Experimental Study on Driving Behavior of Personal Mobility Vehicle

パーソナル・モビリティ・ビークルの走行挙動に関する実証研究

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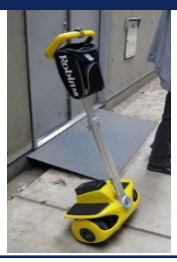
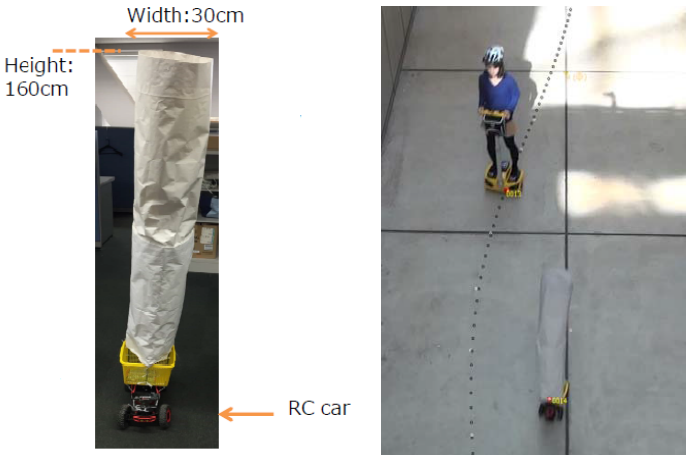
What are Personal Mobility Vehicles (PMV)?

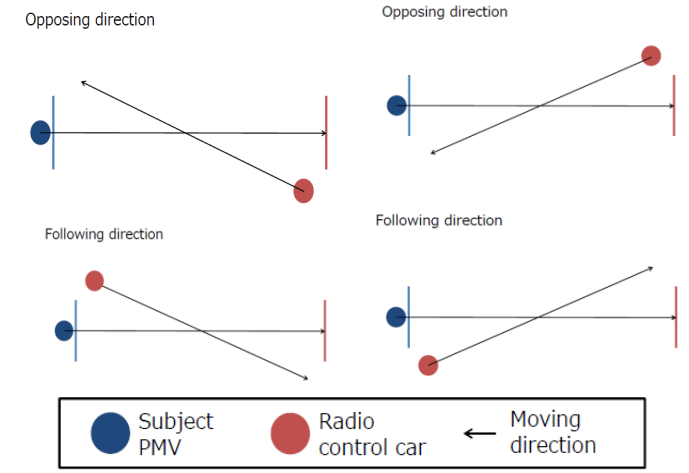
Personal Mobility Vehicles (PMV) are electric vehicles for single passenger. PMVs provide a convenient means of transportation, allowing users to move along sidewalks and get around inside large buildings, with great safety and ease. They are a valuable option as a new transport mode in compact cities and low-carbon societies. Currently they are not allowed for use on public roads in Japan. It is necessary to understand characteristics of PMV maneuver. The objective of the experiment is to clarify characteristics of PMV maneuver at crossing conflicts through experimental analysis.



Experiment Settings

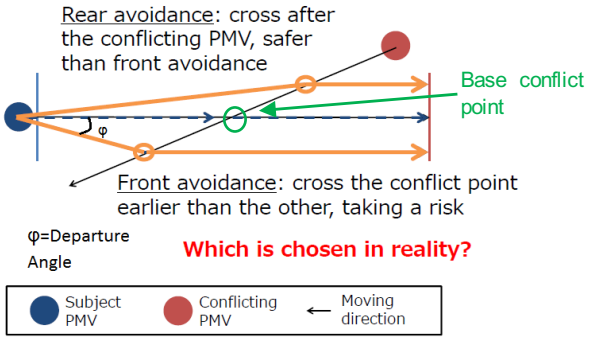
An experiment to study the avoidance behavior was conducted in the atrium space of Institute of Industrial Science, Univ. of Tokyo. The PMV used for the experiment is Robstep (M1) which weighs 18.5 kg. The maximum speed of the PMV is 15kmph and it has a minimum turning radius of 0m. Radio Control (RC) car was used as imitation of other PMV Video observation was done by overhead cameras tracking the position of PMV and RC car. An Android application connecting to PMV by Bluetooth gave information about wheel speed and angle of hand grip.





Hypothesis of Collision Avoiding

The collision avoiding behavior is divided into two types: front and rear avoidance. In the former case, PMV crosses the conflict point earlier than the RC car and vice versa in the latter case. PMV chooses one of them for collision avoidance. With a given departure angle (and certain assumption of the path shape), travel time is uniquely determined. In this analysis, the minimum travel time under the front avoidance and that under the rear avoidance are considered as costs for each avoidance type.



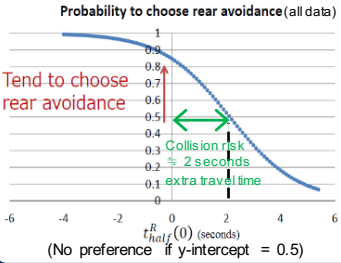
Results and Discussions

Binomial logit model is applied for probability to choose rear avoidance. Deterministic utility of rear avoidance is given by the equation

$$V_1 = \alpha \times t^R_{half}(0) + \beta$$

Where, $t^R_{half}(0)$: Normalized arrival time of RC car to base conflict point

When $t^R_{half}(0) = 0$, theoretically travel time of rear and front avoidance are equivalent. The larger the value is, rear avoidance travel time becomes relatively larger. The estimation results of V_1 (utility of rear avoidance) is shown below. People tend to choose rear avoidance which has less risk of collision. Consideration of the collision risk is needed for development of PMV behavior model.



(All data) $R^2 = 0.053$	Estimate	t-value	significance
Constant (β)	0.8529	7.414	***
Coefficient of $t^R_{half}(0)$ (α)	-0.4011	-6.440	***

(following) $R^2 = 0.096$	Estimate	t-value	significance
Constant (β)	1.1365	6.556	***
Coefficient of $t^R_{half}(0)$ (α)	-0.5294	-5.832	***

(opposing) $R^2 = 0.023$	Estimate	t-value	significance
Constant (β)	0.5865	3.755	***
Coefficient of $t^R_{half}(0)$ (α)	-0.2709	-3.086	**

'***' 0.1% significance level '**' 1% significance level
R^2: McFadden's pseudo-coefficient of determination