.Fusion of Tire Lateral Force Estimation and Integral Sliding Mode Control for Improved Vehicle Handling

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**ABSTRACT−**Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here.Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. Type the abstract here. [Capital letter at the beginning of each sentence, put a period at the end, Please write in 100 ~ 200 words, Times New Roman, 9pt]

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nomenclature

[All should have small letters, Times New Roman, 10pt]

A : area, m2

subscripts

|  |
| --- |
| [All should have small letters, Times New Roman, 10pt]  A,B,C,P : nodal point |
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1. INTRODUCTION [All should have capital letters, Times New Roman, 10pt]

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Table 1. Type the caption here. Type the caption here. [Capital letter at the beginning of each sentence, put a period at the end, Times New Roman, 10pt]

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|  | A  (MPa) | B  (MPa) | n | C | C1 | C2 | M |
| SPCEN | 208 | 350 | 0.48 | 0.140 | 0.080 | 0.007 | 0.31 |
| 60TRIP | 432 | 800 | 0.59 | 0.075 | 0.030 | 0.012 | 0.55 |
| 60C | 463 | 800 | 0.63 | 0.036 | 0.037 | 0.004 |  |

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2.2. Subheading [Capital letter at the beginning of each keyword, Times New Roman, 10pt]

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This is an example of the equation.

 (1)

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 (2)

3. Torque-vectoring

The implementation of Torque Vectoring requires a control strategy capable of accurately distributing torque between individual wheels to achieve the desired yaw rate. A typical driving environment is subject to various disturbances, and due to the inability to fully sense some aspects of driving dynamics in real time, these parts remain uncertain. Therefore, the controller must ensure robustness to maintain performance under these conditions. To satisfy these requirements, this paper employs a Sliding Mode Controller (SMC) to calculate the yaw moment. However, the use of SMC introduces a chattering problem, where the control input rapidly switches between different values, deteriorating vehicle ride comfort and the durability of vehicle components. To address these challenges, this paper utilizes the lateral tire force (Fy) estimated by the Extended Kalman Filter (EKF), as detailed in Section 2

3.1. Sliding Mode Controller

A SMC can be developed based on the vehicle's yaw moment balance equation

|  |  |
| --- | --- |
|  | (X) |

~~where~~  ~~is the vehicle yaw moment of inertia;~~ ~~is the lateral tire force;~~  ~~is the lateral tire force;~~  ~~is the steer angle at the wheels; FL,FR.RL,and RR are position of front left, front right, rear left, rear right;~~  ~~and~~  ~~are the front and rear wheelbases, respectively; and a and b are the front and rear lengths of the wheelbase and the mass center.sds~~

This Equation can be partitioned into two components: one is , which consis of , and the other is , which consists of . of the  can be predicted with driven motor torque and brake pressure. So we can use this part for the control, as dscriben in the following:

|  |  |
| --- | --- |
|  | (X) |

 of the is estimated by the EKF, as dscribed in the following:

|  |  |
| --- | --- |
|  | (X) |

For torque vectoring, a sliding surface is designed to achieve the desired yaw rate as follows.

|  |  |
| --- | --- |
|  | (X) |

The process of setting the control input involves following two steps. First, establish the equivalnt control, which ensures  under the assumtion of no disturbances and can be determined by imposing . Next, add a switching term to eliminate disturbances

|  |  |
| --- | --- |
|  | (X) |
|  | (X) |
|  | (X) |

Where is the control gain for slidng mode control.  is the disturbances, and  is error of the EKF results

To ensure the sliding surface converges in finite time, Lyapunov functions V(s) are used. According to equation (x), control gain must be over the .

|  |  |
| --- | --- |
|  | (X) |

3.2. Torque Distribution

The desired momentum generated by the SMC, but it is constrained by the tire-road frictional force. As a result various distribution startagies can be employed. [who gonna same, who gonna adaptive, references is here]. In this paper, torque is generally distributed equally, but if the tire force exceeds the maximum force, the excess value is edistributed to the other motor. The maximum force is estimated by by Fz​ from the EKF and frictional coefficients.

4. Simulation and result

4.1. Simulation setup

This section includeed Simulation setup and

4.2. EKF

This section includeed EKF setup and results

4.2. Torque Vectoring

This section includeed Torque Vectoring setup and results

5. CONCLUSION

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REFERENCES

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