건설기계 동반성장을 위한
안전기반 구축

시뮬레이션을 통한 스마트 모터 그레이더 자율작업 알고리즘 비교 분석

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Comparative Analysis of Autonomous Operation Algorithms for Smart Motor Graders Through Simulation

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Key Words : Construction machinery for road pavement(도로 포장 건설 기계), Motor grader(모터 그레이더), Autonomous driving algorithm(자율주행 알고리즘), Vehicle simulation(차량 시뮬레이션), Automation (자동화)

ABSTRACT

모터 그레이더는 도로 포장 시 노면 평탄화, 제설, 도로 보수 등에 활용되는 건설 기계이다. 기존 모터 그레이더는 숙련된 작업자를 통해 시공을 의존하며 인적 오류와 작업자의 안전에 대한 위험이 존재한다. 또한, 건설 현장에서 근로자의 감소로 인해 인적 비용과 시간 등의 자원 소모가 증가하는 실정이다.

이러한 문제를 해결하기 위해, 스마트 모터 그레이더를 개발하였고 자동화 및 무인화 기술을 적용하여 모터 그레이더의 생산성과 안전성을 높이는 연구를 진행 중이다.

자동화 및 무인화 기술을 구현하기 위하여 자동차 연구 분야에서 많이 활용하는 Stanly method와 Pure-pursuit 방식의 자율 주행 알고리즘을 시뮬레이션으로 제작하여 비교 하였다. 두 알고리즘에 대하여 스마트 모터 그레이더의 차량 정보를 입력하였고 자율작업 시 작업 경로에 대한 오차를 확인했다. 경로점(Waypoint)과 실제 주행한 위치의 차이를 평균 제곱근 편차(RMSE, Root Mean Square Error)를 사용해 오차를 분석하고 스마트 모터 그레이더에 적합한 주행 알고리즘을 채택하였다.

알고리즘의 검증은 향후 소형 주행로봇에 대한 시뮬레이션 및 실차 주행을 수행하여 분석하려고 한다. 소형 주행로봇에 알고리즘의 안전성과 성능 검증 후 스마트 모터 그레이더 실차시험을 통해 적합한 주행 알고리즘을 채택할 예정이다.

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고투명 홀로그래픽 스크린 기반의 안전 영상 디스플레이 장치

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A Safety Image Display Device Based on a Highly Transparent Holographic Screen

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Key Words : HUD(허드), Holographic screen(홀로그래픽 스크린), Windshiedl(윈드쉴드), Safe contents(안전 영상)

ABSTRACT

Since the introduction of head-up displays (HUDs) for vehicles in the late 1980s, the technology has evolved from simply projecting speed onto the windshield to providing drivers with more comprehensive information such as road and traffic conditions. However, for special purpose vehicles, it is crucial to provide specific information that is tailored to the vehicle's purpose in order to prevent accidents. Currently, information is typically displayed on the dashboard side of working vehicles, but this can create visibility issues for operators who must divert their attention from their work to check the display. To address this problem, a proposed solution is a safety image display device that utilizes a high-transparent holographic screen attached to the windshield. The device works by projecting safety images onto the holographic screen, which offers at least 80% transparency. This allows operators to view the display information and their actual target vehicle simultaneously, thereby reducing the risk of accidents. The use of holographic screens with high transparency ensures that the display information does not obstruct the operator's view of the road.

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Sprocket 재질의 고주파 침탄 처리 공정 최적화

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Optimization of High-Frequency Carburizing Process of Sprocket Material

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Key Words : Construction Equipment(건설장비), Sprocket(스프라켓), Centrifugal Casting(원심주조)

ABSTRACT

The sprocket is a key component of the undercarriage that is responsible for driving construction machinery such as excavators, dozers, and cranes. It is a key component that determines durability. The sprocket requires high tensile strength and yield strength, and due to the nature of off-road equipment that travels on uneven ground, it must be able to withstand the impact generated during driving, so high strength and impact value are required, and relatively low hardness is required in terms of internal hardness of the material. do. In addition, high wear resistance capable of withstanding continuously occurring intermetallic friction is required. In this study, a high-strength and high-toughness material was developed to be suitable for centrifugal casting in the existing sand casting, and the life characteristics and surface wear resistance characteristics were improved.

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ICT기반 이동식 기계류 안전장치의 기능안전 설계/평가 프로세스에 대한 해외 규제 동향 검토

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Trends of Design and Evaluation Processes on Functional Safety of ICT Based Safety Devices for the Mobile Machinery

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Key Words : Functional safety(기능 안전), 제어시스템의 안전관련부품(SRP/CS, Safety Related Parts of Control System), Construction equipment(건설기계), Safety device(안전 장치), 기술규제(Technical regulation)

ABSTRACT

Application of ICT based safety devices has been rapidly increased in order to enhance the convenience for operation and reinforce the worksite safety, for the workers who works near the construction equipment. In addition, regulations on the design, verification and validation processes for ICT-based safety devices of which hardware and software are convoluted has been reinforced in the advanced nations such as EU. These kinds of regulations are widely applied for mobile machinery including Construction Equipment such as excavators, forklift industrial trucks, tower cranes, mobile cranes and tractors for agriculture, etc.

Particularly, among the European Union nations, Machinery Directive(2006/42/EC) request the conformity assesment including the Safety Related Parts of Control System(SRP/CS), which covers ICT-based safety devices classified as the safety component in order to prevent random failure, malfunctions, etc.

As the conformity assessment procedure, ISO and/or EN safety standards must be published via official journal of EU in advance, and then based on the related safety standards, the conformity assessment shall be validated for each safety component including ICT-based safety devices for Construction Equipment.

In this paper, focused on functional safety of the SRP/CS, I will briefly review the ISO and/or EN safety standards, which are applied for so-called mobile machinery such as Earth-moving machinery(ISO/TC 127, CEN/TC 151), Industrial Trucks(ISO/TC 110, CEN/TC 150), Cranes including mobile cranes and tower cranes(ISO/TC 96, CEN/TC 147), Agricultural machinery(ISO/TC 23, CEN/TC 144), etc.

Finally, I will introduce what kinds of functional safety standards for ICT-based safety devices shall be applied as the conformity assessment standards for the various fields of industries of mobile machinery such as excavators, fork-lift industrial trucks, tower cranes, mobile cranes, tractors, etc.

이 논문은 국토교통부의 지원을 받는「고위험 건설기계 안전성 평가 및 관리 기술 개발(과제번호: RS-2032-00244879)」과제의 결과물임을 밝힙니다.

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고위험 건설기계 안전성 평가 및 관리 기술개발 사업 소개

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Introduction of High-Risk Construction Equipment Safety Evaluation and Management Technology Development Project

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Key Words : Construction equipment(건설기계), Technology development(기술개발), Safety(안전)

ABSTRACT

As of December 2022, about 540,000 domestic construction equipment have been registered and are in operation. The number of registered construction equipment has been continuously increasing since exceeding 500,000 in 2020, and accidents related to construction equipment continue to occur. Although domestic construction equipment is managed by law, it is a situation that cannot keep up with various and rapid technological changes. The purpose of this project is to prevent accidents caused by mechanical factors of construction equipment by advancing the current construction equipment management system. Therefore, tower crane, crane, pile driver and excavator that cause large-scale accidents in the event of an accident are defined ad high-risk construction equipment, and plans for advanced management are proposed starting with this construction equipment.

국내 건설기계는 `22.12월 기준으로 약 54만대가 등록되어 운영되고 있다. 등록대수는 20년도 50만대를 넘어선 이후 지속적으로 증가하는 추세이며, 건설기계와 관련된 사고도 지속적으로 발생하고 있다. 현재 건설기계는 건설기계관리법에 의해 관리되고 있으나, 다양하고 급격한 기술변화를 따라가지 못하고 있는 실정이다. 본 사업은 현재 건설기계 관리 체계를 고도화하여 안전성을 확보함으로써 기계적 요인으로 발생하는 건설기계의 사고를 예방, 저감하는 것이 목적이다. 이에 사고 발생 시 큰 인명 사고를 유발하는 타워크레인, 기중기, 항타기, 천공기, 4개 기종의 건설기계를 고위험 건설기계로 설정하고, 해당 건설기계를 시작으로 건설기계 관리의 고도화 방안을 제시한다.

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