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TRAFFIC VIOLATION PREDICTION USING DEEP LEARNING BASED ON HELMETS WITH NUMBER PLATE RECOGNITION

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ABSTRACT

At the moment, two-wheelers are the most widely used kind of transportation. It is highly advised that both bike riders and soldiers wear helmets. Many academics are interested in object tracking in video surveillance, which is an important application and burgeoning field of study in image processing and machine learning. Finding objects in an image with a bounding box and different categories or shapes of the objects placed is called object detection. This study reviews tracking techniques, classifies them into several categories, and concentrates on significant and practical tracking approaches. After reviewing broad strategies under a scan of the literature on various methodologies, we analyze potential research areas. This study uses the YOLOv8 algorithm, an image processing technique, to identify motorcycle riders who do not wear helmets. Additionally, put the Optical Character Recognition method into practice to identify the license plate in a picture and retrieve user information. Next, determine the fine amount. Eventually, SMS services will be able to notify consumers in order to prevent motorbike accidents. We evaluate the framework in terms of speed and accuracy.

Keywords: Number plate Recognition, Object detection, Object Recognition, Optical Character recognition, Traffic Violations

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1. INTRODUCTION

Since accidents and injuries are more likely to occur as a result of the increasing congestion on our roads in the modern world, traffic safety is of utmost importance. For a very long time, motorcycle riders and cyclists have been linked to helmet safety and protection. However, the importance of helmets goes beyond their symbolic value; they are necessary to reduce the severity of brain damage caused in collisions. Governments and law enforcement organisations have therefore established stringent helmet-wearing laws to improve road safety. We will examine the relevance of helmet traffic offences, the justifications for these laws, and the possible repercussions for both individuals and society when helmet laws are disregarded in this debate. The fundamental objective of helmet regulations is to protect the lives and wellbeing of riders of motorcycles, bicycles, and other two-wheeled vehicles. In order to ensure that the head and brain are appropriately protected in the case of an accident, these regulations frequently demand those riders wear helmets that adhere to strict safety standards. Helmets are an essential part of road safety since they have been shown to drastically lower the risk of fatalities and head injuries in motorcycle accidents. One important application in many safety-critical domains, such as building sites, sports facilities, and road traffic, is the detection of helmets in pictures and video feeds. This system ensures compliance with safety rules and improves overall safety by using machine learning and image processing algorithms to identify individuals wearing helmets. Figure 1 depicts the police's real-time helmet detection system.

Figure 1: Police Intervention for Helmet detection

2. RELATED WORK

Susa, Julie Ann B, et.al,…[1] It has been suggested that vision-based technology may be used to detect bikers donning too-small helmets. In order to employ the helmet detection model in this experiment, the system merged the YOLOv3 model with a deep learning technique. On many public roads, setting up multiple checkpoints to inspect riders' helmets may result in traffic bottlenecks. In order to protect them from harm and comply with the law requiring them to wear certified helmets, it is essential to put in place an early detection system. This study will make use of the YOLOv3 methodology. After testing and deployment, the system achieved scores of 90% above for every testing feature.

Waris, Tasbeeha, et al,…[2] created a quicker region-based convolutional neural network (R-CNN) method for automatically identifying motorcycle riders who are not wearing helmets. The technology recognizes helmet infringement by converting camera data into frames. The two sources from which the dataset was gathered were self-captured movies shot in various parts of Lahore, Pakistan, and online repositories. According to an experimental examination, the accuracy of the suggested system is 97.69%. It could be beneficial to take the proper action against people who violate traffic laws. Future developments could see this work expanded to include other features like number plate recognition and other offenses related to traffic.

Tran, Duong Nguyen-Ngoc, et al,…[3] gives a framework for tracking the use of individual rider- specific helmets while detecting and identifying different motorcycles. In comparison to earlier research, the helmet-use classification approach demonstrates improved efficiency. This method expands and develops upon an earlier framework, utilizing novel approaches and algorithms to attain even higher levels of precision and accuracy. Modern technologies and industry best practices have allowed us to develop a potent tool that can identify helmet use in a variety of contexts. This strategy will show to be a priceless tool for increasing motorcycle safety and lowering the amount of avoidable collisions and fatalities. Deng, Lixia, et al,…[4] offers ML-YOLOv3, a lightweight object detection network. Three network optimization techniques that can drastically lower the model's computational cost without sacrificing its potent detection effect are shown in this research. We present a CSP-Ghost-ResNet that achieves roughly the same degree of detection impact as YOLOv3 while successfully reducing the model's complexity based on the helmet dataset. Meanwhile, ML-Dark net successfully minimizes the model's detection effect while keeping a reduced processing cost. In this article, PAN-CGR-Network is also redesigned. It lowers computing expenses even more.

An, Qing, et al,…[5] suggested a modified YOLOv5 network that can extract discriminative picture features from small targets by adaptively modifying the anchor box to increase the matching degree between the target box and the anchor box. The CPS module of the CBAM attention mechanism is combined with the GAM attention mechanism in the suggested method. It is included into the neck and backbone networks of the original YOLOv5s network to improve the performance of the neural network by increasing global interaction and reducing feature information loss. In order to create high-dimensional spatial feature correlation and extract significant elements of the target, this study offers a three-dimensionally arranged channel attention and convolutional spatial attention sub-module with a multi-layer perceptron. Every convolutional block in the network structure is adaptively refined by the feature map through the use of a combination module.

3. EXISTING METHODOLOGIES

These days, one of the main factors contributing to fatalities among humans is traffic accidents. Accidents involving motorcycles can cause severe injuries. For everyone who rides a motorcycle, a helmet is required. However, many people do not believe that wearing a helmet is required. A vital piece of equipment for ensuring worker safety during operations and inspections is a helmet. Supervisors and the plant's entire video monitoring system must keep an eye on whether workers are wearing helmets because some employees might not always do so. However, there are so many surveillance screens that it can be challenging to spot any helmet violation behavior at all, which raises the possibility of disastrous mishaps. Computer vision-based inspections are becoming one of the most significant industrial application domains due to the quick development of image recognition technology. The technology in use today is meant to distinguish between different colors of helmets and determine whether or not workers are wearing them. To extract features of different colored helmets (red, yellow, and blue), a color-based hybrid descriptor made up of color histograms (CH), hu moment invariants (HMI), and local binary patterns (LBP) is presented. Next, all features are classified into four groups using a hierarchical support vector machine (H-SVM): red- helmet, yellow-helmet, blue-helmet, and non-helmet.

3.1 LOCAL BINARY PATTERN FOR HELMET DETECTION

One texture analysis method that can be used for helmet recognition in photos is called Local Binary Patterns (LBP). Because LBP is renowned for being able to accurately describe the local texture patterns in an image, it can be used to identify the texture of helmets in a variety of scenarios. The way LBP works is by comparing a pixel's intensity to that of its nearby pixels. Based on whether the neighboring pixels in a picture have intensities higher or lower than the central pixel, a binary code is created for each pixel. Next, a decimal value is generated from the binary code. For helmet detection, LBP can be applied to extract texture features from a region of interest (ROI) around the head area, which may include the helmet. The local texture patterns within the ROI are characterized by this feature extraction method. Gather a labeled image dataset that features both people wearing helmets and people without them. The training set for your LBP-based helmet detection model consists of these pictures.

3.2 HU-MOMENT INVARIATIONS

A collection of mathematical descriptors known as Hu Moment Invariants (HMI) are used in computer vision and image processing to describe the form and spatial distribution of an item in a binary or grayscale image. These moment invariants are useful for shape analysis and object recognition since they are translation, scale, and rotation invariant.

Hu Moment Invariants, denoted by the letters H1, H2, H3, H4, H5, H6, and H7, are calculated from the central moments of a picture. Below is a synopsis of every Hu Moment Invariant:

- H1 (Invariant to Scale): Measures the overall intensity of the image. It is invariant to scale changes in the object.
- H2 (Invariant to Rotation): Describes the skewness and orientation of the object. It remains unchanged when the object is rotated.
- H3 (Invariant to Rotation): symbolizes the object's lengthening or balancing. It is invariant to object rotation, just like H2.
- H4 (Invariant to Scale and Rotation): Measures the fourth moment of the distribution of the object's pixel intensities, making it invariant to both scale and rotation.
- H5 (Invariant to Scale): establishes the object's compactness. It is not impacted by shifts in scale.
- H6 (Invariant to Scale and Rotation): Represents the object's skewness. It is invariant to scale changes and rotations.
- H7 (Invariant to Scale): Measures the elongation or thinness of the object. It remains unchanged under scale transformations.

Hu Moment Invariants can be used to describe the form and orientation of helmets in order to detect them in photographs and differentiate them from other objects or the backdrop. It can help detect people wearing helmets by comparing the computed HMI of a region of interest (ROI) with pre-determined values for helmets, guaranteeing adherence to safety rules.

3.3 COLOR HISTOGRAMS BASED OBJECT DETECTION

The distribution of colors in an image is statistically represented by color histograms. They offer important details regarding the existence and quantity of different hues in an image. In image processing and computer vision, color histograms are frequently utilized for tasks including object detection, image segmentation, image retrieval, and more. The color space is separated into distinct bins by a color histogram. For an 8-bit color space (e.g., RGB with 256 intensity levels for each channel), there can be 256 bins per channel. The number of bins can vary, and it influences the granularity of the color distribution information. The image is scanned for each channel (such as Red, Green, and Blue), and each pixel's color value is assigned to the appropriate bin. The histogram is used to count the pixels in each bin. To make histograms in different images uniform, they are often standardized. Divide the count in each bin by the total number of pixels in the image to generate a probability distribution.

3.4 ASSISTANT VECTOR UNIT FOR HELMET IDENTIFICATION

Support Vector Machine (SVM)-based approach for helmet detection, which is designed to automatically identify individuals wearing helmets in images or video streams. The system is built on a foundation of machine learning, with an emphasis on robust feature extraction and real-time processing. The methodology begins with data collection and preprocessing, ensuring that images are consistent and ready for analysis. Helmet essential attributes are represented using feature extraction approaches such as color histograms and shape-based features. Because the dataset is split into training and testing sets, a range of helmet and non-helmet instances can be used to help the SVM model grow and become broader. Model assessment measures include accuracy, precision, recall, and F1 score, which are used to evaluate the model's performance. The trained SVM classifier detects whether or not people are wearing helmets by analyzing image or video frames in real- time applications.

4. PROPOSED METHODOLOGIES

Because there is currently no automated mechanism in place to identify motorcycle riders who do not wear masks or helmets, traffic police officers must manually record the number plate of any such offenders of traffic laws, either by remembering it or by taking a picture of it. Errors can occasionally occur from this manual management. To address these shortcomings, we have developed an automatic face mask and helmet identification system that can identify and identify all motorcyclists who do not use masks and helmets by simply saving their license plate information. To overcome the drawbacks of the current method, we have proposed an automated system that is more accurate and requires less human labor. The main goal of this system is to identify and capture any motorcycle riders who are without wearing a helmet. In this study, use the framework to identify helmet traffic infractions in real-time scenarios. The helmet can be identified using the YOLO approach by employing an object detection and recognition system. And also recognize the number plate using Convolutional neural network algorithm to extract user details. The suggested method can identify the item under various lighting and occlusion conditions. The extracted feature determines the class of objects that the system extracts. The system makes use of the You Only Look Once (YOLO)-Dark net deep learning architecture. It combines computer vision with convolutional neural networks trained on Common Objects in Context (COCO). There are several processes involved in using YOLOv8 helmet detection on motorcycles. First, it is necessary to gather a varied dataset of pictures of motorbike riders wearing helmets. To ensure the reliability of the model, these photographs should cover a range of settings, lighting conditions, and perspectives. To appropriately categorize the helmets, the gathered dataset must then be annotated. Based on CNN, we can detect the text object and recognize the objects to print the number plate. The Send fine amount as SMS to non-wearing helmet persons. Then check the fine amount paid status and updated in database. The number will be automatically blocked and a status notification will be sent if the user fails to settle the outstanding balance. Once the money has been received, the admin can renew the license plate. The suggested system's overall architecture is shown in Fig. 2.

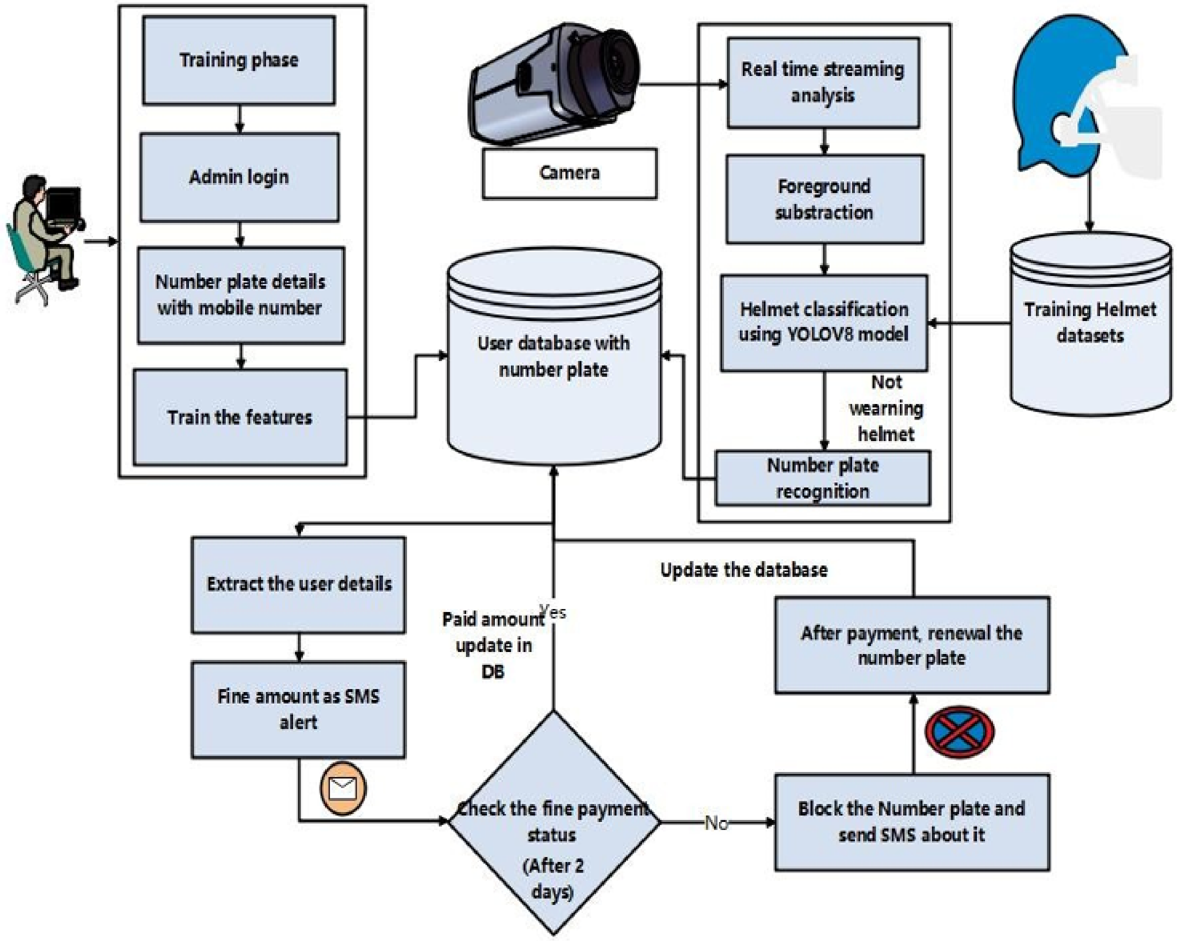

Fig 2: Proposed architecture

4.1 YOLOV8 ALGORITHM FOR HELMET DETECTION

YOLOV8 is a neural network-based approach that offers real-time object detection. This algorithm's accuracy and quickness make it popular. It can recognize items in a variety of applications, including humans, parking meters, animals, and traffic lights.

The YOLOV8 algorithm employs the subsequent three methods:

- Residual blocks
- A bounding box is an outline that draws attention to an object in a picture. Every bounding box in the picture has the following features:
- Breadth (bw)
- Altitude (bh)
- Class (individual, vehicle, traffic signal, etc.)- The letter c stands for this.
- Centering the bounding box (bx,by)

Bounding box regression Relative bounding boxes

- An image's object is highlighted by an outline, also known as a bounding box. Each bounding box in the image has the following characteristics:
- Width (bw)
- altitude (bh)
- Class (individual, vehicle, traffic signal, etc.)- The letter c stands for this.
- Centering the bounding box (bx,by) Intersection Over Union (IOU)

- In object detection, the phenomenon known as intersection over union (IOU) describes how boxes overlap. YOLO creates an output box that precisely encircles the items using IOU.
- The task of anticipating the bounding boxes and their confidence scores falls on each grid cell. If the actual and anticipated boundary boxes match, the IOU is equal to 1. Bounding boxes that differ from the real box are removed using this method.

Give the object's label based on its feature for a higher accuracy rate.

4.2 NUMBER PLATE RECOGNITION

In every nation, vehicle identification is achieved through the use of number plates. The number plate recognition system recognizes cars by their number plates by using a picture handling technique. Number plate recognition systems are used to implement realistic movement control and security features, such as entry control to limited locations and the pursuit of desired cars.

The detected license plate proceeds as follows:

1. To photograph the license plate
2. To divide and identify characters.
3. The identified license plate is shown via a graphical user interface, and it is stored in a database for further use along with the time and date.
4. Text the user with the fine amount.

4.2.1 OPTIC CHARACTER IDENTIFICATION

OCR, or optical character recognition, has long been of interest. It is described in the dictionary as "the process of digitizing an image of a document into its individual characters." It is still difficult to produce OCR with human-like abilities, after decades of diligent effort. Because of this challenging feature, researchers in academia and industry have concentrated on optical character recognition. Character recognition research has become more and more prevalent in academic labs and commercial enterprises in recent years. This study aims to give a summary of the OCR research that has been done thus far. Optical character recognition (OCR) software can be used to digitally transform printed text and photos for computer editing. Despite the human brain's exceptional capacity to detect letters or characters from sights, machine intelligence is unable to comprehend the information found in photos. Consequently, many research initiatives have been put forth in an attempt to transform a document image into a format that can be read by machines. OCR is a difficult task because of the variety of languages, typefaces, and writing styles that might be utilized, in addition to the complex linguistic rules that are involved. As a result, strategies for various problems are taken from a range of computer science fields, such as natural language processing, pattern recognition, and image processing. The stages of the multi-phase OCR process are acquisition, pre- processing, segmentation, feature extraction, classification, and post-processing. This is not an atomic process. Every stage is thoroughly described in this document. These techniques can be combined in future study to develop an efficient OCR system. Moreover, there are other real-time applications for the OCR system, such as smart libraries and number- plate recognition.

5. EXPERIMENTAL RESULTS

Images of helmets are gathered from KAGGLE databases. A wide range of performance metrics can be calculated to assess the system's effectiveness, including accuracy, sensitivity, specificity, error rate, and precision.

- True positive (TP): the number of true positives, also known as perfect positive forecasts.
- False positive (FP): the number of false positives, or erroneous positive predictions
- Real negative (TN): the number of perfect negative forecasts, or real negatives.
- False negative (FN): the percentage of real negatives or projections that are not accurate

Error rate

The fraction of all inaccurate forecasts to all test data is used to calculate the error rate (ERR). The maximum error rate is 0.0, while the lowest possible value is 1.0. Any classifier's main goal is to lower this mistake rate.

$$RR = \frac{P + N}{P + N + N + P}$$

ALGORITHM	ERROR RATE
RANDOM FOREST	0.75
SUPPORT VECTOR MACHINE	0.5
YOLOV8 ALGORITHM	0.4

Fig 3: Error rate

According to the graph above, the suggested YOLO algorithm has a lower mistake rate than the current approach.
Accuracy: Accuracy (ACC) is defined as the ratio of the total number of perfect predictions to the total amount of test data. It can also be displayed as 1 - ERR. The accuracy has a range of 0.0 to 1.0, where 1.0 represents the highest possible accuracy.

$$CC = \frac{P+N}{P+N+N+P} \text{ x } 100$$

ALGORITHM	ACCURACY
RANDOM FOREST	50%
SUPPORT VECTOR MACHINE	65%
YOLOV8 WITH OCR	80%

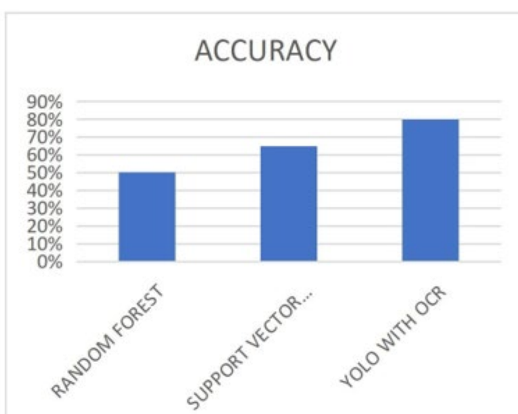

Fig 4: Accuracy chart

From the above graph, proposed YOLO with CNN algorithm provide high level accuracy rate than the existing algorithm

6. CONCLUSION

The current systems only support picture datasets for helmet analysis, and we have discussed different helmet detection techniques in this study. Therefore, we may propose a system that automatically obtains the license plate information of motorcycle riders who are not wearing helmets by using real-time video capturing. OCR and YOLOV8 can be used to identify motorcycle riders who do not wear helmets with a high degree of accuracy. But identifying these riders alone is not enough to bring charges against them. As a result, the system will also be able to identify and save their motorcycle license plates. For this study, the YOLOV8 has been utilized to identify people in real time who are wearing and are not wearing helmets. YOLOV8 can identify a single object in an image, but it cannot identify all objects if there are several objects in a single cell, according to YOLO's limitation. Furthermore, a deep learning model for Indian drivers' automatic license plate identification was completed. The outcomes demonstrate that, when it comes to generating datasets of Indian fonts with high irregularities, such number plates, the proposed strategy performs noticeably better than the current approaches. Additionally, it has been successful in creating a custom dataset of Indian font variants. Effectively trained the model using YOLO using the CNN approach. The Transport Office can then utilize the stored number plates to access their database of licensed cars and obtain information about the motorcycle riders. Then, concerned motorcycle riders may face consequences.

CONFLICT OF INTERESTS

None

ACKNOWLEDGEMENTS

None

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