JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

AI POWERED TRAFFIC MANAGENENT SYSTEM USING SIMULATION: A SURVEY

[1]Kripal Sp, [2]Muhammad Zain P M, [3]Muhammed Irfan, [4]Vivek KrishnanT, [5]Mrs. Smitha M
[1,2,3,4]Student, [5]Assistant Professor,
[1,2,3,4,5] Computer Science and Business System Engineering
[1,2,3,4,5]Srinivas Institute of Technology, Valachil, Mangalore-574143, India.

Abstract: In This project focuses on building and simulating an AI-based traffic management system to help improve traffic flow in cities. The system uses live video input to detect how many vehicles are at an intersection and then uses machine learning to decide how long each signal should stay green. Instead of using fixed timers, the system adjusts signal timings based on actual traffic, which helps reduce waiting time and congestion. We evaluated the model in a simulated setting to determine how well it operates under several traffic scenarios.

The core components of the system involve detecting vehicles through computer vision, analyzing traffic congestion levels, and making decisions using reinforcement learning techniques. The AI continuously improves by learning from both real-time and historical data. To evaluate how well the system performs, we focused on metrics such as the average wait time, the length of traffic queues, and the number of vehicles moving through each intersection.

All things considered, this initiative demonstrates how artificial intelligence may be applied to improve traffic lights' intelligence and reactivity.

Keywords: AI traffic system, smart city, machine learning, traffic simulation, adaptive signals, computer vision.

Introduction:

The Urban traffic congestion is becoming a major issue in many cities around the world. It not only causes long delays for commuters but also leads to higher fuel usage and increased air pollution. As cities continue to grow and the number of vehicles on the road rises, managing traffic effectively has become more difficult. Traditional traffic control systems usually work on fixed timers, which means traffic signals change at set intervals no matter how many vehicles are waiting. This often results in unnecessary delays, especially during rush hours or unexpected traffic build-ups.

New technologies are being investigated to solve this issue. Among the most promising is artificial intelligence (AI). By developing smart systems that change in real time, artificial intelligence could transform traffic control.

By gathering and analyzing live data—Like how many cars are queued at a crossroads, artificial intelligence can make better choices about when to alter traffic signals. This leads to shorter wait times, smoother traffic flow, and fewer emissions from idling cars.

In this project, we look into possible applications of artificial intelligence to design a smarter traffic system that adjusts signal timings automatically based on actual traffic flow. We test how well this system operates in various scenarios using simulation tools and compare it to conventional fixed-timer systems.

I. Literature Review

In today's fast-growing cities, traffic congestion is a major challenge, and many researchers believe that smart traffic systems could offer a solution. These modern systems often rely on Artificial Intelligence (AI) to make quicker and more informed decisions using real-time traffic data. For example, vehicle movement is monitored using technologies such computer vision and neural networks, which then modify traffic signals depending on the present flow of traffic. Compared to older, fixed-timing systems, AI-powered approaches can adapt more efficiently and respond faster to changing conditions.
Advanced tools such as image processing and deep learning allow these systems to accurately detect vehicles and recognize traffic trends. Another promising technique is reinforcement learning, where the system gradually learns from experience to optimize signal timings and reduce delays at intersections.

By integrating these AI technologies, smart traffic systems can help improve road safety, ease traffic jams, and reduce fuel consumption by minimizing the time vehicles spend waiting at red lights. Researchers have run several simulation-based tests during the last several years to evaluate the efficacy of these systems prior to their use in actual situations. The findings consistently suggest that AI has the potential to significantly enhance traffic management, especially in densely populated urban areas.

II. Methodology

The system we are proposing uses a traffic simulation to model how a real city intersection would work. Intersections in this simulation are fitted with virtual traffic cameras recording road views. Computer vision methods are then used to examine these pictures and determine how many cars are there at any one time. This helps the system understand how crowded each road is.

Once the vehicle count and traffic density are known, a reinforcement learning algorithm comes into play. This algorithm makes smart decisions on how long each traffic signal should stay green or red, depending on the amount of traffic. Over time, the system learns the best way to reduce waiting times and improve the overall flow of vehicles.

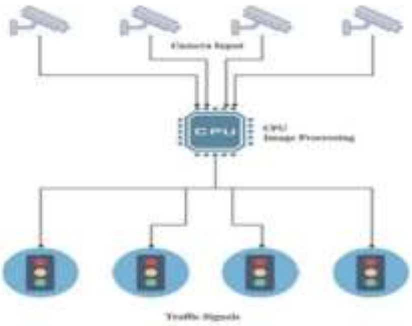
To build and test this model, we used tools like SUMO (Simulation of Urban Mobility), which is a popular traffic simulation platform. We also used Python along with libraries for AI and machine learning to create the logic behind the system. This setup allows us to test different traffic scenarios in a controlled environment and see how well the AI responds to real-time changes in traffic patterns.

III. Simulation Design

In our simulation, we created a virtual four-way intersection to represent a typical traffic scenario in a city. Each road leading to the intersection experiences different levels of traffic, just like in real life. The flow of vehicles is designed to follow realistic traffic patterns, including peak and non-peak hours, to make the simulation more accurate.

The AI system, acting as a traffic controller, keeps track of how many vehicles are present on each road. It uses this information to decide how long each traffic light should stay green or red. The goal is to avoid long lines of waiting vehicles and keep the traffic moving as smoothly as possible.

As the simulation runs, the system keeps track of important data such as the average time cars wait at the signal, the line length at each lane, and how many vehicles successfully pass through the intersection. These metrics help us evaluate how effective the AI is in managing traffic and whether it performs better than traditional fixed-timer systems. This setup gives us a safe and flexible way to test different traffic conditions and see how well our AI system adapts to them.



IV. Results and Discussion

Our simulation findings indicate that the AI-based traffic system outperforms conventional fixed-timer traffic lights**.** The reduction in average intersection wait times was among the most obvious changes. Vehicles didn't have to stop for long periods, which helped reduce congestion, especially during peak hours. The system was also able to manage traffic queues more effectively, preventing long lines from building up on busy roads.

What makes this system stand out is its ability to adjust signal timings based on real-time traffic data. Instead of following a set schedule, the AI responds to actual traffic conditions, which allows it to handle sudden changes in vehicle flow. This is especially helpful during unexpected traffic surges or emergencies.

We tested the system under different traffic conditions, from light traffic to heavy congestion, and the results remained consistent. The AI adapted well in all scenarios, showing that the model is both reliable and scalable. These findings suggest that the system could be applied to larger intersections or even entire city traffic networks in the future.

V. Conclusion:

AI-powered traffic management systems present a promising solution to the growing issue of urban traffic congestion. These systems utilize real-time vehicle detection combined with advanced machine learning algorithms to dynamically adjust traffic signals based on current traffic conditions. The simulation model showcases the potential of such systems by demonstrating how they can reduce waiting times, optimize traffic flow, and alleviate congestion. In this model, the AI continuously monitors traffic patterns, making data-driven decisions to control the flow of vehicles, which helps in minimizing traffic jams and improving overall road efficiency.Looking forward, the next stage is moving from the simulation to a practical application. This calls for not just improving the AI algorithms for real-time processing but also guaranteeing the system's compatibility with current smart city infrastructure, including IoT sensors and automated traffic lights. The final aim is to design a completely autonomous system able to adjust to various traffic conditions, hence offering a sustainable and effective means to control urban mobility.

Future Kal advancements will also include improving the learning capacity of the AI, hence enabling it to grasp long-term traffic trends and forecast congestion patterns more. The system can so maximize routes, minimize environmental effect, and offer a more smooth travel experience for city dwellers. Including such AI-driven traffic control systems into smart cities could be a major turning point in transforming urban mobility and building smarter, more sustainable cities. **V.**

References:

[1] R. Saini and M. S. Khan, 'AI Based Traffic Light Control: A Review', IEEE Access, 2020.

[2] Y. Lin et al., 'A Deep Reinforcement Learning Approach for Urban Traffic Light Control', ACM Transactions, 2021.

[3] M. Treiber and A. Kesting, 'Traffic Flow Dynamics: Data, Models and Simulation', Springer, 2013.

[4] Shailesh Shetty S and DPK.A Private Blockchain Based Approach for Securing Clinical Trials Data to Provide Data Security and Interoperability Journal of Information Systems Engineering and Management 10, 1139-1149

[5] Bhambri, P., Rani, S. and Fahim, M, Shailesh Shetty, 2024. Computational intelligence and blockchain in biomedical and health informatics. CRC Press.

[6] Shetty, S.S., Singh, C., Rao, S.B., Desai, U. and Srinivas, P.M., 2022, September. Prediction on Illegal Drug Consumption Promotion from Twitter Data. In International Conference on Emergent Converging Technologies and Biomedical Systems (pp. 647-657).Singapore: Springer Nature Singapore.

[7] Smitha, M., Nisa, A.K. and Archana, K., 2018. Diabetic retinopathy detection in fundus image using cross sectional profiles and ann. In Computational Vision and Bio Inspired Computing (pp. 982-993). Springer International Publishing.

[8] Sweety, T.J., Arun, T.R. and Sajith, K., 2022, August. CB-CPW Fed Double Hexagonal Spender Shape Antenna for ISM Band Applications. In 2022 Third International Conference on Intelligent Computing Instrumentation and Control Technologies (ICICICT) (pp. 1335-1338). IEEE.

[9] Genders, W., & Razavi, S. (2016).Using a Deep Reinforcement Learning Agent for Traffic Signal Control.

[10] Chu, T., Wang, J., Codeca, L., & Li, Z. (2019).Multi-Agent Deep Reinforcement Learning for Large-Scale Traffic Signal Control.IEEE Transactions on Intelligent Transportation Systems.

[11] Mousavi, S. S., Schukat, M., & Howley, E. (2017).Traffic Light Control Using Deep Policy-Gradient and Value-Function-Based Reinforcement Learning.IET Intelligent Transport Systems.

[12] Lopez, P. A., Behrisch, M., Bieker-Walz, L., et al. (2018).Microscopic Traffic Simulation Using SUMO.IEEE ITSC 2018.

[13] Yousefpour, A., Ishigaki, G., & Gour, R. (2020).AI for Traffic Congestion Management: A Survey.IEEE Access.

[14] Krajzewicz, D., Hertkorn, G., Rössel, C., & Wagner, P. (2002).SUMO – Simulation of Urban Mobility: An Open-Source Traffic Simulation.Proceedings of the 4th Middle East Symposium on Simulation and Modelling (MESM).

[15] Azfar, T., & Ke, R. (2024).Traffic Co-Simulation Framework Empowered by Infrastructure Camera Sensing and Reinforcement Learning.arXiv:2412.03925.

[16] Rafique, M. T., Shahid, A. R., & Anwar, Z. (2024).Reinforcement Learning for Adaptive Traffic Signal Control: Turn-Based and Time-Based Approaches.

[17] Wei, H., Zheng, G., Yao, H., & Li, Z. (2019).IntelliLight: A Reinforcement Learning Approach for Intelligent Traffic Light Control.

[18] Yadav, S., & Doke, M. (2019). IoT Based Traffic Management System: A Review. International Research Journal of Engineering and Technology (IRJET).

[19] Bhonde, S., & Barhate, V. (2018). Intelligent Traffic Signal Control System Using Image Processing and Internet of Things. Journal of Emerging Technologies and Innovative Research (JETIR).

[20] Li, S., Da Xu, L., & Zhao, S. (2015). The internet of things: a survey. Information Systems Frontiers.

[21] Bisht, R., & Garg, D. (2016). IoT based Smart Traffic Signal Monitoring System. International Journal of Scientific and Research Publications