

Development of Kinematic Posture Control (KPC)

Naoki Hiraga¹⁾ Fuminori Kato¹⁾ Daisuke Umetsu¹⁾

Makoto Yamakado²⁾ Masato Abe²⁾

¹⁾ Mazda Motor Corporation

3-1 Shinchi, Fuchu-cho, Aki-gun, Hiroshima, 730-8670, Japan (E-mail: hiraga.na@mazda.co.jp)

²⁾ Kanagawa Institute of Technology

1030, Shimoogino, Atsugi 243-0292, Japan

KEY WORDS: Vehicle Dynamics, Suspension System, Brake System, Motion Control, Driving Stability (B1)

KPC is a control concept of vehicle dynamics which integrates the effects of a suspension geometry and longitudinal tire force. Figure 1 shows the control concept of KPC: when the bilateral difference of wheel speeds is large, KPC applies slight brake force according to the required anti-lift force to the rear outer tire as shown by Figure 2. The brake force is described by Equation 1, there is a threshold for KPC. The larger the bilateral difference of wheel speeds is, the larger the controlled brake force is.

The system configuration of KPC is shown in Figure 3. KPC algorithm is implemented in Powertrain Control Module (PCM). PCM calculates the control requirement of the brake force.

An experimental verification is carried out for evaluating that the vehicle body heave is reduced by KPC. The vehicle trajectories are visually the same as shown in Figure 4. When KPC is active, yaw rates response in relation to steering wheel angle is almost same and the vehicle body's heave is small as shown in Figure 5. It is evaluated that KPC is able to reduce heave, and almost all drivers recognize the vehicle more stable by KPC.

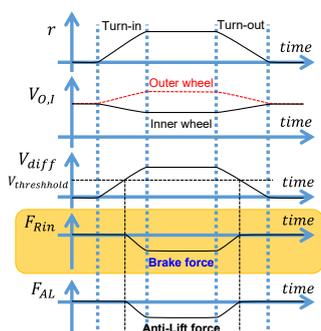


Fig. 1 Kinematic Posture Control Concept

$$\begin{cases} V_{diff} = V_{Rout} - V_{Rin} & (V_{Rout} - V_{Rin} \geq V_{threshold}) \\ V_{diff} = 0 & (V_{Rout} - V_{Rin} < V_{threshold}) \end{cases} \quad (1)$$

$$F_{Rin} = \frac{C_{KPC}}{1 + Ts} V_{diff}$$

V_{Rout} : Wheel Speed of Rear Outer Tire
 V_{Rin} : Wheel Speed of Rear Inter Tire
 T : Time Constant, C_{KPC} : Control Gain of KPC
 $V_{threshold}$: Threshold for KPC
 s : Laplace Operator



Fig. 2 Anti-Lift Force by Rear Brake

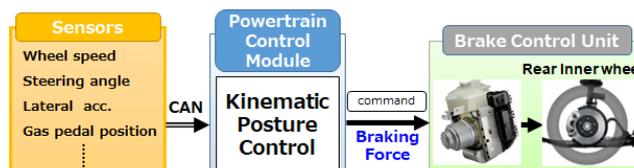


Fig. 3 Control System Configuration

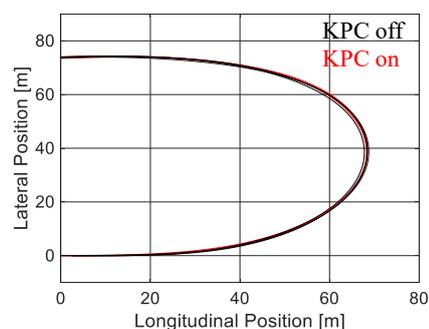


Fig. 4 Trajectory

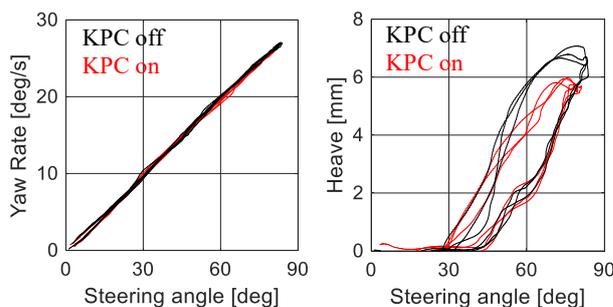


Fig. 5 Lissajous Graphs of Experiment