Virtual Reality
Winter Term 2017/2018

Assignment Sheet 4

A sophisticated interaction technique is strongly dependent on the properties of the input device and the applied transfer function (see Figure 1). Input devices can provide isotonic, elastic or isometric input. Examples of transfer functions, on the other side, include position, rate and acceleration control. In this assignment, you will work with a mouse as a representative of isotonic input, which measures relative movements in two directions. The spacemouse device provides elastic input for six degrees of freedom.

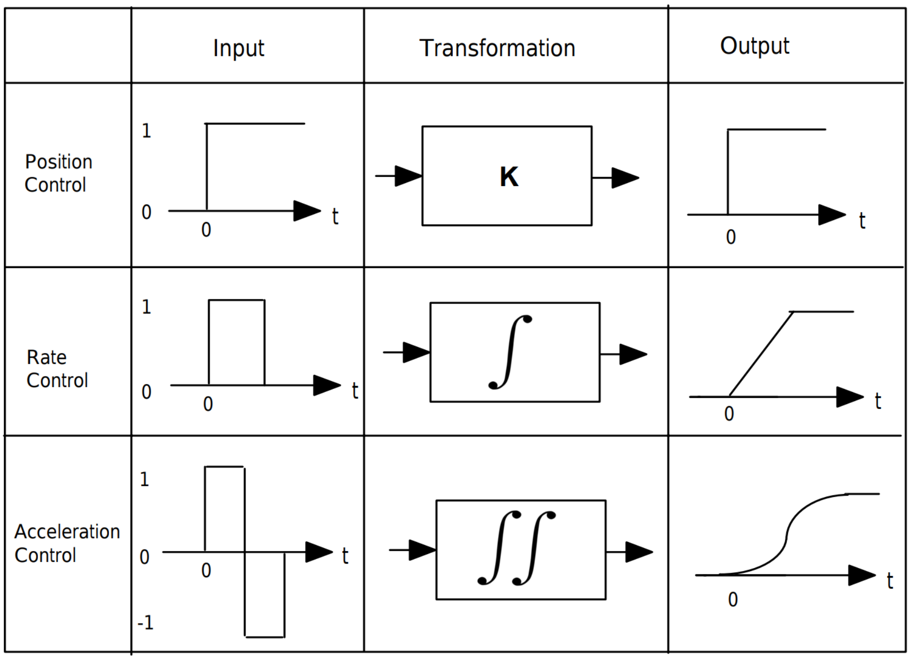

Figure 1: Idealized control inputs (left column) for obtaining step changes in output level (right column) for position, rate and acceleration control[1]

[1] Zhai, Shumin. Human performance in six degree of freedom input control. University of Toronto, 1996.

The goal of this assignment sheet is to implement a spatial manipulation task in which multiple target objects have to be selected and moved with a virtual hand using *isotonic* and *elastic* input devices in combination with the three mentioned transfer functions (see Figure 2). The resulting six combinations of input type and transfer function are assigned to the number keys 1 to 6 in the provided framework.

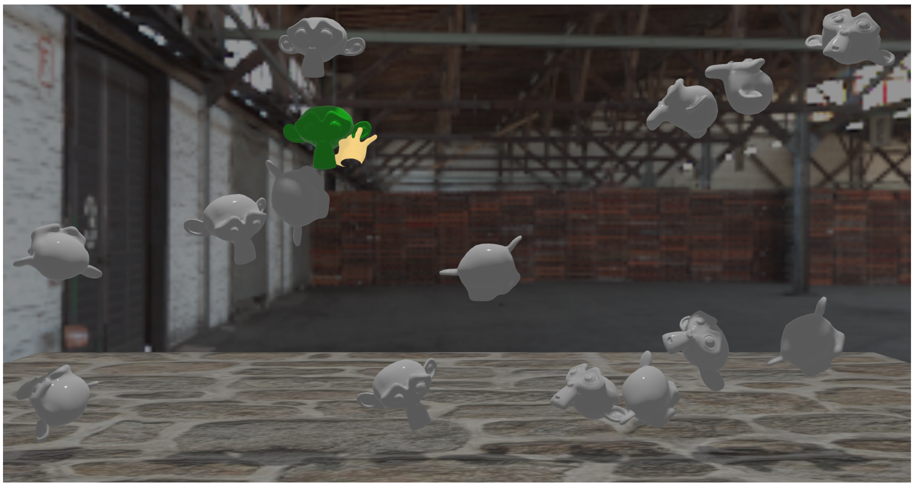

Figure 2: Spatial manipulation task to be implemented in this assignment sheet. Objects in close proximity of the virtual hand are highlighted and can be dragged to another location.

The class `ManipulationManager` initializes and administrates the six manipulation techniques. Each individual technique is derived from the base class `Manipulation`. The respective behavior of each technique is implemented in its `manipulate()` function, which is executed every frame. As a starting point, the class `IsotonicPositionControlManipulation` is already given and serves as a reference implementation for the remaining techniques.

Group work in pairs of two is permitted. The presentation of the results will take place on **Friday, 08 December 2017** in the lab class.

This assignment sheet is worth **20%** of your total lab class grade.

Exercise 4.1 (0%)

Analyze the code of the provided framework in order to understand what functions are already given and how the different classes work together. Start from the file `main.py`.

Exercise 4.2 (15%)

The class `IsotonicPositionControlManipulation` is already implemented such that the virtual hand can be moved using isotonic position control. Objects in close proximity of the hand are highlighted. Implement a dragging functionality such that the highlighted objects can be moved when the mouse button is pressed. For this purpose, implement the three functions `start_dragging()`, `object_dragging()` and `stop_dragging()` in the class `ManipulationManager`.

Hint: We have added an additional helper field `DraggingOffsetMatrix` to each TriMeshNode that can be used to temporarily store a transformation matrix, e.g. `node.DraggingOffsetMatrix.value = ...`

Exercise 4.3 (30%)

Implement the classes `IsotonicRateControlManipulation` (key 3) and `IsotonicAccelerationControlManipulation` (key 5) such that the virtual hand can be moved using isotonic rate control and isotonic acceleration control. Adjust the input scaling factors or insert additional helper variables if required.

Exercise 4.4 (45%)

Implement the classes `ElasticPositionControlManipulation` (key 2), `ElasticRateControlManipulation` (key 4) and `ElasticAccelerationControlManipulation` (key 6) such that the virtual hand can be moved using elastic position control, elastic rate control and elastic acceleration control. Adjust the input scaling factors or insert additional helper variables if required.

Exercise 4.5 (10%)

Assess the usability of each of the six combinations in the context of precise object manipulation. Come up with suitable use cases for each of the combinations. For this purpose, think within the scopes of both object manipulation and viewpoint navigation.