

Gait Variability Measures for Younger and Older Adults under Four Walking Conditions

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SUMMARY

When young adults walk at a natural self selected speed, their gait is observed as a smooth, periodic motion. Older adults on the other hand seem to exhibit higher gait variability. Furthermore, for both young and older adults, walking at a different speed than normal (either slower or faster) results in increased gait variability factors.

In this study, we present the gait variability measures obtained for four different conditions for young and older adults. The results indicate decreased smoothness measures, such as harmonic ratios, for the slow walking, walking while talking, and walking backwards conditions. Analyzing these signals may help in generating natural, human like walking gaits for various applications in graphics and robotics.

INTRODUCTION

Gait variability is a high interest research topic in the domain of geriatrics and biomechanics due to its association with risk of falls in elderly [1]. The exact nature of this relationship is still disputed and because multiple methods for analyzing and gathering gait variability data are available studies result in a wide range of results [2]. One hypothesis about the interpretation of gait variability data is that stride time variability reflects gait timing mechanisms and the pattern generator of gait, while balance control is reflected by variability of support time and step width [3].

Harmonic ratios (HRs) have been used lately as a measure of the smoothness of and rhythm of the acceleration patterns with lower harmonic ratios indicating less stable walking patterns [4-5]. HRs are calculated by decomposing the acceleration signal into a Fourier series and calculating the ratio of summed even to odd amplitudes of the harmonics. In this study, we present gait time, variability in stride duration and HRs.

PROCEDURE AND METHODS

Fifteen young adults and fifteen older adults with a range of gait speeds participated in this study. Data were collected with foot sensors (to obtain temporal gait characteristics), a tri-axial accelerometer worn on the lower back, and an uniaxial accelerometer worn on the head. Three walking conditions are reported this study:

- Usual walking at a self selected pace in a straight path
- Slow straight path walking
- Walking in a straight path while repeating every other letter of the alphabet – alpha condition

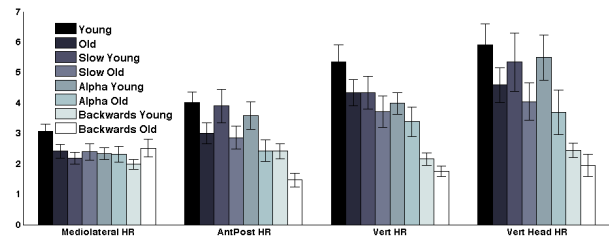


Figure 1: Harmonic Ratios.

Average harmonic ratios for young and old participants with standard errors.

- Walking backwards.

RESULTS AND DISCUSSION

In all conditions older adults were more variable than younger adults. The walking backwards, walking while talking condition, and the slow condition resulted in significantly lower harmonic ratios (more gait variability)(Figure 1). A previous study [5], includes similar data analysis and results for a subset of these conditions with an extended set of participants.

Artificially generated human gaits generally lack the variability exhibited by humans. Future work will focus on incorporating a gait variability factor in the design of human controllers in order to portray different walking styles and age group characteristics.

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