

# AUTOMATIC QUANTIFICATION OF HANDWRITING CHARACTERISTICS BEFORE AND AFTER REHABILITATION

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Handwriting represents a complex motor behaviour recently analysed by using direct measurements carried out by digitizing tablets. This technology allows objective quantitative kinematic analyses of the quality of writing and can be used to study handwriting disturbances, that can be found in elementary school-aged children, as well as the effects of a rehabilitation treatment.

The aim of this paper is to present a system able to analyse handwriting movements produced by children presenting dysgraphia, submitted to a rehabilitation treatment. The writing task consisted of a sequence of 'lelele', written by the subjects before and after a suitable space-temporal rehabilitation treatment (Terzi method). Handwriting samples from 14 non-proficient handwriters children attending primary school, aged 9-12 years, were collected before and after rehabilitation, with the aid of a digitizing tablet (Intuos3®, Watcom). The movements were segmented and each identified stroke was analysed by a suitable ad hoc software that calculated a series of static and kinematic parameters linked to pressure, trajectory and velocity features of the tract, in order to measure the procedure efficacy and to evaluate what parameters are more sensitive to the recovery process.

By means of the realized system significant differences in handwriting characteristics estimated before and after treatment were found. In particular a significant increase of the mean pressure calculated on each stroke ( $p < 0.001$ ) as well as an increment of the mean velocity during single stroke ( $p < 0.02$ ) and the mean width of a stroke ( $p < 0.02$ ) were pointed out. Significant differences were also found for the mean velocity along the whole curvilinear written tract ( $p < 0.02$ ) between the two conditions. On average the subjects improved in speed of writing after the intervention period. At an individual level, three out of the fourteen children after the treatment showed a little velocity reduction rather than the increment; this is compatible with the hypothesis that these children required a longer time for recovery.

These results demonstrated the potential of the realized system that provides quantitative spatio-temporal measures of handwriting performance, useful for the evaluation and treatment assessment of handwriting difficulties. The system can also assist for a more comprehensive understanding of handwriting difficulties. Furthermore, the specific application of the system reported in this study suggests that the Terzi method seems to especially improve the stroke speed of children initially identified as having poor handwriting quality.