VDC System: Vehicle Dynamics Stabilization Controller Design
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Goal

➢ Design a phase-lead controller that monitors the vehicle lateral dynamics and stabilizes its response
➢ Simulate the system response through Simulink and analyze the improvement in overshoot and settling time
➢ Implement the designed controller on an electronic board and observe the performance of the system

Motivations and Objectives

➢ Motivations
  ▪ Vehicle dynamics control system improves stability in difficult driving conditions, enhances the safety of driver and reduces the chances of an accident
➢ Objectives
  ▪ Analyze error dynamics from control engineering point of view and design an appropriate controller to improve the system response
  ▪ Derive the closed-loop transfer function for the system with controller using Bode diagram method and observe the stability robustness
  ▪ Design and build an electronic simulator modelling the transfer function of controlled system using operational amplifiers resistors and capacitors

Research and Design Challenges

➢ Minimizing error caused due to the high gains and non-ideal circuit component values
➢ Overcoming the operational amplifiers saturation and noise
➢ Reducing the circuit complexity by keeping the number of components at minimal

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Steps

- Closed-loop transfer function
- Observe step and ramp responses
- Phase/ Gain stability margins
- Controller design and circuit testing

Methodology

Figure 1: Synopsis of turning vehicle scenarios

Figure 2: Closed loop system with controller

Figure 3: Block diagram of system with controller

Figure 4: Diagram of tested circuit in LTSpice

For circuit design, 15 Op-Amps were used along with 5 capacitors and 30 resistors

Simulated System

➢ Overshoot for initial system was 38% while for controller system it was reduced to 15%
➢ Settling time with controller was 1.55s and for initial system it was 1.15s

Figure 5: Simulated results without(up) & with controller

Implemented System

➢ Overshoot for initial system was 52% while for controller system it was reduced to 25%
➢ Settling time with controller was 1.61s and for initial system it was 1.31s

Figure 6: Experimental results with tested circuit with controller

Conclusions

References