Auto-erecting Agents for a collaborative Learning Environment

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Abstract

A collaborative learning environment based on 3D media with interchangeable real and virtual components is introduced. This environment is supported by a special knowledge space, which allows the accumulation of concrete haptic as well as abstract physical and logical knowledge. Firstly we present the concept of complex objects, having a real part and various virtual parts of different levels of abstraction. These complex objects allow a synchronous generation and manipulation of real systems and their virtual counterparts. The concept is then extended by a mechanism of auto-erection, enabling these objects to simulate their own potential environment. With this mechanism we are able to freely exchange real and virtual parts of a system in a distributed real learning space. This kind of learning environment is expected to support new forms of interaction, suitable for individual traditions, cultures, norms and conventions of learning styles and pre-knowledge.

1. Introduction

In a series of papers we introduced the concept of coupling real physical worlds with their virtual counterparts by a graspable user interface and its practical application in sveral domains: robotics, flexible assembly system design and pneumatics [1,2,3]. The basic idea of this concept is the introduction of complex objects (Fig. 1). These complex objects have one single real physical part and various virtual, computer-internal representations which may be projected on the screen, wall or table. Real and virtual parts are coupled by a mechanism of pattern recognition, that may be either grasp-recognition of a sensorised hand (data-glove) or by object-recognition with a video-system, sensing the building area. Using a construction kit of complex objects it is possible to synchronously build a real system and generate its virtual representations. The prototypes we developed so far are able to combine real construction kits for pneumatics, robotics and conveyor-systems with 3D-VR models based on VRML, special and general application simulators, help-functions and control systems for programmable logic controller (PLC)[1]. We use various real construction kits and discrete event simulators. Our *real object manager* is responsible for the representation of the real world, serves as a central agent for possible internet clients asking for a view-service on various layers of abstraction.

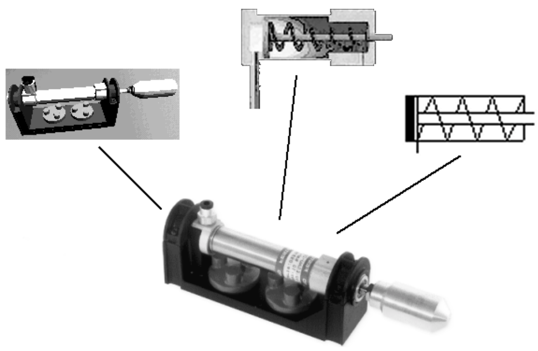

Fig. 1: Complex Object with real and virtual parts

The advantages of this approach are manifold: For learning purposes, it allows the support of individual, cultural and experience oriented learning styles, the building of mental models either by starting from the concrete and advancing to the abstract or vice versa. For vocational training it is most desirable to have three kinds of access to a new subject, by hand, head and heart. For system design, our concept allows the specification of complex systems by concrete demonstration, including geometry, topology and dynamic behavior. The specification of the synchronization between several processes is realized by a role play of different actors, generating an abstract representation of the desired behavior via Petri-

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Nets. This will improve the reliability of systems and decrease development time.

It has been argued among pedagogical experts, applying our prototypes in learning situations, that it would be desirable, not only to have a whole real system with its adequate components and connections to be coupled with a whole virtual system with its virtual components and connections, but to freely mix virtual and real parts on one level of work. This would allow the construction and simulation of a system on a table, having some especially interesting parts as *real* parts connected by virtual, light projected links to the virtual environment. Although the virtual parts being only projected into the scene, they would determine the real functioning of the real part. This would allow completely new forms of co-operative distributed learning.

2. Basic Concept

Our actual prototype allows the construction of a real system with real parts, mechanisms and real connections and the synchronous generation of a virtual system with virtual parts and virtual connections (Fig 2). If we want to replace real object 2 by a light projection of a virtual object and still have a physical behavior of its neighboring components 1 and 3, we have to serve the cut connections by some means of simulated computer controlled self-erection of the concerned objects. This can be done by a hidden surrounding model attached to the real component. For each connection, we only have to provide a hidden junction, a source and a sink for this type of physical phenomena and an electrical controllable mechanism to stimulate all input/output behavior of this junction. Removing a real part and replacing it by a virtual one, would require the disconnection of real wires/tubes from the real object and connecting them to the own hidden connectors, forming a closed loop on the remaining real object. The behavior of the real object remains physical real, but its connections to the virtual parts are stimulated by its hidden surrounding mechanism (Fig 3).

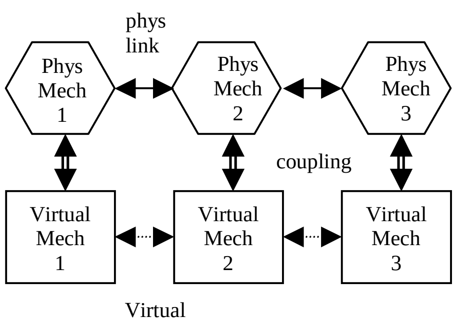

Fig. 2: Links within System Boundaries

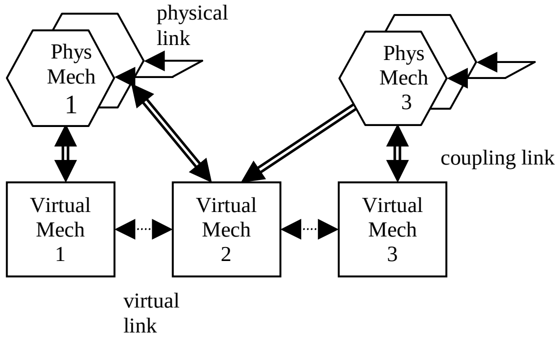

Fig. 3: Links across System Boundaries

In the area of electro-pneumatics we have these mechanisms that provide the hidden behavior. For other areas they have to be developed. In generalizing this concept for mechatronic systems, we could be able to build very powerful learning-environments allowing the study and experimentation of concrete physical objects embedded in a larger complex system that might even be distributed over different places, being materialized here or there and virtualized at other places. Unified concepts of system description in terms of causal-functional representations and ontologies would help to build such a system.

3. Related Work

Coupling tangible objects of real work spaces with information spaces of digital representation has been subject of increasing interest during the last decade [4-6]. The merging of real and virtual parts is a new concept.

4. References

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