From Reality to Hypermedia through Artificial Reality

Introduction

Information technology is teaching how to represent reality in the computer and practically all subjects have been considered suitable to computing. The role of the computer has been very different from traditional scientific approaches. While the traditional scientific disciplines tend to underline the specific results and the rules governing a subset of reality in a unified way, computer disciplines lead towards an integration of knowledge in order to reproduce the considered subset of reality as a unity governed by known rules.

Such an integration is changing the nature of programming and seems to transform the art of computer programming into a scientific discipline capable of modelling pieces of the real world as well as pieces of the ideal worlds (Plato just called this world IperUrania!). With such an attitude in mind, in this paper we will analyze the development of hypermedia systems. We will try to show that the development of hypermedia systems started from models of reality (ideality), not only corresponds to a well founded scientific discipline, but also introduces a clean methodology suitable for improving both quality and productivity for hypermedia systems.

Artificial reality

With the increase in computer quality, the interaction between the computer and its users resembles increasingly an interaction of the users themselves with an artificial reality. The users take actions, send messages, modify things and receive commands and messages exactly as in the ordinary world. Moreover, with the increase of graphical capability, the computer world is frequently very similar to the real one as, for example, in the case of the user working with the desktop metaphor. The possibility of connecting the artificial world of the computer with reality through command networks produces the possibility for users to observe directly entities under their own control from their workstation. Whenever the communication between remote agents and the computer is such that both the remote agents, which are real, and the users, through the computer in the artificial reality, can act independently on a same entity, there will be a bi-causal relationship that permits that the status of the governed entity be kept updated. This can be perceived, for example, in the graphical interface of the computer display or in what is actually being controlled.

Environments for artificial reality systems

The development of artificial reality systems requires suitable software whereby the development of suitable graphical interfaces and the description of part of these interfaces as active indicators is made as easy as possible, depending on the judgement of the ease of economic constraints relating to the project under consideration. Object-oriented environments well equipped with graphical interfaces and windowing systems, eventually capable of accommodating existing software for re-use, seem now to be the best candidates to such developments. Many of the existing systems should be certainly considered at this point. In the author's opinion the wide understanding of the phenomenon is due to Hypercard. This package, developed by Bill Atkinson and introduced by Apple Computer, has suggested so many prototypical applications involving graphical interfaces that it must be considered currently as one of the most successful optional pieces of software. Its development follows historically the first successful example of artificial reality (the desktop metaphor as developed earlier at Xerox and used in the Macintosh). Hypercard can be considered from many points of view as an hypertext generator system, as an artificial reality builder, as a metaphor generator, etc., equipped with various extensions (for example voice treatment, interface with videodiscs, optical memories, animation facilities and so on). Certainly it can be defined as an environment for hypermedia development.

The development of artificial reality systems is now in its infancy. Much effort is needed in order to obtain productive environments for an easy development of artificial reality systems: good CAD (Computer Aided Design) techniques have to be improved and integrated, good navigators in the artificial reality have to be produced, description languages suitable for explaining the artificial reality concisely have to be introduced. All this is more or less within the limits of today technologies, and it is certainly possible to build systems for a more productive development and maintenance of artificial reality systems.

Navigating in the artificial reality systems: the use of the metaphor

One of the fascinating aspects of the artificial reality metaphor is related to the use of the mouse or any other pointer or identifier. In fact, if the pointer acts in the artificial world it acts as a user's *alter ego* and it is actually related to the system perception of the user. In a sense, the user enters the reality and navigates in it. The system following the user (mouse, keyboard, etc.) can make a history of his choices and use it for future inferences. The re-use of the navigations for developing new ones, for communicating to other people the results of navigations, for modifying the path to be selected by future users, are all examples of possible consequences of histories.

Combining an artificial reality system with a good navigator adds to the computer system the capability of observing the user's life and of simplifying a partial or full playback of his or her navigations. There are numerous reasons for storing full as well as partial playbacks. Forgetting those related to the possible use of histories in increasing the system reliability, here we are interested in developing the navigation metaphor as a communication device. So, for example, a well edited playback could be used for individual and collective presentations. Past histories will be retrievable by the actual reader/writer (user) and could be subjected to many suitable observations. For example, histories will let the system measure, in some way, the users' behaviour with respect to their navigational attitude (linearity of paths, presence of loops, etc.), or the users could ask the system if during their navigation they have come across something.

The navigation metaphor can be used at many different levels. It is interesting, for example, to consider the development of an hypermedia just as a navigational path made visible in the artificial world by some expert Cicero who displays arrows (buttons and links) in order to help someone who is visiting the reality.

Another suggestive use of the navigational metaphor - leading itself to methodologies - is related to the use of navigation in an artificial reality in a public environment such as a classroom. In this case the metaphor suggests that the new rhetoric (originated by the old need for communicating combined with a new technology, for example, the large display of a computer) is just old as when ancient teachers used to show a country to pupils. Immediate suggestions arise: do not forget that some pupils have probably been lost around the corner! We do not want here to develop this last metaphor in detail or anticipate all possible uses of the metaphor itself. The user can certainly invent many other ones appreciating the power of the artificial reality paradigm.

From artificial reality to intelligent hypermedia systems

The design of an hypermedia system is a rather complex task. The present conceptual discussion aims at simplifying such development, recognizing that a hypermedia system is a multimedia interactive system whereby interactivity is obtained through possible actions on some part of a selected reality. Actions are the input from the user to the system: as a consequence of these actions, events happen and context is changed. Context is what the user is looking for, as a consequence of his or her past actions. Events are either acts on the reality, or retrieve acts to find new contexts (going somewhere in space, at some other time, either in the past or in future). In the new context new actions will be possible as will be shown by the appearance of indicators. When the reality is a text a hypertext results. In this case indicators are generally identifiable parts of texts (e.g. single words, paragraphs) acting as meaningful guides to other texts or anything else that can be made happen. Indicators can be predefined at the time the system is developed or can be generated by the system when in use. Whenever indicators are generated by users or have a behaviour modified by the system experience, we will talk of intelligent indicators. These are just the way in which artificial intelligence techniques can be accommodated and placed into hypermedia systems. One way of accommodating the intelligent indicators quite naturally is to give them a human appearance and to call them agents. Here a discussion has to be opened about the correctness of giving a human appearance to indicators (the secretary, the user, etc.). The problem at present is somewhat academic, but with the increasing use of computers it could become a serious source of confusion about responsibilities. Our answer to the many problems raised by these considerations is that the human appearance has to be limited to difficult tasks where some assessment has to be used and where the final decision made by the agents as to using the computations should be taken ultimately by the user and possibly never by default. It is interesting to note that the presence of agents is a natural way of using concurrent indicators: in fact, if actions are finally taken by the user, then the concurrent indicators can act without dangerous consequences. Users have to be conscious of the order in which the final decisions will be taken at the end of the concurrent computation: the sequential ordering will influence the final results.

Reality, models, documentation, knowledge and object-oriented programming

Technically, the main content of the present note is a discussion about a natural interpretation of object-oriented programming. The possibility of such an interpretation leads quite naturally to various simple considerations about the nature of knowledge. In the artificial reality paradigm, the models of reality are the primary entities which lead to uses of the associated documentation (details, texts, formal representations, properties, bibliography, explanation computed or not, and so on) through the links associated to the indicators. Ideally, hypermedia seem then to combine our models with a variety of more or less computable documents.

Models will convey a strong cognitive content as well a strong historical content. If well designed, accessibility to the details gives a verification capability to the critical user: this latter will have the possibility of redoing the reasoning that the designer has done at the time of the hypermedia development. As a result, the hypermedia system seems to be the best candidate for combining rigorous scientific tradition in documentation with the practical purposes of technological development. In fact, a user having enough documentation at his or her disposal could, for example, design experiments to disprove the basic foundation on which the hypermedia being used are based.

It is interesting to observe at this stage that the entities in the artificial world can quite naturally be considered instances of some more general entity represented by a class in the sense of object-oriented programming. A complete use of this attitude leads quite closely to the right environments for artificial reality as already discussed. Accepting the many theses contained here, a good environment for artificial reality must certainly accommodate descriptions of desired entities as objects capable of exchanging messages with other objects. The building of an actual system will be related to the instancing of these descriptions (the classes in terms of object-oriented programming). It is now rather obvious to consider the foregoing descriptions as texts having a graphical interpretation. This leads to a rather interesting semantic of descriptions and reduces strongly (at least conceptually) the distance between general hypermedia and hypertexts.

The role of animation

In the above picture, animation has a rather interesting role. If we are able to represent entities in some way, it is useful to move those entities about, at least for browsing purposes, and this browsing will improve our understanding (the ultimate goal of any communication system). However, to see at some time an aspect of an entity is related to the description, to the details, to the documentation, etc., of that aspect at that time. This makes the animation a rather interesting conceptual browsing system. Technically, the animations have to be developed starting from an animation process description whose states are related to the documentation of the modelled reality. To stop the animation at some space-time interval (for example, by using the mouse) leads immediately to the accessibility of all the documentation related to the selected space-time interval.

The main difficulties are related to the representation choices. In fact, representing physical reality is certainly the easiest way to implement animated realities which are relevant from a cognitive point of view. Representing more general entities leads to the needs of developing space-time metaphors for those entities. Various difficulties arise, probably as a consequence of our extreme incapability of representing things outside our ordinary 3-dimensional space. The subject is itself a matter of research that has still to be undertaken. A first indication, nevertheless, can be given in general terms: the representation of processes at various levels of abstraction can be considered as a way of using animation as a general browsing approach.

The use of the voice

In hypermedia systems based on the artificial reality paradigm the use of the voice can be interpreted in various ways, one of which is related to the use of animated navigations. Voice could do exactly what a Cicero does for a tourist. Two extreme cases have to be considered depending on the listener's capability of seeing. If the listener can see, the voice conveys redundant or complementary information or tries to avoid context changes with voice details present at a different level of description or in another context. If the listener can not see, the voice is the result of translating the navigation to a reality for descriptional purposes.

This could lead to a different use of the voice in the case of large amounts of information. In this case the voice could play the same role of text-indicators in ordinary visual hypertexts.

Reading a sequence of texts is like reading the entire content at some level of abstraction. If done with the voice, this kind of browsing has interesting side effects: it can be listened to without devoting all the attention to the hypermedia, just as in the case of one who listens to the radio while working. When the listener (the user) wants to have some details, he stops the high level voice replay (navigation) into the content (with some suitable command: by the mouse, by talking, etc.) and accesses directly the desired details. These will be presented using texts, voice, images and so on.

In our discussion on the use of the voice in hypermedia we have purposely neglected many possibilities. Our main aim was to show that the artificial reality paradigm is a suitable one even in discussing aspects that, at a first glance, seem scarcely related to the artificial reality descriptions. The reader acquainted with the paradigm will not have any difficulty in designing new uses of the voice in that frame.

Conclusion

We have tried to develop a very high level description of a paradigm capable of giving a unified view of hypermedia systems. The purpose of our description was to put as much common sense as possible in the design of hypermedia with a double aim in mind: first, improving interfaces using cognitive contents as much as possible, and second, improving the feasibility of hypermedia following the ease of understanding the entire project as an interacting collection of its (visual) parts. The results have suggested a rather high number of topics for further investigations and have lead to the possibility of combining technology with scientific attitudes (documentation and validation) in the case of the design of hypermedia systems. The ideas discussed here are associated with a natural view of object-oriented programming and are suitable for many suggestions in the design of environments for hypermedia systems. These will possibly enter our information or office environment as cognitive information systems, while the artificial reality user interface will eliminate substantially the common command language that in recent years has been predicted as mandatory for extending the office automation to a wider audience.