Nighttime Road Traffic Videos Classification based on a Custom Deep Convolutional Neural Network

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ABSTRACT

Intelligent Transport Systems (ITS) focus on gathering, storing, and offering real-time road traffic data to enhance road efficiency, ensure safe and convenient transportation, and decrease energy usage. By integrating advanced technologies, ITS contributes to cleaner, safer, and more efficient transportation. Consequently, ITS has gained prominence in regulatory and legislative initiatives across nations. This research aims to develop a highly accurate algorithm for estimating road traffic density in challenging conditions, particularly low visibility, such as nighttime. In this study, we propose a novel macroscopic approach for categorizing road traffic congestion using videos recorded during nighttime. This method employs deep convolutional neural networks (DCNN) to classify traffic into three categories. We utilized a custom CNN model trained on nighttime videos from the UCSD public dataset (University of California San Diego) over 100 epochs. With this dataset, we achieved a Correct Classification Rate (CCR) of 98.91%, surpassing the known state-of-the-art CCR of 89.47%.

Keywords: Convolution neural network, Traffic classification, Night traffic

1 Introduction

Road traffic accidents globally cause immense loss of life and disabilities, with low visibility, especially at night, significantly increasing the risk [1]. Traffic congestion compounds these issues, impacting society, economy, health, and the environment. Although technology, such as sensors and cameras, is used for traffic monitoring [2], existing studies focus mainly on daytime traffic [3], leaving nighttime congestion classification overlooked. Addressing this gap, our research proposes a new method for classifying nighttime traffic congestion using surveillance videos. Nighttime analysis is challenging due to poor lighting and environmental factors. While infrared-thermal cameras are effective, their high-cost limits use. Our approach introduces a Macroscopic method that doesn't rely on complex vehicle tracking, overcoming traditional limitations. By accurately classifying traffic congestion during low visibility conditions, especially at night, our method significantly enhances transportation safety, cleanliness, and cost-effectiveness.

2 Methodology

The proposed approach employs a Deep Convolution Neural Network (DCNN) to categorize road traffic into three groups: free, medium, and heavy, representing traffic density levels. DCNNs are recognized as the cutting-edge method for image classification. In this study, a standard Convolutional Network (ConvNet) architecture, featuring convolution layers and pooling layers was utilized. The input data for the network comprises images extracted from UCSD dataset videos, each consisting of 40-50 frames with a resolution of 320x240 pixels. To optimize memory usage during model training, these frames are cropped and resized to 64x64 pixels. These resized images serve as inputs, starting from the initial 64x3x3 convolution layer, followed by a 2x2 max pooling layer. The network undergoes six iterations. To prevent overfitting, a dropout layer with a dropout probability of 0.25 is introduced before the final max pooling layer. The softmax activation function is applied across the entire model.

DOI: 10.21467/abstracts.163 ISBN: 978-81-965621-5-1 (eBook)

3 Results and Discussion

Figure 1: *Frames from nighttime UCSD dataset*

The UCSD dataset (Fig.1) comprises 19 nighttime highway traffic videos with varying weather conditions (clear, rainy, overcast). Each video, about five seconds long, is categorized as light, medium, or heavy traffic, totaling 1112 frames. The dataset was split into training (75%) and testing (25%) sets across four trials. Dropout regularization and data augmentation were employed to prevent overfitting. The developed model achieved a remarkable accuracy of 98.91% % as it is shown on the Table 1, surpassing the only comparable method mentioned in reference [4].

Table 1: *Comparison between the proposed method and the motion vector method.*

	Motion vectors method [4]	Proposed method
Accuracy	89.47%	**98.91%**

4 Conclusion

This research introduces a novel method for classifying nocturnal traffic congestion using a deep-learning neural network. Achieving a remarkable accuracy of 98.91% as it is shown on the Table 1, on the UCSD nighttime dataset, it outperforms previous methods and offers potential benefits for drivers by aiding in avoiding traffic jams.

5 Declarations

5.1 Acknowledgments

The authors would like to thank Dr. Antoni. B. Chan from the City University of Hong Kong for providing the UCSD night-time video traffic dataset.

5.2 Competing Interests

The authors declared that no conflict of interest exists in this work.

How to Cite

S. A. Khalladi, A. Ouessai, M. Keche, “Nighttime Road Traffic Videos Classification based on a Custom Deep Convolutional Neural Network”, *AIJR Abstracts*, pp. 145–146, Feb. 2024.

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ISBN: 978-81-965621-5-1
Series: AIJR Abstracts
DOI: 10.21467/abstracts.163