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# Vehicle Run-Off-Road and Recovery - Development of Laboratory Training Tools and Nonlinear Control Algorithms for On-Board Systems


## JOHN WAGNER

*Professor,*
*Department of Mechanical Engineering*
*Clemson University,*
*Clemson, SC*


## ABSTRACT:


Traffic fatalities and injuries continue to affect a vast number of drivers on roadways each year in the United States. Of deaths due to vehicular accidents, around 60% are involved in a run-off-road crash, a scenario in which the vehicle leaves the paved portion of the roadway and travels along the shoulder or side of the road. To help reduce the number and severity of vehicular crashes, roadway infrastructure modifications and electronic safety systems have been developed and are continually implemented. However, 95% of all single vehicle run-off-road events have been found to be driver related. Poor driver performance is a major contributing factor that results in run-off-road scenarios evolving into serious crashes. The driver often executes dangerous maneuvers, such as overcorrection, which can ultimately cause fatal results. One countermeasure that is under development to directly address the driver's performance is a driving education and training program. To specifically target run-off-road recovery training, a simulator-based driving experience can be implemented immediately, providing a safe environment and the ability to gather data. A human subject study is used to validate the simulator as an effective tool for replicating the run-off-road experience and gathering insight into driver reactions. In addition, a series of nonlinear control algorithms, including sliding mode and state flow, have been developed for synchronized steering and braking actions to return the vehicle safely to the road surface. An analysis of subjective questionnaire data and objective performance evaluation parameters show strong correlations between run-off-road crash data and driver-vehicle-environment factors (e.g., higher vehicle velocities, curved roads, and large friction coefficient differences between the road and shoulder) which negatively impact drivers' recoveries from this situation. To best combat run-off-road crashes, the behavior of drivers must be addressed in addition to the application of on-board safety control algorithms.


## BIOGRAPHY:

John Wagner holds B.S., M.S., and Ph.D. degrees in mechanical engineering from the State University of New York at Buffalo and Purdue University. He was previously on the engineering staff at Delco Electronics (Kokomo, Indiana) designing and testing automotive electronic control systems using hardware-in-the-loop technology. His research interests include nonlinear control theory, behavioral modeling, diagnostic/prognostic strategies, and mechatronic system design with application to automotive and power generation systems. His multi-disciplinary research activities emphasize a collaborative teaming approach with both industrial and government sponsors. Dr. Wagner is a licensed Professional Engineer and a Fellow of the American Society of Mechanical Engineers.