Real-time Animation of a Virtual Arm and its Collisions with a Virtual Environment

Massimo Bergamasco
PERCRO
Scuola Superiore S.Anna
Via Carducci, 40
56127 Pisa, Italy
bergamasco@percro.ssup.it

Abstract

Realistic rendering of the virtual body limb movements represents one of the most interesting research areas for the design and implementation of the representation component of a Virtual Environment system. This paper addresses the description of a complete experimental Virtual Environment system including real-time graphical rendering of upper limb movements as well as force feedback capabilities to the user. The virtual arm and hand are modeled with a set of 40 non-uniform B-splines: mono and multi-processors algorithms have been used in order to convert parametric surfaces in polygon meshes. Upper limb movements are recorded by means of joint rotation sensors (optical encoders) integrated on a 7 degrees of freedom mechanical structure wrapping up the whole arm and possessing the same joint rotation axes. The same mechanical structure is devoted to replicate virtual contact forces to the user's hand. Data from joint rotation sensors are used to move the control points of the parametric surfaces. In this way, a realistic representation of the shape of the virtual hand and arm, including the deformation of the skin, has been empirically obtained. Collision detection algorithms as well as modules for the modeling of physically-based behavior of the virtual hand in contact with virtual objects have been developed. The paper will contain the complete description of their design. Results of experimental tests aimed at verifying the performances in terms of frame rates and force feedback capabilities during practical manipulative and exploratory tasks of virtual objects are presented.