School of
Electronics and Communication Engineering

Mini Project Report

on

Traffic Light Detection in Diverse Weather Conditions Using Machine Learning

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SCHOOL OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to certify that project entitled **"Advanced Traffic Light Detection in Diverse Weather Conditions Using Advanced Machine Learning Technique "** is a bonafide work carried out by the student team of **"Naveenkumar Gumaste 01FE22BEC407 "**. The project report has been approved as it satisfies the requirements with respect to the mini project work prescribed by the university curriculum for BE (V Semester) in School of Electronics and Communication Engineering of KLE Technological University for the academic year 2023-2024.

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-The project team

ABSTRACT

This project presents a current exploration into the critical realm of traffic light detection within intelligent transportation systems (ITS), crucial for enhancing road safety and traffic management. Motivated by the continuous evolution of methodologies, our research provides a comprehensive analysis of detection techniques. From traditional computer vision to deep learning integration, we scrutinize strengths, limitations, and potential future directions. The study is conducted using datasets from ROBOFLOW UNIVERSE, demonstrating novelty in the approach. Ongoing advancements in detection strategies are crucial for improving road safety and traffic efficiency, establishing this research's significance within the evolving landscape of intelligent transportation systems.

Contents

Chapter 1

Introduction

In the Smart Transportation Systems (STS) domain, the efficiency of traffic light detection is integral to advancing road safety and optimizing traffic flow. The burgeoning growth of urban environments amplifies the demand for sophisticated systems capable of managing intricate traffic networks. This project responds to this imperative by concentrating on elevating the precision and efficiency of traffic light detection, specifically addressing challenges posed by urban mobility. The methodology employed involves a thorough examination of detection approaches, spanning from traditional computer vision to cutting-edge deep learning. This comprehensive analysis delves into the strengths, limitations, and applications within Intelligent Transportation Systems (ITS). By leveraging datasets from ROBOFLOW UNIVERSE, the project ensures its relevance in real-world scenarios. The integration of traditional computer vision with deep learning not only contributes valuable insights but also positions the project to make meaningful contributions within the dynamic field of ITS.

1.1 Motivation

Improving the precision and efficiency of traffic light detection within Smart Transportation Systems (STS) is pivotal for enhancing road safety in increasingly complex urban environments. As urban areas expand, the demand for advanced systems to manage intricate traffic networks grows, compelling this project to focus on optimizing traffic flow through enhanced traffic light detection. The motivation stems from addressing urban mobility challenges, prompting a thorough review of detection approaches and leveraging datasets from ROBOFLOW UNIVERSE to develop solutions relevant to real-world scenarios. The integration of traditional computer vision with cutting-edge deep learning technologies adds a novel dimension, offering valuable insights and advancing traffic light detection methodologies within the dynamic realm of Intelligent Transportation Systems (ITS). In essence, this project is driven by the overarching goals of fostering road safety, optimizing traffic flow, addressing urban mobility challenges, and integrating innovative technologies to contribute meaningfully to the evolution of ITS.

1.2 Objectives

- **Precision in Detection:** Formulating algorithms that exhibit high precision in detecting the presence of traffic lights within captured images, aiming to significantly enhance road safety and traffic flow optimization.
- **Advanced Image Processing:** Developing sophisticated algorithms for extracting relevant features from input images. The system must demonstrate robustness in

handling variations such as occlusions, distortions, and changes in perspective, ensuring accurate and reliable traffic light detection.

- **Intelligent Classification:** Implementation of classification algorithms to intelligently recognize the specific type and significance of each detected traffic light. This step is crucial for providing nuanced insights into the traffic signal status and facilitating effective decision-making in Intelligent Transportation Systems (ITS).
- **Robust Adaptability:** Ensuring the system's robustness and adaptability to diverse environmental conditions, encompassing different lighting scenarios, weather variations, and changes in the appearance of traffic lights. The objective is to create a system that performs reliably in real-world settings.

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1.3 Literature survey

Mark P Philipsen, proposed the learning-based detector outperformed heuristic model-based detectors, exhibiting superior precision and recall—a critical parameter due to the irrevocable loss of false negatives. Emphasizing the significance of the learning-based detector's heightened recall, the study primarily assessed its success in detecting traffic lights. Proposed enhancements involved incorporating tracking methods to refine its output. The overall system performance was evaluated through precision-recall curves and the Area Under the Curve (AUC), providing a com- prehensive analysis of the effectiveness of the implemented learning-based detector and associated methodologies.
Trung-Hieu Nguyen's, proposed real-time traffic sign recognition model, integrated into a 1:7 RC vehicle, demon- strated remarkable effectiveness and robustness in challeng- ing scenarios. The system exhibited an impressive average accuracy of 99.78 percent in detecting traffic signs on the embedded platform. Despite its success, limitations were iden- tified, including the impracticality of many existing systems in real-time environments, the computational weight of deep learning methods on embedded systems, consideration of only five common traffic signs, and a response time of 22 to 23 frames per second. The study advocates for further system expansion and methodology refinement, emphasizing a lightweight model, optimal recognition methods, and image processing techniques for training data.
Noor Hussain Sarhan's study, the primary focus was on evaluating and comparing two traffic light detection models, emphasizing their accuracy in classifying images and video frames. The findings centered on the precision of traffic light detection in both static images and video frames. Identi- fied limitations included the necessity for further research to amalgamate the strengths of the two models and the call for future investigations employing deep learning algorithms and an expanded dataset. The methodology comprised developing two distinct models utilizing the OpenCV library for image and video processing, with the YOLO detection system fine- tuning the video model's weights, and employing predefined color ranges for traffic light detection in images.
Amara Dinesh's, research highlights the success of capsule networks, achieving a state-of-the-art accuracy of 97.6 percent on the German traffic sign dataset. Capsule networks prove superior to CNNs in the challenging task of traffic sign detection, excelling in recognizing pose and spatial variances. This enhances reliability and accuracy in image classification, even for blurred, rotated, and distorted images. The study evaluates the algorithm's performance in different orientations, emphasizing its proficiency in correctly identifying traffic signs. Limitations include inherent CNN limitations, the need for manual feature engineering, an unbalanced test set, and relatively lengthy training times. Methodologically, capsule Fig. 1.

Functional Block Diagram networks are employed with specific layers, a route by agree- ment algorithm, and a decoder network

1.4 Problem statement

Traffic Light Detection in Diverse Weather Conditions Using Machine Learning.

1.5 Organization of the report

Name of chapter 2 and brief description about it
Name of Chapter 3 and brief description about it and so on

Chapter 2

System design

In this Chapter, we list out the interfaces.

2.1 Functional block diagram

2.2 Design alternatives

2.3 Final design

We select one of the optimal solutions based on its working and ease of implementation.

Chapter 3

Implementation details

3.1 Specifications and final system architecture

3.2 Algorithm

3.3 Flowchart

Chapter 4

Optimization

4.1 Introduction to optimization

4.2 Types of Optimization

4.3 Selection and justification of optimization method

Chapter 5

Results and discussions

5.1 Result Analysis

5.2 Discussion on optimization

Chapter 6

Conclusions and future scope

6.1 Conclusion

6.2 Future scope