A Study on Vehicle Body Acceleration and Body Motion of a Rider during Riding a Bicycle

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Abstract

This study evaluated the relationship between the acceleration of a bicycle and the motion of a rider while riding a bicycle. By using the singular value decomposition of the acceleration, we determined that the trunk was mainly used to keep balanced on an uneven road.

Bicycle is a vehicle with two wheels or with more wheels which a person rides by sitting on it and pushing two pedals with his feet. Bicycles are used by millions of people, from young children to the elderly. One has to keep balance when he rides on a two-wheeled vehicles, which are widely used in general. Training wheels are often used when children begin to ride a bicycle for the first time. Clarifying how to keep balance of left-right when stepping on the pedals enables to develop an efficient method to practice riding a bicycle. Several studies on operating handlebars have described that a rider could keep balance while riding at high speeds without operating handlebars periodically [1]. However, there are many uncertainties regarding the mechanism of keeping balance while riding a bicycle. Therefore, this study evaluates the relationship between the acceleration of a bicycle and the motion of a rider while riding a bicycle. We clarify how to keep balance by using the coordinated relationship between the acceleration sensor outputs attached to body parts of a rider.

A healthy adult male (height 1.73 m, weight 75 kg) participated in the experiment. The measurement was conducted at two locations in Hachioji City, Tokyo. Following an explanation of the purpose and requirements of the study, the participant gave his written informed consent to participate in the study. Study approval was obtained from the Research Ethics Board, Kogakuin University. Fig. 1 shows the sensor positions. The analysis was conducted focusing on the acceleration of a bicycle and the acceleration of each body part of a rider. [1]. The singular value decomposition was performed on the three-axis synthetic acceleration for each sensor.

Figure 2 shows the results of spatial basis patterns obtained by singular value decomposition. Fig. 2(a) shows the results of the first mode on a flat road

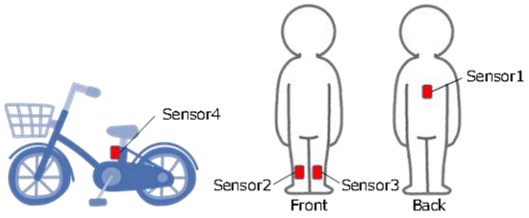
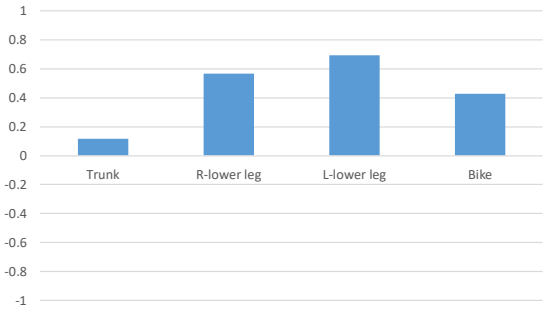
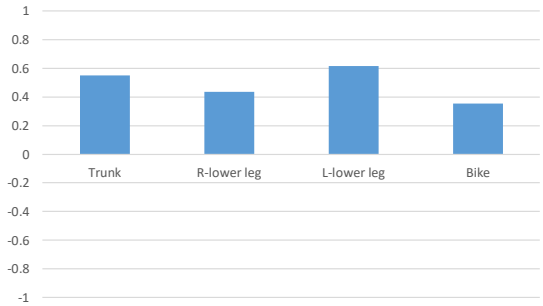


Fig.1 Sensor positions



(a) Flat condition



(b) Unevenness condition
Fig. 2. Results

surface (contribution rate of 94%), and Fig. 2(b) shows the results of the first mode on an uneven road surface (contribution rate of 93%). The results indicate that stepping on the pedal with the left and right legs is dominant on a flat road and almost no acceleration of the trunk is generated. While, the acceleration of the trunk was generated greatly on the uneven road, suggesting that the trunk was mainly used for keeping balance.

This study evaluated the relationship between the acceleration of a bicycle and the motion of a rider while riding a bicycle. By using the singular value decomposition of the acceleration, we determined that the trunk was mainly used to keep balanced on an uneven road.

References:

[1] Y. Usami, K. Ishikawa, T. Takayama, M. Yanagisawa, N. Togawa, *Proceedings of Multimedia, Distributed, Cooperative, and Mobile Symposium*, I. Syuhei, C. Aoki, *Physical Therapy Science*, 1670-1675 (2019).