Exploration of Psychological Feedback Systems in Immersive Virtual Environments

Our current means of interacting with computers is painfully slow and non-intuitive, so much effort has been spent around the world in devising novel (and occasionally effective!) communications devices. Too often, people confuse ‘interactive’ with ‘reactive’, and devote energies into building interfaces which cause the machine to react, yet have minimal impact on the other half of the communicating pair; the user. In the Theory Center at Cornell we have a fairly accessible CAVE (a three-dimensional visualization space) which is run on PC-like computers, and this has been used extensively in allowing ‘walk-throughs’ of proteins, aircraft wings, and multi-dimensional data.

This project arises from a desire to build elementary feedback into this environment. Currently there are trackers on the ‘controlling’ glasses for both spatial location and view orientation, and an enhanced ‘pointer’ which can ‘grab’ parts of the presented image in order to pull or rotate it about the user. Imagine a sheet of latex stretched across the field of view at some short distance from the user. The goal is to have tracking on the user’s hands so that when, for example, their right hand ‘contacts’ the sheet and presses forwards, the sheet distorts in a realistic manner. Further enhancements would be to allow the sheet to react to the pressure of two separated hands, and to simulate the ‘friction’ as a hand either moves laterally (when in contact with the sheet) or twists. A rather more distant goal, for which the summer would most likely be only a preparation, is to design wearable mechanics to allow the simulation of the resistive forces for the user. A lively imagination, being a quick learner, and having strong programming skills are the prerequisites for this project. Good comfort with standard PDEs has clear value in approaching this project.

Modelling Human Movement

There’s been a successful history of collaboration between some of our Computer Science students and the faculty in the Textiles Department ... they have a laser scanner which will take 300,000 data points on your body in roughly 8 seconds! This has had many uses within the fields of apparel design - however the project being offered is focussing on a slightly different aspect. If you think of 300,000 data points in three dimensional space, they can be connected by short straight line segments giving a ‘triangulated’ model of the body, or joined by appropriate curves for a more natural modelling. Currently the software being used for this has some unfortunate restrictions, so a first stage could be to work as part of a team to write a more effective and flexible package.
There are two projects being planned currently, but the aspect which we’ll want to focus on is building a library of ‘poses’ for a person. The scanner is very fast, but 8 seconds is too slow to capture movement (except artistically!). Using inexpensive video cameras and an appropriately constructed body suit carrying its own graph-paper like pattern, the first step is to gather a collection of moving images carrying their intrinsic coordinate systems, thus giving information on the local deformations across the body. This will allow the subsequent ‘stitching’ of the detailed laser images, correctly deformed, to create highly detailed ‘moving laser scans’. As a by product of this, we will also get real data estimates on changes in local body densities due to conformation changes, which allows the building of a helpfully detailed momentum map relating to human movement. This has many quite obvious and valuable applications. The skill sets for this should include strong programming skills, good comfort with multivariable calculus (classical differential geometry would be a surprising, but welcome plus, though scarcely anticipated!).