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Helmet Detection and Number Plate Recognition using Machine Learning

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Abstract

Motorcycle riders who do not wear helmets put themselves in grave danger. According to a 2017 UN motorcycle research, over 15,000 biker fatalities may be prevented. every year with safety precautions in India. Additionally, it states that riders who wear helmets have a 42% higher chance of surviving collisions and a 69% higher chance of avoiding injuries. The high volume of traffic has made manual vehicle monitoring difficult. The goal of our effort is to use deep learning to automate this Our program tracks traffic and identifies riders who are not wearing helmets with the use of video feeds. After then, it makes a note storing the vehicle's license plate information in a database, which enables authorities to more easily monitor and alert drivers who are breaking traffic laws.

INTRODUCTION

Motorcyclists are a common form of transportation in practically every country. However, two-wheelers carry a higher risk because they have less protection.

In order to lower the risk, it is quite desirable for two-wheeler riders to wear helmets. In the past few years, head injuries have been the primary cause of is illegal, and because of its significance, numerous manual tactics have been used to apprehend offenders. Many two-wheeler riders continue to disregard the rule. Automation of this procedure is urgently needed in order to monitor these violations accurately and in real time, as well as to drastically cut down on the amount of human intervention. Many nations have established surveillance camera systems in public areas; so, utilizing the current infrastructure, the solution for It is economical to identify those who violate traffic laws [1–3].

C. Chiu and colleagues suggested a method for identifying helmets in security footage. This technique uses probability to detect two-wheelers and heads after cropping the moving item.

The occlusion issue was also resolved by this method, however noise and illumination effects prevented it from handling subtle changes. Additionally, it detects heads using Canny edge detection. [5]

To identify two-wheeler drivers, J. Chiverton et al. employed edge histogram characteristics. Due to the use of edge histograms close to the head, this technique worked effectively even in surveillance footage with low light levels. However, as the edge

histograms compared and categorized helmets using circular hough transformations, It causes a lot of misclassification among motorcycle riders wearing helmets since helmet-like things were categorized while helmet-differentiating objects were not. [6] To overcome this problem, R.sliva et al. proposed an approach in which vehicles were tracked using Kalman filter [10]. This tracking system's benefit [10] is the capacity to identify objects even when they are partially obscured. But when there are more than two or three motorcyclists in the same frame, it fails because the filter [10] works well for linear state transitions (i.e tracking single objects/one object at a time). But to track multiple objects, non-linear functions are required to track them.[7, 9]
K. Dahiya et al. suggested a method that initially detects moving objects using a Gaussian model. This paradigm functions effectively despite minor modifications. in the distance. It employs two classifiers: one to distinguish between two-wheelers and moving objects, and another to distinguish between riders wearing helmets and those who are not. However, both classifications use kernel SVM in conjunction with hand-engineered features like SIFT,HOG,and LBP. Under challenging circumstances, their method was unable to reliably distinguish between riders wearing helmets and those not, but it could correctly categorize two- wheelers among other vehicles. [11–13]
Convolutional neural networks are used by C. Vishnu et al. to choose two-wheelers among a variety of moving vehicles. [3]

LITERATURE REVIEW

T. Lin, P. Goyal, R. Girshick, K. He, and P. Doll´ar, "Focal loss for dense object detection," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 42, no. 2, pp. 318–327,
2020
"This project introduces Focal Loss, a novel loss function designed to tackle class imbalance in dense object detection. Traditional detectors struggle with an overwhelming number of easy negatives, so Focal Loss down-weights well-classified examples and focuses more on hard, misclassified ones. This is achieved by adding a modulating factor (1−pt)γ(1 - p_t)^\gamma(1−pt)γ to the standard cross-entropy loss, where γ\gammaγ controls the focus on difficult samples. The authors integrate Focal Loss into RetinaNet, a one-stage detector, achieving performance comparable to two-stage detectors like Faster R-CNN. This innovation significantly improves accuracy for small and rare objects in complex detection scenarios."

N. Boonsirisumpun, W. Puarungroj, and P. Wairotchanaphuttha, "Automatic detector for bikers with no helmet using deep learning," in 2018 22nd International Computer Science and Engineering Conference (ICSEC), 2018, pp. 1–4
"This project presents an automatic detection system for motorcyclists without helmets using deep learning techniques. It utilizes convolutional neural networks (CNNs) to analyze images or video frames and classify riders based on helmet usage. The system enhances road safety by enabling real- time detection and automated law enforcement. Experimental results show high accuracy in distinguishing between helmeted and non-helmeted bikers. This research contributes to traffic monitoring and accident prevention efforts."

J. Redmon and A. Farhadi, "Yolov3: An incremental improvement," CoRR, vol. abs/1804.02767, 2018. [Online]. Available: http://arxiv.org/abs/1804.02767 give me paragraph in 5 line start with This project
"This project introduces YOLOv3, an improved version of the You Only Look Once (YOLO) real-time object detection model. It enhances accuracy by using a deeper Darknet-53 backbone and multi-scale feature detection with three prediction layers. The model employs logistic regression for classification and binary cross-entropy loss for better performance. YOLOv3 balances speed and accuracy, making it highly effective for real-time applications. This research significantly advances object detection by improving efficiency and robustness."

PROPOSED SYSTEM

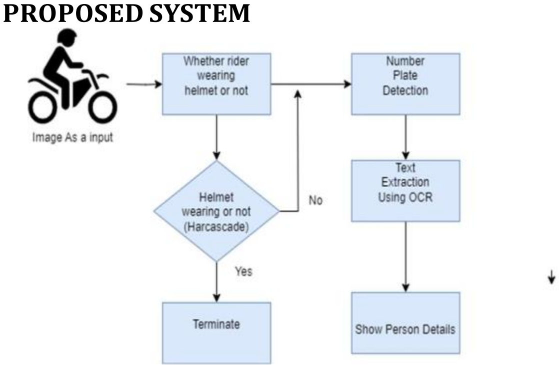

Fig1.Flow Chart

This project focuses on improving road safety by automatically detecting whether motorcyclists are wearing helmets and recognizing their vehicle's number plates. Using machine learning, the system can identify riders without helmets and extract their license plate details for enforcement. It relies on deep learning models to detect both the rider and the number plate, ensuring accurate results. The system also uses optical character recognition (OCR) to read the license plate numbers. By automating this process, the project helps promote helmet use and supports traffic law enforcement more efficiently.

METHODOLOGY

The proposed system follows a structured approach to detect helmet violations and recognize vehicle number plates using machine learning and deep learning techniques. The methodology consists of the following key steps:

Data Collection and Preprocessing: Collect images and video footage of motorcyclists with and without helmets from traffic surveillance cameras.Gather a dataset of vehicle license plates from different angles, lighting conditions, and environments.Apply image preprocessing techniques such as resizing, noise reduction, and normalization to improve detection accuracy.

Helmet Detection Using Deep Learning: Use an object detection model like YOLO (You Only Look Once) or Faster R-CNN to detect the presence of a rider. Train a Convolutional Neural Network (CNN) to classify whether the rider is wearing a helmet or not. If a helmet violation is detected, proceed to the next step (license plate recognition).

Number Plate Detection and Recognition: Apply object detection algorithms (e.g., YOLOv3 or OpenCV-based Haar cascades) to locate the number plate in the image. Use image processing techniques like edge detection, thresholding, and contour detection to extract the plate. Implement Optical Character Recognition (OCR) (e.g., Tesseract OCR or EasyOCR) to convert the plate image into readable text.

Data Storage and Fine Generation: Cross-check the recognized number plate with the RTO database to retrieve vehicle owner details.Generate an automated challan (fine) for helmet violations and send a notification to the offender via SMS or email. Maintain a record of violations in a database for law enforcement authorities.

System Deployment and Monitoring: Integrate the system with CCTV cameras for real- time monitoring. Develop a web and mobile application for users to check and pay fines online. Improve system accuracy by continuously updating the dataset and refining detection algorithm

OBJECTIVE OF SYSTEM

The main objective of this system is to automate the detection of helmet violations and recognize vehicle number plates using machine learning. The system is designed to improve road safety and assist traffic authorities in enforcing helmet laws efficiently.

Key objectives include:

a. **Helmet Detection** – Identify whether a two-wheeler rider is wearing a helmet using deep learning models like **YOLO** or **CNNs**.

b. **Number Plate Recognition** – Capture and extract the vehicle's registration number using **Optical Character Recognition (OCR)**.

c. **Automated Fine Generation** – If a violation is detected, update the **RTO database** and generate a **challan (fine)** for the vehicle owner.

d. **Real-Time Monitoring** – Process live video feeds from **CCTV cameras** for continuous traffic monitoring.

e. **User-Friendly Fine Payment** – Provide an **online and mobile platform** for users to conveniently pay fines.

RESULTS

After setting up the system, we observed that it worked smoothly in detecting helmet violations. The Raspberry Pi successfully connected to CCTV cameras and processed the video feed. The system was able to differentiate between two-wheelers and other vehicles on the road and accurately identify riders with and without helmets. If a rider was not wearing a helmet, the system automatically generated a fine (challan) and updated the RTO's database.

The results clearly show that when a rider is not wearing a helmet, the system detects both their face and the vehicle's registration number. On the other hand, if the rider is wearing a helmet, the system ignores them and does not take any action. To make the process even more convenient, we have developed a web and mobile app that allows people to pay their fines online anytime from anywhere. Currently, no state RTO in India offers this service, which often leads to issues like bribery and middlemen taking advantage. Our app aims to eliminate theseproblems and make fine payments simple and transparent.

In short, this smart system automates helmet rule enforcement, reduces manual work, saves time, and makes roads safer.

CONCLUSION

This system successfully detects two-wheeler riders and determines whether they are wearing a helmet. If a rider is not wearing one, the system automatically identifies the vehicle's number plate and extracts the text using OCR. This information is then used to generate a challan for the violation. To improve accuracy, the system could be enhanced to detect unsafe helmets, caps, and other head coverings that do not meet safety standards. Special cases, such as riders wearing turbans, should also be considered. Addressing these factors would make the system more effective for real-world use and a significant step forward in traffic automation.

FUTURE SCOPE

A functional prototype has been developed to detect bikers who violate traffic rules by not wearing helmets, putting their safety at risk. This system can play a crucial role in reducing traffic violations and improving road safety. After thorough research, advanced deep learning models like YOLOv3 and ResNet were selected to ensure a balance between speed, accuracy, and reliability. With high-quality equipment, the system's accuracy can be further improved, and future upgrades could allow it to work with different camera angles and detect unsafe helmet designs that do not meet safety standards. Currently, the model operates effectively under good lighting and clear weather conditions, using a small dataset suitable for prototyping.

Expanding the dataset would enhance its robustness, enabling it to function across various environments, lighting conditions, and angles. The system is currently limited to reading government-issued license plates, but future improvements could expand its capabilities. Additionally, it could be adapted to detect other traffic violations, such as seatbelt violations in cars and mobile phone usage while driving.

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