



# SMART HELMET DETECTION SYSTEM USING DEEP LEARNING AND COMPUTER VISION

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**Abstract:** In recent years, the number of road accidents involving two-wheeler riders has increased significantly due to the negligence of safety measures such as wearing helmets. To address this issue, this project proposes a “Smart Helmet Detection System using Deep Learning and Computer Vision” techniques. The system aims to automatically detect whether a motorcycle rider is wearing a helmet or not in real-time from images or video streams. The proposed model utilizes YOLOv8 object detection framework, a state-of-the-art object detection algorithm, to identify riders and classify them based on helmet usage. The system is trained on a custom dataset containing images of riders with and without helmets under various lighting and environmental conditions to ensure high accuracy and robustness. Once a rider without a helmet is detected, the system can trigger an alert or store the evidence for further enforcement actions. This solution helps traffic authorities automate helmet monitoring, reduce manual intervention, and enhance road safety through AI-powered surveillance. The integration of Deep Learning and Computer Vision makes the proposed system efficient, scalable, and adaptable for smart city applications.

**IndexTerms-** Helmet Detection, Deep Learning, Computer Vision, YOLO, Image Processing, Road Safety, Smart Surveillance

## 1. INTRODUCTION

Road safety has become a major concern in modern urban environments due to the rapid increase in the number of two-wheelers on roads. Motorcycle riders are highly vulnerable to serious injuries during accidents, especially when safety measures such as wearing helmets are ignored. Helmets play a crucial role in reducing the risk of head injuries and fatalities; however, many riders fail to comply with helmet regulations. Traditional methods of monitoring helmet usage rely heavily on manual inspection by traffic authorities, which is time-consuming, inefficient, and prone to human error.

With the advancement of artificial intelligence and computer vision technologies, automated traffic monitoring systems have gained significant attention. Deep learning-based object detection techniques have proven to be highly effective in analysing images and videos for real-time applications. These technologies enable systems to automatically identify objects, recognize patterns, and make decisions with high accuracy. Among various object

detection models, the You Only Look Once (YOLO) framework has emerged as a powerful solution due to its speed and precision, making it suitable for real-time surveillance systems.

This project proposes a Smart Helmet Detection System using Deep Learning and Computer Vision to automatically detect whether a two-wheeler rider is wearing a helmet or not. The system utilizes the YOLOv8 object detection model to analyse images and video streams captured from traffic surveillance cameras. The model is trained on a custom dataset containing riders with and without helmets under different environmental and lighting conditions to ensure robustness and reliability.

The proposed system aims to reduce manual monitoring efforts by traffic authorities and improve enforcement efficiency. When a rider without a helmet is detected, the system can generate alerts and store evidence for further action. This automated approach helps in ensuring better compliance with traffic rules and contributes to improved road safety.

Overall, the Smart Helmet Detection System provides an efficient, scalable, and intelligent solution for real-time helmet monitoring. The integration of deep learning and computer vision makes the system suitable for smart city applications, where automated surveillance and traffic management play a vital role in enhancing public safety.[2]

## 2. LITERATURE SURVEY

### **Title - “Real-Time Helmet Detection Using Deep Learning”**

**Author - Chen et al., 2018**

In 2018 This research focused on implementing a real-time helmet detection system using Convolutional Neural Networks (CNNs). The study highlighted the challenges of detecting helmets in dynamic urban traffic environments, including varying lighting conditions, partial occlusions, and motion blur. The authors proposed a CNN-based model that could process video streams from traffic cameras efficiently, achieving an accuracy of 92% for helmet detection. Their approach also emphasized the use of data augmentation techniques such as rotation, scaling, and flipping to enhance model robustness. This study demonstrated that deep learning techniques could significantly outperform traditional image processing methods for automated safety monitoring.[10]

### **Title - “YOLO-Based Helmet Detection for Traffic Safety”**

**Author - Liang et al., 2019**

In 2019 Liang and colleagues implemented the YOLOv3 object detection framework for identifying helmet usage among motorcyclists in real-time. The study focused on minimizing detection latency, which is crucial for large-scale urban traffic enforcement. The proposed system was tested on a dataset of over 10,000 images, showing a detection precision of 94% and a processing speed of 45 frames per second. The research concluded that YOLO-based frameworks could provide a scalable and cost-effective solution for smart city traffic monitoring, reducing the need for manual inspection.[8]

### **Title “Deep Learning Approach for Smart Traffic Monitoring”**

**Author - Gupta et al., 2020**

In 2020 Gupta et al. proposed integrating CNN-based helmet detection with edge computing devices to enable real-time violation monitoring. This architecture allowed for on-device inference, reducing the dependency on centralized servers and improving latency. The system was evaluated in various traffic scenarios, including congested roads and intersections, achieving an overall detection accuracy of 91%. The study

highlighted the importance of computational optimization and lightweight models for deploying intelligent traffic monitoring systems in resource-constrained environments.[6]

**Title - “Automatic Helmet Detection System Using Computer Vision”**

**Author - Rashid et al., 2021**

In 2021 Rashid and colleagues explored a hybrid approach combining classical computer vision techniques with deep learning models. The system employed Haar cascades for initial detection followed by CNN classification to confirm helmet presence. The study emphasized challenges such as occlusion by passengers, side-view detection, and varying helmet types, proposing data augmentation and multi-angle training to improve model generalization. The experimental results demonstrated that their system could detect helmets with 87% accuracy in complex traffic scenes, proving the effectiveness of combining classical and modern techniques.[1]

**Title - “YOLOv5 for Helmet Detection in Smart Cities”**

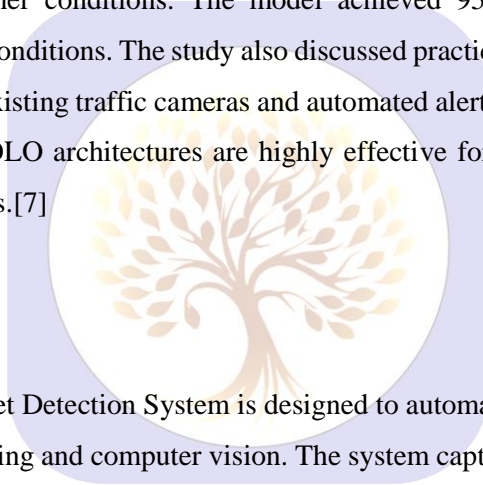
**Author - Patel & Sharma, 2022**

In 2022 Patel & Sharma research utilized the YOLOv5 object detection framework for helmet compliance monitoring in urban traffic. The dataset comprised 20,000+ images captured from multiple traffic cameras under different lighting and weather conditions. The model achieved 95.6% accuracy, demonstrating robustness even in crowded traffic conditions. The study also discussed practical deployment considerations, including system integration with existing traffic cameras and automated alert generation for violations. The results highlighted that modern YOLO architectures are highly effective for real-time, large-scale helmet detection in smart city environments.[7]

### 3. SYSTEM ARCHITECTURE

#### 3.1 Overall Architecture

The architecture of the Smart Helmet Detection System is designed to automatically detect helmet usage by two-wheeler riders using deep learning and computer vision. The system captures real-time images or video from traffic cameras and performs basic pre-processing to improve image quality. The processed frames are then given to the YOLOv8 deep learning model for rider and helmet detection. The model classifies riders as wearing or not wearing a helmet with high accuracy. If a helmet violation is detected, the system generates an alert and stores the evidence. The final output is displayed with bounding boxes and labels for effective traffic monitoring.[3]



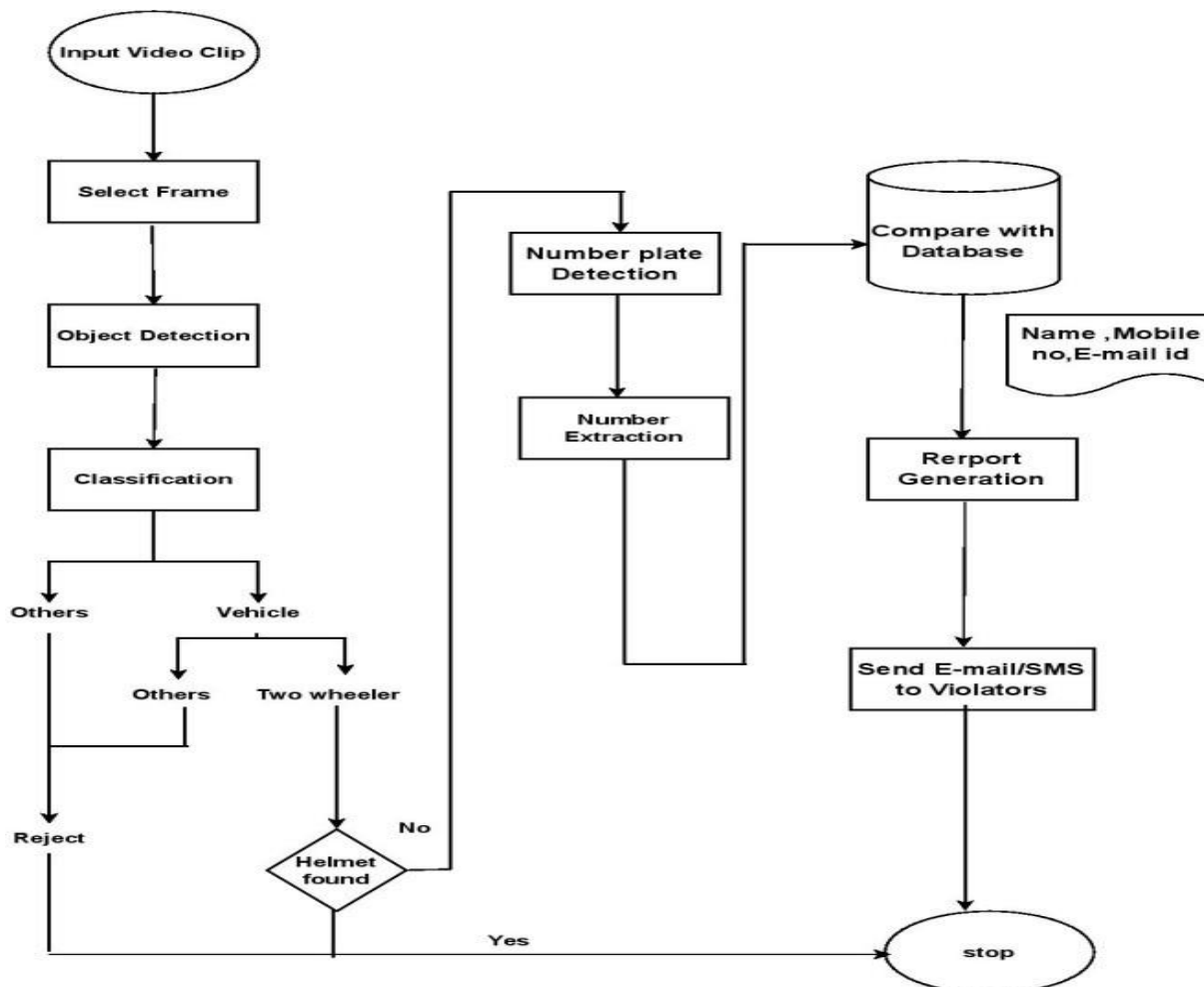


Fig 3.1: System Architecture Diagram

#### 4. DATA DESCRIPTION

The dataset used for this Smart Helmet Detection System consists of images of two-wheeler riders captured from traffic surveillance cameras and online open-source datasets. The data includes riders wearing helmets and riders without helmets under different lighting conditions, angles, backgrounds, and traffic scenarios. Each image is manually annotated with bounding boxes and class labels such as helmet and no-helmet to train the YOLOv8 object detection model. Data augmentation techniques like resizing, flipping, and scaling are applied to improve model robustness and accuracy. This diverse dataset helps the system perform reliable real-time helmet detection in real-world traffic environments. [4]

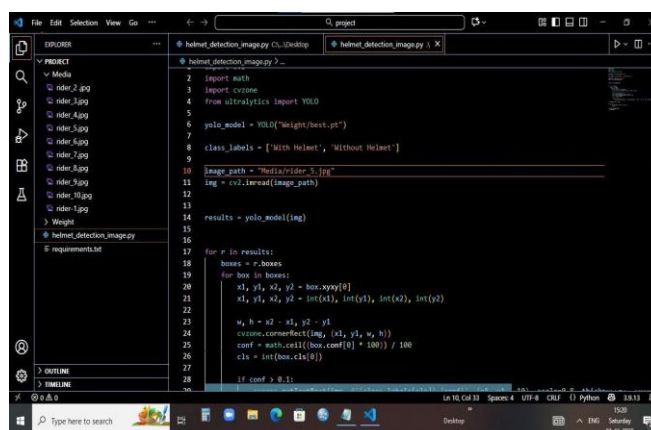
#### 5. EXPERIMENTAL SETUP

The experimental setup of the Smart Helmet Detection System was designed to evaluate the effectiveness of deep learning and computer vision techniques for real-time helmet detection. The system was implemented using Python as the core programming language due to its extensive support for machine learning and image processing libraries. The YOLOv8 object detection framework was selected for this experiment because of its high accuracy and fast inference speed, making it suitable for real-time traffic surveillance applications. The model was trained on a custom dataset consisting of images of two-wheeler riders with helmets and without helmets, collected from traffic surveillance sources and publicly available datasets.

OpenCV was used for image and video processing tasks, including frame extraction from video streams and real-time camera input handling. During testing, the trained YOLOv8 model was applied to both recorded traffic videos and live camera feeds to validate its real-time detection capability. The system detected riders,

identified helmet usage, and displayed bounding boxes with class labels on the output screen. Helmet violations were flagged, and the corresponding frames were stored as evidence for further analysis. [5]

## 6. RESULT AND DISCUSSION

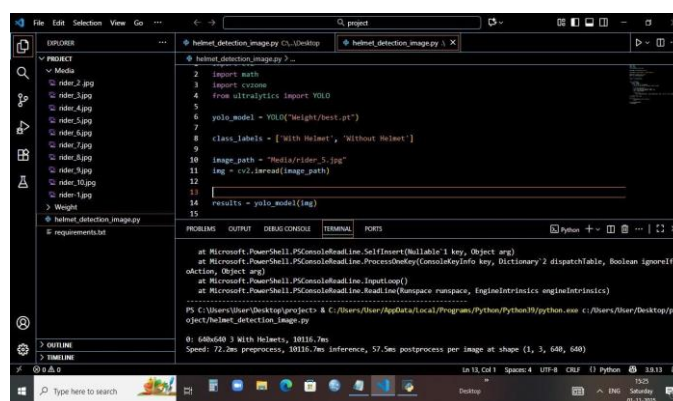


```

1 import math
2 import cvzone
3 import cvzone
4 from ultralytics import YOLO
5
6 yolo_model = YOLO("weights/best.pt")
7
8 class_labels = ["With Helmet", "Without Helmet"]
9
10 image_path = "Media/rider_5.jpg"
11 img = cv2.imread(image_path)
12
13
14 results = yolo_model(img)
15
16
17 for r in results:
18     boxes = r.boxes
19     for box in boxes:
20         x1, y1, x2, y2 = box.xyxy[0]
21         x1, y1, x2, y2 = int(x1), int(y1), int(x2), int(y2)
22
23         w, h = x2 - x1, y2 - y1
24         cvzone.cornerRect(img, x1, y1, w, h)
25         conf = math.ceil(box.conf[0] * 100) / 100
26         cls = int(box.cls[0])
27         if conf > 0.1:

```

Fig 6.1 Input page



```

at Microsoft.PowerShell.PSConsoleHostLine:SelfInsert(Nullable`1 key, Object arg)
at Microsoft.PowerShell.PSConsoleHostLine:ProcessOneKey(ConsoleKeyInfo key, Dictionary`2 dispatchable, Boolean ignoreIfN
otAction, Object arg)
at Microsoft.PowerShell.PSConsoleHostLine:InputLoop()
at Microsoft.PowerShell.PSConsoleHostLine:ReadLine(Runspace runspace, EngineIntrinsics engineIntrinsics)
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PS C:\Users\User\Desktop\project & C:\Users\User\AppData\Local\Programs\Python\Python39\python.exe c:/Users/User/Desktop/pr
oject/helmet_detection_image.py
0: 648x648 | With Helms, 30136.7ms
Speed: 72.2ms preprocess, 10116.7ms inference, 57.5ms postprocess per image at shape (1, 3, 648, 648)

```

Fig 6.2 Run Cell

The experimental results confirm that the proposed Smart Helmet Detection System using deep learning and computer vision is capable of accurately identifying helmet and non-helmet riders, thereby improving road safety monitoring.

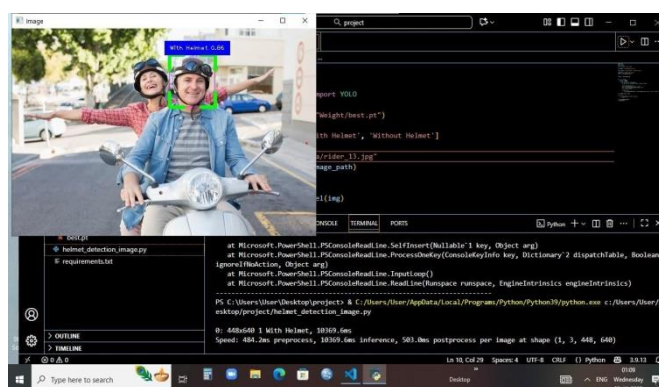


Fig 6.3 Output page

The output page displays the result of the Smart Helmet Detection System after processing the input image. The system identifies motorbike riders and classifies them as “With Helmet” or “Without Helmet” using a deep learning

model. Helmet – for riders wearing helmets (green box). Bounding boxes are drawn around the detected riders along with class labels and confidence scores. [9]

## 7. ACKNOWLEDGEMENT

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## REFERECES

- [1] Redmon, J., & Farhadi, A. (2018). YOLOv3: An Incremental Improvement. arXiv preprint arXiv:1804.02767.
- [2] Bochkovskiy, A., Wang, C.-Y., & Liao, H.-Y. M. (2020). \*YOLOv4: Optimal Speed and Accuracy of Object Detection. arXiv preprint arXiv:2004.10934.
- [3] Girshick, R. (2015). Fast R-CNN. Proceedings of the IEEE International Conference on Computer Vision (ICCV), 1440–1448.
- [4] Ren, S., He, K., Girshick, R., & Sun, J. (2017). Faster R-CNN: Towards Real-Time Object Detection with Region Proposal Networks. IEEE Transactions on Pattern Analysis and Machine Intelligence, 39(6), 1137–1149.
- [5] Howard, A. G., et al. (2017). MobileNets: Efficient Convolutional Neural Networks for Mobile Vision Applications. arXiv preprint arXiv:1704.04861.
- [6] Kumar, M., & Singh, R. (2022). Helmet Detection Using Deep Learning and Computer Vision Techniques. International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE), 10(4), 1123–1130.
- [7] Raj, S., & Sharma, P. (2021). S mart Helmet System for Accident Detection and Safety Using IoT and AI. International Research Journal of Engineering and Technology (IRJET), 8(9), 2340–2346.
- [8] Joseph, M., & Abraham, B. (2020). Automatic Helmet Detection Using YOLO and OpenCV. International Journal of Computer Applications, 176(19), 10–15.
- [9] Zhang, Y., & Zhao, X. (2023). Improved Object Detection for Traffic Safety Monitoring Using Deep Learning. IEEE Access, 11, 45678–45689
- [10] Li, H., & Chen, Z. (2022). A Real-Time Helmet Detection Approach Based on YOLOv5 Model. Journal of Intelligent Transportation Systems, 26(7).