to handle the data found in the different bases.

Thus, we will probably have to consider a multimedia database – it will rely on a real object formalism or an object layer added onto a relational kernel – for which the user interface would recover the hypermedia concepts developed by "Crystal hy-map".

6. CONCLUSION

Ultimately, through powerful graphic design capable of structuring metadata, "Crystal hy-map" pioneers in a new Human-Machine interfacing concept that facilitates the formulation of inquiries, information display, and surfing within hypermedia.

The development of this system is conditioned by that of research devoted to task description, modelling of cognitive processes involved, by surfing and associating it to other projects such as that of decision aid. Therefore, it integrates the different stages that lead to the knowledge discovery process:

- collection and filtering
- preprocessing
- exploration
- display
- interface.

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