IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 11, November 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.625

© 2024 IJIRCCE | Volume 12, Issue 11, November 2024| DOI: 10.15680/IJIRCCE.2024.1211088

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.625| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Enhancing Traffic Management and Accident Prevention through Artificial Intelligence

G.Revathi[1], M.Ratna Koushik[2], T.Jnaneswari[3], S.Kusumapriya[4], M.Abhishek[5]

Assistant Professor, Department of CSE, NSRIT, Vishakhapatnam, India[1]

Student, Department of CSE, NSRIT, Vishakhapatnam, India[2,3,4,5]

ABSTRACT: The rapidity of urbanization and an exponential growth in vehicular traffic have challenged the challenges of managing and detecting road accidents. New solutions with innovative technology will be adopted to make safety and effectiveness on roads easier. Older traffic management systems depend on fixed sensors and hand monitoring, which are not fully responsive to dynamic urban traffic as it evolves over time. This relationship further often results in long-standing crowding and retarded responses to an accident and increases threats to public safety. But, overall AI technologies involving ML, computer vision as well as the big data analytics would serve as general transformative approaches in these areas. It is an integral approach because it enhances the flow of traffic but also contributes towards a safe urban environment. Some good outcomes have been seen from the application of AI-based traffic management in cities such as Barcelona and Los Angeles. In the case of Barcelona, the AI-based solution made the place less congested by 20% coupled with an improved response to emergencies. In Los Angeles, the signal lights came at optimized timings for ensuring a smooth flow of the traffic. The use of AI in the management of smart traffic in Singapore is analyzing a number of sources of data so as to generate the predictions of congestion and the dynamic changes in traffic signals to give optimized performance and reduce peak hour congestion. Adoption of AI is therefore very fundamental in adopting the approach to urbanization. This is not only a method of improving operational efficiency but also an important step towards creating safer, smarter urban environments. With the help of AI, cities change the way their traffic management systems work to improve the quality of life for citizens and ensure safer journeys for everyone on the roads.

KEYWORDS: Machine Learning, Deep Learning ,Artificial Intelligence, Urbanization, Bigdata Analytics, Sensors and Hand Monitoring, Traffic Management, Smarter Urban Environments.

I. INTRODUCTION

This perhaps is one of the big dilemmas urban cities face-mostly traffic congestion, so much time spent in transiting, more fuel being consumed, and more gases emitted from greenhouse. Well, of course, reversing this trend of increased vehicular numbers can hardly be done; however, it becomes quite clear that the number far exceeds the available capacity in these infrastructures. Traditional traffic management systems are usually reactive and fail to meet the variability in the real time of traffic flow, hence contributing to bottlenecks that plague commuters and put a strain on urban resources. Traffic accidents also pose a significant public safety threat and can severely disrupt normal patterns of traffic flow. Conventionally, methods of accident detection through manual reporting or fixed sensors delay responses and increase the adverse impacts of collisions. Emergency cases require every second since medical attention and the proper management of traffic might reduce other incidences and improve the victims' condition. It is unfortunate that the systems do not act fast enough in detecting accidents and real-time reporting to the right agencies. The AI development is changing how cities design their traffic management system and incident response. Some of the key AI technologies are machine learning (ML), computer vision, and big data analytics, which provide innovative solutions in a wide range of aspects. Machine learning algorithms will be able to examine both historical and live data traffic and identify trends toward anticipating future conditions. Reinforcement learning can be one approach that adapts signal control in real-time conditions, thereby improving traffic signals with time. High end algorithms such as YOLO (You Only Look Once) and Faster R-CNN are also used on the video feeds captured from the traffic cameras in real-time to know moving things in the cars' pathways, people, and accidents. This makes it find accidents much sooner than otherwise. The reason why traffic management center gets a ready response to take control to reduce speed that would minimally cause any obstruction on the road, is through these capabilities of computer vision. Computer vision

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.625| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

also saves pedestrians and cyclist safety especially at intersections whereby their reaching the cross roads may either control or reduce the certain traffic light on their own timing. Big data analytics aggregates information from GPS-data points, social media, and so on to identify hotspots of congestion, accident zones, or other areas, ultimately helping the city planner in infrastructure development and resource allocation.

II. METHODOLOGY

2.1 Road Anomalies Detection

The AI system is used in the automatic classification and detection of anomalies on road surfaces, such as cracks, potholes, or faded road markings. This is done by analyzing thousands of large datasets that contain high-resolution images. Most of these data are collected using cameras mounted on vehicles or taken through satellite images. From among the AI models that animate image recognition tasks, arguably, one stands out the most: CNNs. These models process visual information at the pixel level. This means that they should be able to pick out even slight differences in textures and colors indicative of issues with road surface.

For example, by feeding continuous images of roads to a CNN, one will have the system identify areas where the road surface deviates from the norm. This would automatically alert the road maintenance team so that the teams can prioritize the repairs based on the gravity of anomalies detected. This proactive approach to maintenance would ultimately prolong the duration of the infrastructural systems reduce the possibility of an accident resulting from the terrible conditions of the roads and enhance the driving experience. With continuous up-gradation in the architecture of CNN and training methodologies, these systems increase their accuracy and efficiency while analyzing the urban and rural road networks.

2.2 Driver Behavior Analysis

It can be utilized to observe and evaluate the behavior of drivers in real time for hazardous driving patterns such as over-speeding, harsh braking, heavy hard jerks at turns, irrational lane changes, etc. Critical data pertaining to 'speed', 'braking intensity', and 'steering pattern' are captured by accelerometers and gyroscopes embedded in the vehicle. Such data is then being processed by the AI-driven system to establish a baseline of normal behaviour and spot deviations that may amount to dangerous acts.

For instance, if the driver has a history of sudden braking or sharp turns, the system may recognize these patterns and send out an alert warning the driver of the possible dangers. In advanced applications, the AI may analyze the real-time driving parameters and predict the chances of an accident taking place before warning the driver to avoid accidents in time. This system does not just ensure instant safety but also serves as a medium for long-term improvement in driving behavior.

The first advantage that AI systems provide is personalization. Over time, an AI model learns what would be the typical behavior of one driver, hence making it easier for the alert system to tailor the message for that driver. This reduces false alarms and will give an alert only if a deviation of significant levels exists in the driver's general pattern. It will hence enhance the safety of both the driver and others by stopping the potential accident that could arise from human error.

2.3 Predictive Road Incident Management

Therefore, predictive algorithms play a crucial role in analyzing historical traffic data, weather conditions, and accident records to predict the likelihood of incidents occurring on the road. Machine models used are Random Forest, SVM, and Gradient Boosting, which can handle elaborate multi-dimensional data. Such algorithms can foresee potentially hazardous patterns in traffic flow, weather, time of day, and previous accidents to give some level of insight.

For instance, if it determines that a particular crossing is accident-prone during peak hours, it will adjust the traffic lights in order to minimize the excess congestion and thereby decrease the chance of accidents. In case of any bad weather forecast in a particular area, the system will warn the drivers of an alternative route to take and send teams to the spot ahead of time so that they decrease response time and save lives.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.625| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

This approach will ensure that traffic management is more flexible and responsive to situations developing on the ground, thus highly promoting better road safety. Predictive models are then put in contact with live monitoring systems, which provide real-time traffic updates, enabling authorities to take adaptive measures well towards an evolving condition, safety proactively rather than reactively.

III. CASE STUDIES

3.1 Automated Road Safety in Molise, Italy

Recently, the region of Molise, Italy installed an AI-based system to monitor the safety of roads by scanning road anomalies and conditions of road signs. Cameras mounted on vehicles and sensors capture information in real-time about road surface and signage. Such data that are processed through machine learning algorithms identify holes in the road, worn out road markings, and obscured traffic signs. The system alerts maintenance teams of areas that may require repair attention in advance to ensure timely repairs.

This AI-based approach changes the strategy from scheduled inspections to demand-based maintenance based on the actual condition of roads. It ensures early detection, thus diminishing the chances of accidents and helping in optimizing resources with respect to repairs on roads. The system also ensures that repairs are undertaken where they are most needed, thus saving on maintenance cost while improving safety on roads.

3.2. Bibliometric Review on AI and Road Safety

A bibliometric analysis of scholarly articles and research papers shows increased interest in using AI for road safety. The analysis was directed towards emerging major areas, including computer vision in infrastructure monitoring, machine learning to predict incident management, and AI-driven driver behavior analysis. The rising body of research suggests a crucial role of AI in reducing the number of cases of accidents or improving the road safety issues.

The review further emphasizes that, over the years, there has been more collaboration among higher education institutions, private sectors, and government departments, thus developing new AI-based solutions in traffic management and road safety. This trend also indicates that AI will continue to be critical in addressing the global challenge of road safety.

IV. DISCUSSION

The integration of AI in Road Safety has several benefits, including real-time monitoring and predictive interventions to improve the time management of emergency response. However, the systems still come along with a myriad of challenges that have to be undertaken to maximize their benefits.

For instance, building an accurate predictive model may require large quantities of high-quality data like traffic sensor readings, history accident records, and real-time feeds from traffic cameras. Such data collection challenges the issue of privacy and legal compliance. Public trust and acceptance will be essential for the development of widespread use of such AI-based safety systems.

Such AI systems need strong infrastructures from IoTs, such as sensors and cameras, and cloud computing. Scaling these technologies appropriately requires interoperability with existing traffic management systems, which may require major overhauls of current infrastructure. Future efforts should focus on the fine-tuning of predictive models, data collection techniques, and privacy-preserving algorithms that maintain anonymity of users with safety-increasing insights.

V. CONCLUSION

AI can change the road safety game in anomaly detection, driver behavior analysis, and incident prediction. This can therefore reduce the risk of accidents and optimize traffic management in real-time data processing. As the technology evolves, so will the role of AI in developing safer and smarter roads. Global cooperation, continued investment, and supportive policy frameworks will be necessary to unlock this potential.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.625| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

REFERENCES

1. Z. Chen, L. Xu, and S. Jin, "Road Surface Condition Monitoring Using Deep Learning and IoT," IEEE Internet of Things Journal, vol. 8, no. 7, pp. 5880-5891, 2021.
2. P. Zhang, Q. Zhao, and X. Liu, "Real-Time Detection of Dangerous Driving Behaviors Based on Vehicle Sensors and Deep Learning," IEEE Transactions on Vehicular Technology, vol. 70, no. 5, pp. 4380-4392, 2021.
3. Shafiq et al., "AI-Based Predictive Analytics for Traffic Incident Management: A Comprehensive Review," IEEE Access, vol. 9, pp. 90062-90078, 2021.
4. N. Gupta and R. Kumar, "Review of Convolutional Neural Networks in Anomaly Detection for Road Infrastructure," International Journal of Computer Vision and Applications, vol. 15, no. 2, pp. 175-185, 2022.
5. H. Song et al., "Predicting Traffic Congestion Using Machine Learning Algorithms and Real-Time Data," Transportation Research Part C: Emerging Technologies, vol. 130, pp. 148-161, 2021.
6. C. Brown, L. Tan, and D. Hsu, "AI and IoT for Improving Driver Safety: A Review of Current Techniques and Future Directions," IEEE Sensors Journal, vol. 22, no. 1, pp. 601-613, 2022.
7. M. Hu, Y. Wang, and F. Zhang, "Machine Learning Models for Predictive Maintenance of Road Infrastructure," Journal of Intelligent Transportation Systems, vol. 29, pp. 123-134, 2022.
8. J. Park and K. Choi, "Anomaly Detection for Urban Road Infrastructure Using Convolutional Neural Networks and Image Processing Techniques," Applied Sciences, vol. 11, no. 14, pp. 6248-6258, 2021.
9. R. Kim et al., "Artificial Intelligence for Smart Traffic Management and Road Safety," IEEE Transactions on Intelligent Transportation Systems, vol. 23, no. 6, pp. 5302-5315, 2022.
10. G. Tiwari, P. Varma, and S. Dutta, "A Review of Machine Learning Approaches in Traffic Accident Prediction and Prevention," Accident Analysis & Prevention, vol. 158, p. 106235, 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INNO SPACE SJIF Scientific Journal Impact Factor

doi crossref

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

9940 572 462 6381 907 438 ijircce@gmail.com

www.ijircce.com

Scan to save the contact details