

Four-wheel independent steering control extended Ackerman theory

Yuta Suzuki¹⁾ Takafumi Sato¹⁾ Motoki Tachiiri²⁾ Tomoya Takahashi¹⁾ Shuji Kuramitsu¹⁾ Masayuki Hijikata¹⁾

1) DENSO CORPORATION 2-1 Nagane, Satocho, Anjo, Aichi, 446-8511, Japan (E-mail:yuta.suzuki.j8d@jp.denso.com)
 2) SOKEN,INC 500-20 Minamiyama, Komenokicho, Nisshin, Aichi, 470-0111, Japan

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As a future trend in mobility, independent steering systems that can steer each wheel individually are expected to become widespread to improve mobility freedom in MaaS. In addition, improvement in fuel consumption and electric power cost are also desired with a concern for environmental issues. Then, we proposed a control method for four-wheel independent steering that can achieve both vehicle behavior unique to independent steering systems and reducing the driving energy.

Theory of Ackerman steering geometry determines steer angles of right and left front wheel so that the normal perpendicular to these wheels intersect at a turning center which existed on the rear axle, and has an advantage of reducing side slip of each tire to the minimum during turning. We focused on characteristics and devised a method that extend the theory to four-wheel independent steering. Our proposed method locate a turning center, which was conventionally only existed on the rear axle, on inside and outside the vehicle freely, and realize smooth turning by setting tire angles to intersect the center, as shown in Figure.1,2,3.

Figure.4 shows that effects of our proposed method by CAE. Results indicate paths of the vehicle center and total driving torques of all wheel when the vehicle drives a steady circular turn at velocity of 5 km/h and turning radius of 5 m. Comparing with and without the method, the method reduce the total torques by 37%. Hence, the method can achieve smooth turning.

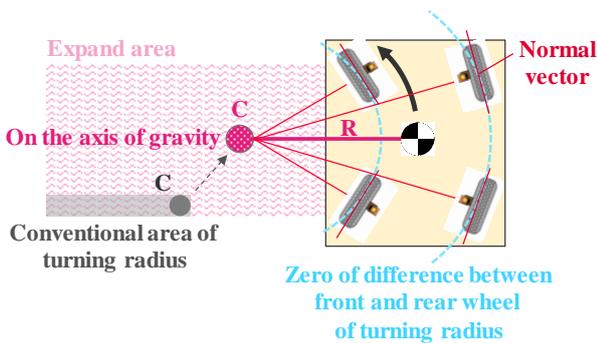


Fig.1 Small turn

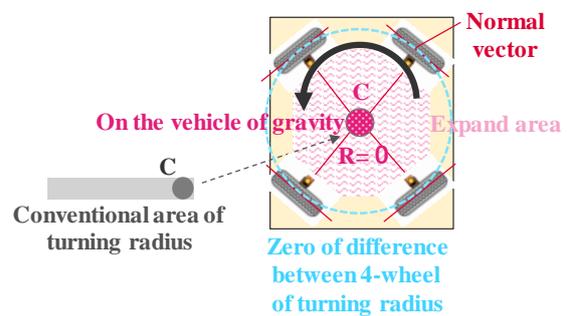
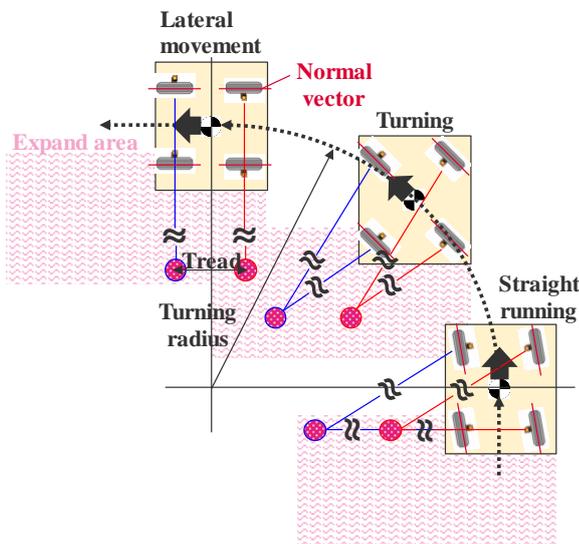


Fig.2 Ultra-small turn



Set the turning center C in two points
 Fig.3 Yaw less turning and lateral movement

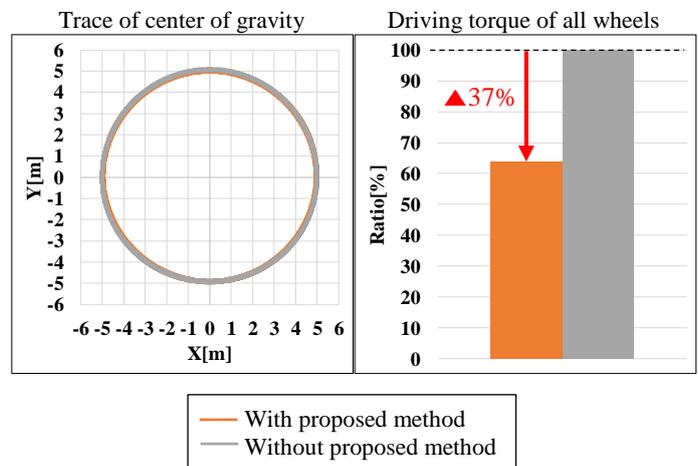


Fig.4 Simulation results (turning radius 5m)