Beep, Bleep, Oops! A Discussion on the Misuse of Advanced Driver Assistance Systems (ADAS) and the Path Moving Forward

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Abstract: The potential of Advanced Driver Assistance Systems (ADAS) to enhance road safety and driver comfort is significant. However, its realization can be compromised by driver misuse. This paper discusses the misuse of ADAS, defined as the suboptimal, inappropriate, or incorrect utilization of these systems. Such misuse not only diminishes their safety benefits but also poses new risks. In this paper, I argue that misuse encompasses at least three distinct behaviours: Non-Use When Beneficial, Overuse, and Non-Compliant Use. Each presents unique challenges to leveraging ADAS's full safety capabilities. Through an analysis of these behaviours, the paper aims to shed light on the underlying reasons for ADAS misuse and its implications for road safety and vehicle efficiency. The study underscores the importance of addressing these issues through the development of more effective ADAS technologies, comprehensive education programs, and other interventions tailored to encourage correct usage. By exploring the specific pathways of misuse and their impact on road safety, this research contributes to the broader understanding of how to maximize the benefits of ADAS, ensuring they serve their intended purpose of making roads safer for all users.

1 INTRODUCTION

Advanced Driver Assistance Systems (ADAS) encompass a range of technologies designed to enhance vehicle safety and driver comfort. These systems leverage a combination of sensors, cameras, and algorithms to offer features such as adaptive cruise control, lane keeping assistance, automatic emergency braking, and parking assistance, among others. The primary goal of ADAS is to prevent the ocurrence of crashes, mitigate the severity of those that do occur, and generally make driving a safer and more manageable task (Oviedo-Trespalacios et al., 2021). Examples of ADAS in action include a car automatically adjusting its speed to maintain a safe distance from the vehicle ahead or alerting the driver when it detects an unintended lane departure.

The integration of ADAS into modern vehicles has been met with both enthusiasm and skepticism. On one hand, there is a general expectation that these systems will significantly increase road safety by reducing human error and risky behaviors (Bayly et al., 2007; Haque et al., 2021). Recent analyses support this view, indicating that the long-term savings in terms of lives saved, injuries prevented, and reductions in traffic congestion and vehicle damage can outweigh the initial investment in ADAS technology (Kuang et al., 2019; Masello et al., 2022). However, the reality of ADAS adoption is fraught with challenges. In particular, recent studies have highlighted several issues, including instances of misuse by drivers.

This paper aims to delve deeper into the nuanced ways in which the misuse of ADAS may undermine the anticipated benefits of these technologies. Drawing on previous research, the focus will be on explaining the specific pathways through which behaviors manifest and impact road safety.

2 TYPES OF ADAS MISUSE

Misuse of ADAS technology involves incorrect, inappropriate, or suboptimal use by drivers,

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undermining safety benefits and introducing new road risks. Enhancing the effectiveness of ADAS and promoting its proper use requires a clear understanding of misuse. As outlined in this paper, misuse is categorized into at least three distinct types: Non-Use When Beneficial, Overuse, and Non-Compliant Use. Each presents a unique challenge to maximizing ADAS's safety potential.

2.1 Non-Use when Beneficial

Non-Use when Beneficial occurs when drivers choose not to utilize ADAS in situations where these systems could significantly enhance their safety or driving experience. For instance, a driver might disable lane-keeping assistance because they prefer the feel of manual control, even in heavy highway traffic where the system could help maintain a safe lane position amidst distractions or fatigue. Research by Lijarcio et al. (2019) found that a significant portion of 1,207 Spanish drivers considered certain ADAS—such as speed limiters (47.9%), adaptive cruise control (41%), and automatic lighting (34.2%)—to be useless or unnecessary, opting not to use such technologies. Similarly, a study in the Netherlands found that some ADAS, such as Cruise Control and Lane Keeping Assist, have low utilization rates, 33.3%-9.8% respectively (Boelhouwer et al., 2020). This is problematic given that these technologies have arguably great potential in reducing road crashes (Bayly et al., 2007). ADAS can serve as a redundancy, providing drivers with a layer of protection in case proper vehicle control is not sustained. Therefore, not using ADAS negates the system's benefits by sidelining technologies designed to reduce crash risks and improve road safety.

2.2 Overuse

Overuse (or dependency) is characterized by drivers excessively relying in ADAS, resulting in a decline and even atrophy of their driving skills. This form of misuse typically becomes apparent when ADAS is unavailable, revealing a deterioration in performance compared to the baseline established before its use. An illustrative example of this phenomenon is the overreliance on parking assistance technologies. Drivers may become so dependent on automatic parking systems that they lose confidence in their ability to manually parallel park or accurately judge distances without assistance of the technology.

Previous research has highlighted situations where the overuse of technologies has influenced behaviour in their absence. Casner et al. (2016) point out that navigation systems, designed to automate a task at which people already seemed reasonably competent, have led to a loss of navigational skills. More recently, Miller et al. (2017) found that the use of lane-keeping assist affects driving skills and cognitive workload. In a study involving 48 participants across three driving simulator sessions, it was observed that drivers who utilized lane-keeping assist showed a decline in driving performance once the system was deactivated. This was marked by an increase in the standard deviation of lateral position (SDLP) and a reduction in the time to collision (TTC) relative to their performance before using ADAS. Additionally, cognitive workload increased when lane-keeping assist was withdrawn, indicating that dependence on ADAS might complicate the transition back to manual driving. These findings underscore that while ADAS can enhance safety and driving comfort, their intensive use followed by discontinuation can result in lasting behavioural changes, potentially introducing new risks.

Considering the impact of ADAS overuse, it is crucial to differentiate the safety implications of skill atrophy. The loss of navigational skills, for instance, did not lead to major safety issues due to effective technology substitution (Casner et al., 2016), despite concerns like increased distraction (Oviedo-Trespalacios et al., 2019). However, the reliance on more critical systems like lane-keeping assist can pose greater risks when these aids are withdrawn, as they directly affect vehicle control and situational awareness. Identifying scenarios where ADAS dependency might lead to significant safety conflicts is essential.

2.3 Non-Compliant Use

Non-Compliant Use emerges when ADAS leads to unintended changes in driver behaviour, resulting in less-than-optimal vehicle control. For instance, drivers may incorrectly rely on systems like Tesla's Autopilot as fully autonomous, removing their hands from the wheel and not watching the road, wrongly assuming the car can handle all tasks. Similarly, when using parking assistance, there is a tendency to monitor the car's displays rather than the parking environment (Kidd et al., 2018). This indicates a clear consequence of ADAS: it can lead to shifts in driving behaviour that are not officially recommended.

Research has shown that drivers utilizing ADAS might start engaging in other risky behaviours. For example, some drivers using autopilot systems become increasingly distracted by activities like phone use or even engage in extreme behaviours such

as sexual activities (Lin et al., 2018; Oviedo-Trespalacios et al., 2022). Alarmingly, there's evidence that ADAS features, such as Lane Departure Warning, do not reduce distractions (Cades et al., 2016). Additionally, a recent study identified a positive correlation between safety systems and the prevalence of speeding tickets, suggesting that safety systems may encourage adaptive behaviour that undermines their intended safety benefits (Vertlib et al., 2023).

ADAS are not replacements for a human driver, yet some individuals use them incorrectly as if they were. Such reliance is not always for comfort but also occurs when drivers use ADAS to manage their physical impairments. Vaezipour et al. (2022) found that individuals with chronic pain use ADAS to reduce discomfort, utilizing features like cruise control to avoid prolonged static postures and minimize foot pain, and blind-spot warnings to mitigate neck pain, thus easing the need to look over the shoulder. However, this dependence on ADAS for physical aid can lead to incorrect vehicle control and reduced safety behaviours, as drivers may wrongly believe that ADAS can completely compensate for their limitations.

Non-compliant use can also occur among road users who interact with vehicles equipped with advanced technology. For example, Li et al. (2023a) investigated how the presence of autonomous vehicles might influence yielding behaviour and found that drivers with existing risky behaviours might exacerbate these tendencies, further reducing safety margins during interactions with autonomous vehicles. Similar findings have also been reported among bicycle riders (Li et al., 2023b). This underscores the urgent need for strategies to mitigate such behaviours among non-users of the technology as well.

3 REASONS BEHIND ADAS MISUSE

Research has identified a lack of knowledge and dissatisfaction with ADAS as key reasons for its non-use. Harms et al. (2020) explained that 83% of owners not fully aware of their vehicle's features. Yet, once informed, 95-98% of drivers actively use systems like cruise control and navigation, emphasizing the importance of awareness in ADAS usage. This suggests that increasing awareness could significantly enhance utilization rates.

Another key aspect related to non-use is that the technology might not meet drivers' expectations. Reimer (2004) noted that ADAS may not always fulfill drivers' expectations, leading to dissatisfaction and the deactivation of systems such as adaptive cruise control, often due to discomfort with unexpected behaviours like sudden acceleration. This discomfort usually arises from a misunderstanding of how these systems function, especially their design to maintain a predetermined speed or distance from the vehicle in front. Arguably, better design of ADAS and awareness of its functioning could help prevent this form of misuse.

Overuse and dependency on ADAS, though not fully understood, might result from the technology's perceived advantages and widespread acceptance among users. If drivers hold positive perceptions and experiences with ADAS, they are more inclined to use it frequently. This notion aligns with technology acceptance theory, a framework that explains technology adoption and use (Kaye et al., 2022). Currently, ADAS lack built-in controls to moderate reliance on these systems and prevent skill deterioration or atrophy. The significance of incorporating "Safety-by-Design" principles becomes apparent, highlighting the necessity for manufacturers and designers to proactively integrate safety considerations into the development phase of technology. This strategy is aimed at foreseeing potential misuse scenarios, creating systems that either prevent unwanted behaviours or significantly reduce their likelihood.

Non-compliant use often stems from a lack of understanding of the technology. Kaye et al. (2022) found that many drivers learn about ADAS from vehicle manuals or through trial and error, approaches that Oviedo-Trespalacios et al. (2021) noted do not build accurate mental models of ADAS. Additionally, Nandavar et al. (2023) noted instances of surprise reactions from ADAS users with insufficient knowledge, such as a 49-year-old male driver startled by an early activation of the automatic braking system and a 68-year-old female relying on both the rear-view camera and traditional methods for better precision. Pradhan et al. (2021) warned that drivers' knowledge of ADAS could become outdated or worsen over time, raising the accident risk if drivers ignore or sidestep the system's advice. This highlights a major gap in current driver education practices and points to the need for enhanced training methods.

Finally, risky use is heavily influenced by individual differences, such as gender, which contribute to riskier behaviours with ADAS. Research has shown that male drivers are more prone to engaging in risky practices and may be more likely to misuse ADAS for such behaviours when these

systems are available (Rezaei et al., 2021). This highlights the importance of considering individual differences when addressing potential ADAS misuse, ensuring that safety interventions are both effective and comprehensive.

4 PATH MOVING FORWARD

The integration of ADAS and the advent of autonomous vehicles present both opportunities and challenges for enhancing road safety. To capitalize on these technologies effectively, a unified approach by practitioners, policymakers, and researchers is imperative.

For Practitioners. It is essential for vehicle manufacturers and technology developers to incorporate safety as a fundamental aspect of design. This includes creating ADAS features that not only aid driving but also actively promote safe driving practices. Ensuring ADAS are intuitive and support the driver without fostering overreliance is crucial. Developing mechanisms within vehicles that educate and correct ADAS misuse in real-time could significantly improve road safety.

For Policymakers. Updating regulatory frameworks to reflect the latest technological advancements in vehicles is necessary. Policies should facilitate the safe integration of ADAS by setting standards that encourage manufacturers to prioritize safety and usability. Additionally, creating guidelines that require the inclusion of comprehensive, accessible education on ADAS within driver licensing and renewal processes can help bridge the knowledge gap and prevent misuse.

For Researchers. The field calls for continued investigation into the behavioural effects of ADAS on drivers. Understanding how these systems influence driving habits, decision-making, and safety perception is key to developing technologies that truly benefit road safety.

A multidisciplinary approach is necessary to address the nuanced challenges presented by the integration of advanced driving technologies. Through collaboration and innovation, stakeholders can ensure that the development and adoption of ADAS and autonomous vehicles genuinely contribute to creating safer driving environments. This approach requires continuous adaptation and commitment to education, regulatory evolution, and technological refinement to achieve the shared goal of reducing road accidents and enhancing driver safety.

5 CONCLUSIONS

In conclusion, addressing the challenge of integrating ADAS and autonomous vehicles into our roads necessitates a concerted effort from manufacturers, policymakers, and researchers. It is critical to not only focus on the advancement of technology but also on understanding and mitigating forms of ADAS misuse. By embedding "Safety by Design" principles, refining regulatory frameworks to encourage safe and informed use, and deepening our research efforts into the drivers' behavioural response to ADAS, we can make significant strides toward enhancing road safety. With a commitment to continuous education, technological refinement, and adaptive policies, the future of driving can be safer for everyone, marked by a responsible and informed integration of ADAS and autonomous driving technologies.

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