

## RELATIONSHIP BETWEEN MINIMUM FOOT CLEARANCE, WAIST ROTATION AND AGING: TOWARDS FALL PREVENTION

*Ryutaro Himeno, Shigeho Noda, Gen Masumoto, Keisuke Okuno, Zhe Sun, Andrzej Cichocki,  
Hiroshige Takeichi*

RIKEN, Japan

*himeno@riken.jp, shigeho@riken.jp, masumoto@riken.jp, keisuke.okuno@gmail.com, zhe.sun.vk@riken.jp,  
a.cichocki@riken.jp, takeichi@riken.jp*

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**Summary:** In order to develop a practical device to reduce risk of falls of elderly people, their gait patterns were analyzed and processed. The gait measurements were performed on healthy elderly adults (n=28) with age over 55 during normal walking using an optical motion capture system (Optitrack) and inertial measurement unit sensors with 3-axes gyro sensors and 3-axes accelerometers (ATR-Promotions). Various stages of gait patterns were investigated, especially on the insteps and hip over the sacrum, in order to estimate and compare among subjects' feet trajectories and body movements. It was found that chronological age did not correlate with minimum foot clearance during the swing phase (MFC; correlation coefficient,  $r=0.22$ ,  $p>0.05$ ) as an index of likelihood of potential falls. Moreover, one-leg standing duration with vision did not correlate with MFC ( $r=0.16$ ,  $p>0.05$ ) neither, suggesting their independence. On the other hand, medium correlations were found between MFC and waist rotation ( $r=0.40$ ,  $p<0.05$ ), between body mass index and upper-body rotation ( $r=-0.44$ ,  $p<0.05$ ), and one-leg standing duration and lateral body movements ( $r=0.44$ ,  $p<0.05$ ). Taken together, these observations suggest that a major predictor of falls can be formed in terms of individual gait patterns, waist and upper body movements, and overall physique, in addition to aging and associated muscle weakness. A follow-up study (n=23) successfully replicated a part of these observations. In addition, successful identification of the gait phases of the gait cycle was achieved, and the estimated MFC and mean absolute error (MAE) between the measured and estimated trajectories showed significant agreements between the measurements using the optical motion capture system and the inertial sensors ( $r=0.73$ ,  $p<0.05$ ,  $MAE = 0.071 \pm 0.069$  (standard deviation) for the left foot;  $r=0.66$ ,  $p<0.05$ ,  $MAE = 0.072 \pm 0.072$  for the right foot). These provide basic and fundamental characteristic data markers and lead to new techniques required for the implementation of the fall prevention devices.