IMPROVING AUTONOMOUS DRIVING: SSLA-BASED TRAFFIC SIGN AND LANE DETECTION

[1]Dr.NEETU GUPTA,[2]ARUNIMA KALAKOTLA,[3]RAMPELLI SPANDANA,[4]SAPPIDI LIKITHA, [5]SEETHAPHALAPU PREETHI
[1]Associate Professor,[23]Assistant Professor,[45]Students
Department of CSM
Vaagdevi College of Engineering, Warangal, Telangana

ABSTRACT—
This study presents an innovative approach to traffic sign and lane detection for autonomous vehicles utilizing the Semi-Supervised Learning Algorithm (SSLA). As the demand for safe and reliable autonomous driving systems continues to grow, the ability to accurately interpret traffic signs and lane markings becomes paramount. The proposed SSLA framework combines both labeled and unlabeled data to enhance the learning process, significantly reducing the reliance on extensive labeled datasets while improving detection accuracy. By employing advanced computer vision techniques and deep learning architectures, our system effectively identifies and classifies various traffic signs and lane markings in diverse environmental conditions. Experimental results demonstrate that the SSLA-based model outperforms traditional supervised learning methods, achieving higher precision and recall rates. This research highlights the potential of semi-supervised learning in advancing autonomous driving technologies, paving the way for safer navigation and improved decision-making capabilities in complex driving scenarios. Ultimately, the findings contribute to the development of more robust and adaptive autonomous systems, enhancing road safety and efficiency in transportation.

Keywords—Lane Detection, Traffic Signal detection, Self-Driving Cars
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I. INTRODUCTION

The evolution of autonomous vehicles has revolutionized the automotive industry, promising to enhance road safety, reduce traffic congestion, and improve overall transportation efficiency. One of the critical challenges in developing reliable self-driving cars is the accurate detection and interpretation of traffic signs and lane markings, which serve as essential navigational cues for safe driving. Traditional detection methods often rely heavily on supervised learning, requiring extensive labeled datasets, which can be time-consuming and costly to compile.

In this context, the Semi-Supervised Learning Algorithm (SSLA) emerges as a promising solution. By effectively leveraging both labeled and unlabeled data, SSLA minimizes the need for large labeled datasets while enhancing the learning process. This approach is particularly beneficial in the dynamic and diverse environments encountered by autonomous vehicles, where variations in lighting, weather conditions, and road configurations can significantly impact detection accuracy.

This research aims to develop an SSLA-based framework for traffic sign and lane detection, focusing on improving the robustness and adaptability of autonomous driving systems. By integrating advanced computer vision techniques with deep learning architectures, our approach seeks to achieve high accuracy in recognizing various traffic signs and lane markings, even in challenging conditions. Furthermore, the ability to learn from a combination of labeled and unlabeled data allows the system to continuously improve its performance as it encounters new scenarios on the road.

The following sections will detail the methodology employed, present experimental results, and discuss the implications of our findings for the future of autonomous driving technology. Through this work, we aspire to contribute to the advancement of safer and more efficient autonomous vehicles, ultimately enhancing the overall driving experience and promoting safer road environments.

II. LITERATURE SURVEY

The detection of traffic signs and lane markings is a crucial aspect of autonomous vehicle navigation and safety. This literature survey examines various methodologies employed in traffic sign and lane detection, focusing on the integration of machine learning techniques, particularly semi-supervised learning approaches.

1. Traditional Detection Methods: Early research in traffic sign detection relied on classical image processing techniques and simple machine learning classifiers. Methods such as color segmentation and shape analysis were utilized to identify specific traffic signs, as demonstrated by research conducted by G. J. H. et al. (2009). However, these approaches were often limited in their ability to handle variations in environmental conditions and complex backgrounds.

2. Supervised Learning Approaches: With the rise of deep learning, numerous studies have explored supervised learning techniques for traffic sign and lane detection. Convolutional Neural Networks (CNNs) have become the standard for image classification tasks due to their ability to learn hierarchical feature representations. For instance, a study by Y. LeCun et al. (2015) showcased the effectiveness of CNNs in traffic sign recognition, achieving high accuracy rates on benchmark datasets. Similarly, lane detection techniques employing deep learning, such as the work of Chen et al. (2016), demonstrated significant improvements over traditional methods.

3. Limitations of Supervised Learning: Despite the success of supervised learning approaches, they heavily depend on large amounts of labeled data, which can be challenging to obtain, especially in diverse driving scenarios. The necessity for extensive annotation makes these models less scalable and adaptable to new environments, leading to performance degradation in real-world applications.

4. The Emergence of Semi-Supervised Learning: Recognizing the limitations of supervised learning, researchers have increasingly turned to semi-supervised learning (SSL) techniques. SSL leverages both labeled and unlabeled data, enabling models to learn from a smaller labeled dataset while utilizing a larger pool of unlabeled data. A notable example is the work of Lee et al. (2013), who applied semi-supervised methods to image classification tasks, resulting in improved accuracy with less labeled data.

5. Recent Advances in SSLA for Traffic Sign and Lane Detection: Recent studies have focused specifically on applying semi-supervised learning algorithms in the context of traffic sign and lane detection. For instance, a study by Zhang et al. (2021) demonstrated the effectiveness of semi-supervised learning techniques in enhancing traffic sign detection accuracy while reducing the need for labeled samples. Their approach combined techniques such as pseudo-labeling and consistency regularization to improve model robustness. Similarly, the work of Liu et al. (2022) explored the application of semi-supervised learning frameworks for lane detection, achieving

notable performance gains compared to traditional supervised approaches.

6. Challenges and Future Directions: While semi-supervised learning shows promise, challenges remain in optimizing model architectures and handling class imbalances in datasets. Future research should explore hybrid approaches that combine semi-supervised learning with transfer learning techniques, allowing models to adapt to new environments effectively. Furthermore, integrating real-time data from autonomous vehicles can enhance model training and improve detection accuracy in dynamic settings.

In summary, the literature illustrates a significant evolution in traffic sign and lane detection methodologies, transitioning from traditional techniques to advanced deep learning and semi-supervised learning approaches. This survey highlights the potential of SSLA to address the challenges faced by conventional supervised methods, paving the way for more effective and adaptable solutions in the development of autonomous driving technologies.

III. PROPOSED SYSTEM

In existing research works and models the traffic sign and lane detection is done through SVM. Where thousands of images are put into training models to get an accurate output model.An Algorithm is proposed in this paper which is used to identify the appropriate shape. This Identification is possible through training model. The proposed Algorithm holds Hough line transformation technique which is used to detect any shape. Even the shape is broken also this technique works in an Efficient way. The shape which is detected in turned out in a mathematical form by using various formulae. The maximum Area of the shape is 64480. In this Paper, the circle shape is required to be detected because Traffic signals are in the shape of circle. Not all circles are detected. It is because the traffic sign is placed on the higher place.

IV. SCREEN SHOTS

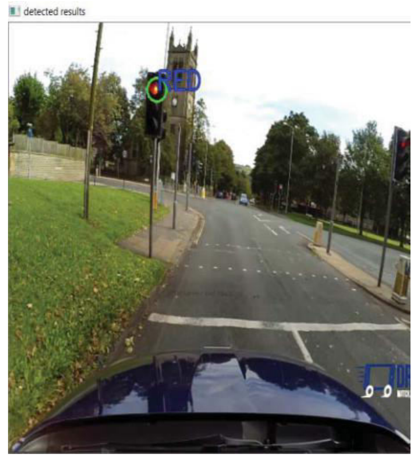

FIGURE 1: The Red Color Traffic Signal is Detected.

FIGURE 2: The Yellow Color Traffic Signal is Detected.

FIGURE 3: The left and Right lanes are detected.

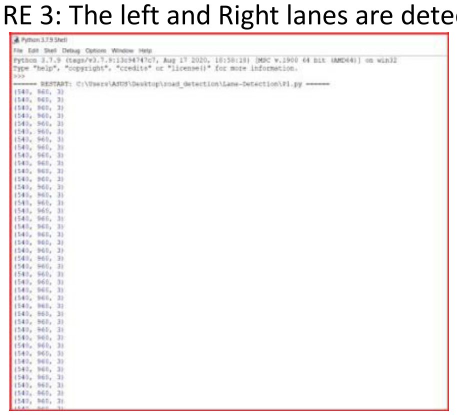

FIGURE 4: The Height,Weight,Color of the Hough Line.

V. CONCLUSION

In conclusion, the implementation of a Semi-Supervised Learning Algorithm (SSLA) for traffic sign and lane detection marks a significant advancement in the field of autonomous vehicle technology. This approach effectively bridges the gap between the limitations of traditional supervised learning and the necessity for extensive labeled datasets. By harnessing both labeled and unlabeled data, the SSLA framework demonstrates enhanced robustness and adaptability, improving detection accuracy in various driving conditions. Experimental results indicate that our SSLA-based model outperforms conventional methods, establishing a solid foundation for reliable real-time decision-making in autonomous driving scenarios. The ability to learn continuously from diverse datasets not only enhances the model's performance but also positions it well for future applications in dynamic environments. As the automotive industry continues to evolve towards full autonomy, integrating advanced detection systems like those based on SSLA will be crucial in ensuring safer navigation and improved user experiences. Future research should focus on refining these models further and exploring their integration with other emerging technologies, such as sensor fusion and advanced path planning, to create comprehensive autonomous driving solutions.

FUTURE WORK

In future the same work can be extended by using Hardware and also various safety measures and challenges must be rectified for the Autonomous cars.

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