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論 文 内 容 要 旨

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学位論文題目	An AI based Safe Driving Support System using Two Dashboard Cameras (デュアルドライブレコーダーを活用したAIによる安全運転支援システム)		

内容要旨: Driving support systems are of paramount importance in the modern era due to their ability to reduce human errors and improving overall road safety that saves lives by reducing and preventing accidents. They also address the rising issue of distracted driving, optimize traffic flow, meeting consumer preferences for enhanced vehicle features, and align with regulatory efforts to make driving safer and more efficient.

Detecting driver distraction promptly is imperative for enhancing road safety. While various methodologies and technologies have been explored to address this issue, we present an innovative, cost-efficient, non-intrusive, and lightweight Safe Driving Support System (SDSS) that utilizes dual dashboard cameras. In addition to conventional driver's gaze tracking, our system considers broader aspects, including monitoring the road environment and pedestrian safety. Our study comprises two primary modules: driver distraction detection and pedestrian safety.

Driver's distraction detection: This module evaluates distraction by analyzing the driver's gaze direction and the position of pedestrians on the road. This module consists of two parts with parallel procedures. The first is to estimate the direction of the driver's gaze, and the second is to detect the pedestrian and determine his position. In the first procedure, to accomplish this, receives the video captured through the driver monitoring camera and then defines the gaze region the driver is looking at. We explored several strategies for this task.

Through extensive experimentation, we investigated how different camera positions affect gaze estimation. Also, presented strategies that use appearance-based solutions, including a combination of gaze and head features, and domain adaptation solutions to enhance gaze mapping's robustness to various drivers and environments. From these strategies, the strategy OpenFace with SVM classifier (using gaze angle, head position_R, head rotation_R, and eye position WO-Z features) using camera position 2, outperformed others, achieving an 85.6% accuracy rate for Strictly Correct Estimation Rate (SCER) and a 98.7% accuracy rate for Loosely Correct Estimation Rate (LCER). Notably, we also employed unsupervised domain adaptation through a conditional Generative Adversarial Network (GAN) to ensure accurate gaze mapping across diverse drivers and environments. The domain adaptation approach we used showed an average Strictly Correct Estimation Rate (SCER) accuracy of 81.38% and 93.53%, along with a Loosely Correct Estimation Rate (LCER) accuracy of 96.69% and 98.9% for the two different strategies, respectively. These results demonstrate the effectiveness of our method in adapting to different domains. Additionally, we achieved an average SCER accuracy of 85.00% and 94.84%, along with LCER accuracy of 98.80% and 99.23% for the two strategies, respectively. This showcases the adaptability of our approach to various environments and even different camera positions for the same driver, indicating potential self-calibration capabilities.

Simultaneously, the second procedure receives video from the front-view camera to identify

pedestrian activity. By combining the data from all road users, we can evaluate the driver's distraction level.

Pedestrian Safety: This module assesses the risk level of pedestrians based on road lane lines and pedestrian's relative positions using the video feed from the front-view camera. To determine pedestrian's safety, we divided the road into sections based on the level of risk to the pedestrians, including high-risk, risky, and safe regions based on the lane lines. Our pedestrian safety module relies on two procedures: lane line detection and pedestrian distance and position detection. We have experimented with pedestrian distance and position detection procedures using methods such as the optic flow method and Deep learning methods. This integration enables the system to provide real-time feedback on potential hazards in the driver's vicinity. Moreover, recognizing the paramount importance of pedestrian safety, we have introduced a dedicated Pedestrian Safety part. This module demonstrated promising results, with an average lane line recognition accuracy of 95.79% and a pedestrian distance and position detection accuracy of 86.45%.

Together, these modules offer an early detection and mitigation solution for the leading causes of accidents: driver distraction and pedestrian risk. In summary, our Safe Driving Support System provides a comprehensive and cost-effective approach to enhance road safety by addressing driver distraction and pedestrian safety. The results from our experiments demonstrate the system's effectiveness in detecting and mitigating potential hazards on the road, contributing to a safer transportation environment and the prevention of accidents.