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Proposal of personal mobility vehicle based on stabilization control of Two-Wheel Steering and Two-Wheel Driving

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Abstract

Mobility in a city is an important part of our life. For the sustainable development, there should be a mobility which is friendly for human and environment[1]. Recently, as a new mean, a personal mobility vehicle (PMV) which is compact and convenient attracts attention[2, 3]. As a PMV, the following features should be considered. 1. To make short range transport be efficient and comfort by using low-impact actuator, 2. To be used safely in non-exclusive space for pedestrians, 3. To be enough compact to achieve seam-less transit with existing public transportation.

A bicycle is the one of PMV, however, it becomes unstable at low speed[4]. The smaller the tire diameter becomes, less stable it becomes. The authors propose a stabilized vehicle with two-wheel steering and two-wheel driving(2WS/2WD) that solves the problem. The stability of the conventional bicycle has been discussed in a lot of papers, however, the study about the stability and control of the 2WS/2WD bicycle has not been investigated so much. In this paper, first the stabilization of 2WS/2WD bicycle is shown and then the new bicycle based on the simulation is suggested.

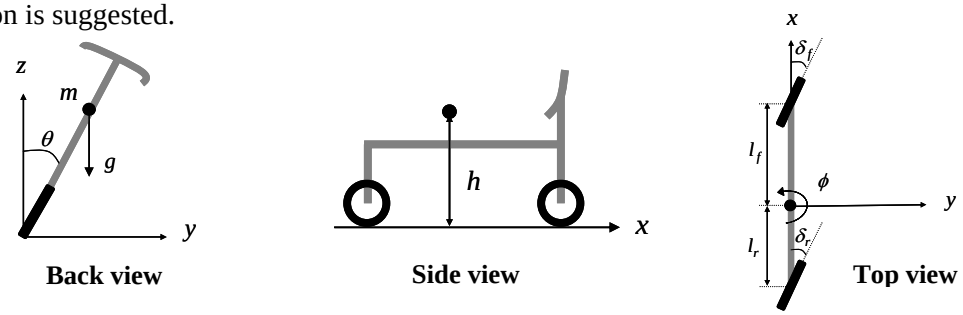

Figure 1. Model of bicycle

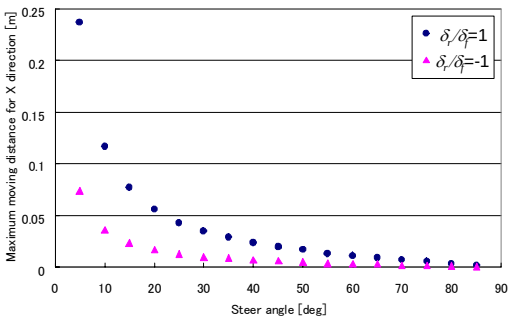

Figure 2. Maximum moving distance

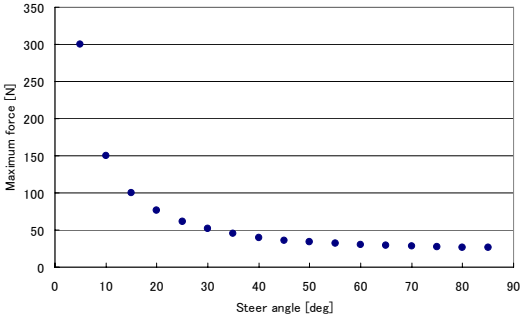

Figure 3. Maximum driving force

The model of the bicycle is shown in Figure 1. The authors propose the stabilization of the bicycle using driving forces and design a controller using linear-quadratic control theory. The prior analysis made clear that the same steer angle between the front wheel and rear wheel makes the bicycle the most stable at low speed.

Figure 2 shows the plot of the maximum moving distance for *x* direction shown in Figure 1 and Figure 3 shows the maximum driving force. It is shown that by increasing the front and rear steering angle, the required moving distance for *x* direction for stabilization becomes smaller. The condition of the steering angle 90 degree corresponds to the parallel two-wheel vehicle[2].

Bicycle mode **Parallel two-wheel mode**

Figure 4. Concept of PMV

Finally, a new PMV for this result is proposed. The concept of PMV that authors propose consists of two modes, the bicycle mode and the parallel two-wheel mode shown in Figure 4. These two modes are convertible each other. It will be an effective mobility with low energy consumption by switching between two modes.

References

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