Analysis of Human Push Recovery based on Mathematical Models

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Abstract: As the human gait is a very complex movement, it is hardly surprising that people go through different stages of abilities during their life. Not knowing how to manage a stable gait, young children often fall. Once adult, humans normally learned to perform an efficient, adaptable and robust gait. While they are able to react on disturbances in a suitable way to avoid falling for most of their lifetime, humans become more likely to fall again reaching a certain age. But the injuries they sustain are worse than in their childhood. Therefore it is a very important to learn more about human reaction on disturbances.

The focus of this work lies in the analysis of push recover and fall avoidance strategies. Experiments including motion capturing and the measurement of ground reaction forces are performed for a selection of different perturbations, such as pushing or sudden starting and stopping of a treadmill, to gain reference data. The different perturbations, are transformed into a mathematical formulation and applied to a suitable mathematical model which is able to mimic the relevant characteristics of human behaviour. Furthermore the model is adapted such that external forces can be applied. Fitting the motion of the model to the captured data, the underlying dynamics of the human are analysed. The optimization allows to calculate physical quantities that can not be measured. Therefore it is possible to include them in the rating of different criteria that motivate certain movements, recover strategies or capture point calculations.

The improved understanding of human movement can be used to support medical diagnoses and treatment planning as well as to develop devices that prevent eldery people from falling. Another application of the results is the development of new control strategies for humanoid robots.

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