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](image-url)
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].

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


