HUMAN GAIT OPTIMIZATION TRAINING USING FEEDBACK ON THE RATIO OF FORWARD TO VERTICAL ACCELERATION

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ABSTRACT:
Feedback on the qualities of human gait can assist with efforts to improve gait dynamics, leading to enhanced vigor and resiliency. The metric for feedback is efficiency in gait - that maximal forward gain is achieved per unit vertical expenditure of kinetic energy. This value can be evaluated as the summarized ratio of forward to vertical acceleration across a sample. Proffered as a value, this ratio provides dynamic feedback on the efficacy of gait tactics.

PROBLEM STATEMENT:
Many of us embed compensations and adaptations in our tactics for movement, acquired both as we learned to move, and as we adjusted to injuries we may have acquired. Feedback on the relative efficiency of gait provides a guideline for experimenting with gait tactics that may be more efficacious. It is observed that the simple ratio of forward to vertical acceleration suffices as an indicator for developing improved gait dynamics.

KNOWN SOLUTIONS AND DRAWBACKS:
Gait (re)training is an integral part of Physical and Occupational Therapy, as well as many other therapeutic modalities. Traditionally this has been done by visual assessment. More recent innovations primarily involve sensing pressure at the feet at multiple points. All of these strategies embed sometimes conflicting biases on the qualities of optimal gait. The art of optimizing gait has consequently not evolved significantly in a century, and as further generations experience an urban life cycle, is perhaps devolving.

NOVELTY STATEMENT:
Summarized two axis' accelerometer data (forward and vertical) accessed on the front/back midline of the body proffers sensory information not available to our innate proprioceptive inputs on qualities of our gait. Efficiency equates to maximal forward gain per unit vertical kinetic energy expenditure. This statement has always been foundational to the art of optimizing gait, but without any means to accurately monitor this data, has remained inapplicable. Accessing and processing this data into a summarized ratio is a paradigm shift in gait training - moving the art beyond an opinion of what an optimized gait should be to a foundational metric for efficiency.

IMPLEMENTATION/PROCESS STEPS:
A multi-axis accelerometer is attached to the body on the front/back midline. Accurate data can be acquired at the base of the Spine, Sternum, T1 and other places. Readings are taken frequently (i.e.: ~.020 seconds). The data is processed using this guideline:
if forward acceleration(F) > vertical acceleration(V), ratio(R) = F/V. If F<V, R=V/F*-1.
Values are summed over a few seconds and presented as a value (score).
If this score is monitored while a range of gaits are tested, it will be observed that the "score" is both sensitive to minor variations and robust over consecutive samples. With application, gait patterns that deliver consistently higher scores will be observed.

EXAMPLE EMBODIMENT:

For most of us our gait dynamics are “good enough” to get by. However, implicit compensations and adaptations diverging from optimized gait can eventually lead to chronic musculoskeletal issues and joint degeneration. As children, we primarily settled on our gait dynamics by observing those nearby, principally our parent(s), who themselves may have modeled sub-optimal gait patterns. Once children are walking around “good enough” their development progresses to more complex skills, which they build on top of whatever locomotor competency they have acquired. Practice with gait optimization feedback will enhance physical robustness and locomotor scope at any age.

There has been no direct way to tackle the issue of optimizing gait known to this writer until it was realized that optimized gait equates to efficiency in gait, and that this value is easily captured at the base of the spine. The configuration of the feedback should be both age appropriate and simple to use. It can be embedded in some form of child’s game or as an attribute of a complex health metrics app. It is therefore considered important that the concept be protected to remain freely available for anyone to develop for any cohort.

SUPPORTING FIGURES/IMAGES:

Note: Maximum vertical acceleration per sample (in G’s) is also represented in the graphs, but is not considered novel, and is not discussed in this publication.

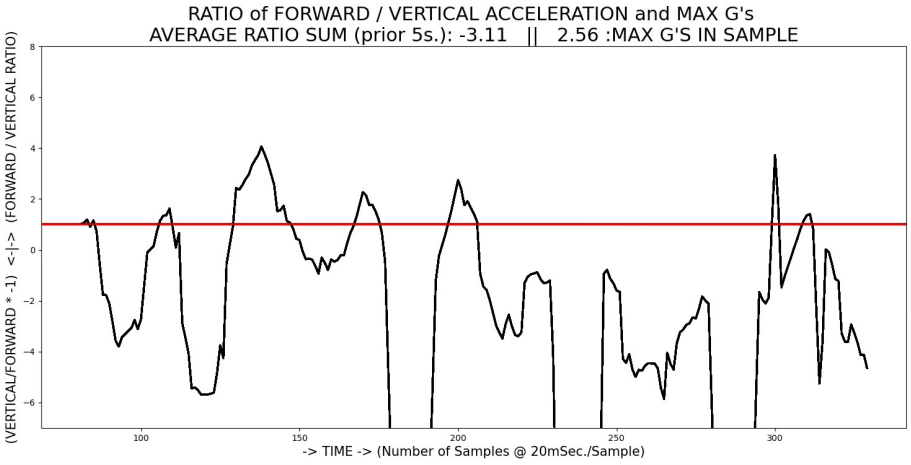

Figure 1: Not Highly Optimized Gait

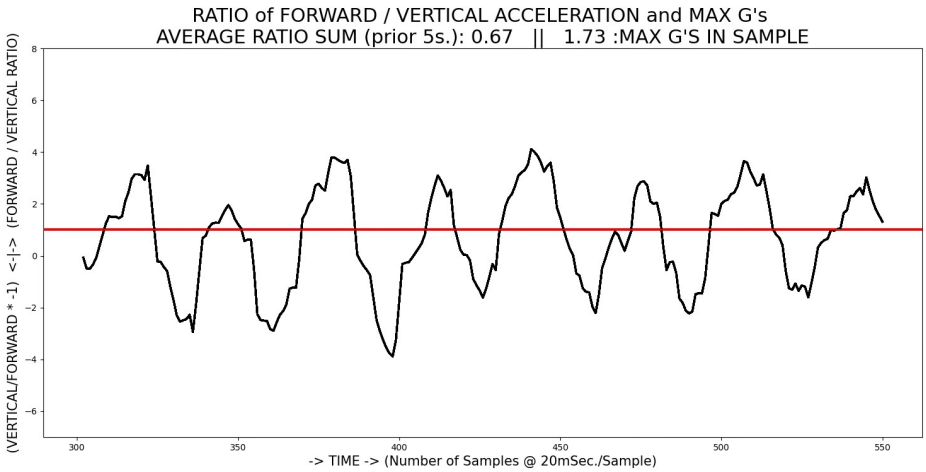

Figure 2: Better Optimized Gait