

Distributed Stiffness

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Abstract

Interactive simulation through distributed virtual environments has been at the very cutting edge of research in the last few years, not least through the developments in the hardware required (e.g., internet connection speed, desktop processing) and critically, the novel algorithms applied to overcoming the single significant problem in the field - communication delay.

There have, over the years, developed two distinct yet complementary approaches to overcoming the problem associated with delay. The main focus has tended to concentrate on the more human oriented and hence application driven tasks that have yielded at times excellent solutions for specific circumstances. The second path is for a more generic solution, but this is also largely unsatisfactory as a singular answer to delay, as the very generic nature of the solution precludes optimisation.

While it is undeniable that a combination of both approaches is certainly the optimum route to success, the main resource in terms of research effort appears to be devoted to the former approach. I would like in this presentation to overview some of the fundamentally theoretical and practical difficulties associated with time delay and will do so through the exploration of what many might consider to be the last "great frontier" of virtual environments - that of haptics.

There can be little doubt that the internet and the subject area of virtual reality and distributed simulation has been tremendously enhanced or facilitated by the developments in communication technology provided by the pornography industry. Yet, as with virtual reality technology itself, the ratio of hype over results has remained too high to allow for a realistic expectation of value. However, the pornography industry has pioneered the efficient transfer of visual still and moving imagery and it is in the visual arena that virtual reality has excelled. But what about the other senses?

Certainly there has been considerable developments in the area of audio "reality" and this progression can be clearly catalogued: from mono to stereo and then quadrasonic home entertainment systems to the more complicated ambisonic systems including head transfer functions. There are also a few areas that remain in their infancy: while taste and smell remain elusive, the new developments in haptics represent an exciting addition to

the sensory requirements of a true feeling of presence in a virtual environment. Haptics, which builds on earlier research in force feedback and master-slave systems in robotics, allows the interaction through touch and feel.

While the development of force feedback systems has been ongoing for some two decades, the developments in haptics are still in their infancy. In distributed environments, there is the additional difficulty of allowing (or enabling) two or more users to access the same "haptic" environment. What appears a reasonably difficult but at least tractable problem in visual terms becomes ever more intractable when touch and feel become a requirement.

For this talk I will present the underlying reasons why, for distributed simulation, "what you see is not what I see" and "what you can touch is not what I can touch", and why, in theory, this will never be so.

In practice, however, we are blessed with application specific heuristics than can come to our aid. I will outline a generic mechanism which may allow us a partial solution to overcome the problems associated with distributed haptic systems.

The key to this issue is how a distributed simulation of an object, with all of its attributes, can be haptically displayed over a distributed environment? Central to this issue is the main physical attribute of an object in a haptic sense, and that is of object compliance, or stiffness. When is a stiff object stiff and when must it be otherwise? I would rather scientists found the answer to this question rather than the pornographers!

Paul Sharkey graduated in 1985 with an Honours Diploma in Electronic & Electrical Engineering from Dublin Institute of Technology and, by happy coincidence, with a B.Sc. (Eng.) in the same year from the University of Dublin (Trinity College). He was awarded a Ph.D. for research in the area of nonlinear control systems from the University of Strathclyde in 1988 and then spent 5 years at the Robotics Research Group of the University of Oxford. He joined the Department of Cybernetics at Reading University in 1993 as a Lecturer, gaining promotion to Senior Lecturer ('97), Reader ('98) and, in June '99, Professor of Cybernetics.