Intel® Unnati Grand Challenge – Summer 2023 - Phase 1
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Abstract

This report presents a comprehensive analysis of various alert patterns and their underlying factors in a fleet of vehicles equipped with advanced driver assistance systems (ADAS), with a keen focus on enhancing road safety. The study explores the correlation between weekly workloads and alerts, the impact of festivals on alert rates, weather-adaptive safety solutions, and the influence of external events on traffic alert patterns. Additionally, it delves into driver adaptation, alert patterns, and parking skills, shedding light on issues related to lane departures, headway monitoring, and pedestrian collision warnings, all contributing to road safety.

Notably, this report goes beyond the initial dataset by introducing additional columns, yielding new and insightful findings. These additional insights are presented in the final five sections of the report, shedding light on critical aspects of the data analysis that directly impact road safety.

Navigating Work-Related Stress: Exploring The Correlation Between Weekly Workload And Alerts:

A striking trend emerges from the analysis of the data: the number of alerts varies significantly throughout the week. For example, on Fridays, there were 38.2% of alerts, which is significantly higher than the number of alerts on Mondays (34.5%). This pattern suggests that there is a correlation between the emotional state of individuals involved in accidents and the demands of their workweek.

The substantial increase in alerts on Fridays may reflect the cumulative stress and fatigue experienced by individuals, which could lead to a higher likelihood of accidents. This pattern is also evident when we compare the number of alerts on Saturdays (9.9%) and Sundays (1.6%). These days are typically associated with lower levels of stress and fatigue, which is reflected in the lower number of alerts. The pattern of increasing alerts throughout the workweek is further supported by the data for Thursday (38%) and Tuesday (37.7%). These days are typically associated with higher levels of workload and pressure, which may contribute to the increase in alerts.

Weather-Adaptive Safety Solutions:

The number of lane departure warnings (LDW) is highest during cloudy weather, suggesting that reduced visibility may lead to more lane departures.

Alert Counts by Weather Condition
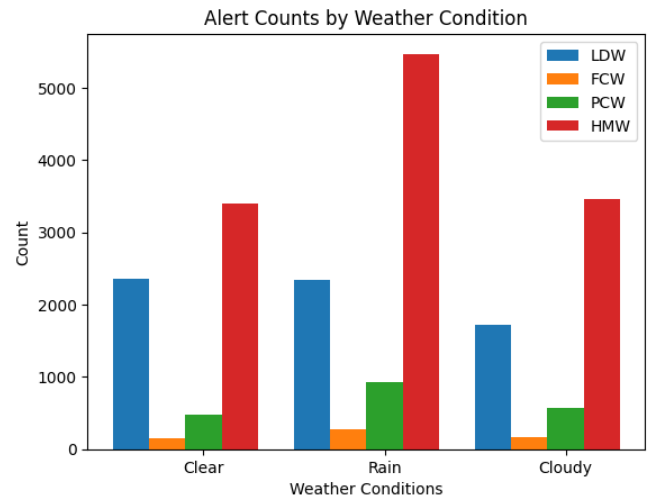
However, LDW systems are still effective in detecting lane departures even in rainy weather. The number of forward collision warnings (FCW) is relatively lower during cloudy weather, but FCW systems are still effective in preventing forward collisions under these conditions. Pedestrian collision warnings (PCW) are also more common during cloudy weather, suggesting that reduced visibility may increase the risk of pedestrian collisions. Headway maintenance warnings (HMW) are also more common during cloudy weather, indicating that maintaining safe distances between vehicles is particularly important when visibility is reduced. These findings highlight the importance of promoting advanced warning systems to improve road safety, particularly during adverse weather conditions.

The Impact of Political Events and Security Measures on Traffic Alert Patterns:

On June 22, 2022, an unusual occurrence was noted with just four alerts reported. Intriguingly, these alerts were solely from vehicle ID '2846,' a stark contrast to the previous day, June 21, 2022, which had a high alert count. Further investigation revealed that on June 22, 2022, an altercation involving a prominent political party, ADMK, occurred, leading to the imposition of police control in the 'Vanagaram' area.

This external event, involving heightened security measures and political tensions, likely contributed to the significant reduction in alerts on that particular day. This highlights how external factors can impact alert patterns, emphasizing the need to consider contextual factors when analysing alert data.

Statistical Analysis of Festival-Related Alert Rates:

The data reveals a considerable variation in alert rates during festival times compared to ordinary days. This indicates a notable impact of festivals on the occurrence of alerts, suggesting potential shifts in traffic patterns or driver behaviour. Notably, on Independence Day (15/08/2022), there was a substantial increase in alerts, accounting for approximately 2.81% of the total alerts. This spike may be attributed to heightened activities associated with the celebration, potentially indicating higher traffic density or more cautious driving. Janmashtami (19/08/2022) also saw an elevated alert rate at around 2.28%. This suggests a noteworthy impact of the festival on driving conditions, warranting additional attention to road safety during this period. Ganesh Chaturthi/Vinayaka Chaturthi (31/08/2022) exhibited a lower alert rate, approximately 1.29%. It's noteworthy that this festival saw only 2 vehicles in operation, compared to 4 vehicles on the other holidays. This discrepancy in vehicle count may have contributed to the lower alert rate.

The difference in vehicle count on Ganesh Chaturthi/Vinayaka Chaturthi (31/08/2022) compared to the other holidays showcases the potential impact of traffic volume on alert rates. This emphasizes the importance of considering not only the percentage of alerts but also the actual number of vehicles on the road. On average, during festival times (Muharram/Ashura, Independence Day, Janmashtami, and Ganesh Chaturthi/Vinayaka Chaturthi), approximately 9.29% of total alerts were recorded. This indicates that festivals have a notable influence on the occurrence of alerts.

Acceleration Amidst Celebration:

Despite the expectation that vehicles might slow down during festival days, it appears that high-speed alerts during festival days accounted for 10 percent of all high-speed alerts. It is counterintuitive that during festival days, when one might assume vehicles would move more slowly due to increased traffic or cautious driving, the data suggests that a notable portion of high-speed alerts actually occurred on these days. This defies the conventional notion of festival-related traffic being slower and more congested. During festivals, individuals might be in a rush to reach their destinations, leading to instances of speeding in an attempt to make it to events or celebrations on time. This behaviour could contribute to the higher occurrence of high-speed alerts. While festivals can indeed lead to increased traffic volume, they may also result in more dispersed traffic, with some areas experiencing reduced congestion. In such areas, drivers may be more inclined to accelerate, contributing to high-speed alerts. Festivals can vary significantly in terms of their impact on traffic. While some festivals involve processions or parades that slow down traffic, others may not have the same effect.

A Comprehensive Analysis of Alert Occurrences at 0 Speed:

The occurrence of certain alerts, such as PCW and HMW at 0 speed can be attributed to the specific safety functions and design considerations of ADAS.

Percentage of Alerts on Zero Speed
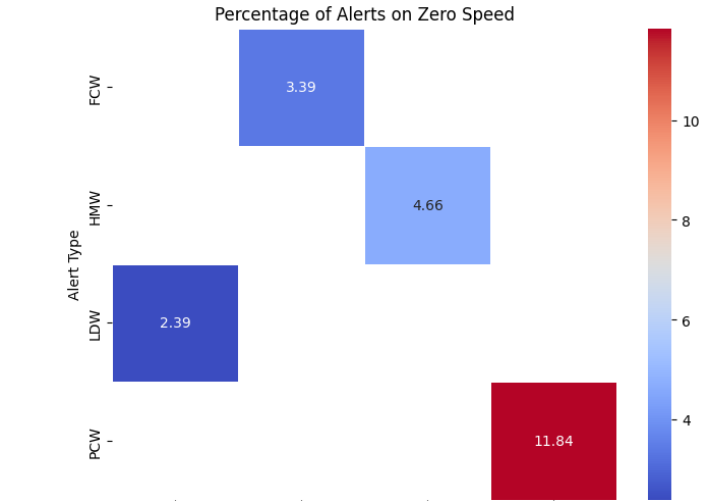
The data reveals interesting insights into the behavior of various driver assistance systems (DAS) based on vehicle speed. PCW alerts have the highest occurrence percentage at 0 speed (11.84%), aligning with their purpose of preventing collisions with pedestrians, particularly in congested or urban areas where vehicles frequently stop.

HMW alerts also show a relatively high percentage at 0 speed (4.66%). This can be attributed to the importance of maintaining safe following distances, especially in situations like traffic jams or intersections, where vehicles are stationary. In contrast, FCW and LDW alerts have lower percentages (3.39% and 2.39%, respectively) when the vehicle is not moving. This suggests that these systems may prioritize scenarios when the vehicle is in motion, as they are primarily designed to detect potential collisions and lane departures, which are more critical at higher speeds.

In summary, PCW and HMW systems are more active when the vehicle is stationary, emphasizing pedestrian safety and safe following distances in congested areas. On the other hand, FCW and LDW systems are less active at 0 speed, indicating a focus on scenarios where the vehicle is in motion, aligning with their primary objectives of preventing forward collisions and lane departures, typically more critical at higher speeds.

Analysing Driver Adaptation and Alert Patterns in a Fleet of Vehicles:

Vehicle	Average Alerts in 6th Month	Average Alerts in 8th Month
805	157.43	183.91
2846	152.93	106.25
3143		
		(Before 15th) 145.3
		(After 15th) 99.4
5339	179.36	146.30

Vehicle 2846, operating in two parts (first and second parts), shows a decrease in alerts from the 6th to the 8th month. This aligns with the expected behaviour of drivers becoming more familiar with their routes over time. Vehicle 3143, in the 8th month, experiences a significant reduction in alerts. Interestingly, this decrease is more pronounced in the first part compared to the second part. This decline is consistent with the overarching pattern of drivers becoming increasingly familiar with their regular routes.

Vehicle 5339 showcases a decrease in alerts from the 6th to the 8th month, aligning with the general trend of drivers getting accustomed to their routes. Vehicle 805 displays a unique behaviour compared to the other vehicles. While most vehicles exhibit a decrease in alerts as drivers become familiar with the area, vehicle 805 experiences an increase in alerts between the 6th and 8th months. This unexpected trend suggests that the driver of vehicle 805 may be encountering new challenges or conditions in their route during the 8th month.

High Incidence of Lane Departure Warnings on Curvaceous Roads:

The frequent occurrence of Lane Departure Warnings on the "Madurantakam - Vennangupet Road" for vehicles 805 and 2846 in the ADAS data suggests a significant road safety concern. The fact that "Madurantakam - Vennangupet Road" is described as a round curve road suggests that it likely has a significant number of curves, bends, or turns. This road design can pose challenges for drivers, especially if they are not familiar with the road or if the curves are sharp.

The high occurrence of LDW events in the ADAS data suggests that drivers in vehicles 805 and 2846 may have experienced difficulty in maintaining their lane positions while driving on this curved road. This could be due to factors such as the road's geometry, speed, visibility, or driver distraction. To clarify, vehicles 805 and 2846 are indeed just examples, and there are many curves like the one on the "Madurantakam - Vennangupet Road" in the given area with noticeable high count of LDW.

We have enhanced the given dataset by introducing additional columns, leading to a deeper analysis of the data. These added columns have provided us with the following valuable insights: (link for Extended Dataset)

High Prevalence of HMW Alerts on Bridges:

Among the alerts received on the bridge, an overwhelming 85.71% of them are categorized as HMW (Headway Monitoring and Warning) alerts. This strikingly high percentage underscores a pronounced concern related to headway monitoring and safe following distances specifically on bridge sections. The prevalence of HMW alerts suggests a notable issue with tailgating, where vehicles follow too closely behind one another on these bridges. This insight underscores the importance of addressing tailgating behaviour, especially on bridge structures where maintaining a safe following distance is crucial.

Navigating School Zones: A Detailed Analysis of PCW Warnings:

After analysing the data, it is evident that vehicle 5339 has the highest number of PCW (Pedestrian Collision Warning) alerts. Additionally, vehicle 2846 is the only one with PCW alerts at high speeds in school areas. Specifically, in the address "Triplicane High Rd, Ellis Puram, Padupakkam, Triplicane, Chennai, Tamil Nadu 600005," vehicle 5339 received three consecutive PCW warnings. This location is near a bus stop commonly used by schools such as CHENNAI MIDDLE SCHOOL, K.P.ILM International School, and D.Ahmed Ali Parpia Memorial Matriculation Higher Secondary School. This suggests that these PCW alerts may have been triggered by interactions with pedestrians near the bus stop, which is a common area for school children to gather.

On the other hand, vehicle 2846 had a PCW alert with a speed of 35 km/h in "Velachery Rd, Annai Theresa Nagar, East Tambaram, Tambaram, Chennai, Tamil Nadu 600059." This high-speed alert in a school area indicates a potential lack of caution while driving near school zones, posing a risk to the safety of school children. It is important to note that vehicle 5339 received a high

number of PCW warnings despite traveling at a low speed in this area. This could imply that the driver of vehicle 5339 may not be experienced in handling sudden incidents or pedestrian interactions, even at lower speeds.

Alert Distribution by Toll Location:

In our analysis, we have located and recorded the alerts received in various toll areas, and the following table provides a comprehensive summary of these alerts:

Toll Plaza Name	Latitude	Longitude	FCW Alerts	HMW Alerts	LDW Alerts	PCW Alerts
Paranur Toll Plaza	12.7241906	79.981877	1	12	10	2
Varadarajapuram Toll Plaza	12.930224	80.080118	0	1	5	0
Vanagaram Toll Plaza	13.043554	80.149746	0	1	2	0

Paranur Toll Plaza has a relatively high number of HMW alerts, which suggests that there may be frequent instances of drivers not maintaining a safe following distance or engaging in unsafe headway behaviours. The LDW alerts also indicate that lane departure is a concern here, possibly due to drivers not staying within their designated lanes. Additionally, it's important to note that this toll plaza may have a high number of alerts not only due to unsafe driving but also because of its frequent usage. Varadarajapuram Toll Plaza experiences fewer alerts compared to Paranur Toll Plaza, but it still has a notable number of LDW alerts. Vanagaram Toll Plaza has the lowest number of alerts among the three toll areas. However, there are still instances of HMW and LDW alerts, indicating that drivers may be engaging in risky movements and not staying within their lanes.

Navigating Remote Challenges:

From Vehicle 3143 (2022-08-06 at 15:16): Several HMW and LDW alerts were got. The combination of HMW and LDW alerts suggests that this remote location may have challenging road conditions or maintenance needs.

From Vehicle 5339 (2022-07-01 at 18:27): Several PCW alerts were got. The presence of a PCW alert indicates that pedestrians or wildlife might be crossing the road. Drivers should stay vigilant and adhere to recommended speed limits, especially during low-light conditions.

From Vehicle 805 (2022-06-16 at 15:48): Several PCW alerts were got. Similar to vehicle 5339, this vehicle also experienced a PCW alert, highlighting the potential presence of pedestrians or wildlife.

From Vehicle 1995 (2022-06-09 at 07:32): Several HMW, and some LDW and PCW alerts were got. The diverse range of alerts in this location indicates a complex driving environment. The high number of HMW alerts may suggest ongoing maintenance activities. Drivers should exercise caution and adhere to recommended

safety measures. These insights emphasize the importance of driver awareness and adherence to safety guidelines in remote areas where road conditions and unexpected obstacles can pose unique challenges. Safety should always be a top priority when navigating such environments.

Assessing Parking Skill Based on Driver Behaviour and Alert Data:

We have conducted research and expanded upon the given dataset by adding some additional columns to provide a more comprehensive view. And using this we spotted the alerts got from the parking areas. This added information allows for a more in-depth analysis of the drivers and their parking skills.

Vehicle 805 's driver has Excellent parking skills. The driver consistently receives no alerts related to forward collision warning, headway monitoring warning, or pedestrian collision warning while parking. This indicates excellent parking skills with no safety alerts.

Vehicle 2846 's driver has Moderate parking skills. The driver occasionally receives alerts related to lane departure warning while parking. While generally proficient, there may be occasional deviations from the lane during parking.

Vehicle 3143 's driver has Good parking skills. The driver occasionally receives alerts related to lane departure warning while parking. This suggests generally safe parking behaviour, with occasional deviations from the lane during the parking process.

Vehicle 5339 's driver has Moderate parking skills. The driver receives alerts related to forward collision warning while parking. This indicates inconsistent or less safe parking behaviour, possibly involving close encounters with objects or vehicles during parking.

Unravelling the Complexity of Parking Spots:

Several parking locations, such as "SP Kovil Yard" and "Vandaloor Zoo Car Parking," consistently appear in the data with ADAS alerts. This suggests that these locations may have recurring issues or complexities leading to alerts. The "Speed" column shows variability in vehicle speeds within parking areas. For example, in "Vandaloor Zoo Car Parking," speeds range from 0.0 to 46.0 and even 58.0, indicating some erratic driving behaviour within the parking area. Alerts at parking locations like "SP Kovil Yard" are spread across different dates and times, indicating that the issues leading to alerts may not be tied to specific hours or days. It's worth noting that alert frequencies vary over time, as seen in the data for "Vandaloor Zoo Car Parking" between August and June. Understanding the reasons behind these fluctuations could reveal insights into parking complexities.