Public Transportation System Using Personal Mobility Vehicles with Automatic Platooning Control

Background

Personal mobility vehicles (PMVs) are recently receiving more and more attentions as a novel riding vehicle, which is ecological as well as friendly to people.

A novel conception was proposed to use PMVs as a public transportation system based on automatic platoon driving, like a moving walkway or an escalator. The feasibility to realize the proposed public transportation system, was discussed by our simulating and actual-vehicle experiments.

Control Method

The control method for the PMV is based on path following and gap distance controls.

As is shown in figures, the path following control is to control the turning angular velocity, for keeping a desired driving in a reference path.

The gap distance control is to control the acceleration of the following PMV in longitudinal direction, for keeping a desired distance with the preceding PMV during driving.

Driving Experiments

Two prototypes of PMVs were produced for the actual-driving experiment. During the driving experiments, the following PMV was automatically controlled to keep a desired distance to the wall and the preceding ones. The performances to achieve the path following and gap distance controls, whose target gap distance and velocity are 1.5m and 0.5 m/s, respectively, are examined.

Experimental Results

... Experimental Results ...

Conclusions

A new transportation system using automatically controlled PMVs is proposed. Through driving experiments using our developed prototypes of PMVs, it is shown the path following and the gap distance control, which are essential control methods to achieve automatic platooning of PMVs, can be achieved.
Dynamics and Ride Comfort of Two-wheeled Inverted Pendulum Vehicle System with a Rider

Personal Mobility Vehicle (PMV)

Two-wheeled Inverted Pendulum Vehicle as shown in right figure is stabilized by the control power produced by the driver and the vehicle itself. But, there have been no detailed discussion about control gain of vehicle. And the relation between the value of gain and riding comfort is not clear yet.

Aim

- Clarify the relation between stability of PMV and comfort through the measurement of driver’s electromyogram (EMG).
- Construct the PMV-driver model and examine the stability of the whole system including driver’s operation.
- Search for the proper control gain to improve riding comfort and operability.

PMV-Rider Model

We propose PMV-driver model which is composed of inverted pendulum and standing human model.

\[ \tau_u = k_p \theta_1 + k_d \dot{\theta}_1. \]

\[ \tau_1 = c_{hl}(\dot{x} - v) + k_{hl} \theta_1 + c_{h2} \theta_1 + k_{h2} \theta_2 + c_{h2} \dot{\theta}_2 \]

Experiments

The drivers’ lower limbs muscle activity was measured. Drivers’ EMG in 11 different control gain conditions are measured.

Conclusions

Though there is correlation between the value of the gain and the driver’s muscle activity, value of the gain and comfort are not completely correlates.

The stability of the system can be described by the PMV-driver model; The PMV system can be stabilized with driver’s operation even the PMV only system were not stable.