Abstract

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2013MEZ8179

Automotive crash reconstruction is an essential part of automotive injury biomechanics. Vehicle crash reconstruction attempts to determine the kinematics of the vehicle before, during, and after the crash (also named pre-crash, crash, and post-crash phases) along with the effect on occupants in terms of injuries. With the advancement in computing at a lower cost, computer simulations of the vehicle crashes have been used extensively using Finite element vehicle models in recent years. Other approaches e.g., crash reconstruction using PC crash, was developed for vehicle pre-crash and post-crash motion simulations rather than for crash phase simulations. Multibody methods such as MADYMO can be used with crash phase simulations; however, they require detailed crash test data to model the vehicle, which is unavailable to common public for most vehicles manufactured in developing countries like India. This thesis attempts to fill this gap by proposing a method for crash simulation that incorporates crash test data from databases like Global NCAP, such as consumer rating reports and videos, in conjunction with multibody-based approach MADYMO, to simulate crash phase simulations. In order to build confidence in the proposed method, the proposed methodology was first implemented with detailed crash test data provided by the NHTSA, followed by real-world crash data provided by the NASS/CDS (In Chapters 4 and 5). 'MB-interiors and FE-vehicle' (referred here as MB-FE) coupled models were used along with proposed 'MB-interiors and MB-vehicle models' (referred here as MB-MB) simulating under the same initial condition estimates (e.g. Initial velocities of vehicles etc). These initial estimates are available for vehicle crash tests but determined using damage-based methods like Ai-damage for real-world crash data. Once it was established that both the MB-FE and MB-MB methods are comparable with one another in terms of vehicle and occupant response and also with shreds of evidence found in real-world crash data. Subsequently, this method was also implemented with the Indian RTA case (In Chapter 6), knowing that the number of unknowns is much more. These unknowns are determined from the analysis of videos and consumer rating reports obtained from GNCAP data. It was found that the MB-MB method was implementable with whatever minimal data was available. The proposed MB-MB simulation method was found to be an effective alternative for both the vehicle crash reconstruction and occupant simulations, to finally determine the occupant crash conditions (Velocities of occupants, the orientation of impact with interiors, etc.). These occupant crash conditions were further used to correlate injuries using FE human body model (the particular injuries, for which the HBM is validated previously) and FE model of interiors and interacting surfaces having correlated responses with MB interior models. This final step further strengthened the proposed methodology and checks the injury prediction capability of FE HBM in real world crash scenarios for head and chest injury.