충돌시험 및 시뮬레이션

실도로 주행 데이터 분석 기반 센서의 성능저하를 모사하는 상세 시나리오 생성 및 시뮬레이션 연구

김승환* · 임동현* · 송봉섭**

Generation and Simulation of Concrete Scenarios Based on Sensor Performance Degradation of Field Operational Test Data

Seunghwan Kim*, Donghyeon Lim*, Bongsob Song**

Key Words : Automated vehicle(자율주행자동차), Unexpected scenario(돌발상황 시나리오), Concrete scenario(상세 시나리오), Field Operational Test(실도로 실증), Performance degradation(성능 저하)

ABSTRACT

This paper aims to propose a preliminary generation method of concrete scenarios for simulations in order to emulate the performance degradation of commercial environment sensors, e.g., radar or camera. Although most commercial simulators include sensor models which capture the characteristics of sensors, it is still limited to simulate performance degradation events of the sensor which may occur randomly in real driving tests. To consider these unexpected events of the sensor, a concept of safety of the intended functionality (SOTIF) was introduced and its systematic process to handle unknown hazardous events was published in ISO 21448 recently. Furthermore, data-driven approaches including machine or deep learning are widely used for development of advanced driver assistance systems (ADAS) and automated vehicles (AV). Therefore, it is necessary to generate a similar set of concrete scenarios to emulate the performance degradation of the sensor based on field operational test (FOT) data. First, the performance degradation scenario is defined by analyzing the performance of sensor. For example, if a random bias of lateral position measurement occurs, resulting in false alarm of a forward collision warning system (FCWS), it is defined as one of false positive scenarios. That is, a “car-in like” scenario with appropriate parameter space is simulated via a virtual simulator to generate similar concrete scenarios. Finally, it is shown that the performance of FCWS is improved after learning the set of false positive scenarios as augmented training data.

This work was supported in part by the Korea Planning & Evaluation Institute of Industrial Technology(KEIT) grant funded by the Ministry of Trade, Industry and Energy, Under grant 20018248(SOTIF).

* 아주대학교 D.N.A.플러스융합학과/대학원생
** 아주대학교 D.N.A.플러스융합학과 및 AI모빌리티공학과/교수
E-mail : rla0813@ajou.ac.kr

이동식 크레인 아웃트리거 유압실린더의 내압에 따른 차량 수평도 추정 시뮬레이션 모델 개발

박현준* · 조정우** · 오주영**

Development of a Simulation Model for Estimating Vehicle Horizontal Stability Based on the Internal Pressure of the Mobile Crane Outrigger Hydraulic Cylinder

Hyune-Jun Park*, Jung-Woo Cho**, Joo-Young Oh**

Key Words : Mobile Crane(이동식 크레인), Outrigger(아웃트리거), Simulation Analysis(시뮬레이션 해석), Hydraulic Cylinder(유압실린더), Vehicle Horizontal Stability(차량 수평 안전성)

ABSTRACT

In construction sites, accidents involving mobile cranes used for lifting heavy loads occur repeatedly every year. The causes of these accidents are presumed to include operator error, exceeding the allowable load capacity, and ground subsidence. Among these, accidents caused by ground subsidence can be prevented by using reinforcements to fix the outriggers on the ground, thereby dispersing the load. However, it is difficult to predict this in real-time. Therefore, research is needed to monitor the condition of the outriggers to prevent crane accidents and minimize losses and damages.

This study aims to investigate the relationship between the inner pressure the hydraulic cylinders of the mobile crane outriggers and the vehicle's horizontal stability. A simulation model was developed to estimate changes in the inner pressure the outrigger hydraulic cylinders when the vehicle's horizontal stability changes due to ground subsidence during crane operation. Based on this research, it is expected that quantitative predictions of crane movements and postures due to ground subsidence can be provided in the future, serving as a safety aid for crane operators to operate safely during work, thus enhancing the safety of the work environment

후기

이 연구는 국토교통부/국토교통과학기술진흥원이 시행하고 대한건설기계안전관리원이 총괄하는 “고위험 건설기계 안전성 평가 및 관리 기술개발 사업(과제번호 RS-2023-00244879)”의 지원으로 수행하였습니다.

* 한국생산기술연구원/연구원
** 한국생산기술연구원/수석연구원
E-mail : goldneiya@kitech.re.kr

AEB 작동 사고에서 승객 상해 저감을 위한 에어백 전개 시점 최적화에 관한 연구

정경진*,** · 심동하***,†

Study on Optimization of Airbag Deployment Timing for Injury Reduction in Autonomous Emergency Braking (AEB) Scenarios

Kyungjin Jung*,**, Dongha Shim***,†

Key Words : AEB(자동 긴급 제동 장치), Airbag(에어백), Passenger Injury(승객 상해), Machine Learning(머신 러닝)

ABSTRACT

With recent rise in the deployment of vehicles equipped with Advanced Driver-Assistance Systems (ADAS), there has been a lot of researches on the effects of the Autonomous Emergency Braking (AEB) system for passenger injury. From this perspective, the study developed scenarios for AEB activation and simulated passenger injuries. The research focused on the analysis of how three primary variables—the seating angle of the passenger, the speed of the vehicle, and the timing of airbag deployment—affect the severity of passenger injuries. The analysis of injury data and the application of machine learning models are conducted to predict the optimal timing of airbag deployment based on specific seating angles of passengers and vehicle speeds. The objective is to explore the feasibility of adjusting the timing of airbag deployment in real-time within AEB systems. Based on machine learning, the prediction model can improve the passenger injury accroding to passenger seating angle and vehicle speed. This study shows the potential for the adjustments in airbag deployment timing to improve the effectiveness of AEB systems to mitigate injuries during accidents.

* Siemens
** 서울과학기술대학교, 정보통신미디어공학과/박사과정
*** 서울과학기술대학교, MSDE학과/교수
† 교신저자 : dongha@seoultech.ac.kr
E-mail : kyungjin.jung@siemens.com

고속 전방 충돌시 뒤보기 착좌 기증자 응답과 상해

강윤석* · Gretchen Baker* · Angelo Marcallini* · Amanda Agnew* · 송지운** · 정용현** · 이동길** · 함재준** · 김형주*** · 고석훈** · 이규상**

Responses and Injuries of Male Post-Mortem Human Subjects (PMHS) Seated in a Production Seat in Rear-facing Frontal Impacts

Yun-Seok Kang*, Gretchen Baker*, Angelo Marcallini*, Amanda Agnew*, Jiwoon Song**, Yong Hyun Jung**, Dong Gil Lee**, Jae Jun Harm**, Hyung Joo Kim***, Seokhoon Ko**, Kyu Sang Lee**

Key Words : Rear-facing (뒤보기), PMHS (기증자), Rib fractures (늑골 골절), Cervical spine injuries (경추 상해)

ABSTRACT

A recent rear-facing PMHS study utilized reinforced seats to ensure the setup durability. It has been argued that the reinforced seat contributed to severe rib and pelvis injuries. This study aims to investigate male PMHS responses and injuries using an unreinforced production seat in rear-facing frontal impacts. Two PMHS were tested in a production seat with a pretensioner using 20- and 40-degree recline angles at DV of 56kph. The PMHS were positioned using the same procedures in the previous rear-facing study. An instrumented panel was installed behind the seatback with a gap of 100mm that limited the seatback rotation. PMHS instrumentation was identical to the previous study, and additional strain rosettes on the ribs and strain gages on the superior pubic rami of pelvises were installed. The major PMHS injuries occurred at the thorax and spine. Both PMHS sustained severe rib fractures (PMHS1: bilateral flail chest and pneumothorax; PMHS2: pneumothorax) and cervical spine injuries (e.g., spinal cord complete transaction). All rib fractures occurred before the maximum seatback rotations. Based on strain rosette outcomes, directions of the principal strains on the posterior ribs were in the upward shear direction due to thorax upward deformation. The PMHS neck experienced severe hyperextension injuries. PMHS sustained severe rib fractures in the unreinforced rear-facing seat configurations. These injuries were due to the large upward thorax deflection induced by the ramping motion and seatback rotation. The yielding seatback considerably increased rearward head angular kinematics, which resulted in severe cervical spine injuries. Pelvis fractures were not observed; however, fibula fractures were sustained, which suggests more energy possibly transferred to the lower extremity when the seatback deformed and rotated rearward. The results from this study provide information that can be used as a guideline for designing rear-facing seats in vehicles with automated driving systems.

* 오하이오주립대/교수
** 현대모비스/책임연구원, 연구원, 셀리더, 섹터장
*** 현대자동차/책임연구원
E-mail : yunseok.kang@osumc.edu