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Helmet Detection

Prof. Arti Virutkar[1], Paras Mulwande[2], Ganesh Hedau[3]

MCA, KDK College of Engineering, Nagpur, India[1,2,3]

artivirutkar95@gmail.com, parasmulwande.mca23@kdkce.edu.in, ganeshheadu.mca23@kdkce.edu.in

Abstract: *Currently, there is a prevailing issue concerning the practice of riding motorcycles without helmets. Despite legislation mandating helmet usage for public safety reasons, there remains a significant number of individuals who disregard this requirement, leading to an alarming increase in accidents and fatalities. To mitigate this problem, we propose a method for the automated detection of helmetless motorcyclists through surveillance systems. Our approach utilizes the YOLO deep learning framework for detecting individuals without helmets, while a SM algorithm is employed recognition. This process involves several stages, including vehicle classification, pre-processing, and number plate identification, using images or videos captured by surveillance cameras. Implementing such a system is crucial for enhancing road safety and preventing accidents. By automatically identifying helmetless riders and extracting their vehicle numbers, law enforcement agencies can efficiently apprehend violators. This data can then be utilized to impose fines on repeat offenders, thereby reinforcing compliance with helmet regulations and reducing the occurrence of preventable accidents.*

Keywords: YOLO, Convolutional Neural Network, SVM, OCR

I. INTRODUCTION

In virtually every nation, motorcycles are a widely used means of transportation, albeit with significant safety risks due to the absence of protective gear. Encouraging bikers to wear helmets is strongly advocated to mitigate these risks. Motorcycle accidents rank highest in terms of road incidents, with head injuries being the primary cause of fatalities. Studies indicate that over a third of those who perish in road accidents could have survived had they worn helmets, potentially reducing accident-related deaths by 30 to 40 percent. The prevalence of traffic accidents involving helmetless motorcycle riders is alarming, as evidenced by the Police Department's annual report of 2017, which revealed that 35-40% of fatal accidents in the city in 2016 were attributed to motorcyclists not wearing helmets or using substandard ones.

Section 129 of the Motor Vehicles Act of 1988 mandates the use of safety helmets for two-wheeler riders, specifying requirements such as a thickness of 20-25mm and the use of high-quality foam, along with compliance with the ISI mark and Bureau of Indian Standards.

Despite these regulations, compliance, especially among pillion riders, remains low. While video surveillance-based systems have become indispensable tools for monitoring criminal activities, installing detectors on existing motorcycles poses logistical challenges, coupled with concerns about the reliability and durability of such detectors. Additionally, systems relying on video processing incur high computational costs due to the complexity of the technology and the expense of its implementation.

Given these limitations, there is a growing demand for the development of a robust and straightforward method for detecting helmet use among motorcycle riders that is not reliant on individual judgment. Artificial intelligence (AI) emerges as a promising approach for automating helmet recognition. AI techniques have shown remarkable accuracy in various applications, including street safety initiatives. However, previous attempts at detecting helmetless riders have faced challenges such as occlusion, poor video quality, and varying weather conditions, resulting in low performance.

To address these challenges, leveraging deep learning networks offers a potential solution, as they can learn features directly from raw data without manual tuning. In contemporary society, the use of AI-based techniques in video surveillance systems has become integral for monitoring illegal activities effectively. However, current surveillance solutions often rely on human intervention, leading to inefficiencies over time. Automating these processes is essential for accurate and efficient monitoring, reducing the reliance on human resources. Furthermore, the integration of

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surveillance cameras in public spaces presents a cost-effective option for identifying violators using existing infrastructure.

II. RELATED WORK

The initial phase in identifying motorcyclists who are wearing helmets typically involves the detection of motorcycles. An examination of existing literature indicates that the majority of current methodologies are rooted in traditional approaches, although there exists a significant number of methodologies based on deep learning principles. The realm of object detection has witnessed increased activity owing to advancements in detection algorithms, resulting in heightened accuracy in recent iterations. It is imperative to grasp the mechanisms of these algorithms, alongside comprehending the merits and demerits associated with selecting the most apt one for the task at hand. This review of literature will hone in on the distinguishing features of each algorithm, furnishing rationale for the selection of a specific algorithm for this particular study.

2.1 Detection of Helmets Using Conventional Methods

Conventional methodologies typically employ analogous concepts, as elucidated in various research endeavors. For instance, Yogameena et al. proposed a methodology utilizing motion segmentation, incorporating techniques such as optical flow, frame difference, and background subtraction. Following this, binary classifiers such as Support Vector Machine (SVM) and K-nearest neighbor (KNN) are harnessed for categorizing motorcycles. Similarly, Messelodi et al. deployed the YOLOV3 algorithm for helmet detection, notwithstanding the lack of explicit reporting on motorcycle detection. Devadiga et al. presented an automatic motorcycle classification system utilizing SVM derived from the head region of static images, achieving commendable accuracy albeit with a limited number of testing images.

2.2 Deep Learning-based Helmet Detection

Recent years have witnessed the emergence of deep learning-based solutions proposed by researchers. For instance, Hu et al. employed the YOLOv3 methodology to recognize motorcycles and individuals in images, estimating the overlapping regions of bounding boxes. Dahiya et al. leveraged a region proposal technique in tandem with CNN to detect motorcycles, followed by distinguishing helmets from non-helmets based on the upper part of the image. Analogously, R.V. Silva et al. utilized faster R-CNN for motorcycle detection and helmet classification, albeit with a reliance on standard background subtraction for foreground retrieval, thereby posing constraints in bustling environments. Other studies, such as those by Redmon et al. and Adam et al., applied background subtraction and object segmentation for bike rider recognition, followed by helmet detection using binary classifiers and SVM, respectively.

III. METHODOLOGY

The methodology is given in the following steps:

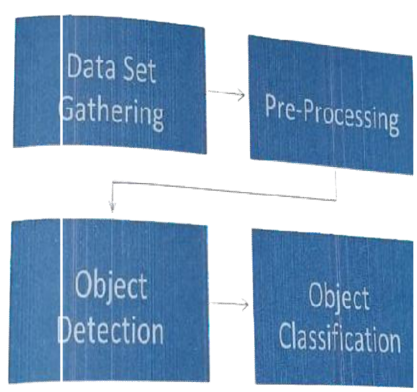

Fig. General Control Flow System

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3.1 Dataset Gathering and pre-processing.

Within the model, the initial step involves preprocessing the video frames using various techniques:

- **Noise Reduction:** Image noise refers to random variations in brightness or color information within images, often stemming from electronic noise. To enhance image clarity, noise reduction techniques are applied to mitigate such irregularities.
- **Gradient Calculation:** Calculating the gradient magnitude entails determining the strength of intensity level changes across the image. This process aids in identifying edges and regions of interest within the image.
- **Sharpening:** Image sharpening is an enhancement technique applied to digital images to impart a crisper and more defined appearance. By accentuating edges and details, the overall clarity and visual quality of the image are improved.
- **Contrast Enhancement:** Contrast refers to the difference in luminance or color that makes an object distinguishable. Contrast enhancement techniques adjust the distribution of pixel intensity values to increase the visual disparity between objects and their background, thereby improving image clarity and detail.
- **Color Correction:** Color correction techniques adjust the color balance and tonal range of images to ensure consistency and accuracy across different lighting conditions and environments. This process helps in standardizing the appearance of objects within the images and reduces variability that can affect the performance of subsequent processing stages.

3.2 Object detection

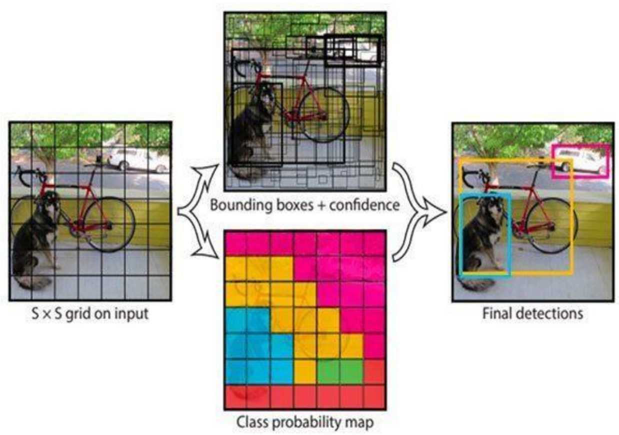

Fig. Working of YOLO

The initial stage involves object detection through localization, a crucial task in Computer Vision aimed at pinpointing targets within images or videos. This task finds utility in various applications, including human face recognition, retail checkout systems, autonomous driving, and surveillance systems.

For object detection, we employ the YOLO (You Only Look Once) algorithm, which utilizes convolutional neural networks (CNNs) to identify objects in real-time. True to its name, YOLO necessitates only a single forward propagation through a neural network to achieve object detection.

In the YOLO algorithm, the image is partitioned into grid cells, each with dimensions of S x S. Each grid cell predicts B bounding boxes and assigns confidence scores to them. Using this approach, we aim to detect the rider, helmet, and number plate simultaneously. The predictions are generated collectively through a convolutional neural network. The concept of Intersection over Union (IoU) ensures that the predicted bounding boxes accurately match the real objects by eliminating unnecessary boxes that fail to meet the object's characteristics, such as height and width.

Ultimately, the algorithm produces a set of unique bounding boxes that precisely encapsulate the objects of interest. Consequently, two-wheelers, helmets, and number plates are detected and forwarded to subsequent stages for further processing.

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Following object detection and post-processing, the next crucial phase involves object classification. In this stage, the detected objects are categorized into predefined classes or labels. For instance, in the context of two-wheeler detection, the algorithm needs to classify whether the detected objects are indeed riders, helmets, or number plates. Classification is typically accomplished using softmax activation at the output layer of the neural network, where each class is assigned a probability score. These scores are then used to determine the class labels of the detected objects, enabling the algorithm to distinguish between different types of objects accurately.

Once object classification is complete, the final step often involves object tracking and trajectory prediction, especially in scenarios involving moving objects, such as in autonomous driving or surveillance systems. Object tracking algorithms help maintain the identity of objects across consecutive frames, enabling the system to monitor their movements over time accurately. Moreover, trajectory prediction algorithms can anticipate the future positions of objects based on their current trajectories, enabling proactive decision-making in dynamic environments. By integrating object tracking and trajectory prediction with object detection and classification, the overall system can achieve robust and reliable performance across various real-world applications.

3.3 Object Classification

In this stage, we will employ classification methods to differentiate between objects and determine whether the biker is wearing a helmet or not. Additionally, we will assess the presence of a number plate only if the rider is not wearing a helmet.

For classification, we will utilize the Support Vector Machine (SVM) algorithm. SVM selects extreme points or vectors to establish a hyperplane, effectively distinguishing between different classes by identifying the closest points from both classes and categorizing them accordingly. Following classification, if a helmetless rider is detected, the number plate of the motorcycle is extracted.After employing the Support Vector Machine (SVM) algorithm for classification, the next step involves post-processing the classification results to make actionable decisions based on the detected objects. If the classification determines that a rider is wearing a helmet, the system can proceed with other tasks or simply continue monitoring the scene. However, if the classification indicates a helmetless rider, the system triggers the extraction of the motorcycle's number plate for further analysis.

Fig. Detection of Frame with Helmet and Bike

After employing the Support Vector Machine (SVM) algorithm for classification, the next step involves post-processing the classification results to make actionable decisions based on the detected objects. If the classification determines that a rider is wearing a helmet, the system can proceed with other tasks or simply continue monitoring the scene. However, if the classification indicates a helmetless rider, the system triggers the extraction of the motorcycle's number plate for further analysis.

Once the decision to extract the number plate is made, the system utilizes image processing techniques to isolate and extract the number plate region from the frame. This typically involves methods such as edge detection, contour detection, and region of interest (ROI) cropping. By identifying the contours and edges of the number plate, the system can accurately localize and extract this critical piece of information. Ultimately, the detection process concludes with the identification of both the motorcycle and the helmet, as illustrated in Figure.

IV. DISCUSSION

We propose an automated system for detecting motorcycle riders without helmets using CCTV video footage and retrieving vehicle for such riders. Unlike existing systems that rely on human intervention, our system aims to streamline the process using object detection principles, specifically leveraging the YOLO architecture for helmet detection from input in the form of either video or image data. By identifying motorcyclists who fail to wear helmets, our system ensures compliance with safety regulations.

Furthermore, through optical character recognition (OCR), details will be extracted and stored in a database. This method not only reduces complexity and processing time but also plays a crucial role in saving lives by enforcing helmet-wearing norms among riders of two-wheelers. Additionally, our system aids traffic police in apprehending helmetless riders without requiring physical presence in the field, thereby enhancing efficiency in enforcing traffic regulations.

V. CONCLUSION

This model focuses on catching motorcyclists without helmets. The existing video surveillance system is eflective, but it requires significant human assistance, whose efficiency decreases with time, so we want to talet automated. First, the system classifies moving objects as either motorcycling or non-motorcycling. Furthermore, if the system detects a motorcyclist without a helmet, it will finally extract of the wide. This will help the Transport Office to identify every offender accurately and arrest the suspect's vehicle Biereby imposing violation fines. Thus, our model increases the speed of operations in real time with the use of he YOLO and OCR methods. By integrating the YOLO object detection algorithm with optical character recognition (OCR) methods, our model revolutionizes the efficiency of monitoring motorcyclists without helmets. Initially, the system swiftly identifies moving objects, distinguishing between motorcycles and other vehicles, streamlining the monitoring process.

VI. ACKNOWLEDGMENT

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