Spatio-Temporal Registration of Plantar Pressure Image Sequences

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The analysis of plantar pressure data provides valuable information on the role of the foot and ankle during gait and other activities. The information gathered can be used, foe example, to define suitable rehabilitation programs through alterations of footwear, foot orthoses, exercise programs and weight-bearing restrictions. It can also assist the diagnosis and rehabilitation of impairments associated with musculoskeletal, integumentary and neurological disorders. Particularly, it has a vital role in the assessment and prevention of ulceration of patients with diabetes and peripheral neuropathy.

Generally, the plantar pressure data can be converted into a discrete rectangular array at time instant (static image) or over a period of time (image sequence). It is common accepted that 3 to 5 walking trials enhances the reliability of the dynamic pressure measurements. Hence, the automated spatio-temporal registration of image sequence trials is worthwhile to attain representative plantar pressure image sequences and support comparisons on a pixel-by-pixel basis.

Here, the use of automated computational methods in the spatio-temporal registration of plantar pressure image sequences is presented and discussed. It will be shown that the spatio-temporal transformations that best align the pairs of sequences are obtained by minimizing the mean squared error (MSE) among the plantar pressure values. Also, as only intra-subject registration is involved in this work, a rigid geometric model reveals to be efficient in the spatial registration, and linear and cubic B-splines based transformations suitable for the temporal registration.

Using synthetic control transformations applied on real image sequences acquired according to a frame rate of 25 Hz (40 ms period), the best mean temporal error achieved was around 0.2 milliseconds (ms) and the spatial error around 0.08 mm, which is several times inferior to the spatial resolution of the acquisition device used.

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