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Analysis of the Pen Pressure and Grip Force Signal During Basic Drawing Tasks: the Timing and Speed Changes Impact Drawing Characteristics

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Abstract

Writing is a complex fine and trained motor skill, involving complex biomechanical and cognitive processes. In this paper, we propose the study of writing kinetics using three angles: the pen-tip normal force, the total grip force signal and eventually writing quality assessment. In order to collect writing kinetics data, we designed a sensor collecting these characteristics simultaneously. Ten healthy right-handed adults were recruited and were asked to perform four tasks: first, they were instructed to draw circles at a speed they considered comfortable; they then were instructed to draw circles at a speed they regarded as fast; afterwards, they repeated the comfortable task compelled to follow the rhythm of a metronome; and eventually they performed the fast task under the same timing constraints. Statistical differences between the tasks were computed, and while pen-tip normal force and total grip force signal were not impacted by the changes introduced in each task, writing quality features were affected by both the speed changes and timing constraint changes. This verifies the already-studied speed-accuracy trade-off and suggest the existence of a timing constraints-accuracy trade-off.

Keywords: writing kinetics, sensor design, feature extraction, signal features

1. Introduction

Handwriting is both a fine and well trained motor skill, and it involves several complex biomechanical processes along with cognitive and sensory abilities [15, 21, 7]. The complexity of the systems involved in the writing process, along with its trained nature, results in variations between and within subjects [21]. The biomechanical processes entailed in handwriting is more particularly the result of the coordination of the arm-finger biomechanical system, which involves more than ten mechanical degrees of freedom [1]. However, this high degrees of freedom system can be simplified to a process involving only two degrees of freedom, related to the motion of the fingers and the wrist, and writing can consequently be modeled with

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