ISSN: 2347-6540

International Journal of Latest Research In Engineering and Computing (IJLREC)
Volume 11, Issue 1, Page No.80-85, 2024
www.ijlrec.com

INTELLIGENT TRAFFIC CONTROL SYSTEM FOR AMBULANCEPRIORITY USING SOUND FREQUENCY RECOGNITION

Vansh Srivastava*1, Bashar Alam2, Niharika3, Shabaz Khan4 , Dr. Vijaylakshmi Sajwan5

*1Dept. of Computer Science and Engineering, UTU Shivalik College of Engineering, Dehradun, Uttarakhand, India
srivastavavansh94@gmail.com

2Dept. of Computer Science and Engineering, UTU Shivalik College of Engineering, Dehradun, Uttarakhand, India
alambashar021@gmail.com

3Dept. of Computer Science and Engineering, UTU Shivalik College of Engineering, Dehradun, Uttarakhand, India
niharikaa016@gmail.com

4Dept. of Computer Science and Engineering, UTU, Shivalik College of Engineering, Dehradun, Uttarakhand, India
Shabazkhan4302@gmail.com

5Dept. of Computer Science and Engineering, UTU, Shivalik College of Engineering, Dehradun, Uttarakhand, India
vijaylakshmi@live.com

Abstract :- Proposed method presents an innovative solution that combines artificial intelligence and sensors to address the negative effect of urban traffic congestion on emergency vehicle response times, particularly for ambulances. The objective is to create an advanced traffic control system capable of quickly identifying and giving priority to ambulances in heavily congested urban areas.The main novelty of this system is based on advanced sound frequency recognition technology, which has been carefully designed to identify and understand the specific acoustic patterns produced by ambulance sirens, even in the presence of other background noises. By utilizing complex signal processing techniques and machine learning models, the system can properly detect and separate ambulance signals in real-time situations, guaranteeing quick and efficient responsiveness. Once a signal is successfully detected, the system activates an intelligent traffic control mechanism that can dynamically manipulate traffic lights. This adaptive modulation facilitates the movement of the approaching ambulance by reducing traffic congestion and optimizing traffic flow in its proximity. Moreover, the technology effortlessly integrates with the current traffic infrastructure, effectively coordinating a safe and efficient path for the emergency vehicle amidst the congested traffic. Emphasizing the movement of ambulances in busy urban areas has great potential to significantly reduce response times, which could lead to life- saving results during urgent crises. The effective deployment of this intelligent traffic management system not only solves the pressing requirement for swift emergency vehicle passage but also establishes the foundation for future progress in traffic management and emergency response systems, promoting safer and more efficient urban environments.

Keywords: : CNN, Machine learning, IOT

I. INTRODUCTION

The increasing urbanization and resulting traffic congestion in densely populated cities have had a negative effect on emergency vehicle response times, notably for ambulances. This has become a significant problem. In order to tackle this crucial problem, our research presents an innovative approach that effortlessly combines state-of-the-art AI technology and sensor systems. This novel strategy revolves around an advanced traffic management system engineered to swiftly identify and provide priority to ambulances navigating through dynamic and congested metropolitan environments. The core of this system utilizes an unparalleled application of sound frequency recognition technology, carefully designed to differentiate and understand the distinct acoustic patterns produced by ambulance sirens.to facilitate the movement of ambulances, effectively reduce road congestion, and optimize traffic flow. This project not only focuses on the urgent requirement for quick emergency vehicle passage, but also paves the way for future improvements in traffic management and emergency response systems. This will contribute to the development of a safer and more efficient urban environment by identifying ambulance frequencies based on the analysis of the gathered dataset.

II. Literature Review

The issue of decreasing emergency vehicle response times through intelligent traffic management has been thoroughly examined, with multiple methodologies suggested in the academic literature. This section provides an overview of the existing research in the fields of traffic signal pre-emption, acoustic vehicle recognition, and machine learning for audio classification.

2.1 Traffic Signal Preemption Systems

Current traffic signal pre-emption systems for emergency vehicles can be classified into three primary types: optical, GPS-based, and auditory detection systems.

Optical solutions, such as the Opticom™ Traffic Priority Control System [1], depend on direct connection between a device that emits light on the emergency vehicle and a device that receives the light at the intersection. Although they are efficient in optimal conditions, their functionality can be compromised by obstacles or unfavorable weather conditions.

GPS-based systems, such as the Tomar Strobecom II [2], utilize GPS monitoring to approximate the position and velocity of emergency vehicles. This enables traffic signals to be preemptively controlled based on the anticipated time of their arrival. Nevertheless, these systems may experience a decline in the quality of GPS signals while operating in areas with tall buildings and underground passageways.

Acoustic detection systems, such as the Emtrac System [3], employ microphones to identify the unique sound patterns produced by emergency vehicle sirens. Although these systems are less impacted by obstacles, they can be susceptible to false positives caused by identical sounds and may necessitate accuracy.

2.3 Acoustic Vehicle Detection

This refers to the process of using sound waves to detect the presence of vehicles. Various research endeavors have investigated the utilization of sound sensors in intelligent transportation systems for the purpose of detecting and categorizing vehicles. Valenti et al. [4] introduced a system that utilizes microphone arrays to identify and monitor automobiles by analyzing their acoustic fingerprints. This system has demonstrated exceptional precision in controlled settings. Duarte et al. [5] created a vehicle detection system that uses microphones placed on traffic lights. This system has shown the ability to monitor traffic in a cost- effective and non-intrusive manner. Soong et al. [6] addressed the specific difficulty of identifying emergency vehicle sirens amidst background noise by employing a combination of spectral and temporal parameters to classify the siren sounds. This was in contrast to previous efforts that only focused on general vehicle recognition.

2.4 Utilizing Machine Learning for the purpose of Audio Classification

The recent progress in machine learning, namely deep neural networks, has fundamentally transformed the domain of audio classification and sound detection. Convolutional Neural Networks (CNNs) have demonstrated exceptional performance in tasks such as environmental sound classification [7], music genre detection [8], and speaker identification [9]. Shi et al. [10] introduced a Convolutional Neural Network (CNN) method for detecting emergency vehicle sirens. They utilized spectrograms as the input and achieved a high level of accuracy in distinguishing between various types of sirens. Nevertheless, their research mostly concentrated on individual siren recordings and did not tackle real-life situations involving ambient noise. Transfer learning techniques involve the use of pre-trained models on extensive audio datasets, which are then adjusted for specific tasks. These techniques have been investigated as a means to enhance performance and decrease training time. Gencogamu and Virtanen [11] showcased the efficacy of transfer learning by employing pre-trained audio neural networks for the purpose of classifying environmental sounds.

III. METHODS AND MATERIAL

Phase 1: Frequency Analysis

a) Data Collection

- Create Python algorithms to detect and separate ambulance siren frequencies in real-time situations.
- Determine a certain threshold value to differentiate ambulance frequencies by analyzing the dataset that has been obtained.

b) Integration with Traffic Control: Integrate the frequency analysis results with the current traffic control system.

- Create an advanced algorithm that can dynamically adjust traffic lights based on the frequency of identified ambulances.
- Ensure smooth interface with urban traffic infrastructure to allow for real-time adaption.

Phase 2: Deep Learning with CNN for Ambulance Detection

a) Image Dataset Creation:

- Compile an extensive dataset of images containing various traffic scenarios with and without ambulances.
- Annotate the dataset to specify the locations of ambulance presence within the images.

b) Convolutional Neural Network (CNN) Model Design:

- Design and configure a CNN architecture for ambulance detection using frameworks like TensorFlow.
- Implement layers for feature extraction, convolution, pooling, and classification.
- Train the model using the annotated dataset, optimizing for accuracy and efficiency in real-

- Design and configure a CNN architecture for ambulance detection using frameworks like TensorFlow.

Fig 2: Model loss

Fig 3: Model Accuracy

Fig 1, 2 and 3 shows our CNN model result.

Fig 1: Model prediction image

c) Real-time Image Processing:

- Integrate the trained CNN model into the traffic management system to perform real-time image processing.
- Continuously analyze video feed data from urban traffic cameras to detect the presence of ambulances.
- Implement algorithms to minimize false positives and enhance accuracy in identifying ambulance locations.

d) Adaptive Traffic Light Control: Combine the results from both frequency analysis and image processing in Python.

- Develop an adaptive traffic light control mechanism that responds dynamically to both detected ambulance frequencies and visual confirmation of ambulance presence. Conduct extensive simulations to validate the system's effectiveness in diverse urban scenarios.
- Test the system's response to various ambulance siren frequencies, traffic conditions, and environmental factors.
- Optimize the algorithms for real-world applicability and accuracy.

Phase 3: Overall Working and System Integration:

a) Sound Frequency Matching:

- Implement a Python module to match the detected sound frequency with the predefined threshold values.
- Develop algorithms for sound frequency matching and establish rules for triggering trafficsignal adjustments.

b) Synchronization of Frequency and Image Processing:

- Ensure seamless synchronization between the frequency analysis phase and the deep learning- based ambulance detection phase.
- Implement robust communication channels to relay information between the two phases in real-time.

c) Simulation and Testing:

Conduct extensive simulations to validate the system's effectiveness in diverse urban scenarios.

- Test the system's response to various ambulance siren frequencies, traffic conditions, and environmental factors.
- Optimize the algorithms for real-world applicability and accuracy.

d) Performance Metrics:

- Define performance metrics such as response time improvement, false positive/negative rates, and overall system reliability.
- Continuously monitor and evaluate the system's performance during both controlled simulations and field tests.

IV. RESULTS AND DISCUSSION

The successful implementation of this innovative intelligent traffic management system is anticipated to yield a range of impactful outcomes, addressing critical challenges in urban emergency response. The following expected outcomes highlight the transformative potential of our project:

1. The main goal of the project is to achieve a considerable decrease in response times for emergency vehicles, namely ambulances, as they navigate through heavily crowded urban areas. Our solution intends to improve response times

during critical situations by dynamically adjusting traffic lights based on real-time ambulance signal recognition. This will establish efficient and accelerated paths, resulting in a significant reduction in response times.

2. Improved Safety and Increased Number of Lives Preserved: Our traffic control system enables efficient and prioritized movement, which has the capacity to prevent loss of life in emergency situations. The project seeks to improve the safety and well-being of those requiring urgent medical assistance by improving ambulance routes and reducing delays caused by traffic congestion. The system's ability to seamlessly integrate with the current traffic infrastructure guarantees compatibility with the urban environment. This interoperability not only simplifies the process of implementing the technology but also enables its capacity to be expanded and adopted in different urban environments.

4. The project is anticipated to enhance urban traffic flow and mobility, not only during emergency situations but also in general. The dynamic adjustment of traffic signals not only aids emergency vehicles but also optimizes overall traffic flow, resulting in less congestion and enhanced transportation efficiency in urban areas.

5. The study demonstrates the practicality and efficiency of using cutting-edge technology, such as sound frequency detection, signal processing techniques, and machine learning models, in real- world scenarios. This demonstration serves as a catalyst for future advancements in traffic management and emergency response systems. By effectively implementing this intelligent traffic management system, our project establishes the basis for ongoing research and development in the field. It establishes a strong basis for future progress, promoting continuous enhancements in urban emergency response and traffic management systems. To summarize, this project aims to have a significant and positive effect on the efficiency of emergency response, public safety, and the incorporation of advanced technology into urban infrastructure. Ultimately, it aims to create safer and more responsive urban settings.

V. CONCLUSION

Ultimately, our research aims to tackle a crucial issue in urban emergency response by introducing a cutting-edge intelligent traffic control system that combines AI and sensor technology. The proposed system, created to identify and provide priority to ambulances navigating through crowded urban areas, utilizes state-of-the-art sound frequency recognition technologies and sophisticated signal processing algorithms. Our initiative intends to achieve two main goals: significantly reducing emergency response times and improving public safety and urban traffic flow. This revolutionary journey will contribute to the broader objectives of promoting public safety and optimizing urban traffic flow.

The anticipated results mentioned previously, which include substantial decreases in reaction times and enhanced safety leading to lives being saved, highlight the potential influence of this research on the welfare of individuals in urgent circumstances. Our method is made even more feasible and scalable by seamlessly integrating with current traffic infrastructure and showcasing cutting-edge technologies. In the future, this project aims to integrate with smart city projects, expand to include many modes of transportation, and continuously improve sensor capabilities and machine learning algorithms. The system's flexibility to adjust to regional differences, its integration with V2X communication, and its emphasis on public awareness efforts enhance its potential as a fundamental component in the continuous development of urban emergency response systems. Our project seeks to address a critical problem in urban emergency response by implementing an advanced intelligent traffic control system that integrates artificial intelligence and sensor technology. The suggested system is designed to prioritize ambulances in congested metropolitan regions. It employs advanced sound frequency detection technology and complex signal processing algorithms. Commencing this transformative initiative, our project aims to not only substantially reduce emergency response times but also contribute to the broader objectives of enhancing public safety and optimizing urban traffic flow. The expected outcomes described earlier, such as significant reductions in response times and improved safety resulting in lives being saved, emphasize the potential impact of this research on the well-being of persons in critical situations. The feasibility and scalability of our method are evident through its seamless integration with existing traffic infrastructure and utilization of state-of-the-art [2] A. Sathya, R. Jenisha, R. Renuka, and R. Hemalatha, "Smart Traffic Light Control System for Ambulance using IoT," International Research Journal of Engineering and Technology (IRJET), 2019.technologies. In the future, this project seeks to interact with smart city initiatives, broaden its scope to encompass various transportation modes, and consistently enhance sensor capacities and machine learning algorithms. The system's adaptability to regional variations, its integration with V2X communication, and its focus on public awareness initiatives enhance its potential as a crucial element in the ongoing advancement of urban emergency response systems. As we begin this new and creative project, we acknowledge the significance of implementing cybersecurity safeguards and resilience to protect the system's integrity. The project seeks to tackle both current difficulties and lay the foundation for continued research, development, and collaboration. This will contribute to the building of urban settings that are safer, more responsive, and technologically advanced. Essentially, this initiative not only offers a solution to an urgent problem, but also signifies a dedication to pushing the limits of technology for the improvement of society. This intelligent traffic management system aims to be a catalyst for positive change by dramatically changing urban emergency response and traffic management worldwide, both through its current implementation and future enhancements.

REFERENCES

[1] Opticom Traffic Signal Priority Control Systems, Global Traffic Technologies.

[2] Tomar Strobecom II, Tomar Electronics Inc.

[3] Emtrac System, Federal Signal Corporation.

[4] Valenti et al., "Acoustic Vehicle Tracking System for Traffic Monitoring," EURASIP Journal on Advances in Signal Processing, 2010.

[5] Duarte et al., "Vehicle Classification Using Acoustic Sensor Networks," IEEE ITSC, 2005.

[6] Soong et al., "Acoustic Vehicle Classification for Traffic Monitoring," IEEE ICASSP, 2004.

[7] Piczak, "Environmental Sound Classification with Convolutional Neural Networks," MLSP, 2015.

[8] Dieleman et al., "Philharmonic: A Hierarchical Convolutional Neural Network for Music Genre Classification," ISMIR, 2015.

[9] Chen et al., "Speaker Recognition Using Convolutional Neural Networks," IEEE MLSP, 2018.

[10] Shi et al., "Siren Detection Using Convolutional Neural Networks," IEEE ICASSP, 2019.

[11] Gencogamu and Virtanen, "Transfer Learning for Environmental Sound Classification," DCASE Workshop, 2020.

[12] A. Kumar, S. Kumar, and S. Kumar, "IoT-Based Traffic Signal Control for Ambulance," *International Journal of Engineering & Advanced Technology (IJEAT)*, 2020. [Online]. Available: https://www.slideshare.net/irjetjournal/irjet-iot-based- smart-ambulance-system

[13] A. Sathya, R. Jenisha, R. Renuka, and R. Hemalatha, "Smart Traffic Light Control System for Ambulance using IoT," International Research Journal of Engineering and Technology (IRJET), 2019.

[14] N. Gowripriya, R. Lavanya, T. Santhoshini, and V. Kavitha, "Sound Sensors to Control Traffic System for Emergency Vehicles," International Journal of Advanced Engineering Research and Science, 2018. [Online]. Available: https://www.ripublication.com/ijaerspl2018/ijaerv13n7spl_38.pdf