Cooperation between Reactive 3D Objects and a Multimodal X Window Kernel for CAD

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Abstract. From the early steps of sketching to final engineering, a frequent and very important activity in designing objects is to perform graphical and spatial simulations to solve the constraints on the objects which are being designed. But when we analyse work situations involving the use of CAD systems, it is today an acknowledged fact that these tools are not helpful to perform these types of simulations. While knowledge modeling based on form feature concepts already offers some possibilities for attaching behaviour to objects, the simulation activity requires in addition a ‘real time’ and ‘intelligent’ management of the interactions between the 3D virtual objects and the CAD user.

Our general purpose is to study how future CAD systems could be improved to achieve the simulation steps of object design. In this context we present some issues concerning the cooperation between a model of reactive 3D objects and a multimodal X Window kernel. We have developed a prototype of a system where objects with reactive behaviour can be built, and with which the user can interact with a combination of graphical actions and vocal commands. This prototype is used to evaluate the feasibility and the usefulness of the integration of such techniques in future applications that would be used by object designers in a real working context. We describe the current state of this system and the planned improvements.

1 Introduction

One of the most promising results of the research on multimodal user interfaces is their capacity to transform industrial applications which manipulate 2D or 3D virtual spaces. For example, it has been shown that a user can be more ‘productive’ using a CAD program when keyboard interactions are replaced by vocal ones (Martin, 1989). Hence some researchers propose to rethink these tools in terms of multimodal interaction (Gaildrat et al., 1993).

More than with simple substitutions of modalities added to the traditional user interface of CAD systems, our interest is to study how multimodal interaction could make these systems contribute better to object design. In fact, object design is not only an engineering activity, for which CAD systems are already useful. A frequent and very important activity is to perform graphical and spatial simulations to solve the constraints on the objects which are being
designed. Unfortunately, these simulations are not easily performed with current CAD systems, and the use of such tools for this activity requires complicated work organisations (Lebahar, 1992). We will hereafter refer to such simulations as ‘object simulations’ or ‘3D simulations’.

In this context, our general purpose is to study how future CAD systems could be really helpful for object simulation. Indeed, this activity requires a ‘real time’ and ‘intelligent’ management of the interactions between the 3D virtual objects and/or between these objects and the CAD user. An object (already built by the user or under construction) must have short-delay reactive behaviour in relation to the other objects of the virtual space it has dependencies with. Additionally, the user’s interactions with these virtual objects must be efficient, requiring advanced combinations of modalities both for input and output, syntactic and semantic dialogue analysis, and so on.

But reactive behaviour as well as multimodal interaction with 3D virtual objects presuppose knowledge modeling for these objects. During the last ten years, knowledge modeling for CAD/CAM is one of the main purposes of the form feature approach. According to Shah (1990), “a form feature is a physical constituent of a part with a generic shape realisable or abstract, it has significance in design, analysis, manufacturing, or some other engineering domain and has predictable behaviour or properties”. From this perspective, parametrical and variational modeling concepts of ‘form feature’ are very close to the requirements of a CAD system when used for 2D or 3D object simulations. On the other hand, we have to take into account that the simulation activity for object design can start from the first steps of sketching in the design process. In other words, during some simulation steps the objects might not have sufficient properties to be attached to form feature classes but only to geometrical semantics. Considering that ‘good’ knowledge modeling generally requires a hierarchical strategy, we chose to focus our work on the simulation activity with geometrical and topological objects. Indeed, our objective is to construct a 3D modeling kernel for object simulation that future CAD systems dedicated to particular object design domains could share.

However, manipulating virtual spaces requires a powerful graphical environment. Today, many of these applications are developed on UNIX workstations using X Window as a standard windowing environment, sometimes with additional graphical hardware. In spite of the various functions it can realise, the X server only manages, in terms of input modalities, mouse and keyboard events. In order to support the kind of interactions we require, we have created an architecture which seamlessly integrates new advanced modalities.

In the remainder of this chapter, we first define some basic concepts of multimodality and we show the importance of semantic representations for multimodal user interfaces. We subsequently present the geometrical and topological model of MIX 3D (Multimodal Interactions under X environment with a 3D virtual space) and we explain how knowledge modeling in MIX 3D is used to manage objects simulation. We then present examples of cooperation between reactive 3D objects and multimodal interactions. Finally, we discuss the design of our