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Helmet Detection of Two-wheeler Riders by Image Processing using YOLO Algorithm

[1]**Dr.S.Muthukumar** [2]**Aravind K** [3]**Baskar B**
[1]Associate Professor [2&3]Final Year Students
Department of Computer Science and Engineering, Sree Sowdambika College of Engineering, India.
[1]muthukumar.miste@gmail.com [2]aravindk4541@gmail.com [3]baskarthika2@gmail.com

ABSTRACT

Motorcycle accidents are a significant public concern worldwide. Accidents have been increasing rapidly which leads to the loss of several lives. One of the main contributing factors to the severity of injuries in these accidentsis the lack of helmet use. Though the usage of helmets is necessary, it is also considered a piece of mandatory safety equipment among drivers, but they do not make use of it which causes unfortunate incidents to take place. Traffic police do try to bring awareness among the people but most of the population refuses to follow them. To avoid such incidents and to detect people from breaking the rules, this research was introduced. Here, we present a study based on an automated helmet detection system for motorcyclists using the combined techniques of YOLO and CNN. The combination of these image processing techniques such as You Only Look Once (YOLO) and Convolutional Neural Network (CNN) helps in the identification of helmets from image datasets. Because of this combination, the model can accurately identify helmets with a high degree of reliability due to the use of image datasets. And due to this combination, our system can accurately detect helmets with an accuracy of 94.29%.

Keywords– CNN, Helmet, Motorcycle, Object Detection, YOLO

I. INTRODUCTION

Traffic violations and road accidents have become very common in our life. And especially all these occur in big cities. Civilized areas are not the only location facing these issues. Even uncivilized areas face a lot of accidents and most of the faults fall on the driver. Majority of the accidents are caused by the carelessness of the driver and most of the fault is because of not realizing the importance of helmets on motor bikers. An act that was passed in 1973 applies to those who are using a motorcycle at work. A rule states that a motor biker who does not wear a helmet will be asked to pay afine or in the cancellation of their driver's license. Police officers and law enforcers force people to pay a penalty which will become a ruckus. Instead of creating such a mess with all of this, you can develop a method to detect and identify helmets.

The main objective here is to boost road safety by ensuring that motorcycle riders wear helmets at all times. Several research studies have been done to detect helmets on motorbikes with the help of several techniques. But, this studyfocuses on getting a higher accuracy rate with the combined technique of YOLO and CNN. This combination will surely ensure an effective object detection process. It will also helpin the extraction of features in a more accurate sense.

II. LITERATURE REVIEW

There has been so much research on the detection of helmets. Each research is done using various algorithms. The algorithms are put into two categories.

A. Helmet Detection using Deep Learning Methods*:*

In [1], the authors have used Optical Character Recognition over real-time video camera footage to detect helmets among riders. In [2], the authors proposed a method where the helmet is detected with the help of a deep learning method called YOLO. In [3], The system mentioned is achieved by using a YOLO deep learning darknet framework that consists of CNN where it is trained using COCO and Computer Vision. In [4], the authors proposed a way for all motorcycle riders who do not wish to follow the rules and wear helmets. They identified riders with helmets from video camera footage. They use CNN to identify motor bikers along with a residual network type. In [7], the authors have used YOLO to distinguish if the riders wear helmets or not. In [8], the authors proposed a method where multiple learning method is used using for detecting the motorbikes of every passenger. In [9], the authors propose a deep-learning method that detects helmets by using data from video cameras.

B. Helmet Detection using Traditional Methods*:*

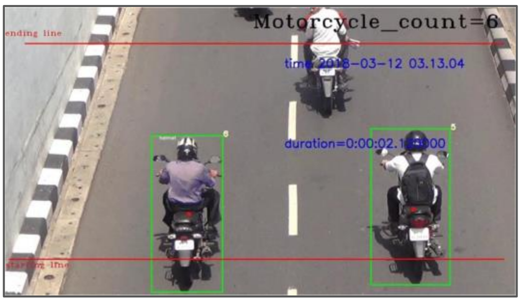
In [5], the authors proposed a method where helmets andvehicles are detected and classified using CHT, Wavelet Transform (WT), HOG, and Multilayer Perceptron (MLP). In [6], the authors mentioned a method where a system is made using Image Processing which will detect riders who violatethe law. In [10], the authors have used the CHT and HOG to detect riders with or without helmets. MLP is used to obtain the end results

III. METHODOLOGY

The planned methodology of this proposed system is to create a helmet detection system for motorcyclists from image datasets using the combined techniques of YOLO and CNN. The system aims to improve rider safety by detecting whether the motor biker is using a helmet or not using image datasets. The system is composed of several key components which include image capturing, image pre-processing, feature extraction, object detection, and result evaluation. The system components are represented in Fig.5.

A. Video feed from camera

In the system designed for helmet detection on two-wheelers, a pivotal component is the camera mounted on the vehicle to capture live video feed of the rider This camera serves as the primary sensory input for the artificial intelligence system, providing real-time visual data of the rider's actions and surroundings. By capturing the rider's movements and behaviors, including whether they are wearing a helmet or not, the camera enables continuous monitoring of helmet compliance. The live video feed offers crucial insights into the rider's safety practices, allowing the system to promptly intervene if a helmet is not detected. The camera provides contextual information about the rider's environment, such as traffic conditions and road obstacles, which may further enhance the overall safety assessment. This role in capturing live video feed is essential for the effective operation of the helmet detection system, enabling proactive measures to promote rider safety on two-wheelers



B. Capture the image

In the helmet detection system for two-wheelers, image capture plays a crucial role in acquiring the necessary data for analysis. Frames from the live video feed captured by the mounted camera are extracted at regular intervals to create individual images. These images represent specific moments in time and serve as input for the subsequent stages of processing and analysis. By capturing frames at regular intervals, the system ensures a continuous flow of data for helmet detection, enabling real-time monitoring of the rider's helmet status. This approach allows for efficient utilization of computational resources and facilitates timely decision-making regarding helmet compliance. Is a critical step in the helmet detection process, enabling the system to analyze the rider's behavior and take appropriate action to promote safety on two-wheelers?

Fig. 2. Image Annotation

C. Preprocessing

In the helmet detection system for two-wheelers, preprocessing plays a vital role in preparing the captured images for subsequent analysis. Once frames are extracted from the live video feed, they undergo several preprocessing steps to enhance their quality and suitability for further analysis. Resizing is performed to ensure that all images have consistent dimensions, facilitating efficient processing and reducing computational complexity. Normalization techniques are applied to standardize the pixel values across images, making them more suitable for comparison and analysis. The noise reduction methods, such as Gaussian blurring or median filtering, are employed to mitigate the effects of noise and improve the clarity of the images. By undergoing these pre-processing steps, the captured images are optimized for accurate helmet detection, enabling the system to effectively analyze the rider's helmet status and take appropriate action to ensure safety on two-wheelers.

D. Feature extraction

In the helmet detection system for two-wheelers, feature extraction is a critical step aimed at capturing relevant information from pre-processed images to distinguish between helmet-wearing and non-helmet-wearing states. Features such as colour, shape, and texture are extracted from the preprocessed images to represent key characteristics associated with helmets. Colour features can capture the distinctive color patterns of helmets, while shape features focus on the overall silhouette and structure of potential helmets in the image. Texture features, on the other hand, provide information about the surface characteristics of objects, which can help differentiate between helmets and other objects or backgrounds in the scene. By extracting these features, the system aims to create a rich representation of the images that facilitates discrimination between helmet-wearing and non-helmet-wearing states. This enables the system to accurately identify instances where a helmet is present on the rider and take appropriate action to ensure compliance with safety regulations on two-wheelers

E. Training using CNN:

After the annotation of images, train the model along with the annotated images and by using the CNN algorithm. In

Fig.3, the pictorial understanding of CNN algorithm is given.

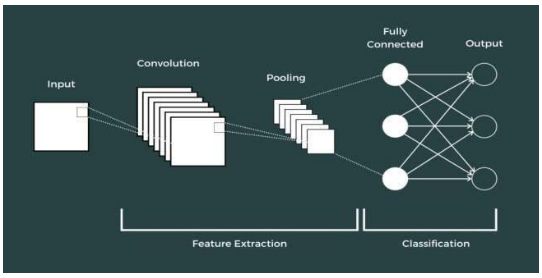


Fig. 3. Convolutional Neural Network (CNN)

F. Helmet Detection using YOLO:

Now, use the pre-trained CNN model to extract the necessary features and use YOLO algorithm which will take the entire image as input and splits the image into tiny cells. In Fig.4 , the pictorial understanding of YOLO algorithm is given.

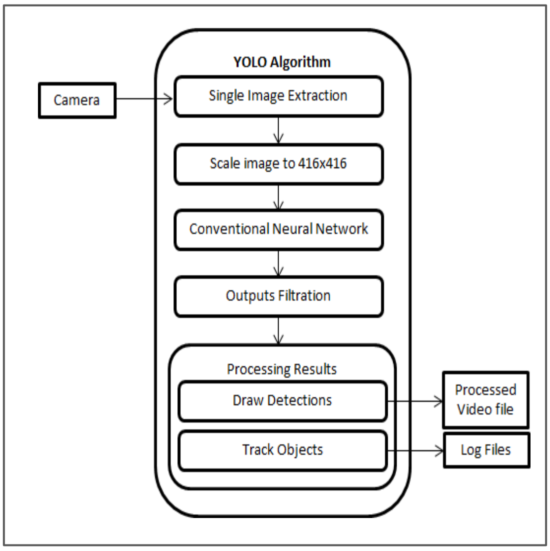


Fig. 4. You Only Look Once (YOLO) algorithm

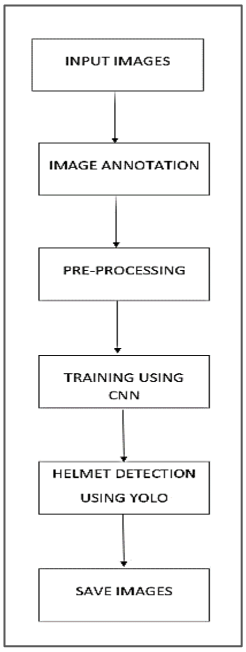


Fig. 5. Block Diagram

IV. EXPERIMENTAL ANALYSIS

In this study, the dataset is collected from Kaggle. In Fig.6, This dataset acquired consists of 30,000 images with riders who wear helmets and do not wear helmets and from that, based on testing, 13,000 images were of people withouthelmets and the rest of the 17,000 images were of people who wore helmets. The objective of this study is to identify if the biker uses a head gear or not.

Datasets	Helmet	No_Helmet	Images
Training	22,871	13,656	7,065
Validation	2,435	1,363	785
Testing	2,707	1,571	873

Fig. 6. Dataset Description

After performing image annotation, the data is labelled which will later be sent to pre-process. After pre-processing,the data is sent to be trained. In this process, the CNN algorithm is used for training. Later, the trained model will be used to detect helmets using the YOLO algorithm

A. Algorithm:

Step 1: Collect image datasets of motor bikers with and without helmets.

Step 2: Annotate the collected images and label the dataset.

Step 3: Pre-process the image dataset by using methods like cropping, resizing, etc to get a consistent quality image.

Step 4: Train the CNN model with general image datasetswhich will help in feature extraction.

Step 5: The trained CNN model will extract the necessaryfeatures from the pre-processed images.
Step 6: The features extracted are then sent for being detected and classification using the YOLO algorithm

B. Result Analysis:

This is the part where we present the results that were obtained after the experimental methodology. We have achieved an accuracy rate of over 94.29% over helmet detection on motorcycles which is provided in Fig.7. In Fig 8, the image represents the number of people who wore helmets and who did not wear helmets from the image datasets.

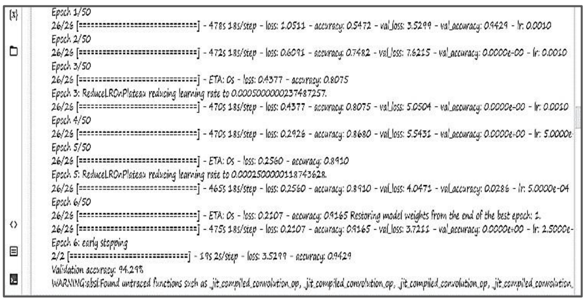


Fig. 7. Accuracy Rate

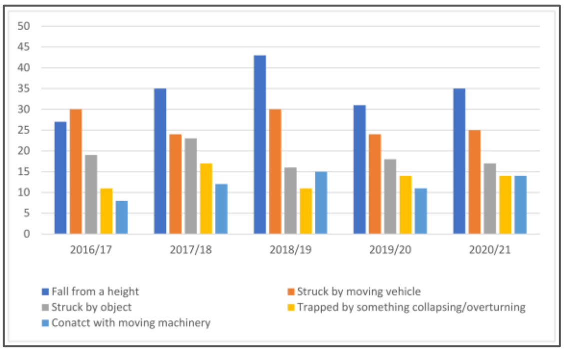


Fig.8 From the image datasets

V. CONCLUSIONS AND FUTURE STUDY DISCUSSIONS

Providing real-time alerts or feedback to the rider, encouraging helmet usage and promoting safer riding habits. Expanding the system to detect other safety gear or objects of interest, such as reflective clothing or road hazards, to further enhance rider safety. Integrating the helmet detection system with vehicle systems to enable features such as automatic emergency braking or adaptive cruise control based on the rider's safety status. In conclusion, the proposed system represents a significant step forward in enhancing road safety through innovative technological solutions. By utilizing the YOLO algorithm and artificial intelligence, the system effectively detects instances of helmet non-compliance among two-wheeler riders in real-time. The integration of automatic image capture and penalty generation mechanisms streamlines the enforcement process, facilitating swift action against violators. This proactive approach not only promotes adherence to helmet-wearing regulations but also serves as a deterrent to potential offenders, ultimately reducing the incidence of head injuries and fatalities on the roads. Moving forward, continued research and development in this field will be essential to further refine and expand the capabilities of such systems, ultimately contributing to safer and more sustainable transportation environments.

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