Real-Time Traffic Sign Recognition with Open-Set Rejection and Temporal Consensus

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Abstract

Our project is a system that can **find and understand traffic signs in real time** using video from a moving car. This is a difficult task because signs can be small, hidden behind things, or look like other objects.

Our system is built to be fast, using a simple detector to find the signs and a detailed classifier to figure out what they mean. To prevent the system from getting confused by things that look like signs but aren't, it has a special feature that **rejects these fake signs** by checking their shape and color.

The system also uses **temporal consensus**, which means it tracks signs across multiple video frames to make its predictions more stable and accurate, especially when signs are blurry or briefly out of sight.

This project is designed to run quickly on a small computer, like the kind found in a car. We have tested it on real video and found that it is both fast and accurate. Our work provides a solid foundation for future projects in driver assistance and smart transportation.

Contents

Introduction

- **The Problem**

  Our project tackles a big challenge for self-driving cars: recognizing traffic signs in real time. This is hard because signs can be tiny, hidden, or look like other objects, and our system has to be super fast to keep up with the car's speed.

- **The Solution**

  To solve this, we're building a special system that has two main parts. One part is a **simple, fast detector** that finds all the possible signs in a video. The second part is a **smarter classifier** that looks at what's been found and figures out exactly what kind of traffic sign it is.

- **Our Unique Approach**

  Our system has two key features. First, it can **reject fake signs**—things that look like traffic signs but aren't—by checking their shape and color. Second, it uses a **temporal consensus** module that tracks a sign across multiple video frames. This makes our predictions more reliable, especially if a sign is blurry or briefly hidden.

- **The Goal**

  The main goal of our project is to create a high-performing system that runs quickly on a small computer. We want to show that our approach is a solid foundation for building practical and safe driver assistance systems.

Literature Survey

No	Title	Author	Journal Name & Year	Methodology Adapted	Key Findings	Gaps
1.	Towards Real-Time Traffic Sign Detection and Classification	Yi Yang, Hengliang Luo, Fuchao Wu	ResearchGate Journal	A fast detection module based on a color probability model and a color HOG. It also uses a Convolutional Neural Network (CNN) to classify detected signs into subclasses.	Achieved comparable performance to state-of-the-art methods with significantly improved computational efficiency. The detection module is 20 times faster than the existing best detection module.	This paper focuses on a closed-set problem (known traffic signs). Your project, however, is addressing the open-set problem to handle unknown signs and distractors.
2	A Real-Time Traffic Sign Recognition Method Using a New Attention-Based Deep Convolutional Neural Network for Smart Vehicles	Hana, B. F., Amani, C., Jamel, B. H., Chokri, S.	MDPI & 2023	Combines the Haar cascade technique with a deep CNN model classifier to recognize 43 types of signs.	Achieved high accuracy (99.91%) and F1-measure rates (99%). The system was validated on a Raspberry Pi 4 board, demonstrating its viability for embedded systems.	While this paper mentions a system for smart vehicles, it does not specifically address the problem of open-set rejection or the use of temporal consensus to handle unknown objects or improve stability in a video stream.
3	Temporal-Guided Label Assignment for Video Object Detection	Jiahui Guo, Guohao Li, Shuo Chen, Guofa Li, Yuxin Chen	MDPI & 2022	Proposed a temporal-guided label assignment framework for a Region Proposal Network (RPN). It uses a feature instructing module to establish relationships among labels over time.	This method improves video object detection by stabilizing the learning process and correcting erroneous labels by using temporal information from other frames.	This paper focuses on general video object detection. Your project adapts this concept specifically for traffic sign recognition, where signs are tiny and their appearance can be challenging due to occlusions and motion blur.
4	"Video Object Detection via Object-level Temporal Aggregation"	Xingyi Zhou, Deva Ramanan	European Computer Vision Association & 2020	Proposes temporal aggregation modules that integrate object detection and tracking at the object or bounding box level. It applies detection on sparse keyframes and uses real-time trackers to propagate object status.	Achieved a competitive speed-accuracy trade-off by reducing redundant computation while maintaining temporal consistency.	This is a foundational approach to using tracking for temporal aggregation in video object detection. Your project will apply this concept specifically to traffic signs, which have a unique set of challenges, and will combine it with an open-set rejection component, which is not the focus of this paper.

Proposed System

- **How the System Works**
  - Our system processes a video to find traffic signs in real time.
  - It first uses a fast detector to spot possible signs. Then, a more detailed classifier identifies what each sign means.
  - To make sure it's reliable, we've added a feature that rejects fake signs and another that helps the system track signs across different video frames.
- **The Fast Detector**
  - We are using a single-stage detector, which is a type of AI model that is very fast.
  - It finds signs in one quick step, which is perfect for real-time video because it helps the system react quickly.
  - This is important because traffic signs are often very small, and we need a system that can find them quickly and efficiently.
- **The Smart Classifier**
  - The classifier is what tells us exactly what kind of sign we've found.
  - It's a "fine-grained" classifier, so it can tell the difference between similar-looking signs.
  - We're also adding a special feature that acts like a bouncer: it uses simple rules about sign shapes (like circles and triangles) and colors (like red and blue) to reject anything that is clearly not a traffic sign.
- **Making It Stable with Tracking**
  - Our system will track a traffic sign as it moves through the video.
  - By looking at a sign in several frames, the system can correct mistakes caused by things like motion blur or a sign being briefly blocked.
  - This makes our predictions much more stable and reliable.
- **Our Goals**
  - We want our system to be fast enough for use in a real car, with a target speed of 50 milliseconds.
  - We will measure its success by checking how accurately it finds and identifies signs, and how well it rejects fake signs.

Reference

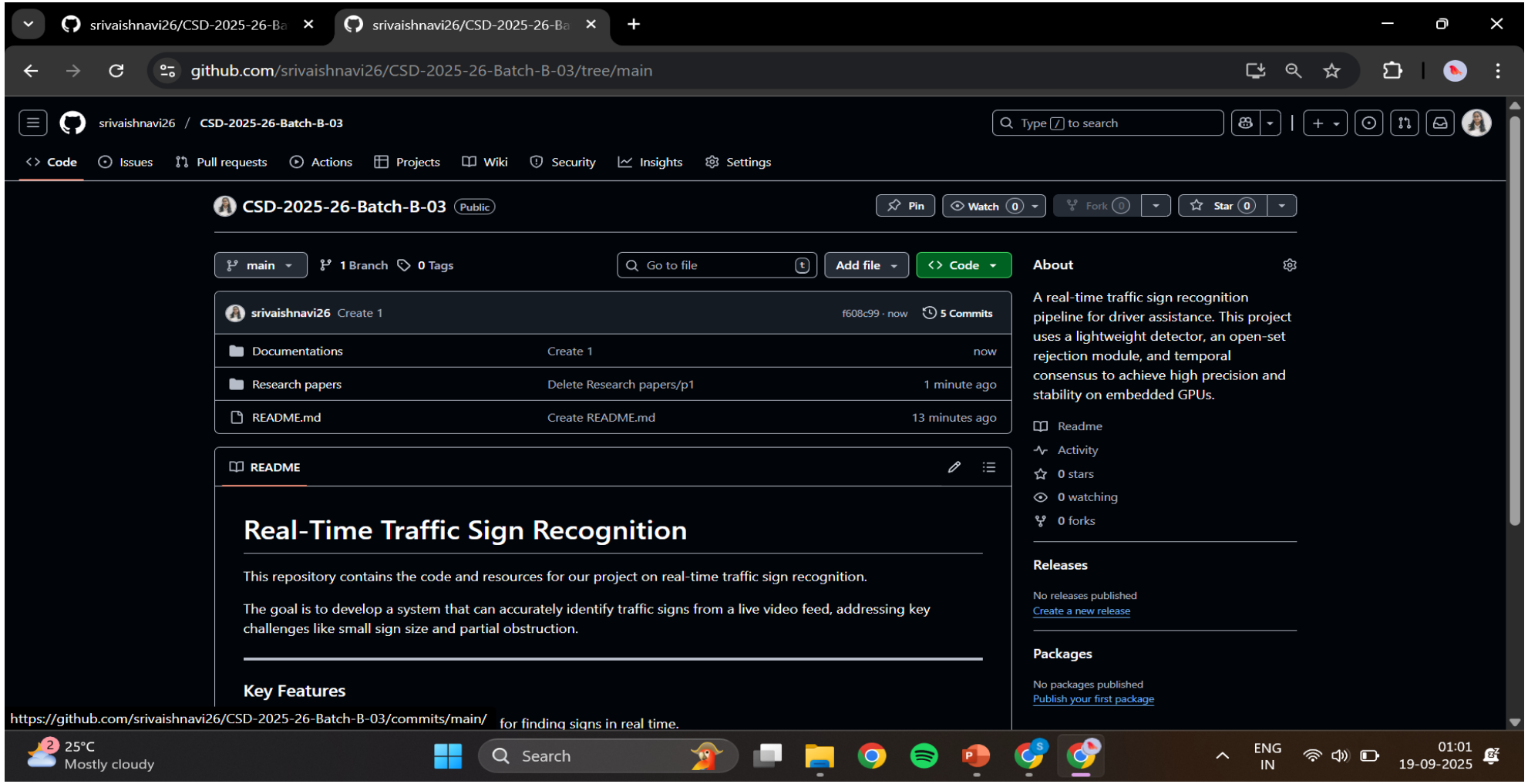
[1]. Yi Yang, Hengliang Luo and Fuchao Wu, "Towards Real-Time Traffic Sign Detection and Classification," ResearchGate Journal.

[2]. Hana, B. F., Amani, C., Jamel, B. H., and Chokri, S., "A Real-Time Traffic Sign Recognition Method Using a New Attention-Based Deep Convolutional Neural Network for Smart Vehicles," MDPI, 2023.

[3]. Jiahui Guo, Guohao Li, Shuo Chen, Guofa Li, and Yuxin Chen, "Temporal-Guided Label Assignment for Video Object Detection," MDPI, 2022.

[4]. Xingyi Zhou and Deva Ramanan, "Video Object Detection via Object-level Temporal Aggregation," European Computer Vision Association, 2020.

Git Hub Dashboard



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Any Queries?

Thank You!!!