RESEARCH NOTES
TRAFFIC OPERATIONS RESEARCH
Task Order 4205
September 2006

Fault Tolerant Lateral Control for Transit Buses and Trucks

Why Was This Research Undertaken?

This research was undertaken to improve the overall performance of the lateral controllers that were used in the vehicles for the Demo 2002/2003 under Automated Highway Systems (AHS). Fault tolerant lateral controllers needed to be developed in order to make them more reliable and less susceptible to magnetometer faults. By improving the lateral controllers, safety was improved on the overall control system.

What Was Done?

Several methodologies for the design of control systems that accommodate hard failures were analyzed. Simulations were conducted on existing lateral controller algorithms used on the lane-keeping control system and simulated faults were introduced in order to study the effects of these faults on the lateral controllers. Simulations were followed by actual tests on passenger cars used in the PATH Intelligence Vehicle-Highway System (IVHS).

What Can Be Concluded From The Research?

Lane-keeping controllers were designed based on design of simultaneously stabilizing controllers as well as the dedicated observer based architecture. The simultaneous stability based design scheme assumed the ”geometric” look-ahead structure. It was shown that the requirement for simultaneous stability imposed restrictions on the look-ahead distance. For the lane-keeping control problem, this limitation was interpreted as representing a trade-off between fault tolerant action versus non-faulty performance. The lane-keeping control design algorithm utilizing dedicated observers was called the *Observer Based Look-Ahead Scheme* since this algorithm uses observers to construct an estimate of the lateral error at the location of a virtual sensor in a manner similar to the ”geometric” look-ahead scheme. This scheme guarantees failure tolerance action even when large look-ahead distances are used. These controllers were tested experimentally to determine the efficacy of the design methodologies. Results of these experiments indicate that safe failure tolerant control action can indeed be achieved.

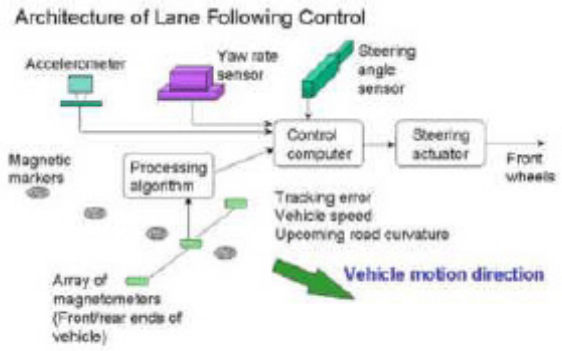

Figure 1: Scheme of lateral control system developed by PATH

What Do The Researchers Recommend?

Researchers recommend further research in order to synergistically integrate the simultaneously stabilizing controllers and the observer-based scheme in the process of design of real-time control systems. One approach could be the use of simultaneously stabilizing controllers can be utilized to exploit redundancy to provide system stability in the event of failures. This stability guarantee could provide the cushion for employing reliable failure detection and identification (FDI) methodologies. These reliable FDI techniques can then be used to spawn appropriate reconfiguration in control action.

Implementation Strategies

The results of the research can best be used to further research the recommendation of the researchers for the development of a robust, reliable, stable and redundant controller system.

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