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Abstract

In this demonstration, we present how the 7-Handle manipulation technique makes it possible to manipulate 3D objects in virtual environments. This technique includes a set of seven points which are flexibly attached to an object. There are three different control modes for these points including configuration, manipulation and locking / unlocking modes.

Categories and Subject Descriptors (according to ACM CCS): I.3.6 [Computer Graphics]: Methodology and Techniques—Interaction techniques. I.3.7 [Computer Graphics]: 3-D Graphics and Realism—Virtual reality.

1. Introduction

Object manipulation is one of the most essential and important interaction in Virtual Reality (VR). Proposing efficient, easy to use and to integrate, flexible and reusable manipulation techniques has been broadly studied over the past few decades. In this demonstration, we focus on accurate manipulation techniques for large objects in 3D Virtual Environments (VEs). This task is usually difficult because of the obstruction of a user's view caused by the objects' size during his manipulation [BH97] and by other objects (if there are many) in the same scene. It becomes more difficult when the user has to position large objects with a high degree of accuracy. Due to these difficulties, we propose a new manipulation technique named *7-Handle technique* for 3D objects in VEs [NDP14]. This technique enables a user to adapt the set of seven points of the tool to objects of different sizes and shapes, and to many kinds of manipulation scenarios.

It can be considered as an extention of the 3-hand manipulation technique [ADL09] that determines the position of virtual objects through the position of three non-aligned manipulation points on a plane and that we have already improved through the 3-point++ technique in order to be used by a single user [ND13]. It enables the user to manipulate one or two of manipulation points, and to lock the remaining ones. We included also additional manipulation points in order to be able to manipulate an object with two hands as described in [HPPK98] and [CFH97].

2. The 7-Handle Technique for Direct Manipulation

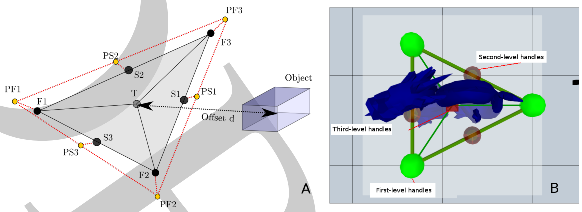

Figure 1: *A (left): Set of seven points of the 7-Handle tool. B (right): Implementation of the 7-Handle tool.*

The 7-Handle technique consists of seven points as illustrated in figure 1.A. The three points F_1, F_2 and F_3, called *first-level* handles, are the three vertices of a triangle. The three points S_1, S_2 and S_3, called *second-level* handles, are initially positioned at the midpoints of the three sides of the triangle. Each second-level handle is used to control its two adjacent first-level handles. The last point, *third-level* handle T, is initially positioned at the centroid of the three first-level handles. The handle T can be used as a direct manipulation tool with 6 DOF. We propose three different control modes

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for the 7-Handle tool, especially for the three first-level handles, including configuration, locking / unlocking, and manipulation modes.

2.1. Configuration Mode

A configuration mode makes it possible to change the positions of the seven handles relatively to the position of the object at run-time, which will modify the shape of the tool without moving or rotating the object. The first-level handles are recommended to be put near some parts of interest of the object. The second-level handles are initially placed at the midpoints of the sides and the third-level handle at the centroid of the first-level handles. The user can change their offset with the object.

2.2. Locking and Unlocking Mode

Our system provides a possibility of locking or unlocking the three first-level handles. If one first-level handle is locked, the user can rotate the 7-Handle tool (and also its associated object) around the locked handle. If two first-level handles are locked, the manipulation of the remaining first-level handle enables the user to rotate the object around the side formed by the two locked first-level handles. The locking / unlocking mode is only possible for the first-level handles.

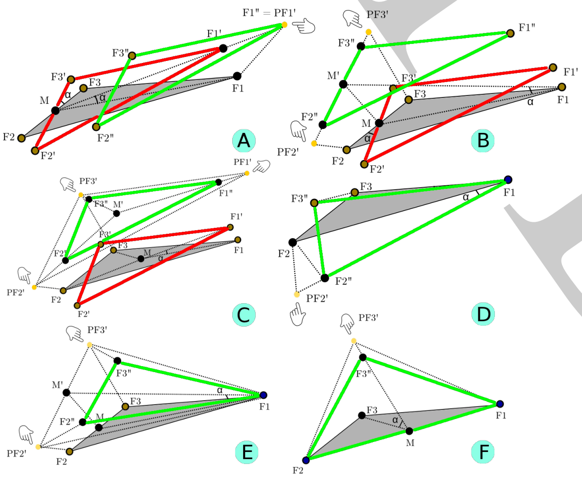

Figure 2: *Six manipulation scenarios using the 7-Handle tool. The triangle with black sides shows its initial position, one with red sides shows its intermediate position, and one with green sides shows its final position.*

2.3. Manipulation Mode

The user can use the tool to modify the position and orientation of the object. Once the tool configuration has been done, its shape remains unchanged. Due to this constraint, we propose controlling these handles through proxy points PF_1, PF_2, PF_3, PS_1, PS_2 and PS_3 (see figure 1.A). We do not need a proxy point for the third-level handle because it can be directly driven in 6 DOF. The proxy points are smaller yellow spheres initially hidden inside their associated handles. The movement of a proxy point reflects the expected position that the user wants its associated handle to go. Therefore, when we talk about controlling a handle, we actually talk about controlling the proxy of this handle. The gap between one handle and its proxy point during the manipulation is made visible by a red elastic link and the deformed triangle shape of the tool is shown in semi-transparent yellow. This proxy point comes back to the position of its associated handle when the user releases it. The way each handle moves depends on the position of its proxy point, its own state (locked or controlled by its neighbour handles), the state of its neighbour handles, and the shape of the triangle.

3. Additionnal feedback

To improve the usability of our technique, we integrated some visual informative feedback about the state of each handle to inform the user about its availability, its behavior and its functionality. Each handle can be in one of three different states: active (bright green) when it is grabbed. The second is the inactive state when the handle is controlled or manipulated by other handles. Its position and orientation are computed according to its relation with the other handles. When a handle is in the inactive state, it appears in a semi-transparent red color and it cannot be grabbed by an interaction tool. The last one is the locked state: the handle is pinned at one place and it cannot be moved unless the user unlocks it. A locked handle appears in blue.

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