High-Performance Stability Control Technologies for Mining Trucks

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1. Overview

Mining haul trucks transport materials such as iron ore, coal and overburden from the digging area to dumping area. A safety is prioritized in mine operation, truck operability is restricted under unstable road conditions such as slippery and rutted road. To improve truck operation efficiency and overall mine productivity while observing safety regulation, it is essential to increase dynamic stability of trucks. We have developed high-performance stability control technologies which include sideslip prevention control and pitching restraint control and commercialized as AC-3 truck series. As a result, improvements in operation efficiency and safety have been realized.

2. Technical Feature

Fig.1 shows schematic of our truck with AC drive powertrain. The truck accelerates by electrical power with engine-generator and decelerates changing electrical power into heat with resistance heating element. The truck stability controller constantly monitors the dynamics of the truck and calculates appropriate torque distribution in AC wheel motors according to road condition. The truck is easier to roll and pitch than a conventional car due to higher position of its center of gravity and bigger weight change between full load and empty condition (EH5000AC-3: 500 ton when loaded, 204 ton when empty). This report discusses the sideslip prevention control technology which incorporates these characteristics of the truck.

Fig.2 shows the sideslip prevention control algorithm. A sideslip prevention control of the two-dimensional motion is employed in conventional cars. However, the study showed that the mining truck has an over-steering characteristic which results in dynamic instability (See Fig.3: instability without controls in place). Moreover, the results showed that yaw rate by lateral acceleration increased and actual yaw rate decreased against target yaw rate. Therefore, we analyzed the truck motion data in two dimensional control model and devised compensation model for yaw rate deviation. As a result, proposed sideslip prevention control algorithm controlled from unstable over-steer area to stable under-steer area (bold arrows) and was able to verify adequacy of the truck dynamics during a turn.

3. Summary

Our mining trucks with the stability control systems enable stabilized operation under various road conditions including slippery rutted surfaces. Moreover, the technology contributes to reduction of operator fatigue and truck body damage. As a result, the trucks made positive effects on overall mine operation efficiency and are favorably received by the mine operators.

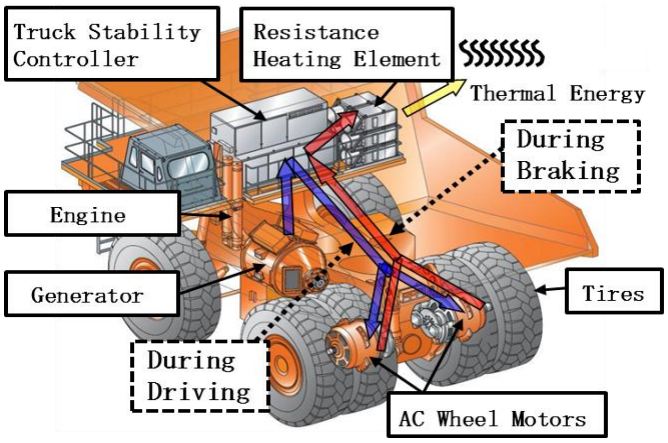

Fig.1 Schematic of our truck with AC drive powertrain

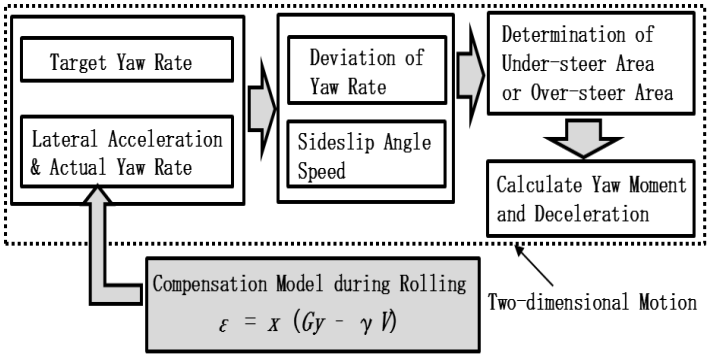

Fig.2 Sideslip prevention control algorithm

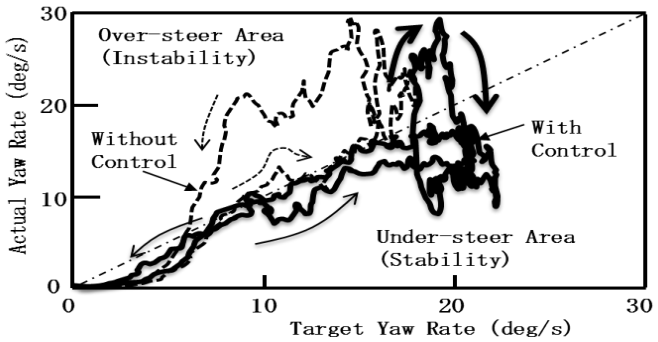

Fig.3 Effect of sideslip prevention control technology (During turning on snow road)