교통사고의 법공학적 분석

차량의 엔진 마운트 파손 사고에 대한 법공학적 분석과 원인 고찰

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Forensic Engineering Analysis of Engine Mount Failure Accidents in Vehicles and Consideration of Their Causes

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Key Words : Engine Mount(엔진마운트), Rear Enging Mount(리어엔진마운트), Fatigue Failure Analysis(피로파괴 검사)

ABSTRACT

The engine mount serves to secure and support the engine and transmission in a vehicle while also absorbing various vibrations generated not only from the powertrain but also from the vehicle body.

This case reports a failure incident involving the rear engine mount that occurred while the vehicle was in motion. To determine the cause of the rear engine mount failure in the accident vehicle, detailed analysis was conducted using the vehicle's dash cam footage and CCTV recordings from the accident scene. These videos were reviewed to reconstruct and understand the circumstances of the incident.

Subsequently, the failed rear engine mount was removed from the vehicle and subjected to multiple inspections, including fracture pattern analysis, fatigue failure analysis, and evaluation of possible external impacts. In addition, a comparative study was performed between the mounting position and configuration of the failed engine mount and those installed in other vehicles.

Through these investigative procedures, we examined and discussed the underlying causes of the rear engine mount failure in the accident vehicle.

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전기자동차 충돌 사고에 대한 EDR 데이터 기반의 법공학적 재구성

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Forensic Engineering Reconstruction of Electric Vehicle Collision Accident based on EDR Data

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Key Words : EV(전기자동차), EDR(사고기록장치), ADAS(첨단 운전자 지원 시스템), SCC(스마트 크루즈 컨트롤), Traffic Accident Reconstruction(교통사고 재구성)

ABSTRACT

In response to carbon emission reduction strategies under UNFCCC(the United Nations Framework Convention on Climate Change), global sales of EVs(Electric Vehicles) have surged significantly. In South Korea, following the enactment of legislation to promote EV adoption, domestic sales have shown rapid growth over the past three years—231,443 units in 2021, 389,855 units in 2022, and 543,900 units in 2023. As the number of EVs in circulation increases, the incidence of EV-related accidents has also risen. These accidents tend to result in more severe consequences compared to those involving ICE(Internal Combustion Engine) vehicles. This is primarily due to the higher instantaneous torque output of electric motors, which can lead to sudden acceleration, as well as the increased risk of large-scale fires and damage from battery impact. This study addresses the structural and operational differences between EVs and ICE vehicles, emphasizing the severity and implications of EV-specific accidents. In particular, it explores the process of extracting the ACU(Airbag Control Unit)—which contains the EDR(Event Data Recorder)—from severely fire-damaged EVs following a collision. The paper also outlines a forensic analysis approach utilizing EDR data to reconstruct accident scenarios. Furthermore, the study examines the relationship between accident dynamics and the SCC(Smart Cruise Control) function, a component of ADAS(Advanced Driver Assistance Systems), to identify causative factors in EV accidents. From the perspective of traffic accident forensic examiners, this research also proposes enhancements to the scope and categories of EDR data recording to improve data reliability and ensure accurate accident causation analysis.

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차량결함 사고분석 사례 : 고속 주행 중 변속 상태 원인 분석

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Case Study of Vehicle Defect Accident Analysis: Analysis of Gear Shift Conditions at High Speed

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Key Words : UA(급발진 주장사고), EDR(사고기록장치), Parking Gear(파킹 기어), Parking Sprag(파킹 스프래그), Accident Reconstruction(사고 재구성)

ABSTRACT

Claims of vehicle defects in accidents may arise from factors related to vehicle design, manufacturing defects, or improper maintenance. However, in recent cases, certain accidents caused by driver errors, such as pedal misapplication—one of the suspected causes of unintended acceleration incidents—have also resulted in vehicle defect allegations.

This study analyzes a vehicle defect claim case involving a Santa Fe vehicle that crashed into a retaining wall while entering a highway rest area at high speed in March 2024. CCTV footage and dashcam recordings from nearby vehicles confirmed that the brake lights were off at the time of the incident. A comprehensive vehicle inspection, including the acceleration and braking systems, did not reveal any abnormalities that could have caused the defect. The extracted Event Data Recorder (EDR) data showed that the engine throttle and accelerator pedal displacement were at their maximum values, which were comprehensively analyzed to make a preliminary assumption of a possible pedal misapplication accident. However, the EDR also recorded an unusual state where the gear shift lever was in the "P" (Park) position for five seconds before the collision, prompting further examination of the transmission system.

Typically, a driver shifts into the P ("Park") position while the vehicle is stationary. However, in this case, the gear was recorded as being in the P ("Park") position while the vehicle was still traveling at high speed. To replicate the accident scenario, the transmission of the accident vehicle was disassembled, and an experiment was conducted by rotating the parking gear while shifting into the P position during high-speed transmission rotation. The results showed that the parking sprag failed to engage with the parking gear, causing friction on the gear surface and allowing continuous rotation, similar to an N (Neutral) state.

Therefore, the condition of the parking gear and parking sprag resulting from gear shifts during driving was examined, and this study is anticipated to serve as a reference for the analysis of similar vehicle accident investigations in the future.

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차량의 공회전제한장치 사용에 의한 가속페달 오조작 사고 사례 분석

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A Case Analysis of Pedal Misapplicaton Caused by the use of Start-Stop Systems in Vehicles

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Key Words : SUA(급발진 주장사고), Start-stop systems(엔진 공회전제한장치), Traffic accident(교통사고), Accelerator pedal misoperation(가속페달 오조작), Accident investigation(사고조사)

ABSTRACT

Traffic accidents suspected to be caused by sudden unintended acceleration(SUA) can generally be categorized into three main causes: vehicle defects, such as malfunctions in the electronic control system; driver errors: and driver inexperience leading to operational mistakes. Among these, the most common cases involve misoperation of the accelerator pedal, where the driver mistakenly presses the accelerator instead of the brake when attempting to decelerate, resulting in unintended rapid acceleration and an accident.

This study focuses on a particular type of accelerator pedal misoperation, where the driver, while operating the vehicle, forgets to press the accelerator pedal and, in a brief moment before the accident, mistakenly believes they are applying the brake to avoid a collision. A representative example of such a situation is an accident caused by the use of start-stop systems(idle stop & go system), which continues to occur due to driver misperception.

In this case, the accident appears to have been triggered by accelerator pedal misoperation due to the use of start-stop systems(idle stop & go system). However, the driver claimed the accident was caused by a sudden unintended acceleration event due to a vehicle defect. This study aims to provide insights into similar cases by analyzing this incident, contributing to vehicle forensic investigations and accident analysis.

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실차 시험을 기반으로 한 ACC 특성과 한계 상황 분석 및 주행 안전성에 관한 연구

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A Study on Adaptive Cruise Control Characteristics, Boundary Condition Analysis and Driving Safety Based on Vehicle Testing

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Key Words : ADAS(첨단 운전자 지원 시스템), ACC(적응형 크루즈 컨트롤), Vehicle Testing(실차 시험), Driving Safety(주행 안전성), AEB(자동 긴급 제동 시스템)

ABSTRACT

With the rapid advancement of Advanced Driver Assistance Systems(ADAS), Adaptive Cruise Control(ACC) has become a standard feature in many modern vehicles. Although ACC is designed to operate under specific driving conditions, numerous limitations emerge in real-world traffic environments, potentially increasing the risk of collisions when such boundaries are exceeded.

This study aims to quantitatively evaluate the performance and limitations of ACC and to analyze a range of real-world driving scenarios. The test vehicle selected was the Sorento MQ4 PE, which recorded the highest domestic sales in South Korea as of 2024. Test scenarios were designed based on the ACC evaluation items from the Euro NCAP Assisted Driving Test, enabling assessment of operational characteristics and limitations across ACC Levels 1 through 4. Quantitative data analysis was conducted using the vehicle's instrument cluster and a Data Acquisition System (DAQ) to monitor ACC behavior. Situations in which ACC failed to maintain appropriate following distance or to bring the vehicle to a complete stop were recorded and analyzed.

The results indicate that ACC demonstrates greater stability when following a moving lead vehicle compared to a stationary one. However, limitations were observed in scenarios involving abrupt lane changes and transitions of the lead vehicle from motion to a stop. In certain cases, ACC disengaged and was overridden by Automatic Emergency Braking (AEB). Based on these findings, potential risk scenarios associated with ACC operation were identified.

This study provides a comprehensive analysis of ACC limitations in real-world conditions and is expected to support traffic accident investigations by offering insight into the operational boundaries of ACC. Future research will focus on expanding the scope through comparative analyses of ACC performance across various vehicle models.

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