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ANALYSIS OF ROAD SAFETY ENHANCEMENT THROUGH ADVANCED DRIVER ASSISTANCE SYSTEMS (ADAS): INSIGHTS, ANALYTICS, AND RECOMMENDATIONS

Aman Raut, Valhari Meshram, Viranchi Dakhare

Abstract:

Dedicated to advancing road safety, this report presents a focused analysis of data from Advanced Driver Assistance Systems (ADAS). Employing Python, QGIS, and various Exploratory Data Analysis (EDA) techniques, this study uncovers pivotal insights.

Rigorous temporal and geospatial analysis, complemented by an examination of speed variations, reveal substantial findings. It unveils patterns in alert occurrences, pinpoints accident-prone regions, and distinguishes between day and night alerts. Moreover, variations in vehicle speed are meticulously scrutinized to establish safe driving thresholds. This study underscores the pragmatic application of data-driven decision-making to enhance road safety. The study serves as a tangible model for harnessing advanced tools and methodologies, offering effective solutions to real-world road safety challenges.

Introduction

In the ever-evolving landscape of transportation, road safety assumes paramount significance. Harnessing data-driven insights and advanced technology promises to be transformative in bolstering road safety practices.

This report is dedicated to the systematic analysis of data generated by Advanced Driver Assistance Systems (ADAS), seeking to unearth critical insights that significantly contribute to road safety enhancement. Employing Python, QGIS, and Exploratory Data Analysis (EDA) techniques, our endeavor acts as a bridge between data and practical solutions.

Driven by the imperative to create safer roads and fortify transportation systems, this study underscores the potential of data-driven approaches and advanced technology in revolutionizing road safety practices. It exemplifies the formidable influence of technology and analytics in effectively addressing real-world road safety challenges.

Data Sources

1. Hospital Dataset: Our study incorporates a vital hospital dataset, essential for precise location-based analysis and healthcare accessibility assessment. Due to the unavailability of a comprehensive hospital dataset for the targeted region, we generated a tailored hospital dataset to support our analytics objectives. This dataset encompasses key hospital information, including geographic coordinates (latitude and longitude).

2. Data Collection and Organization:

We initiated data collection using the initial given Mobility dataset as a foundation. Subsequently, Google Maps served as our primary source for acquiring hospital data. Manual searches on Google Maps were conducted, focusing on high-alert areas defined by our analytics on the dataset. The retrieved hospital data was standardized and formatted to align with the existing dataset.

3. How Hospital Data Enhances Our Analysis

This data empowered spatial analysis, enabling efficient determination of the nearest hospital during emergencies. We developed a Haversine-based algorithm (a standard method for calculating distances between two points on the Earth's surface using latitude and longitude coordinates) for pinpointing the nearest hospital for aby given accident-prone location using latitude and longitude coordinates. This algorithm efficiently determines the closest medical facility based on latitude and longitude, enhancing road safety and response time. As the dataset we generated was relatively smaller, we used the Haversine formula, for large datasets we will rely on k-d trees or spatial indexing structures.

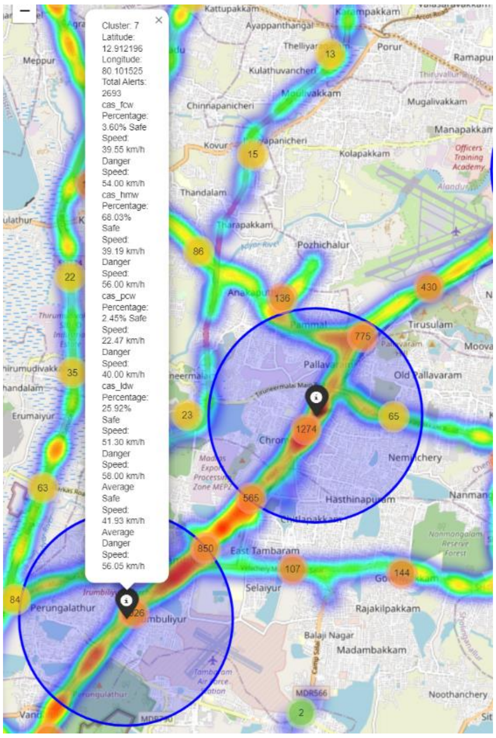


Fig1. Identification of the Top 8 Clusters in the Collective Vehicle Journey Across the Entire Region

Analysis

1. Blackspot identification & Analysis

1. a Methodology

The K-Means clustering algorithm was applied to group alerts based on geographical proximity, facilitating the identification of regions with heightened alert frequencies. Subsequently, cluster-specific insights, such as alert types, frequencies, and safety-related speed statistics were compiled. Visualization was achieved through the Folium library, resulting in a map for comprehensive exploration and density assessment of potential black spots.

1. b Insights

Blackspots are geographic areas characterized by a high frequency of alerts, signifying their status as accident-prone zones.

Establishing Safe Speed: For each blackspot, we have defined an average safe speed threshold that vehicles should adhere to in order to reduce the likelihood of alerts, indicating a safer driving environment and chances of accidents.

Danger Speed Identification: We have calculated the danger speed for each black spot, representing the critical speed beyond which a vehicle is highly likely to trigger consecutive alerts, serving as an early sign of potential work.

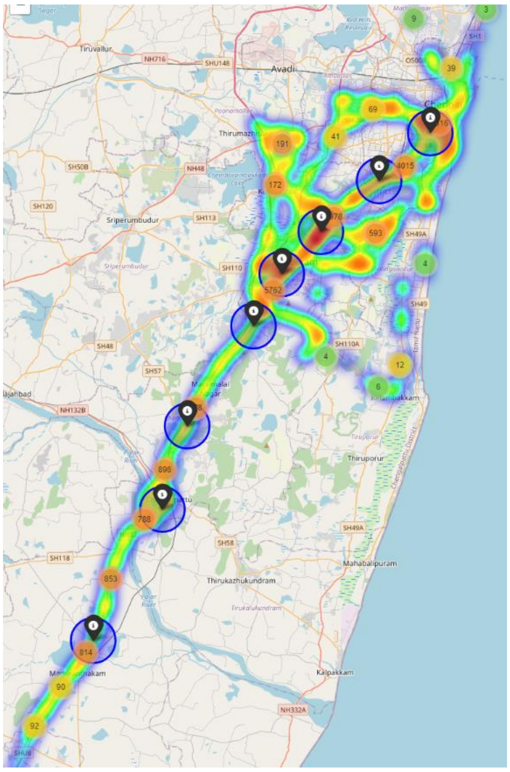


Fig2: Safe speed and danger speed thresholds, along with the % distribution of various alerts within each cluster.

Tailored Alert Analysis: In our comprehensive analysis, we have examined the distribution of different alert types within each black spot. This analysis provides insights into the specific warnings and alerts that are more likely to occur in each region.

Cluster	Region	Safe Speed (km/hr)	Danger Speed (km/hr)	LDW (km/hr)	HMW (km/hr)	PCW (km/hr)	FCW (km/hr)
0	Chengal pattu lakshmi puram	38.69	52.6	49.78	34.44	19.5	35.05
1	St thomas mount cantonment	44.06	56.83	55.84	37.81	24.84	37.24
2	Crompet	38.48	51.58	50.66	34.83	19.5	35.75
3	Gopalapuram	46.15	56.46	51.14	45.48	21.31	27.94
4	Singapuritamakli	37.12	50.01	43.4	47.75	11.87	48.12
5	NH32 highway	33.97	48.14	51.26	37.17	16.27	50
6	Uru Pakkam	34.58	46.54	53.55	27.01	19.23	38.5
7	IrumBlur	41.93	56.05	51.3	39.19	22.47	39.55

Table 1: Comprehensive Cluster Analysis

Region	Hospital Name	Distance(Km)
Chengal pattu lakshmi puram	Vasam Hospital	0.74
St thomas mount cantonment	Chengalpattu Medical College Hospital	0.41
Crompet	Arokia Annai Hospital	2.69
Gopalapuram	HOSANNA HOSPITAL	1.09
Singapuritamakli	Hindu Mission Hospital	1.3
NH32 highway	Dr. Gomathi Clinic,Chennai	0.16
Uru Pakkam	Raadha Rajendran Hospital	0.16
IrumBlur	TamilNadu Gov Multi Speciality Hospital	1.06

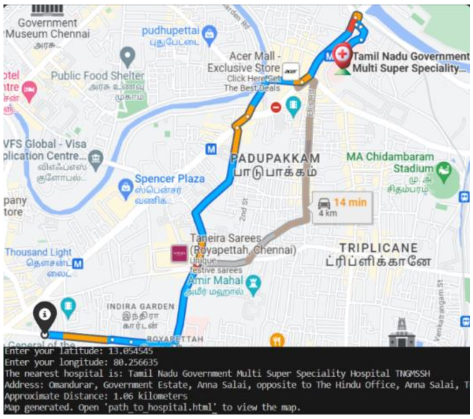


Table 2 Distance between blackspots and nearby hospitals

1. c Conclusion

This analysis forms a robust foundation for implementing targeted safety measures and enhancing road safety in high-risk areas. By empowering drivers with critical information to prevent potential accidents and customize safety interventions based on data-driven insights. The approach is invaluable for bolstering road safety. When seamlessly integrated with ADAS this comprehensive analysis can play a pivotal role in reducing accidents.

2. Geospatial Analysis (Region-based alert density)

2. a Methodology

In this analysis, Geographic Information System (GIS) software, QGIS, was utilized. Four distinct layers were created to plot latitude and longitude data on a base map. By

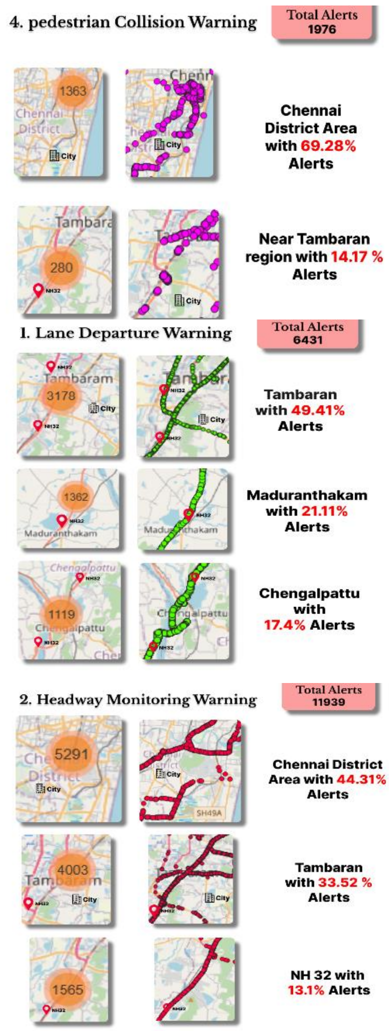
for various alerts were identified. Spatial data visualization, density mapping, and ranking methods were employed to make these determinations. The results were then visualized for further analysis

2. b Insights

Lane Departure Warning (LDW) Analysis: LDW alerts are notably prevalent on highways, suggesting that lane departure risks are more pronounced on high-speed roadways.

Pedestrian Collision Warning Analysis: Pedestrian Collision Warning alerts are disproportionately frequent in densely populated areas and alleys. This observation underscores the significance of pedestrian safety measures in sub-urban and crowded settings, where pedestrian-vehicle interactions are more frequent.

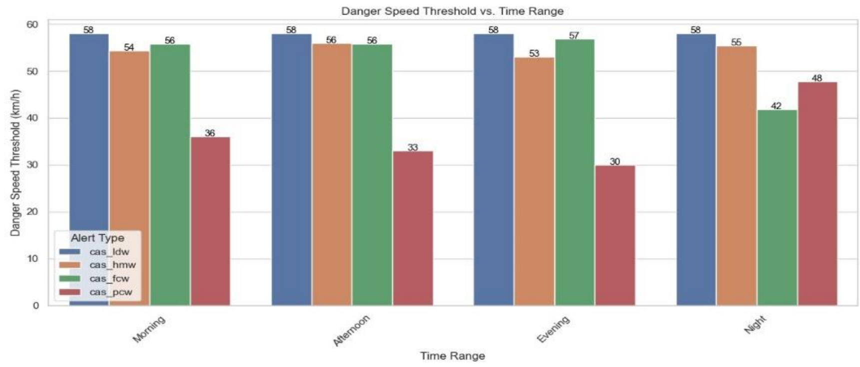
Headway Monitoring Warning Analysis: Headway Monitoring Warning alerts exhibit a higher occurrence in urban city areas. This pattern implies that maintaining safe following distances and monitoring traffic conditions are particularly critical in city driving environments, where traffic congestion and frequent stops are common.



- ❖ Tambaram is a satellite city of Chennai, located in the Chengalpattu district of Tamil Nadu, Which is connected by NH32.
- ❖ Chennai is the smallest and the most densely populated district in the state.

3. Speed Analysis

The safe and danger speed thresholds differ by alert type and time of day, with nighttime generally having lower safe speed thresholds and, in some cases, higher danger thresholds. These thresholds are important for enhancing driver safety and triggering specific warnings or control interventions as needed.



References

[Google Colab Code Link]

[Github]

[1] Nikhil. T.R, Harish .J.K, Sarvadha. H, "Identification of Black Spots and Improvements to Junctions in Bangalore City", 2013.