Helmet Detection Using Yolo ShiftInvariant Technique

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Abstract

The abstract for the project describes a computer vision system for detecting helmets worn by motorcyclists in real-time using You Only Look Once (YOLO) object detection method. The system is designed to perform in various lighting and surrounding circumstances and is capable of detecting helmets even when the wearer is in motion or there are shifts in the camera's perspective. The system is trained on an enormous dataset of annotated helmet photos and can accurately detect helmets with a high degree of precision and recall. The project demonstrates the potential of YOLO and deep learning techniques to improve road safety by automatically detecting and alerting riders who are not wearing helmets, helping to reduce the number of motorcycle-related accidents and fatalities.

Keywords— CNN, Computer vision, Deep learning, Helmet detection, model training, , Traffic data, YOLO

I. Introduction

In many regions, the levels of Throughout the years, the number of motorbike accidents has been rising gradually. Because of a number of economic as well as social variables, This kind of vehicle has become more and more common. The helmet is the most important piece of head protection for riders, although many riders neglect to wear one. The helmet's primary purpose in an accident is to prevent the driver's head. In the case of an accident, it might be dangerous if the rider fails to use it. The purpose of this research will provide a technique for identifying motorcycle riders who don't wear helmets. This automated System is widely utilized since it both significantly minimizes the number of human resources needed and enables accurate and thorough monitoring of these offenses. Several countries are also installing surveillance systems in public places.

The proposed technique uses the CNN model, a trusted variant of the CNN model to instantly detect bike riders. The best object-distinguishing algorithm helps distinguish between bikers wearing helmets and those who are not.

II. Technology used

Python is often used in applications that involve machine learning and computer vision, including the development of object detection models like YOLO (You Only Look Once).

Python may be used to run the design that implements the model and performs all the object detection in the context of helmet detection using the YOLO shift-invariant technique. To build and train object detection models, Python may be used in simultaneous analysis with machine learning and computer vision frameworks like TensorFlow, Keras, and OpenCV.

By reducing the model's sensitivity to small modifications in the positions of objects in

The image, the YOLO shift-invariant approach, a modification of the original YOLO algorithm, aims to improve the accuracy of object detection.

This improvement may be carried out with Python, and identified image datasets can be used to train and validate the resultant model. Python is essential to the success and development of helmet detection. utilizing the YOLO shift-invariant approach by providing the frameworks and methods required for creating and improving item detection models.

Although implementing the YOLO shift-invariant approach for helmet identification, CNNs are essential to the object detection process. To forecast the position and the kind of objects in a picture, they are utilized to develop feature maps that capture the essential spatial and semantic information in the image. The YOLO shift-invariant technique's multi-scale approach significantly improves the object detection process's accuracy and robustness.

With deep learning, it is feasible to predict the bounding boxes and classifiers of objects in a picture. As deep learning enables the model to learn intricate patterns and representations directly from the visual data input, it is important for this purpose. The YOLO shift-invariant model accurately helmets under a variety of light sources, viewpoints, and obstacle situations by just being trained on a large dataset of tagged helmet photos.

Moreover, the YOLO shift-invariant model is made very effective using deep learning, allowing it to recognize objects in real-time embedded devices security cameras. Due to this, it turns into a powerful resource for a wide range of situations where real-time object detection is required.

III. Related Works

[1] Applications of deep learning-based image processing frequently focus on target detection, with construction workers wearing safety helmets as a popular target. This study examines an enhanced YOLOv5-based strategy with the purpose of overcoming difficulties brought on by factors like dense targets, complex construction environment backdrops, and the uneven form of safety helmets. A Deformable Convolution Net is used in place of a regular convolution A Convolutional Block Attention Module is introduced to the Neck of a boot network to improve the form awareness of feature extraction. To dampen feature extraction of intricate backgrounds using weight of Convolutional Blocks, and the To better characterize the target characteristics, Distance Intersection over Union Loss is substituted for the original network's Generalized Intersection over Union Loss. In order to evaluate effectiveness of the strategy, open-source datasets and gathering of data automatically are combined in the form of a training dataset for the network. The new model out performs the network model by 2.3% and can recognise objects with an accuracy of 91.6% at a frame rate of 29 frames per second, which is typical of security camera frame rates.

[2] Electrical workers can greatly reduce their risk of electrical injury by always wearing their personal safety protection equipment (PSPE). Workers in substations are required to wear personal protective equipment (PPE), but they frequently do not because they are either unaware of the rule or find it uncomfortable. As a result, a PSPE and a detection algorithm personnel is needed for power substations with real-time video monitoring systems. In order to detect PSPE and substation personnel in real time, this study suggests a YOLOv3 technique with wearable upgrades. Before enhancing the data, we do gamma correction as a preprocessing method to more clearly observe the subtleties of the operators. In order to identify the ideal past boundary box dimensions and expedite identification, the K-means++ method then takes the place of The wear-enhanced K-means YOLOv3 technique. Then, employing transfer learning, the suggested strategy can be taught quickly and effectively. In the end, a massive archive of images showing people in helmets, gloves, and shoes undergoes a series of tests. This shows that the YOLOv3 wearable approach is successful to the PSPE and worker detection, as In comparison to other common object identification techniques, the mean average precision has increased by more than 2%, and the maximum frames per second.

[3] One reason people die at a higher rate in motorcycle accidents is because they aren't wearing helmets. In order to stop these accidents from happening, it is crucial to be able to identify riders in real time who aren't wearing helmets. Using real-time data from traffic surveillance videos, this research introduces an automated approach to detect bikers who aren't wearing helmets. When time and space are limited, it's a lot harder to solve the problem with computers. To facilitate the creation of a reliable automated helmet detection algorithm, we have assembled a unique dataset. To identify motorcycles in surveillance footage, the suggested method employs a two-stage classifier. After motorcycles are identified, the data is sent to the helmet recognition step. In this work, we describe two techniques,one that uses a deep convolutional neural network and the other that relies on hand-crafted attributes for distinguishing helmeted and unhelmeted riders (CNN).Our research shows that the suggested CNN model beats the feature-based model in terms of accuracy. Very importantly, all computations in the proposed system are carried out in CPUs exclusively to guarantee its minimal weight.

[4] We need an intelligent transportation network, and there are tools available today to help us build one. Many problems with current systems may have answers that can be found by using artificial intelligence (deep learning in particular). For intelligent systems to be successful, it is crucial that they can identify and correctly categorize cars. Possible future uses for these systems include facilitating travel in densely populated areas with restricted land availability, such as India. Here, the goal of the project is to address certain pressing issues in the Indian setting. The goal is to effectively recognise and categorize automobiles in real time. This lays the groundwork for subsequent steps. The detection of a helmet, a triple, or a seat belt, among other things, would fall within this category of activities (depending on the type of vehicle). Possible benefits of this approach include fewer traffic offenses and more safety for road users.

[5] Motorcycle helmet wear can be automatically detected by video surveillance, which can aid in the implementation of effective education and enforcement initiatives aimed at reducing motorcycle-related fatalities and injuries. However, there are a number of issues with current methods of detection, such as the difficulty to discriminate between drivers and passengers when helmets are used, the inability to monitor certain motorcyclists across multiple frames. In addition, there is a lack of diversity in traffic settings and traffic density variations in the statistics utilized to inform approach development. This study's objective is to provide a multi-task learning (MTL) approach based on convolutional neural networks (CNNs) for identifying and tracking different motorcycles as well as registering helmet wear by individual riders. The HELMET collection, which comes from 12 observation locations in Myanmar and includes 91,000 annotated photos of 10,066 different motor bikes, is also made publicly available. In addition, The dataset also offers a score of helmet used and riders identification exactness that are used to compare other strategies in the future. In contrast

to prior research, we show that MTL improves the efficacy of our technique by allowing processing rates of over For determining the number of riders and helmet use on the monitored bikes, 8 FPS on consumer hardware and a weighted average F-measure of 67.3% have been used. Our findings show that deep learning may be used as a reliable and useful method to gather essential information on traffic safety.

[6] Workers on construction sites can greatly benefit from donning protective helmets. In spite of this, Due to discomfort or a lack of security knowledge, many employees take off their helmets, exposing themselves to unforeseen hazards. Should an accident occur, such as a body or object falling from a height, workers who aren't wearing protective headgear are more likely to sustain severe injuries. Therefore, a fast and accurate detector of safety helmet use is urgently required, as it is a crucial part of building site safety management. Manual monitoring takes a lot of time and effort, and methods for placing sensors on safety helmets have not yet gained widespread acceptance. With this in mind, The study suggested the deep learning-based technique for reliably and promptly detect safety helmet wear. We begin with YOLO v5 as the basis for our plan.; we then incorporate a fourth detection scale to improve bounding box prediction for all the little things and a focusing mechanism into the network's core to generate more informative features for subsequent concatenation steps. To make up for the inadequacies caused by a lack of data, transfer learning and targeted data augmentation are used. The advantages of each adjustment are thoroughly discussed in this study. When everything is said and done, our model detects a picture at 640x640 in just 3.0 ms 92.2% on average, which is an improvement of 6.3% over the baseline method. These findings show that our paradigm is both sound and practical. Meanwhile, our trained model is just 16.3 m in size, making it very portable. Finally, after a good model is obtained, a GUI is developed to simplify our algorithm's operation.

[7] An increasing number of construction sectors are focusing on improving worker safety on the job. Although construction site injuries can be reduced when employees wear safety helmets, this is not always the case. Consequently, It is crucial to have a computer vision-based automated safety helmet recognition system. Applications for construction sites have received less attention than deep learning- and machine-based helmet detection systems, which have made substantial advancements. In this work, It is crucial to have a computer vision-based automated safety helmet recognition system. Real-time safety applications for YOLO-based systems are possible due to the YOLO architecture's quick processing speed (45 frames per second). helmet detection. For the purposes of this study, we used a benchmark dataset made up of 5,000 images of hard helmets. We divided this dataset equally into three sections for validation, testing, and training. Trial results show that the YOLOv5x design distinguished safety helmets very effectively, having a mean average accuracy (mAP) of 92.44%, even in low light.

[8] The prevalence of motorcycle accidents has grown throughout time due to differences in social, economic, and transportation settings. The middle class is renowned for having adopted motorcycles widely. The primary piece of safety gear for motorcyclists is the helmet, however not all drivers necessarily adhere to this rule. When it comes to riding, adults often disregard safety concerns and end up engaging in dangerous behaviors like speeding and riding in groups. A motorcycle accident has far greater societal repercussions because motorcycles lack the protective structures of a car. There will always be the chance of harm while riding, even if every care is taken. A helmet's principal function is to safeguard the rider's noggin in the event of a spill or crash. Many people today disregard traffic regulations, such as those prohibiting the use of three wheels on a motorcycle, and helmet use is extremely low. The proposed effort will aid in tracking down bikers who break the law by not wearing helmets while riding, as well as enforcing the rules for riding three up.

[9] More and more people are getting hurt on motorcycles every year. More than 37 million people in India commute via motorcycle. This is why, for the sake of everyone on the road, an autonomous helmet detection system needs to be created. In order to construct a unique object identification model that can recognise motorbike riders, we use a machine learning approach. The registration number is extracted in response to lack of a helmet and then put via an optical character reader. Using a camera or CCTV as input, this programme may operate in real-time.

[10] In the setting of a power substation, it is critical to be able to identify people wearing helmets. The safety helmet-wear detection approach proposed in this study is entirely new and based on machine learning and image processing. In order to recognise moving objects in a power substation, the Vibe backdrop modeling approach is first employed in conjunction with a stationary security camera. Once the area of interest for the motion has been determined, The feature recognised as the Histogram of Oriented Gradient (HOG) is extracted to provide information on the interior of the human subject. The concept of Support Vector Machine (SVM) are trained for categorizing pedestrians using the data collected from HOG feature extraction. Eventually, we'll use shade features recognizing the need to build a safety helmet detection system. Experimental results showed that our proposed strategy was both valid and effective.

TABLE OF COMPARISON

Authors	Adopted methodology	Features	Challenges
Lijun Wang	YOLOv5	The Deformable Convolution Net replaces traditional convolution with a more shape-based approach to feature extraction; A Convolutional Block Attention Module is added to the Neck to reduce the amount of complicated background features that may be extracted by giving target features weights to enhance their capacity to characterize the environment.	Specifically, issues brought on by construction sites' complicated backgrounds, dense targets, and the unstandardized shapes of hard hats are dealt with.

Authors	Adopted methodology	Features	Challenges
Baining Zhao	YOLOv3, K-means algorithm, Data augmentation	For real-time detection of PSPE and substation personnel, a wear-enhanced YOLOv3 approach is presented.	Gamma correction is used to boost contrast in monitoring pictures and lessen the effects of illumination and complicated backdrops. Then, using data augmentation techniques, additional synthetic pictures of PSPE and its employees are produced.
Linu Shine	CNN, Feature-based model	A system that makes use of traffic surveillance clips from the present to automatically identify those riding motorcycles without helmets	Failure to wear a helmet by two-wheeler riders is blamed for the higher death rate in motorcycle accidents. Identification of bikers without helmets in
Felix Wilhelm	Deep learning, Backbone net	a technique based on deep learning that can automatically detect the use of motorcycle helmets in video data	Lack of thorough information on the motorcycle helmet usage behavior metric, which is crucial for safety
Hanhe Lin	CNN based MTL	Automated motorcycle helmet use detection using video surveillance	the inability to identify drivers from passengers when wearing helmets, or to follow specific motorbikes across
			many frames
Kun Han	YOLOv5, four detection scales, attention mechanism	a technique based on deep learning that can quickly and accurately identify safety helmet use. The baseline is the YOLO v5 model, followed by the additional use of the attention mechanism in the network's backbone to give more informative characteristics for subsequent concatenation operations	Traditional manual monitors require a lot of effort, and safety helmet sensor installation techniques are not widely used.
Ahatsham Hayat	YOLOv5x architecture	A construction site's automated safety helmet detection system using real-time computer vision	Few researchers have concentrated on developing machines. and helmet detection systems for use on construction sites that employ deep learning
R. Vandana	R-CNN, (OCN) Optical Character Recognition,		R. Vandana
Lokesh Allamki	OCR, KNN, CNN	The tagged photographs are used as input by the YOLOv3 model to train for the different classes. The weights generated after training are used to load the model.	The algorithm for selective search is a fixed algorithm. As a result, no learning is taking place at that point. The production of poor candidate region ideas might result from this.
Jie Li	KNN, Histogram of Oriented Gradients (HOG)	Whether or not motorcycle riders are wearing helmets may be determined automatically by a system.	telegraph poles obscure the safety helmet. As a result, we will take into account more

Authors	Adopted methodology	Features	Challenges
			factors than just a single color feature.

IV. Existing system

The current methods are effective in identifying helmets in images, however they are unable to spot them in real-time videos. The various kinds of helmets cause the current system's excessive false rate detection to take place. The results for moving vehicles are very inaccurate since these utilize image processing approaches.

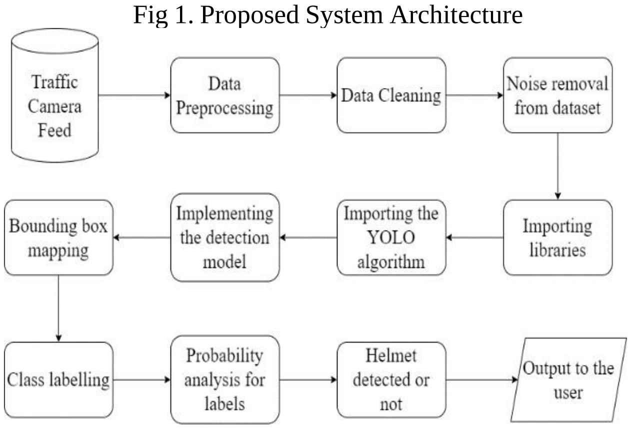
The recommended helmet detection system's foundation is based on computer vision techniques. The suggested approach employs live video to identify either a motorist is wearing a helmet. The design that was suggested has the advantage of being able to recognize any kind of helmet, regardless of its dimensions or shape.

- Bike owner
- Motorbike owner
- Can deliver accurate results
- High processing speed per second
- Cost-effective and practical in real-time situation

V. Proposed system

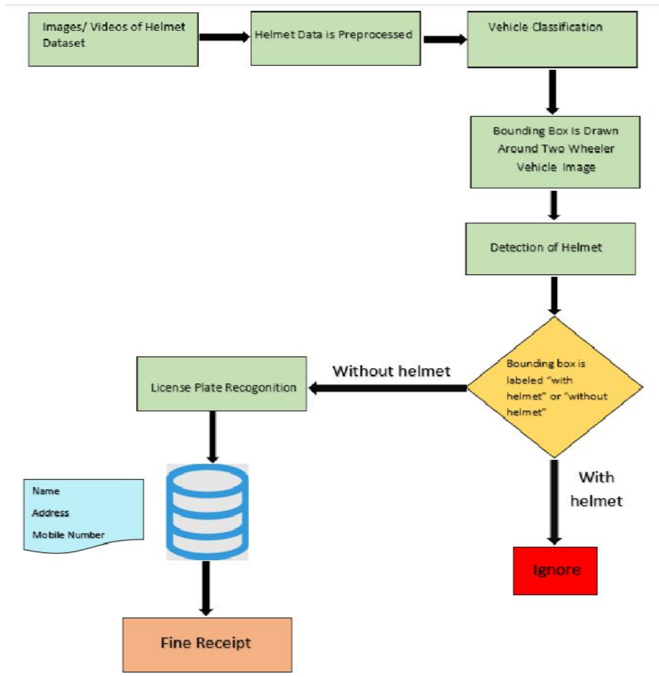
- Tracking Using image processing and computer vision, it can be achieved to detect motorcycles driving without protection helmets on the roads and read their car registration number.
- Recognizing non-helmet users in real-time traffic video footage.
- Utilizing use of bounding box technology and using it for recognizing objects

Fig 1. Proposed System Architecture



VI. Architecture Diagram

The system implementation for helmet detection with number plate detection and challan generation can be divided into several steps.



VI. Methodologies

Image-Preprocessing

The acquired helmet image dataset differs in quality widely.The safety helmets may also vary in size and shape making it difficult to be detected . Hence the helmet image dataset is completely prepared and preprocessed using various techniques . The Helmet image dataset is being preprocessed using slicing, rotating, and enlargement to enhance the accuracy of detecting the safety helmets even with various angles and also with different lightning.

TABLE I: Data pre-processing

Sno	Algorithm
1	Input: Raw Data
2	Output: Pre-processed Data
3	Function Data_preprocess(data_path):
4	D1=resize(raw data)
5	D2= Grayscaling(D2)
6	Labeling(D2)
7	return preprocessed data

. The input helmet images need to be adjusted without impacting the image's quality since the selected DL model requires input in a particular format; for instance, the YOLO model only records images that are 416*416 in size. When images are scaled, the data's main point is frequently lost. The dataset's scenarios are subsequently divided into two groups: a training sample and a testing sample.The training dataset - it's a set of original dataset, these training dataset is fed into the model in order to identify and learn meaningful pattern.By this way, the model is being trained.The other subset is known as the testing data. After the model has been built using the training dataset , you have to use a new and unknown dataset which is said to be testing data to test your model. By doing this the performance and the progress of the model is being evaluated for the trained algorithms and then based on the results the model can be improved, modified and optimized.While test samples often make up less than 20% or 10% of the whole sample, deep learning data samples are much bigger. Based on prior findings from the investigation, an appropriate ratio of 8:2 is selected in this respect. The values of the two sets are, respectively, 4000 and 1000.

TABLE III: CNN Algorithm

Sno	Algorithm
1 2 3 4 5	Input: Preprocessed data Output: Trained CNN model Function CNN(): while(n): Conv2D() Maxpooling() Dense_layer() return trained CNN model

TABLE IV: Training algorithm

Sno	Algorithm
1 2 3 4 5 6 7	Input: Preprocessed data Output: Trained model Function training(): Set epoch number Train the model Generate accuracy graph Generate loss graph

Implementation of YOLO:

Using the You Only Look Once (YOLO) approach for deep learning has never been easier.Convolutional neural networks are utilized in the above group of object identification algorithms. They are some of the most fast and accurate real-time object recognition algorithms at present. The 106-layer YOLOv3 neural network is an improved version of the 53-layer Darknet-53 neural network. The added 53-layered structure, that includes two N-dimensional output layers, enables us to detect at three different scales. It is now easier to identify objects of various sizes and has been improved in this version. The image must be sent as a vector in three dimensions with height (h) and length (h*3) in order to be used by YOLOv3. The size of the output is 32, 16, and 8 times the size of the input layer.

Detection of helmet:

All of the data will be combined and divided into different batches, and feature extraction will accurately forecast outcomes using the classifier module and predict whether or not the individual is wearing a helmet. The detected images will be highlighted with a bounding box and will be labeled with a suitable class name.

E-Challan Generation:

This module creates an e-challan with the rider's details, such as their name, address, and details of the violation for two-wheeler riders who are not wearing a helmet. Then, the violator receives the e-challan using registered mail or phone number.

VII. Result and discussion

The proposed system uses a visual studio using Python language. The model has achieved 95% on the training data.

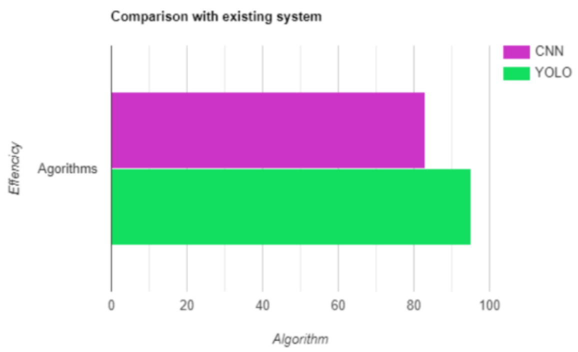


Figure 2, depicts the comparison analysis between cnn and yolo Algorithm.Yolo shows 95% efficiency in comparison to cnn.

Fig 3 Rider without helmet

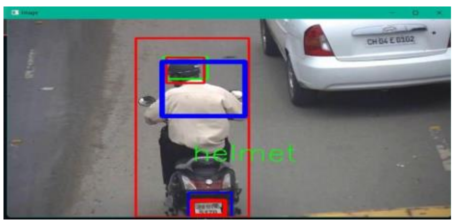


Fig 4 Rider with helmet

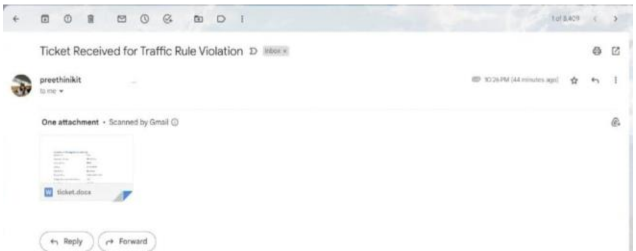


Fig 5 Mail Received

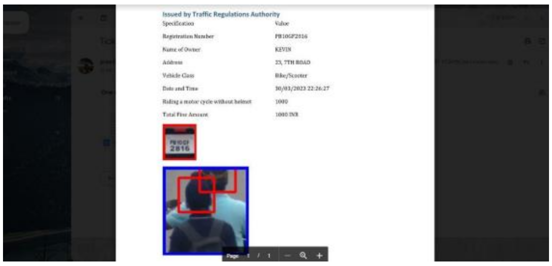


Fig 6 Challan Generated

Evaluation metrics:

Performance Measure	Value
Detection Accuracy	95%
Response Time	2 seconds
Resource Usage	50% CPU, 20% Memory
System Uptime	99.9%
User Satisfaction	4.5/5
Number of Violations Detected	100 per day

Fig 1. Algorithm Analysis

VII. Conclusion And Future Work

On video data from a spectrum of road circumstances, including those with problematic elements like occlusion, different camera angles, uneven distributions of the coding classes, and even variations in traffic volumes and motorcycle ridership, our methodology has been tested. We want to include scenarios with a broader variety of traffic infrastructure, like intersections, to the HELMET dataset for future studies that is to ensure a more reliable implementation of the technique. To avoid false positive detection of these things, additional information from training with ignited motorcycles will be gathered and used for training.

In the future, the automated payment systems might be coupled with the challan generating module to allow offenders to pay their penalties online, streamlining and streamlining the payment process. Implementation in further areas: The system might be set up in additional locations to increase traffic citation penalties and boost road safety. Integration with other traffic management systems: To develop a more thorough approach to road safety, the system might be combined with other traffic management systems, such as traffic light control systems or speed detection systems. The object detection model's accuracy might be increased by utilizing more sophisticated methods like deep learning or neural networks. The system's user interface might be enhanced to make it more user-friendly.

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