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Visual Evaluation of Gesture Motion and Walking Difficulty Using Singular Value Decomposition

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Problem. Singular value decomposition (SVD) was recently used on visual motion sequences in order to extract similarities and differences across human behavioral patterns (T. Ide and K. Inoue, SDM05, 571-576, 2005). In this study, we present a new method based on SVD for recognizing hand gesture motions and formulate a method for the quantitative evaluation of walking ability. This efficient method can be used to automatically analyze the walking patterns of individuals with impaired locomotor skills.

Experiment. The experiment on gesture motion analysis focuses on five kinds of hand gestures: CH (Come here), GA (Go away), GR (Go right), GL (Go left), and CD (Calm down). Each motion pattern is represented by the left singular vectors of the SVD computed over the corresponding motion sequence. In order to compare a given test gesture pattern with the training gesture patterns, we propose to compute similarity using either gesture distances (SGD) or gesture vectors (SGV). In the experiment on walking analysis, in order to verify the usefulness of the SVD-based method, three levels of walking difficulty in the lower limbs are simulated by constraining the knee joint and ankle joint of the right leg.

Result. In the hand gesture recognition task, the proposed method achieves a 90% accuracy level when similarity is computed with gesture distances. Recognition results indicate that the CH, GA, and CD gestures are all easily discriminated. For the walking analysis task, results show that the first few singular values computed from the acceleration of the shanks are inversely proportional to the constraint on the knee joint. These same singular values thus appear to be reliable indicators of walking difficulty.