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DYNAMIC STABILITY OF DAILY-LIFE WALKING USING INERTIAL MEASUREMENT UNIT

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Summary: One of the most frequent activities of our daily-life is walking activities, which provides a lot of information about biodynamics and kinematics of individuals. Usually, gait stability decreases with ages which indicates increasing risk of falling down. In this research, we evaluate qualitatively gait stability and its non-stationarity by using Inertial Measurement Unit sensors to record the 3-directions acceleration and 3-axes angular velocity signals of the subjects' feet. We developed new algorithms for processing the very noisy raw gait data in order to analyze de-noised and de-drifted accelerations of anterior-poster, vertical and mediolateral of foot movements. The perturbed gait dynamics x(t) is constructed from accelerations, and parameter d(t) is the Euclidean distance between x(t) and unperturbed gait dynamics. Parameter λ estimates the linear regression slope of the ln (d(t)). We calculated exponential stability for our dataset for different age groups, and the exponential stability has demonstrated its potential suitability for gait analysis and to enhance our previous results. With the exponential stability, we introduced one single parameter λ_s , which indicates whether the average distance between perturbed gait dynamics and the unperturbed gait dynamics increases exponentially (λ_s>0) or decreases exponentially (λ_s<0). In our extensive experiments, we used totally 21 groups of gait datasets for subjects of age of 60s, 70s, 80s. In the results, we found that for the subjects in their 60s and 70s, the standard deviations of λ_s are 0.61 and 0.58. But for the subjects 80s old, the standard deviations of λ_s increased dramatically to 1.75. We conjecture that the standard deviations of the parameter λ_s has a strong correlation with gait dynamics stability. We believe that exponential stability helps us to predict the risk of falling.