Chapter 18
Supporting Unskilled People in Manual Tasks through Haptic-Based Guidance

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ABSTRACT

This chapter presents a methodology that the authors developed for the evaluation of a novel device based on haptic guidance to support people with disabilities in sketching, hatching, and cutting shapes. The user's hand movement is assisted by a sort of magnet or spring effect attracting the hand towards an ideal shape. The haptic guidance device has been used as an input system for tracking the sketching movements made by the user according to the visual feedback received from a physical template without haptic assistance. Then the device has been used as an output system that provides force feedback capabilities. The drawn shape can also be physically produced as a piece of polystyrene foam. The evaluation methodology is based on a sequence of tests, aimed at assessing the usability of the device and at meeting the real needs of the unskilled people. In fact, the system has been evaluated by a group of healthy and unskilled people, by comparing the analysis of the tracking results. The authors have used the results of the tests to define guidelines about the device and its applications, switching from the concept of "test the device on unskilled people" to the concept of "testing the device with unskilled people."

INTRODUCTION

The aim of the present chapter is to describe the test methodology in order to control and measure the efficiency of the haptic guidance device.

As the design of the haptic guidance device is a widely inter-disciplinary project involving experts from various disciplines, including such diverse areas as pedagogy, psychology, computer science, mechanical, mechatronic, and product design, this

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chapter is written by the intent to make not only the specific methods and procedures of accuracy testing intelligible for readers from various disciplines, but also its motivations. Therefore, not only the methodology itself and the tools that form the basis of this methodology will be described in a more detailed way.

This chapter should also serve as a set of practical guidelines for the testing procedures (but not yet as a detailed manual). It is written with the intent that experts involved in the accuracy testing procedures in the design of the haptic guidance system be able to use it as a detail reference work for actual practical activities within efficiency and accurate testing: explaining the tools to be used, the measurements to be taken, the way of data collecting.

This chapter is also meant to be intelligible, explanatory and enough detailed for those who approach the haptic guidance device and its testing activities professionally somewhat from the outside, but are nevertheless deeply involved via other ways.

By implementing the haptic guidance device we need to prove the followings: 1) the haptic support work; 2) it does suit the scientific facts and the experiences about the nature of the given problem; and 3) it is safe. In other words, we have to offer evidence-based.

A point that is crucial in the logic of evaluation of the accuracy of the haptic guidance device is multiple comparisons. We assess the unskilled people initial state and then its changes due to the use of the haptic guidance device, and we compare before and after measurement results. Moreover, we create an appropriate control group.

At first sight, it seems relatively simple a procedure, but there are several further considerations in order to reach High Methodological quality and to get strong evidence. The following brief review is based on Geyman and colleagues research (Geyman, Deyo, & Ramsey, 2000).

1. A prospective "before-after" evaluation is needed. The retrospective efficiency testing is not as accurate, and could be influenced by interpretations, latter experiences.
2. We have to select the subjects carefully and advisedly. Obviously, the main principles of the selection depend on the goal of the haptic guidance system, but there is no doubt, that solid baseline assessments (e.g. formalized, standard evaluation, etc.) are needed before we started the accuracy testing of the device.
3. After the baseline assessments, we assign the subjects randomly to the experimental group.
4. The sample (the number of experimental subjects) has to be large enough for an appropriate statistical analysis. In this way, by applying and adequate level of statistical significance as a criterion, we will assure the accuracy of the haptic guidance device providing confirmatory results.
5. Testing and evaluation of the results may easily lead with possible errors.

To accomplish our aim it is necessary to assess how the sketching control movements under haptic feedback are affected in people with motor and visuo-spatial disorders, principally by Down syndrome. Sketching is one of the most complex human activities in which the hand movements are controlled by the central nervous system, which regulates the activity of the hand and arm muscles to act in synergy. The central nervous system receives dynamic feedback information from visual sensors and from other body sensors located on the skin, muscles, and joints, while regulating the motor output.

Haptic technology can among other more traditional technical applications, be a great help for a very special group of users with specific disorders, as for example, people with Down syndrome, forms of mental retardation and other development defects (Huanran & Liu, 2011) and