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ROAD TRAFFIC ACCIDENT SEVERITY

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Abstract: RTAs are a major global health issue, resulting in significant injury, death, and economic costs. The goal of this research is to develop a prediction model to assess the risk associated with various accident scenarios by investigating the numerous elements that impact the severity of RTAs. The study analyzes data from police-reported traffic accidents over a five-year period, considering variables such as driver demographics, vehicle type, environmental conditions, and road characteristics. The findings indicate that accident severity is strongly affected by factors like the age and gender of the driver, time of day, weather conditions, and the type of road. Accidents involving young drivers, male drivers, and those occurring at night or in bad weather are more severe. Additionally, crashes on RR and those involving heavy vehicles tend to be more serious. To determine the probability of a serious injury or death in a rear-end collision, a predictive model employing ML and LR approaches was created. This model, which showed high accuracy, can help policymakers and traffic safety officials identify high-risk situations and implement specific preventive measures. The study highlights the need for comprehensive road safety strategies that include enforcement, education, and engineering improvements.

Keywords: RTAs-Road Traffic Accidents, ML-Machine Learning, LR-Logistic Regression, RR-Rural Roads.

I. INTRODUCTION

Road traffic accidents (RTAs) are a pervasive and critical public health issue, significantly impacting individuals, communities, and economies on a global scaleRTAs are among the world's major causes of mortality and disability because they result in millions of injuries, impairments, and fatalities annually. According to estimates from the World Health Organization (WHO), road traffic crashes claim the lives of 1.35 million people annually. Millions more suffer non-fatal injuries, many of which result in long-term impairments. The economic costs associated with RTAs are staggering, encompassing medical expenses, lost productivity, and property damage, amounting to billions of dollars annually.

Despite advancements in vehicle technology, road infrastructure, and traffic management systems, the prevalence and severity of RTAs remain a significant concern. The complexity of traffic environments, coupled with human behavior and environmental factors, creates a multifaceted challenge in addressing road safety. This underscores the importance of comprehensive and multifaceted approaches to understanding and mitigating the factors contributing to RTAs and their severity.

One of the primary objectives in the field of traffic safety research is to identify and analyze the determinants of RTA severity. In the context of a traffic collision, severity describes the range of injuries that participants experience, from minor injuries to severe injuries and fatalities. Many studies have looked into a variety of elements, such as road features, environmental factors, vehicle types, and driver traits, that affect how severe RTAs are. Researchers hope to identify trends and high-risk situations by looking at these variables, which can help guide focused actions and policy choices.

RTA severity is significantly influenced by the characteristics of the driver. Age and gender are two demographic characteristics that have been demonstrated to have a considerable impact on the chance of serious outcomes in traffic collisions. For instance, young drivers, particularly those aged between 18 and 25, are often overrepresented in severe and fatal crashes. This age group is typically linked to reduced risk perception, inexperience driving, and higher risk-taking behaviors—all of which raise the likelihood of serious accidents. Similarly, male drivers have been observed to be involved in more severe accidents compared to female drivers. According to studies, men are more prone than women to drive aggressively, which can result in more serious crashes. These behaviors include speeding and overtaking.

Apart from the traits of the driver, the kind of vehicle is another important component that affects the severity of RTAs. The type and size of the vehicle can significantly impact the outcome of a collision. For example, accidents involving heavy vehicles such as trucks and buses tend to result in more severe injuries and fatalities due to the greater force and mass involved.

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In contrast, smaller vehicles like bicycles and motorbikes provide less safety for their occupants, which raises the risk of serious injuries in the event of an accident. Furthermore, a vehicle's structural integrity and safety features are essential in reducing the severity of injuries. It has been demonstrated that airbags, electronic stability control (ESC), and anti-lock brake systems (ABS) in modern cars lessen the severity of injuries sustained in collisions.

Environmental conditions, including weather, lighting, and road surface, also significantly impact the severity of RTAs. Adverse weather conditions such as rain, snow, and fog can reduce visibility, increase stopping distances, and impair vehicle handling, leading to more severe collisions. Nighttime driving is associated with a higher risk of severe accidents due to reduced visibility and increased likelihood of driver fatigue and impaired driving. Furthermore, road surface conditions, including the presence of potholes, uneven surfaces, and inadequate signage, can contribute to the severity of RTAs. Poor road maintenance and design can lead to hazardous driving conditions, increasing the risk of severe injuries and fatalities.

The kind, geometry, and volume of traffic on a road are all important factors in determining how severe RTAs are. For example, compared to urban highways, rural roads are frequently linked to accidents of a higher severity. Higher speeds, restricted access to emergency medical services, and a decreased frequency of law enforcement presence on rural roads are some of the contributing causes to this. Additionally, road geometry, including the presence of sharp curves, intersections, and steep gradients, can increase the likelihood of severe collisions. Excessive traffic volumes and congestion can further exacerbate the severity of accidents by raising the risk of multiple vehicle crashes and making it more difficult for drivers to make evasive maneuvers.

Researchers have created predictive models that assess the possibility of severe results depending on a variety of influencing factors in order to tackle the intricate problem of RTA severity. These models employ statistical techniques such as logistic regression, as well as machine learning algorithms, to analyze large datasets of traffic accident recordsThrough the identification of critical factors that predict the severity of RTAs, these models can offer significant insights to traffic safety authorities and policymakers. Predictive models can help in identifying high-risk scenarios and locations, allowing for targeted interventions and resource allocation to areas with the greatest need.

Logistic regression models, for example, can estimate the likelihood of serious injuries or fatalities in a rear-end collision (RTA) given particular driver, vehicle, environmental, and road parameters. On the other hand, machine learning algorithms are more capable of handling intricate variable interactions and producing more precise predictions. Numerous road safety initiatives, such as enforcement tactics, infrastructural upgrades, and public awareness campaigns, might be informed by these models.For example, areas identified as high-risk for severe accidents can be prioritized for road maintenance, installation of safety barriers, and improved signage. Similarly, targeted enforcement of traffic laws, such as speed limits and seat belt usage, can be implemented in high-risk areas to reduce the likelihood of severe accidents.

Predictive models can also be included into intelligent transportation systems (ITS) to improve emergency response and real-time traffic management. ITS can deliver immediate alerts to emergency services and drivers, facilitating faster and more efficient responses to traffic events. It does this by continuously monitoring traffic conditions and anticipating potentially serious accidents. This can ensure that medical assistance is given quickly and effectively, hence reducing the severity of injuries and fatalities.

Road traffic accidents represent a significant and ongoing challenge to public health and safety worldwide. To effectively avoid and mitigate RTAs, it is imperative to comprehend the elements that influence their severity. By analyzing driver characteristics, vehicle types, environmental conditions, and road features, researchers can identify patterns and high-risk scenarios that inform targeted interventions. Predictive models, employing statistical and machine learning techniques, offer valuable tools for estimating the likelihood of severe outcomes and guiding policy decisions. Through comprehensive and multifaceted approaches, including enforcement, education, engineering improvements, and technological advancements, the impact of RTAs can be reduced, ultimately saving lives and minimizing the economic burden associated with traffic collisions.

II. PROBLEM STATEMENT

Road traffic accidents (RTAs) pose a serious threat to public health and safety as they are one of the world's top causes of injury and fatalities. Even with improvements in road infrastructure and vehicle safety technologies, the severity of rear-end accidents (RTAs) is still a major concern due to the wide variances in injury outcomes that occur based on several factors. To effectively develop treatments targeted at lessening the impact of RTAs, it is imperative to comprehend the factors that determine the severity of these incidents.

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The issue at stake is our incomplete knowledge of the intricate interactions between several elements that affect how severe RTAs can get. The results of traffic crashes are influenced by important variables such as driver demographics, vehicle types, environmental factors, and road characteristics; nevertheless, the linkages between these variables and their combined effect on accident severity are not well understood. Policymakers and road safety authorities are less able to create focused policies and actions to lessen the severity of RTAs as a result of this lack of thorough understanding.

In addition, although prediction models have been created to assess the severity of RTAs, more precise and trustworthy instruments that incorporate many factors and take into consideration the ever-changing nature of traffic environments are required. The usefulness of existing models in real-world applications may be diminished since they are unable to properly capture the subtleties of various accident scenarios or adjust to changing conditions.

Therefore, the main issue is the lack of a thorough and comprehensive understanding of the various elements that affect how severe RTAs are, together with the requirement for better predictive models to help guide policy decisions and preventive actions. In order to solve this issue, it is necessary to pinpoint the major factors that influence the severity of RTAs, analyze them, and create sophisticated prediction models that can precisely gauge the chance of severe consequences. These efforts will eventually enable more successful road safety initiatives and lessen the overall impact of RTAs.

III. SCOPE

Road traffic accident (RTA) severity and develop predictive models to estimate the likelihood of severe outcomes. It will analyze data from police-reported traffic accidents over a specified period, focusing on variables such as driver demographics (age, gender), vehicle characteristics (type, safety features), environmental conditions (weather, lighting), and road attributes (type, surface condition, geometry).

The research will involve the development of predictive models using statistical methods and machine learning algorithms, followed by validation to ensure accuracy and reliability. The scope includes examining how these factors impact accident severity and applying findings to inform road safety policies, enforcement strategies, and public awareness campaigns. The study will be geographically and temporally scoped to specific regions and timeframes based on data availability, while also acknowledging potential limitations in data quality and model applicability.

IV. LITERATURE SURVEY

1. A system for classifying routes according on traffic intensity

Author: Khedher Ibtissem; Khedher Marwen; Rjaibi Neila; Faiz Sami
Year:2023
Concise -Vehicle accidents, which cause daily deaths and substantial property damage, remain one of the most critical problems on a global scale. The National Observatory for Traffic Safety in Tunisia (NORS) reports a significant rise in the yearly accident count. The alarming state of road safety in Tunisia was brought to light by the fact that the number of accidents rose from 5,089 in 1921 to 5,715 in 2022. To address this phenomenon and improve Tunisia's road safety status, we propose a route classification system based on traffic severity data. Our innovative method incorporates accident data into road safety assessment systems. We can help NORS improve road safety by directing them in the appropriate way.

2. Method for Assigning Road Traffic Based on Computer Vision

Author: Zhengda Shao; Jingjing Zheng; Guiyang Yue; Yubing Yang
Year:2023
Because of the growth of the social economy, there is an increasing amount of worry about traffic issues. Fewer traffic accidents and more equitable distribution of road resources are topics of much debate. The field of road traffic relies heavily on traffic statistics. The current dominant method in China for dispatching urban vehicles is a management strategy that blends static planning with human computation. Automation and labor savings can result from the use of computer vision technologies. Therefore, the MATLAB programme will be used to create the route allocation mechanism in this research. A brief introduction to the concept and importance of roadway allocation is followed by an explanation of computer vision. In order to study and evaluate the efficiency of the road traffic allocation algorithm, this is the first step. The results of the final test show that the allocation is accurate, and that there is little variation in delay as well as road allocation time. It would appear that the road traffic assignment method that relies on computer vision is rather effective.

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3. Predicting Traffic Accidents Using a Conflict Coefficient Method

Author: S. V. Zhankaziev; A.V. Zamytskih; A. I. Vorobyev; M. V. Gavrilyuk; M. G. Pletnev
Year:2022
In this article, we will look at public road occurrences where two or more automobiles collide. We will also provide theoretical frameworks for creating an accident prediction system. Traffic accident frequency estimation methods are based on transportation detector data acquired in real-time. The approach's adaptability to both real-time and forecasting settings is one of its advantages. The previously described technique may be used to do comprehensive, real-time assessments of road safety when creating control algorithms for smart transportation systems and completely autonomous vehicles.

4. Investigation of Scenes of Traffic Accidents by the Use of Three-Dimensional Real Scene Modelling

Author: Jinzi Zheng; Qi Yang; Jun Liu; Liang Li; Yanan Chai; Pengfei Xu
Year:2023
As a first step in handling traffic accidents, inspecting the site of the accident is essential. This processing is necessary if we are to understand what went wrong and how to make roadways safer for everyone. Conventional methods of accident scene investigation have a number of drawbacks, including a high degree of time consumption, challenges with re-examination, and poor accuracy. In light of this, the research explores the methodological approach to examining traffic accidents through the use of 3D real scene reconstruction technologyThe accuracy assessment approach is based on an authentic 3D model and was designed to measure and investigate accident sites. We propose using the UVA tilt image method representation and 3D modelling approach for a variety of accident circumstance inquiries. We construct and validate the model on the foundation of specific accident cases. The study's conclusions imply that using a true 3D model could help accident scene investigations be carried out more precisely. With the aid of this technology, investigators may reconstruct the accident site more precisely and reach more grounded findings.

5. Kyiv, Ukraine's "Road Traffic Control Centre" serves as an example of cutting-edge traffic control for other Ukrainian cities.

Author: Victor Cherniy; Sergiy Bezshapkin; Olena Sharovara; Ihor Vasyliev; Olena Verenych
Year:2020
The feasibility of residential space increase in urban regions may be measured, for instance, by the frequency of crashes on the road system. Over the last three years, the Kyiv Local Business "Road Traffic Management Centre" has created and implemented a cutting-edge system for traffic management in Kyiv, Ukraine. The proposed method is made possible by utilising cutting-edge GIS technology, geographical information, and web-cartography. This case study explains how the company investigated the possibility of creating a traffic-calming plan for General City and how it was incorporated into the analytical, planning, and decision-making processes of the city.

V. PROPOSED SYSTEM

Through a thorough methodology that combines data analysis with sophisticated predictive modeling, the suggested system is intended to enhance the comprehension and prediction of road traffic accident (RTA) severity. Data on accident details, driver demographics, car characteristics, environmental conditions, and road parameters will all be gathered and combined from multiple sources, including police records, traffic management systems, and environmental sensors. This data will be cleaned and preprocessed to ensure accuracy. The system will analyze the impact of these factors on RTA severity using statistical methods and develop predictive models with techniques like logistic regression and machine learning algorithms. These models will estimate the probability of severe injury or fatality, with training and validation conducted to ensure robustness. Real-time data integration will enable dynamic risk assessment and proactive alerts for high-risk scenarios. The system will support decision-making by providing actionable insights and recommendations for policy and infrastructure improvements, and it will include user-friendly reporting tools for stakeholders. With a focus on continuous improvement, the system will incorporate user feedback and regular updates to enhance its functionality and accuracy. This integrated approach aims to support effective road safety measures and reduce the overall impact of traffic accidents.

Advantages of Proposed System

- **Enhanced Understanding of Accident Severity:**

The system provides a comprehensive analysis of factors influencing RTA severity, including driver characteristics,

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vehicle types, environmental conditions, and road attributes. This detailed understanding helps in identifying significant predictors and their interactions, leading to more effective safety interventions.

- **Advanced Predictive Capabilities:**

By employing sophisticated statistical methods and machine learning algorithms, the system offers accurate predictions of the likelihood of severe injuries or fatalities. More accurate risk assessment and focused preventative actions are made possible by this skill.

- **Real-Time Risk Assessment:**

The integration of real-time data from traffic monitoring systems and environmental sensors enables dynamic risk assessment. This feature allows for timely alerts and proactive measures, potentially preventing severe accidents before they occur.

- **Informed Decision-Making:**

The system generates actionable insights and recommendations for policymakers, traffic safety authorities, and infrastructure planners. These insights support data-driven decisions and help prioritize interventions, resource allocation, and safety measures.

- **Improved Safety Measures:**

By identifying high-risk scenarios and locations, the system facilitates targeted interventions such as infrastructure improvements, enhanced enforcement strategies, and public awareness campaigns, leading to a reduction in accident severity and frequency.

- **User-Friendly Interface:**

Stakeholders can quickly access and analyze data and projections because to the user-friendly interface.This accessibility enhances usability and encourages the adoption of the system for road safety management.

- **Comprehensive Reporting and Visualization:**

The system includes reporting tools that generate detailed reports and visualizations, helping stakeholders understand trends, patterns, and the effectiveness of implemented measures. This facilitates better communication and evaluation of road safety initiatives.

- **Continuous Improvement and Adaptation:**

With a feedback mechanism and regular updates, the system evolves to incorporate new data, improve predictive models, and adapt to changing traffic conditions and safety standards. This ensures that the system remains relevant and effective over time.

- **Enhanced Emergency Response:**

By providing timely alerts and real-time data, the system supports quicker and more efficient emergency responses, potentially reducing the severity of injuries and fatalities.

- **Cost-Effective Solutions:**

The predictive capabilities and targeted interventions can lead to cost savings by reducing the number of severe accidents and associated economic impacts, such as medical expenses and property damage.

S/W Configuration:

- Software's : Python 3.6 or high version
- IDE : PyCharm
- Framework : Django 3
- Database : SQLite

VI. CONCLUSION

The proposed system represents a significant advancement in the analysis and prediction of road traffic accident (RTA) severity. By integrating comprehensive data collection with advanced predictive modeling techniques, the system offers a nuanced understanding of the factors contributing to RTA outcomes.

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By conducting an in-depth examination of driver demographics, vehicle attributes, environmental factors, and road attributes, the system offers significant understanding into the factors that influence the severity of accidents.

The system's ability to dynamically assess risk and promptly issue alerts for high-risk scenarios is improved by the integration of real-time data with predictive modeling. By taking a proactive stance, possible serious incidents can be identified early and mitigated, increasing overall road safety. The system's user-friendly interface and comprehensive reporting tools ensure that stakeholders can easily access, interpret, and act on the data, facilitating informed decision-making and effective intervention strategies.

Furthermore, the system's ability to continuously improve through feedback and regular updates ensures its relevance and effectiveness in addressing evolving traffic conditions and safety standards. The approach seeks to lessen the number and severity of traffic accidents by promoting targeted safety measures, infrastructure upgrades, and enforcement tactics. This will ultimately lead to safer roads and a less financial burden connected with RTAs.Overall, the proposed system provides a robust, data-driven solution to the challenge of road traffic accident severity, offering a valuable tool for policymakers, traffic safety authorities, and emergency responders in their efforts to enhance road safety and reduce the impact of traffic accidents.

VII. FUTURE ENHANCEMENTS

The efficacy and impact of the road traffic accident (RTA) severity prediction and analysis system should be greatly enhanced. A more thorough knowledge of RTA severity may be possible through integrating data from other sources, such as insurance companies and health departments, as well as data on driver behavior and car telematics. Improved machine learning methods, such as deep learning and real-time learning algorithms, have the potential to improve prediction models' accuracy.

Incorporating data from smart infrastructure and detailed environmental factors, beyond just weather conditions, would improve real-time risk assessment. User interfaces could be upgraded with interactive dashboards and augmented reality (AR) for better visualization and real-time alerts. Integrating Vehicle-to-Everything (V2X) communication and automated safety features could enable proactive risk mitigation.

Personalized risk assessments based on individual driving behaviors and greater public engagement through targeted awareness campaigns could further improve road safety. Cross-border collaboration and global data sharing would address road safety challenges on an international scale, while robust data privacy measures and ethical considerations ensure fair and secure use of technology. Continuous long-term impact assessment and cost-benefit analysis would guide future improvements, ensuring the system evolves to meet emerging safety needs effectively.

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