Design Tasks in Virtual Environments Development

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ABSTRACT

The use of Inhabited Virtual Environments (IVEs), is growing very quickly and people demand easier and more believable ways to interact in these new sites [3] [4], [5], [10], [13]. We understand by IVE a special kind of 3D virtual environments inhabited by *avatars*, which are the representation either of real humans users of the IVE or autonomous agents.

From the point of view of software engineering, IVEs can be seen as a special kind of software systems. In this sense, they must be analyzed, designed, implemented, etc., as any other software system. However, IVEs development requires special tasks and techniques, which are not provided by traditional software engineering methodologies. The question we would like to address in our research is: define the products to be developed during the construction of an IVE and how to manage that development.

In addressing this question it is necessary to define a set of steps which will provide a well-defined IVEs development process. In this paper we focus on IVEs design, detailing the tasks needed to complete such design.

Keywords

Design, Virtual Environment, Software Engineering

INTRODUCTION

With the spreading out of computer networks and specially Internet [13], people have increasingly felt attracted by applications like CHATs, MUDs (Multi-User Dungeon), social VEs (Virtual Environments), etc.

In this work we focus on the most recent VEs, based on 3D graphics and inhabited by avatars[1] and autonomous agents. We call this kind of VEs *Inhabited Virtual Environments (IVEs)*. This kind of applications has also been referred to as *Multi-user Virtual Worlds* [4].

In the earlier times of IVEs some technical problems were the main concern of researchers [8], [7]:

- Multi-user communication
- Graphical representation
- Real time communication
- Rendering efficiency

STATE OF THE PRACTICE IN IVEs DEVELOPMENT

After revising the most important references dedicated to virtual environments development, with a total amount of forty papers wrote by people which work with VEs, we can conclude that no one describes the development of VEs in a systematic way.

It is difficult to find reports that deal with the process followed to develop IVEs [9], [12], maybe due to the short experience in the field. We can say that IVEs development methods and processes are on their infancy. Nowadays the development of IVEs is not following a mature process. It is necessary to endow these developments with software engineering paradigms, principles and procedures.

Another weakness of the current IVE development processes is that the reuse of 3D design models among different IVEs is often hard or even impossible, due to the lack of standard notations and specification languages/methods. VRML, MPEG4, etc, are only used in the implementation phase, but not during design. Moreover, the verification of the implemented IVE is also difficult because there is not a well-structured design [6].

HCI (Human Computer Interaction) scientists have recognized the need to define new techniques inspired by Software Engineering [1]. Even the EC/NSF group (European Commission/National Science Foundation Strategy) identified Virtual Environments as a key research challenge, given its widespread use despite the poor literature related to its development process [2].

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[1] Avatar comes from Sanskrit and means incarnation.

But in order to reach the goal of defining the steps to develop a VE, we must still walk a long way. This paper aims to take a first step towards it. We are going to focus on the Design Processes, identifying its tasks with the aim of going from the general to the specific.

THE DESIGN PROCESS FOR VIRTUAL ENVIRONMENTS

To date there are many methods whose goal is the disciplined development of software systems supported by Software Engineering paradigms. The methods that best fit the development of IVEs are object oriented. L.Casey [11] said in 1994 that the use of object oriented techniques could be the key to set a real advance in IVEs development based on Software Engineering. In our experience, however, traditional object oriented design is not enough for IVEs Design. Traditional methods need to be enriched with a set of new tasks in order to successfully accomplish IVEs development.

IVEs design is part of a set of processes identified to accomplish IVEs development. These processes are the traditional ones with a set of modifications. We have identified the next processes:

- Analysis (A)
- Estimation (E)
- Planning (P)
- Software Quality Assurance (SQA)
- Software Configuration Management (SCM)
- Verification and Validation (V&V)
- 3D Design (3DD)
- Components Internal Architecture Design (CIA)
- System Design (SD)
- Support Components Implementation (SCI)
- Core Implementation (CI)

As we said above, in this paper we focus on Design Processes. IVE design includes three main processes: 3D Design (3DD), Components Internal Architecture Design (CIA) and System Design (SD). The last one is quite properly addressed by traditional object oriented procedures, while the first and second one fall out of any traditional software engineering method. In Table 1 we present the decomposition of design tasks that we are proposing.

PROCESS	TASK
3D Design (3DD)	IVE Modelling (3DD-IVEM)
	Avatars Modelling (3DD-AM)
Components Internal Architecture Design (CIA)	Perception Modelling (3DD-PM)
	Selection and Modelling of Components Internal Features. (CIA-CIF)
	Physical Actions Modelling (CIA-PAM)
	Reactions Modelling. (CIA-RM)
System Design (SD)	Interface Design (SD-ID)
	Expanded Static Model (SD-ESM)
	Expanded Dynamic Model (SD-EDM)
	System Architecture Design (SD-SAD)
	Methods Detailed Descriptions (SD-MDD)
	Data Persistence Design (SD-DPD)

Table 1 Design process and tasks for IVE development

Now we will describe each of the design processes and their tasks.

3D Design Process

The person in charge of this task must have a good knowledge of the physical features of the world that the environment is aimed to model, but they also must have a basic knowledge of graphic design. The result of this task will be a set of documents to be used by the Graphic Designer during the Implementation Process to build three-dimensional models with the selected tools.

IVE modelling

This task includes the definition of a set of virtual spaces and the objects to be included within them.

Avatars modelling

This task includes the definition of the virtual inhabitants, their appearance and physical structure.

Figure 1 shows dependencies among 3D Design tasks.

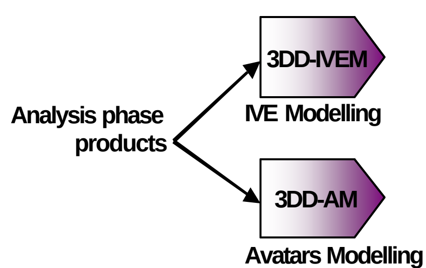

Figure 1 3D Design Process Tasks

Components Internal Architecture Design Process

There will be different people involved in this task: psychologists, sociologists, etc. because a multi-disciplinary work is necessary to endow these kind of applications with interesting enough interaction features.

It is very important to emphasize the important relationship between this process and the 3D Design process; each one must be coherent with the other.

Perception Modelling

In this task is defined the way avatars and agents can perceive the rest of inhabitants and objects in the IVE.

Physical Actions Modelling

The activities that the avatars must be able to execute in the environment must be designed with respect to the avatar's structure defined in the *Avatars modelling* task.

Selection and Modelling of Components Internal Features

Many times, the avatars' credibility depends more on their ability to show a rational behaviour and express emotions than on their physical realism, so it is important to endow avatars with a personality and emotion model and to associate the actions defined above with the appropriate emotions.

Reactions Modelling

In this task is defined the way in which IVE elements will be able to reason and make decisions about how to act.

Figure 2 shows dependencies among the Components Internal Architecture Design tasks.

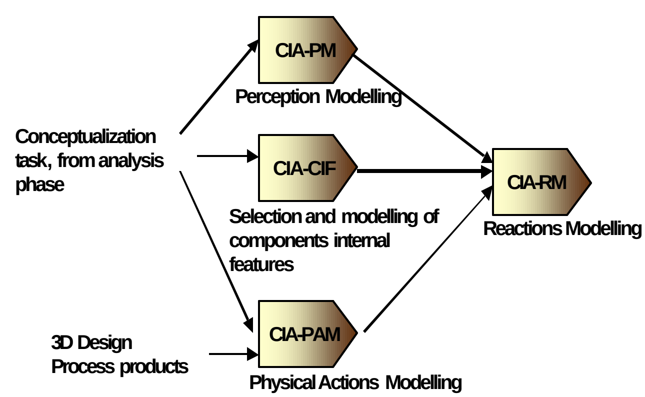

Figure 2 Components Internal Architecture Design Tasks

System Design Process

As we said above, this process is similar to the traditional object oriented design process.

Interface Design

In this task a prototype of the interface must be developed.

Expanded Static Model

The static model developed in the analysis process must be expanded in this task.

Expanded Dynamic Model

The dynamic model developed in the analysis process must be expanded in this task.

System Architecture Design

In this task classes, from the static model, are packaged. Also deployment and component diagrams, from UML, must be developed.

Methods Detailed Descriptions

The actions identified in Components Internal Architecture Design Process are detailed in pseudo-code.

Data Persistence Design

It must be defined the way in which persistent inhabitants behavior data and IVE information are to be managed.

Figure 3 shows dependencies among System Design tasks.

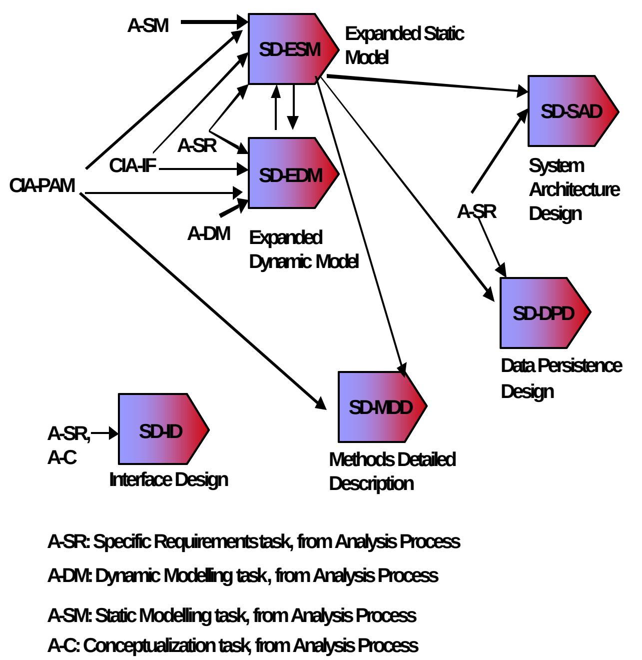

Figure 3 System Design Tasks

In the above figures there appear references to analysis tasks whose definition is beyond the scope of this article. Analysis tasks as well as implementation tasks, management tasks, etc., are part of the whole process defined for the formal development of IVEs.

Relationship between design processes

Figure 4 summarizes the relationship between design processes and the analysis process whose products are inputs to the design processes.

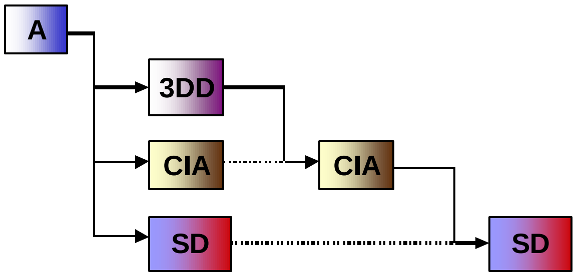

Figure 4 Relation between Analysis and Design processes

3DD, CIA and SD processes can start when the A process finishes, but some CIA tasks can not start until the 3DD process finishes and some SD tasks can not start until the CIA process finishes. To be precise, CIA-PAM, can not start until 3DD finishes because the physical definition of actions depends on 3D models appearance, and SD-MDD can not start until CIA-PAM is completed because the pseudo-code which represents methods to be implemented depends on the way actions are to be represented.

For instance:

- Suppose that in 3DD-AM, an avatar structure is defined with two arms and a body, and the avatar is defined to be able to jump.
- In CIA-PAM the way in which the avatar jumps must be described: "the body jumps up and lift the arms".
- In SD-MDD the jump action is described in pseudo-code:

```
Procedure Jump (avatar)
        {
        Avatar.body=50 pixels over the floor
        Etc. }
```

CONCLUSIONS

Nowadays, IVEs development is chaotic, there are good applications dedicated to the implementation phase only.

We agree that the power of the implementation tools is important, but implementation is just the last step. If the previous steps are ignored, the IVE developed will not be easily reusable because there will be no documentation about its components, its requirements, etc. A good analysis and design is necessary to reach a good IVE implementation "when" and "how" the client needs.

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