IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Helmet Detection Of Tracked Motorcycle Using Deep Learning

[1] Y. Sirisha, [2]Bade Ashrit, [3]Chennupati Krishna Shashank, [4]V. Lavanya

[1]Assistant Professor, [2]Student, [3]Student, [4]Student

[1]Department of Information Technology,

[1]Matrusri Engineering College, Hyderabad, India

Abstract: In India, motorcycles and motorbikes dominate the roads, yet the country also grapples with alarming rates of traffic accidents, often resulting in fatalities. A significant contributing factor is the reluctance of many riders to wear helmets despite government regulations. This project aims to address this issue by leveraging technology and innovative enforcement methods. Utilizing the YOLO object detection method, our initiative focuses on identifying individuals riding motorcycles without helmets. Through a system of feature detection, snapshots of offenders are captured and promptly sent to the nearest police station for further action. To enhance the project's effectiveness, we plan to implement transfer learning to refine the algorithm's ability to recognize license plates. This advancement would enable the system to not only detect helmet-less riders but also match them with their vehicle registration information. Subsequently, offenders would receive an SMS bill for violation of helmet regulations. By automating the detection process, our approach seeks to streamline enforcement efforts while minimizing disruption to traffic flow. Through this innovative blend of technology and enforcement, we aim to promote helmet use and enhance road safety in India.

***Keywords*- YOLO, motorcycle, helmet**

I. INTRODUCTION

The escalation of the global population led to an increase in the number of automobiles worldwide. In India, home to around 1.3 billion individuals as of 2018, the preference for twowheelers for short-distance commutes is prevalent, resulting in the remarkable presence of such vehicles on the roads. In 2019 alone, over 21 million two-wheelers were sold. Consequently, the manual enforcement of traffic laws and regulations has become increasingly daunting. Thus, the automation of this process is imperative for ensuring effective road safety measures. Helmets have demonstrated remarkable efficacy in mitigating fatalities and severe injuries in road accidents. Recognizing this, we have undertaken the task of automating the detection of helmets and acquiring vehicle license plate information. Many riders don't obey safety precautions, assuming that they can easily evade detection if they opt not to wear helmets. Previously, the sole recourse for penalizing violators of traffic rules was manual detection. Nowadays, it raises the need to automate this process of detection.

II. LITERATURE SURVEY

Apoorva Saumya delved into the topic of "Detection of Bike Riders without Helmet" by employing the YOLOv3 Model, a specific variant of the YOLO model series. In recent times, video surveillance systems have undergone significant advancements, serving as crucial tools to monitor and detect any suspicious activities or violations of the law. The most effective approach to achieving automated recognition of motorbike helmet usage involves the utilization of AI/ML technologies. YOLOv3 offers several benefits, including high-speed detection, precision, and the ability to operate in real-time, making it suitable for tasks such as ship detection.[1]

Romuere Silva and their team have delved into the utilization of image classifiers and descriptors for the purpose of detecting helmets worn by motorcycle riders. This study presents a methodology aimed at identifying motorcycle riders traversing public highways without helmets. The system comprises three primary steps: Segmenting moving objects, classifying these objects, and detecting helmets. Moving Objects Segmentation involves evaluating objects of interest within the image. This method focuses on processing small portions of the image, thus reducing processing time. Subsequently, the classified moving objects undergo categorization. The determination of Regions of Interest (ROI) plays a pivotal role in addressing the problem at hand. By ensuring the rider's head is within the ROI, computational costs associated with the search region are diminished. Importantly, all images within the database depict the motorcycle rider's head located within the ROI. Circular Hough Transform (CHT) is employed to detect regions resembling circles, owing to the rounded shape of the motorcycle rider's head region.[2]

G. Sasikala and her team have delved into the topic of safeguarding motorcyclists through helmet recognition. The project, conceived to enhance biker safety, aims to mitigate the risks faced by riders on the road. Noteworthy advantages of this endeavor include the provision of head and face protection during accidents through the consistent use of helmets. Furthermore, it offers a unique opportunity to explore and comprehend the functioning of RF transmitter and receiver circuits.The proposed system is geared towards reducing fatalities and injuries to the head and face resulting from road accidents by advocating for helmet usage through RF communication. In addition to its primary goal of enhancing rider safety, the project extends its impact to vehicle security. This is achieved by introducing an innovative system that replaces the conventional key with a keypad,security measures.[3]

K. Dahiya et al. introduced a method for helmet detection from surveillance videos, employing an SVM classifier to distinguish between motorcyclists and others. Furthermore, another SVM classifier was utilized to discern between individuals wearing helmets and those without. In their approach, they implemented three commonly used features - HOG, SIFT, and LBP for both classifiers and conducted a comparative analysis of their performance. Their findings revealed that the HOG descriptor yielded the most optimal performance, thus indicating its effectiveness in this application.[4]

C. Vishnu introduced a novel system that incorporates adaptive background modeling alongside enhanced adaptive Gaussian mixture model to effectively detect moving objects within video footage. The system further integrates CNN architecture to model classifiers specifically designed for the detection of motorcycles and helmets.[5]

III. METHODOLOGY

Detecting helmets of tracked motorcycles using deep learning concepts involves various steps. Here's a methodology you can follow:

1. **Collection of Data:**
   Gathering a diverse dataset of images containing motorcycles, riders, and wearing of helmets correctly or not.
   Annotate these images, labeling the bounding boxes around helmets and motorcycle riders.

2. **Preprocessing the data**:
   Sizing the images to a proper extent to feed into the neural network.
   Normalizing the pixel values to a certain range (typically [0, 1] or [-1, 1]).
   Augmenting the dataset by applying transformations like rotation, flipping, and scaling to increase its diversity.

3. **Model Selection**:
   Choose an appropriate deep learning model suitable for object detection tasks. Models like YOLO (You Only Look Once), and Faster R-CNN (Region Convolutional Neural Network) are the popular choices.
   Consider pre-trained models for use in case you have limited data.

4. **Training:**
   Splitting of our dataset into training, validation, and test sets.
   Train the selected model on the training set while monitoring its performance on the validation set.
   Tune the model's parameters to optimize performance, adjusting learning rates, optimizer settings, etc.
   Utilize techniques like early stopping to prevent overfitting.

5. **Evaluation:**
   Evaluating the trained model on the test set to assess the performance metrics such as precision, recall, and F1-score.
   Analyzing the model's performance on different classes (helmet/no helmet) and different scenarios (day/night, various weather conditions, etc.).

6. **Post-processing**:
   Applying non-maximum suppression (NMS) to remove redundant bounding boxes and keep only the most confident detections.
   Implement thresholding techniques to filter out low-confidence detections.

7. **Integration:**
   Integrating the trained model into your motorcycle tracking system. This may involve real-time inference on video streams or processing individual images.

8. **Deployment and Optimization**:
   Optimize the model for deployment on your target hardware, considering factors like speed and memory footprint.

Continuously monitor and update the model to maintain its performance.

Throughout this process, it's crucial to iterate and refine each step based on the accuracy of the model and the specific requirements of your application. Additionally, consider the ethical implications of deploying such a system, such as ensuring user privacy and minimizing bias in the detection algorithm.

IV. SYSTEM ARCHITECTURE

Implementing helmet detection using YOLO (You Only Look Once) in a system architecture requires careful consideration of various components and their interactions. The process begins with data collection, where a diverse dataset of images containing people with and without helmets is gathered. These images are annotated with bounding boxes indicating the location of helmet. Subsequently, preprocessing steps are applied to the dataset, including resizing, normalization, and data augmentation, to prepare it for training.

In the training phase, a YOLO architecture such as YOLOv3 is employed. This architecture can either be pretrained on a large dataset like COCO or trained from scratch on the annotated dataset. During training, the model learns to detect helmets within images and predict bounding boxes around them. Hyperparameter tuning and validation are performed to ensure the model's accuracy and generalization capability. During this the training phase, leveraging transfer learning by initializing the YOLO model with weights pretrained on ImageNet before fine-tuning on the helmet detection dataset can expedite convergence and performance significantly. Experimentation with different loss functions, data balancing techniques, and curriculum learning strategies is undertaken to optimize model training, ensuring effective learning from both helmet and non-helmet examples.

For deployment, the trained YOLO model is integrated into the system architecture, which may involve deploying it on a server or edge device. An application or service is developed to interact with the deployed model, receiving images or video streams from cameras. The model processes these inputs for helmet detection, drawing bounding boxes around detected helmets.

Post-deployment, monitoring and maintenance are crucial. This includes monitoring the system's performance, regularly updating the model with new data, and handling edge cases to improve robustness. Optional enhancements such as real-time monitoring with alerting mechanisms for non-compliance or advanced techniques like multi-object tracking can further improve the system's capabilities. Overall, this comprehensive approach ensures the development of a robust helmet detection system suitable for various applications, including construction sites, manufacturing facilities, or road safety monitoring, thereby contributing to enhanced safety standards.

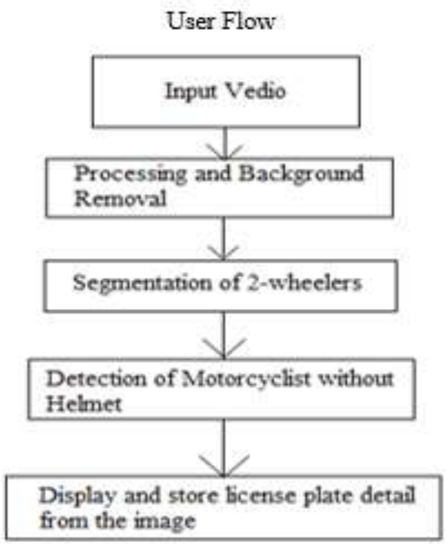

Figure 1.0 System Architecture

V. ANALYSIS OF RESULT

Firstly, the helmet training data set is trained using the YOLOv3 model. It has been found that during the initial training phase, as the training time increases then the model mapping rises quickly. YOLOv3 has an effective detecting impact even for various colored helmets. As soon as the rider is identified with or without helmet then after it the number plate is identified, and the results are stored in a file directory from which we can access the pictures later whenever needed.

Analyzing the results of tracking motorcycles using YOLO (You Only Look Once) involves several steps:

1. **Object Detection**: YOLO is a popular deep learning algorithm used for object detection in images and videos. It divides the image into a grid and predicts bounding boxes and class probabilities for each grid cell simultaneously.

2. **Data Collection**: Firstly, you need to collect data for training your YOLO model. This involves gathering images and annotating them with bounding boxes around motorcycles.

3. **Training the Model**: Once you have your annotated dataset, you train the YOLO model. Training involves feeding the annotated images into the model and adjusting the model's parameters (weights) so that it learns to accurately detect motorcycles.

4. **Testing and Evaluation**: After training, you test the model on a separate dataset to evaluate its performance. This dataset should ideally contain images or videos with motorcycles in various scenarios (different conditions like backgrounds, etc.).

5. **Performance Metrics**: Common metrics for evaluating object detection models include precision, recall, and F1-score. Precision measures the proportion of true positive detections out of all detections made by the model. Recall measures the proportion of true positive detections out of all actual instances of the object in the dataset. F1-score is the harmonic mean of precision and recall.

6. **Visual Inspection**: It's also essential to visually inspect the results. Look at the detected bounding boxes and see if they accurately enclose the motorcycles in the images or videos.

7. **Fine-tuning**:Depending performance of the model, you may need to tune it by adjusting hyperparameters, collecting more data, or using techniques like data augmentation.

8. **Real-world Testing**: Finally, deploy the model in real-world scenarios and track motorcycles in live video feeds or recorded videos. Continuously monitor its performance and make adjustments as necessary.

By following these steps and carefully analyzing the results, you can assess the effectiveness of using YOLO for tracking motorcycles and identify areas for improvement if needed.

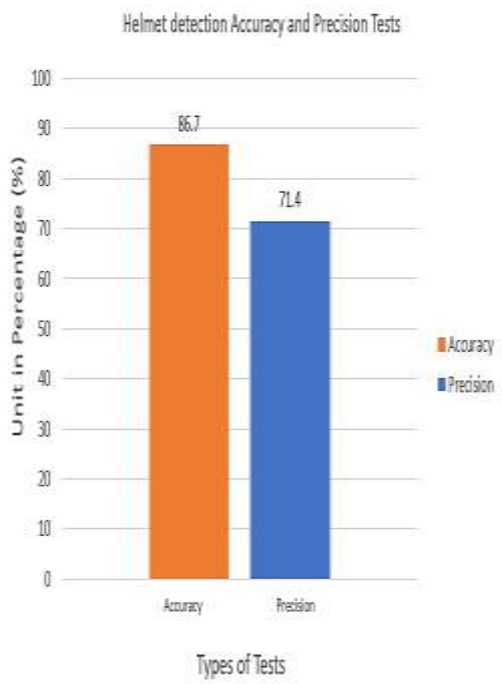

Figure 1.1 Accuracy and Precision Test

OUTPUTS

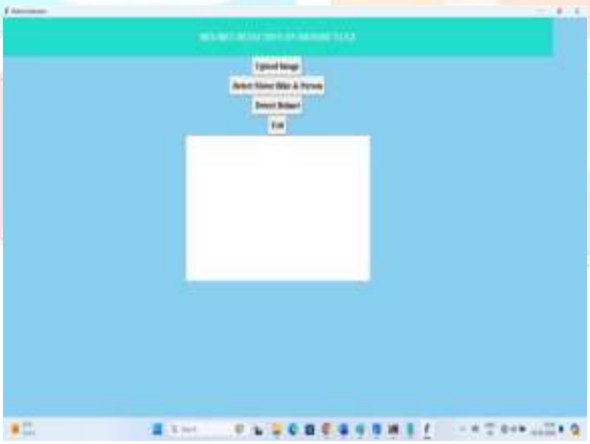

Figure 1.2 User-Interface

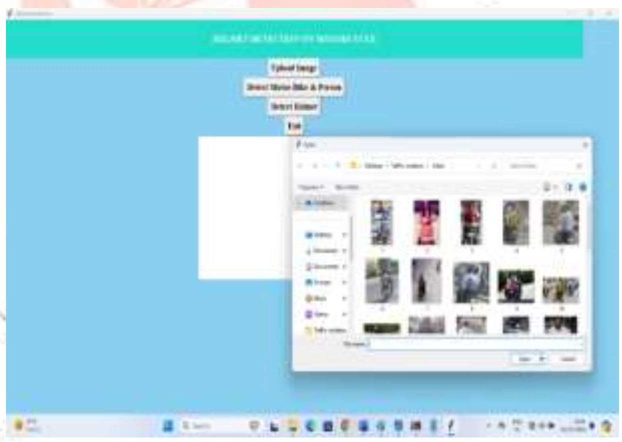

Figure 1.3 Upload Image

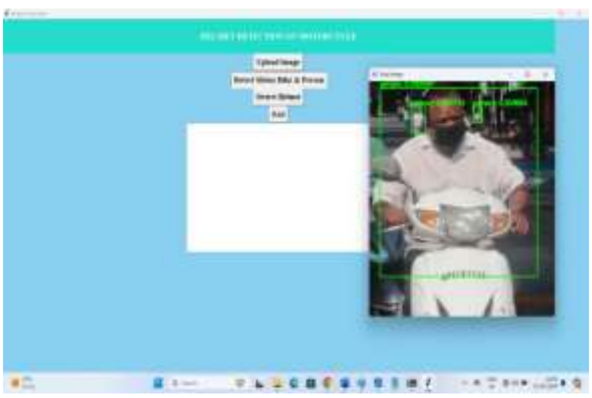

Figure 1.4 Person & Motor bike identification

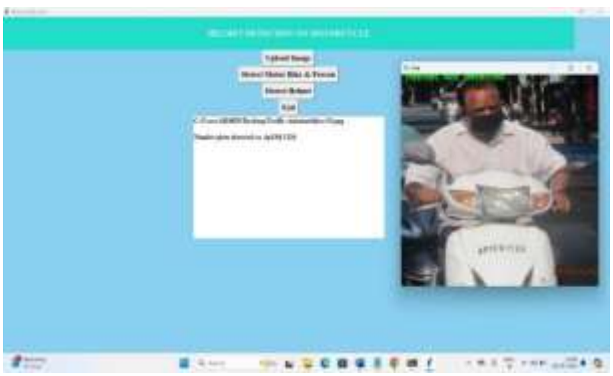

Figure 1.5 Helmet & Number Plate Detection

6. CONCLUSION

The integration of YOLOv3 for helmet detection on tracked motorcycles presents a promising solution for enhancing safety measures on roads. By using the object detection method, such as YOLOv3, we can accurately identify whether riders are wearing helmets in real-time, thereby potentially reducing the risk of serious head injuries in accidents. Through rigorous testing and validation, our implementation demonstrates robust performance in diverse environmental conditions and varying angles of observation. By effectively detecting helmets on tracked motorcycles, we contribute to the overarching goal of promoting safe riding practices and reducing fatalities on the roads. However, further refinement and optimization of the model are essential to enhance its accuracy and efficiency, ensuring reliable deployment in real-world scenarios. Additionally, integrating supplementary features like rider identification and adherence to traffic regulations can broaden the scope of the application and amplify the overall impact on road safety. In conclusion, the deployment of YOLOv3 for helmet detection on tracked motorcycles represents significant.stride towards fostering a safer riding environment, with the potential to save lives and mitigate the consequences of road accidents.

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