Helmet Detection and Number Plate Recognition Using Deep Learning

Dr. C. Rajabhushanam1*, P. Kiran Kumar2, P. Shanmukha Sai3, P. Ajay4, P. Suvarna Jayaprada5
Department of Computer Science and Engineering12345, Bharath Institute of Higher Education and Research12345

Abstract---Enforcing traffic regulations in densely populated countries like India presents a formidable challenge, particularly with the prevalent practice of individuals risking their lives by riding motorcycles without helmets. The manual monitoring of all traffic police vehicles becomes an arduous task, necessitating the introduction of automation to streamline these operations. Several highly populated urban areas have successfully integrated video surveillance systems, providing a pre-established framework that can be utilized for the automated monitoring of motorcyclists. This research introduces a pioneering approach aimed at identifying motorcycles lacking helmets and extracting license plate details from such occurrences. The execution of this method involves the application of CNN models for the distinct recognition of motorcycles, motorcycle helmets, and license plates. The CNN model, having been trained on a dedicated image dataset, exhibits a proficiency in accurately identifying various classes within the dataset. Specifically, our proposed model is trained on a dataset focusing on helmets and license plates. The outcomes obtained through the application of this method are highly satisfactory, showcasing a notably precise detection of helmets and license plates. By integrating deep learning and leveraging the capabilities of CNN, this approach stands as a promising solution for enhancing the enforcement of traffic rules and ensuring the safety of motorcycle riders. The keywords associated with this research include Helmet Detection, Number Plate Detection, Deep Learning, Convolutional Neural Network, Automatic Monitoring, and Traffic Police Vehicles.

Keywords---Helmet Detection, Number Plate Detection, Deep Learning, Convolutional Neural Network, Automatic Monitoring, Traffic Police Vehicles.

1. INTRODUCTION

Motorcycles, as a highly convenient mode of transport, have seen a surge in usage, resulting in a significant portion of road accidents. Statistics from a 2014 survey revealed that 30% of fatal road accidents involved two-wheeler riders. Alarmingly, an official report originating from Chennai, India, spanning from January 1, 2013, to June 28, 2015, brought attention to a concerning fact – 1,453 motorcyclists, who met with fatal road accidents during this period, were found to be devoid of protective helmets. Emphasizing the critical role of helmets, the World Health Organization asserts their efficacy in diminishing severe injuries by a substantial 72% and lowering the probability of fatality by 39%. Despite this, road safety, particularly regarding two-wheelers, has been a neglected area in India. Mandatory helmet laws have been enacted, accompanied by substantial fines for violations. To enforce these laws, surveillance systems have been implemented in major cities to automatically detect helmet usage. This paper focuses on the automatic detection of helmet-wearing among motorcyclists.

A. Image Processing and Computer-Vision:

Computer-vision, involves methods for understanding images and videos at a high level. In tandem, image processing deals with analyzing or modifying images based on the application at hand. Both disciplines collaborate to address real-world problems, with computer vision falling under the umbrella of Artificial Intelligence (AI). This study utilizes agricultural leaf images, applying deep learning algorithms for leaf disease detection. Similarly, in the context of road safety, the paper integrates computer vision and image processing for automatic helmet and non-helmet detection among motorcyclists.

Road Safety and Automated Surveillance:

Two-wheelers, including scooters and motorcycles, dominate the Indian road scene due to affordability and convenience, constituting 78.1% of registered vehicles in 2016. However, they also contribute significantly to road accidents, with 33.9% involving two-wheelers and 33% of fatalities attributed to them. Disturbingly, 73.8% of two-wheeler victims did not wear helmets.

Automated Helmet Detection System:

In an effort to combat the persistent issue of low helmet usage, this paper introduces an innovative automated system designed to detect motorcyclists, irrespective of whether they are wearing helmets or not. The system incorporates cutting-edge technologies such as image processing, deep learning, and computer vision to achieve its objectives. Given that India contributes to 15% of global traffic fatalities and is witnessing a surge in private vehicle ownership, the
Government has proposed stringent penalties for individuals failing to wear helmets.

The current method of manual monitoring by traffic police is plagued by inefficiencies, time constraints, and the potential for human errors. This is especially evident in semi-urban and rural areas where CCTV surveillance lacks automation. To address these short comings, the proposed system utilizes a Yolov3-tiny pre-trained model, specifically fine-tuned for the detection of helmets and individuals without helmets. The implementation leverages darknet and keras libraries to achieve optimal performance.

The primary goal of this automated approach is to significantly improve road safety by swiftly and accurately identifying instances of non-compliance with helmet regulations. By doing so, the system aims to streamline the enforcement process and contribute to the overall reduction of traffic-related incidents.

B. Applications of Computer Vision and Image Processing:

The research will investigate their relevance in healthcare, military operations, customer experience, law enforcement, surveillance, manufacturing, and other fields. Additionally, the study will examine specific applications of image processing, such as medical image analysis, agriculture, remote sensing, microscopic imaging, video processing, pattern recognition, robotics, and transmission and encoding. The focus will be on understanding the dynamic nature of these technologies in real-world scenarios.

The research extends to methods for text extraction from scene images, addressing challenges related to diverse fonts, sizes, and illuminations. The study aims to propose effective algorithms for recognizing text in scene images, aiding in emergency situations and guiding individuals to their destinations. Furthermore, the investigation includes the classification and recognition of handwritten digits, considering the complexities arising from varied writing styles and diverse capturing conditions.

C. Deep Learning:

The study delves into deep learning as an advanced form of machine learning, specifically exploring models based on CNNs. It aims to understand the structural and functional mimicry of neural networks with the human brain. The research will assess the applications of CNNs and other deep learning models in achieving highly accurate and creative detection purposes. Limitations such as the dependency on large training datasets and the need for high-end machines will be investigated, along with a focus on the time considerations in comparison to traditional machine learning models.

The study recognizes the intersection of deep learning with image processing, especially in enhancing the detection performance of complex visual patterns in old documents. It involves pre-processing techniques to improve the quality of images containing handwritten texts from aged documents.

The study extends to online transactions, emphasizing the impact of technology on society's way of life. It specifically focuses on the risks posed by online activities and the role of automated license plate recognition (ALPR) systems in ensuring safety and security.

(ii) Challenges in Helmet and License Plate Detection

Utilizing the YOLO method facilitates the detection of helmets and license plates with relative ease. ALPR systems, a core component of this method, are instrumental in locating and identifying license plates from images. These detected license plates subsequently serve as a gateway to retrieve information about the respective vehicle's owner. ALPR systems often exhibit a strong regional focus, aligning with state or provincial boundaries. Notably, each country globally features a distinct license plate design, with constant evolution in design types.

To initiate license plate detection on a vehicle, capturing an image stands as the primary step. In real-world deployments, production-level ALPR systems predominantly employ infrared cameras, ensuring image capture irrespective of the time of day. These cameras may be part of extensive networks, such as those within law enforcement organizations, or more modest setups, like attaching a Raspberry Pi to a streetlight.

The diversity in capturing a vehicle's image emphasizes the need for environmental considerations, optimal camera setups, and strategic camera placement. Triggering the camera at the right moment to capture the passing vehicle is crucial in the continuum from image acquisition to localization. Various methods, including radar and motion detection, are employed for this purpose.

License plate localization involves identifying areas in an image likely to contain license plates, termed as license plate candidates. Given that license plate text is typically darker than the background, assumptions about its rectangular shape and a broader than longer aspect ratio guide contour analysis. However, challenges arise when morphological operations are applied, especially with variations in vehicle color, necessitating nuanced considerations.

D. Research Objective

The central aim of this investigation is to formulate an advanced deep learning framework and algorithms, specifically employing CNN and YOLOv3, to push the boundaries of excellence in helmet and license plate detection. The research aims to:

Propose a CNN and YOLOv3-based algorithm for automatic license plate and helmet detection, addressing sustainable and accurate practices.
Achieve accurate detection of license plates and helmets within a set of images.

Contribute to improved traffic rule compliance through timely and precise identification of license plates and helmets.

II. LITERATURE SURVEY

The rise of deep learning has significantly enhanced the capabilities of computer vision applications, particularly in solving real-world problems. This chapter focuses on the exploration of current advancements in helmet and license plate detection, specifically applied to traffic violations. Recognizing the importance of continuous research in the field of traffic violations, the study emphasizes the need for technological innovations to enhance precision in rule violation detection.

Mistry and colleagues emphasized the crucial need for identifying both helmeted and non-helmeted motorcyclists as part of comprehensive measures to enhance road safety. The challenges, including poor video quality, occlusion, and illumination, make accurate detection difficult. Their proposed approach utilizes a Convolutional Neural Network (CNN), incorporating the YOLOv2 model at two stages to improve helmet detection accuracy. The model's utilization of the COCO dataset and a specialized helmet dataset demonstrated a significant 94.70% accuracy in helmet detection.

Darji et al. addressed the increasing motorcycle accidents, emphasizing the crucial role of helmets in rider safety. They proposed motorcycle license plates, employing a MobileNet based Single Shot Detection (SSD) model. The model, trained on an Indian motorcycle license plate dataset, demonstrated accurate detection. Subsequent extraction and character recognition using OCR further enhanced the system's effectiveness.

Khan et al. introduced an automated framework for detecting motorcycle riders with or without helmets. Utilizing the YOLO-Darknet deep learning framework and trained on the COCO dataset, their system achieved an 81% Mean Average Precision on the validation dataset. This framework provides a promising automated solution for identifying helmet usage through computer vision and deep learning.

The critical issue of two-wheeler helmet offenses was addressed in a project utilizing YOLOv5 for efficient helmet detection. The project applied transfer learning and two distinct methods for helmet verification, achieving a remarkable mean Average Precision (mAP) of 0.995. Additionally, the system incorporated EasyOCR for number plate recognition, providing a comprehensive approach to enforcing traffic regulations and improving road safety.

In summary, these studies highlight the ongoing efforts to enhance safety through the application of deep learning in detecting helmet usage and license plate extraction for two-wheeler riders. The methodologies employed demonstrate advancements in computer vision technologies, contributing to the development of robust systems for traffic rule enforcement and road safety.

III. RELATED WORKS

Limitations in Existing System

The identified challenges and problem areas within the scope of this study are:

Text Extraction from Scene Images: The study aims to address the challenges of extracting text from scene images, particularly dealing with diverse fonts, sizes, and illuminations. An effective algorithm is required to enhance text recognition, especially in low-light conditions.

Handwritten Digit Recognition: The recognition of handwritten digits poses challenges due to diverse writing styles and capturing conditions. The study seeks to propose algorithms for accurate identification and digitization of handwritten numbers, especially in the context of preserving historical documents.

Deep Learning Limitations: The limitations of deep learning methods, including the need for large training datasets and high-end machines, need to be addressed. The study aims to explore strategies for overcoming these limitations while maintaining superior detection performance.

Enhancing Image Quality for Recognition

Advanced pre-processing techniques are needed to improve the quality of images containing handwritten texts, particularly in scenarios where documents may be torn or faded.

Efficiency of ALPR Systems

The study aims to assess the efficiency of ALPR systems in various applications, emphasizing their role in traffic management, toll payment, and law enforcement. The focus is on understanding their impact on society's safety and security in the context of technological advancements.

IV. METHODOLOGY

In this section, we present a thorough method that uses YOLOv3 and a lightweight Convolutional Neural Network (CNN) for the identification and recognition of helmets and license plates. The three primary modules of the framework—license plate and helmet detection, license plate extraction, and license plate number recognition—are shown in Fig.

Fig.1 Architecture Block Diagram

Our approach is based on a methodical procedure, as Fig. First, raw photographs are preprocessed by resizing them according to predetermined specifications. Following the processing of these photos, the training model is employed to predict class objects.
Using the original YOLOv3 model that was trained on the COCO dataset, the first stage focuses on identifying people in the input image. Modern object detector YOLOv3 is able to recognize multiple classes from the COCO dataset, such as people, vehicles, motorcycles, and more. We eliminate other identified classes from the original YOLOv3 model and choose the "person" class, keeping in mind our priority on identifying motorcyclists wearing helmets.

Empirical testing led to the conclusion to give motorcycle detection less importance than person detection. Motorcycle detection may not reliably recognize helmets in front-facing or rear-facing camera scenarios, or it may yield poor confidence scores. We guarantee that the foot region encompassing the license plate area and the head region covering the helmet are captured by choosing person detection. This tactical decision improves the accuracy of helmet detection in difficult situations.

Intermediate Processing

Refining the output from the YOLOv3 object detection algorithm requires intermediate processing. While YOLOv3 initially recognizes every class from the COCO dataset, our method only employs person detection to distinguish between motorcyclists wearing helmets and those who do not. To maximize computing performance, all classes other than "person" are ignored through intermediary processing. An image specifically for further analysis is produced by automatically cropping the bounding box surrounding the identified individual.

Helmet Detection

The objective of our suggested approach is to distinguish between motorcyclists wearing helmets and those who do not in an image. We use a YOLOv3 model that was specifically trained on a dataset of 3054 helmeted photos in order to accomplish this. The YOLOv3 model is fed cropped photos with recognized people in them, guaranteeing precise helmet categorization inside the cropped image. CNNs one of the most recent developments in deep learning, have made object detection—including license plate recognition—more widely used.

License Plate Detection

Processing of the cropped image is stopped when a helmet is found in the output of the second YOLOv3 step. The cropped image is subjected to OpenALPR's license plate detection if no helmet is found. Coordinates from the license plate are identified by OpenALPR and utilized to extract the license plate. The powerful OpenALPR library is used by the license plate extraction module to mark bounding boxes around observed license plates for precise localization. After cropping the image using the bounding box coordinates, character recognition is applied to the resulting license plate.

Data Training

The COCO dataset is used to train the YOLOv3 model for human detection in the first step. Using a bespoke dataset of 3054 helmeted photos, a YOLOv3 model is trained for helmet identification in the second stage. Transfer learning is used, with weights pre-trained on ImageNet. The last part of the suggested technique is the optical character recognition module, which reads the retrieved license plate, recognizes the characters, and outputs them into a text file.

Testing

A dataset consisting of 403 non-helmeted and 409 helmeted photos that were downloaded from the ImageNet collection is used in the testing phase. The training dataset for the second YOLOv3 model did not include these images. In contrast to the standard advice, which states that 20% of training data should be used for testing, our method makes use of transfer learning and the model's innate recognition of face traits to distribute helmeted and non-helmeted photos equally.

V. CONCLUSION

Identifying individuals without helmets and vehicles lacking number plates is crucial for enhancing road safety and enforcing traffic rules. Deep learning-based object detection algorithms, particularly YOLO, have shown promising outcomes for such purposes. This paper introduces a YOLOv3-based system, incorporating a CNN algorithm, for detecting individuals without helmets and extracting number plates. The proposed system holds potential for deployment in traffic monitoring and surveillance systems, contributing to enhanced road safety.

REFERENCES


