

AN ATTEMPT TO DETECT IMPAIRMENT BY SILHOUETTE-BASED GAIT FEATURE

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INTRODUCTION and AIM

We can usually guess if a person has some impairments, such as a person whose leg is immobilized in a plastic cast, an elder person who cannot bend his/her knees, and a cataract patient, just by seeing them walking. If we can realize a system that can automatically estimate the impairment by observing them by a camera, it would be useful; e.g., in a commercial facility such a system would be helpful for staffs to find and assist a person with impairment immediately. There are several studies that investigate a difference of normal and abnormal walking, but they cannot be applied for our purpose since they use accurate 3-D pose obtained by expensive motion capture systems. Some other studies [1] use cameras but they use theatrical actions which are quite different from natural impaired walking. In our work, we apply a vision-based gait feature extraction technique that has been applied to personal authentication task for discrimination of normal and impaired walking.

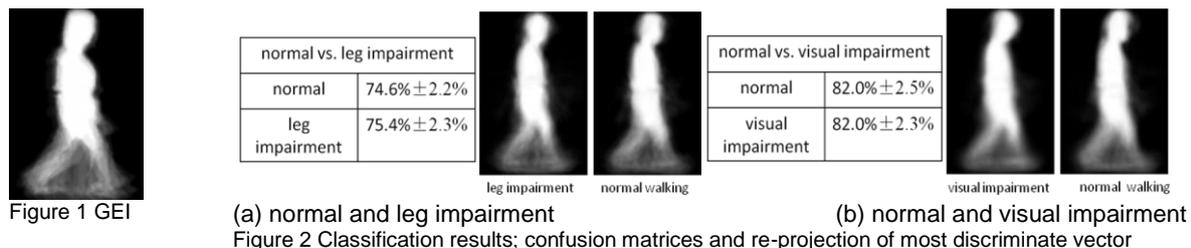
PATIENTS/MATERIALS and METHODS

We need to collect data of walking of a huge number of subjects. It is, however, difficult to find so many subjects who really have impairments. In our study, therefore, we used knee supporters that restrict bending knees to simulate leg impairment, and a goggle glass which narrows their fields of view to act as visual impairment. Each subject walked a straight path, wearing the supporters on both legs, wearing the goggle, or wearing neither of them. The number of these three categories are 189, 142, and 235, respectively.

A camera captured each subject from his/her side. We extracted his/her binary silhouette images from the captured movies by the background subtraction. We call this image sequence Gait Silhouette Volume (GSV). From the GSV, we calculated an averaged image which is called Gait Energy Image (GEI) [2] (Figure 1) that is a feature representation originally proposed for human authentication. Principal Component Analysis (PCA) is then applied to the feature vector to reduce redundancy. To separate the normal walking and the impaired walking, Linear Discriminant Analysis (LDA) is used to find optimal discriminative axes. Once the axes are obtained, we re-project them to the original feature space. The re-projected features well describe dominant differences between the categories, which provide important hints for doctors to detect abnormal regions.

RESULTS

Figure 2 shows experimental results. There are two comparisons; (a) normal and leg impaired, and (b) normal and visual impaired. For each case, classification accuracy is shown for quantitative evaluation. In addition, to illustrate the difference between normal and impaired walking, we show the re-projection of most discriminative vector calculated by LDA.



DISCUSSION and CONCLUSIONS

From the results, we confirmed that it is possible to estimate existence of leg/visual impairment with promising accuracy using the GEI that is originally proposed for gait authentication. Especially, visual impairment is easier to detect since most people with visual impairments bend their heads to the front to take care of their steps. Leg impairment is a little more difficult, but we find consistent difference in their leg motions.

Future work contains increasing the number of subjects to achieve more reliable evaluation.

REFERENCES

- [1] A. Mostayed, "Abnormal Gait Detection Using Discrete Fourier Transformation," Proc. International Conference on Multimedia and Ubiquitous Engineering, 2008.
- [2] J. Han and B. Bhanu, "Individual recognition using gait energy image," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 28, no. 2, pp. 316–322, Feb. 2006.