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Prediction of Balance Control and Instability in Walking at Sea

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Prediction of Balance Control and Instability in Walking at Sea

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A walking strategy in an unstable environment may differ from that of walking on a stable surface. Extreme fluctuations in ships at sea can cause sailors to lose balance on board, which can pose a risk to their safety, such as off-board falls. According to the study by Örtlund and Malin, only about 20% of those who fall off the cruise ship survive. The motion of a ship strongly affects how one keeps their balance on board. The control of center of mass (COM) is essential for balancing and the margin of stability (MOS) is widely used as a measure of dynamic stability during gait. Therefore, the first goal of this study is to assess the effects of ship motions on balance control and stability while walking in sea conditions. We hypothesized that the COM excursion and MOS variability would increase when ship motion gets higher. Our second goal is to develop a predictive model for balance loss and instability by estimating the COM excursion and MOS variability with wearable sensors.

A total of 30 healthy individuals aged 21 to 39 were recruited for this study to achieve these objectives. During the experiment, participants walked on treadmills for two minutes with and without rolling motions at paces selected by themselves. Simulation of the parametric roll motion of ships (up to 20 degrees) was performed with a computer-assisted rehabilitation environment (CAREN). As a result, we found that there were significant effects of ship rolling degrees on mediolateral (ML) COM excursion and MOS variability in ML direction. In addition, the proposed predictive model reliably estimated the COM excursion and MOS variability with tiny mean absolute error (MAE). We anticipate that this study will help improve our understanding of walking characteristics on moving ships and prevent seafarers from falling overboard by predicting the risk of falls.