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AUTOMATED HELMET DETECTION SYSTEM

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Abstract— **Enforcing use of helmet on every bike-rider is mandatory nowadays due to high accident rate and poor conditioned roads. There are laws regarding safety measures which ensure use of helmet. But currently, they involve manual intervention which is not proven to be so effective because sometimes, bike-riders tend to escape without any penalty after breaking the safety rules like wearing a helmet while riding. Au- tomation is efficient & also a better way to deal with this problem but it comes with its own challenges. To name a few, Low quality image frames (low image resolution, pixel density etc.), rain, dew & fog and partly hidden faces. Hence, the robustness of detection methodology strongly depends on the strength of extracted features and also the ability to deal with the extracted data. The first goal of this project is to boost the potency of helmet detection and then recognizing the license number plate recognition. This model consists of many essential steps developed using today's most advanced & optimized image processing techniques. This model is a classifi- cation based model that uses supervised learning approach to train the model. The proposed helmet detection model can be used to detect helmet and recognizes license plate even in adverse conditions.**

Keywords—**machine learning**

I. Introduction

1.1 BACKGROUND

According to India Today survey, more than 48,746 bike-riders died in road accidentsin 2017. Incidentally, 73.8 percent of them did not wear a helmet. Statistics are ac- cording to India Environment Portal [25]. Road accidents lead to a huge number ofdeaths every year. The reasons behind this are bad road conditions, malfunctioning of vehicles, careless driving or bike riding, not following traffic rules and so on. Ofthese, some are avoidable. Like, proper safety measures taken ensure reduction in accidents and thereby reduction in death rate. Though there's been helmet compul- sion for bike riders, many of those don't use it. This project intends to automate thefine application process by detection of helmet on biker's head. Currently, the trafficpolice officers manually apply fine for breaking the traffic rules. But, sometimes due to ignorance or due to other factors they manage to escape without fine even after the traffic rule violation. The automation in this process will reduce such casesand hence increase strict acts against them. The accuracy for detection of helmet is around 90-93 percent and of license plate recognition lies around 50-60 percent. This accuracy needs to be increased for efficient implementation of enforcement acts. Inrecent years, the use of cameras for the security purposes, law enforcement purposeshas increased a lot. There are ways to detect helmet using image processing and machine learning. There are the methods like OpenCV method giving 74 percent accuracy, The Image Descriptors method giving accuracy of 91.37 percent, and TheLocal Binary Patterns (LBP) method giving accuracy of 94 percent. images were not captured in real time. The proposed system will be able to detect motorcyclists wearing the helmet using CNN. The license plate recognition is doneusing the GAN algorithm

1.2 RELEVANCE

According to India Today survey, more than 48,746 bike-riders died in road accidentsin 2017. Incidentally, 73.8 percent of them did not wear a helmet. Statistics are ac- cording to India Environment Portal [25]. Road accidents lead to a huge number ofdeaths every year. The reasons behind this are bad road conditions, malfunctioning of vehicles, careless driving or bike riding, not following traffic rules and so on. Ofthese, some are avoidable. Like, proper safety measures taken ensure reduction in accidents and thereby reduction in death rate. Though there’s been helmet compul- sion for bike riders, many of those don’t use it. This project intends to automate thefine application process by detection of helmet on biker’s head.

1.3 PROJECT UNDERTAKEN

To develop a windows based model using Python and Open CV for helmet detection.

1.3.1 ORGANIZATION OF PROJECT REPORT:

The purpose of a report is to inform the reader. It is helpful, both to the reader and to the writer, if the report is logically organised. Over the years a standard format for reports has been worked out. Although there may be circumstances when it is advisable to change the format to fit a particular need, following the format ensuresthat all the essential information is included and that it is treated in a logical way. Theformat adopted is that described as per the guidelines. The components of a report are as follows: Title; Summary; List of contents; Introduction;Literature Survey; Main body of the report; Conclusions; References

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1.3.2 Objectives:

1. To learn, understand and use python programming language.

2. To detect helmet from video.

II. LITERATURE SURVEY

Over the past years, multiple approaches have been proposed to solve the problem of helmet detection. The authors in [7] use a background subtraction method to detect and differentiate between moving vehicles. And they used Support Vector Machines(SVM) to classify helmets and human heads without helmets. Silva et al. in [9] proposed a hybrid descriptor model based on geometric shape and texture features todetect motorcyclists without helmet automatically. They used Hough transform withSVM to detect the head of the motorcyclist. Additionally, they extend their work in [10] by multi-layer perception model for classification of various objects. Wen etal. [10b] uses a circle arc detection method based upon the Hough transform. They applied it to detect helmet on the surveillance system. The drawback of this work isthat they only use geometric features to verify if any safety helmet exists in the set.Geometric features are not enough to find helmets. In [11b] it proposes a computer vision system aiming to detect and segment motorcycles partly. A helmet detectionsystem is used, and the helmet presence verifies that there is a motorcycle. In order to detect the helmet presence, the edges are computed on the possible helmet region.The Canny edge detector [12b] is used. Waranusat et al. [11] proposed a system to detect moving objects using a k-NN classifier over the motorcyclist's head to classify helmet. These models were proposed based on statistical information of images andhad a limitation to the level of accuracy that could be achieved. With the evolution of neural networks and deep learning models there was further improvement in the accuracy of classification. Alex et al. [13] introduced a convolutional neural network(CNN) based method for object classification and detection. A. Hirota et al. [12] use a CNN for classification of helmeted and non-helmeted riders. Although they use CNN, their helmet detection accuracy is poor with limitations to helmet color and multiple riders on a single motorcyclist.For real-time helmet detection, there is a need for accuracy and speed. Hence a DNN based model You Only Look Once (YOLO) was chosen. YOLO is a state-of-the-art, real-time object detection system.YOLOv3 is extremely fast and accurate and is a huge improvement over the previousYOLO versions. It also makes predictions with a single network evaluation unlike systems like R-CNN which require thousands for a single image. This makes it extremely fast, more than 1000x faster than R-CNN and 100x faster than Fast R- CNN [4]. Object detection is the craft of detecting instances of a certain class, like animals, humans and many more in an image or video. The Pre-Existing Object Detection API makes it easy to detect objects by using pretrained object detection models. But these models detect several Objects which are of no use to us, thereforein order to detect the necessary classes a custom object detector becomes necessary.In order to implement helmet detection and number plate recognition and extraction,5 objects need to be detected. The objects are – Helmet, No Helmet, Motorbike, Person (sitting on the bike) and License Plate. There is a need to create a custom object detection model that is capable of detecting these objects. A collection of images containing the objects of the classes to be detected are used as a Dataset. Thisdataset is then used to train the custom model. Once the model has been trained, it can be used to detect these custom objects.class from every image with the help of ground truth of the required classes. For extracting the features and storing them to recognize those features from other images, we use a deep learning, classifier based on the convolutional neural networks. When an image is given to this trained modelthe detection of the pretrained class is necessary. A few images are taken as an example to show the detection capability of the custom trained model

SYSTEM DEVELOPMENT

3.1 SOFTWARE DESIGN

3.1.1 User Interfaces

The user interface or UI for the software should be compatible to be used by windows operating system. Using this UI user can have access to the system. The UI or user interface can be developed by using Tkinter.

3.1.2 Software Interfaces

It uses Tkinter as the front-end programming tool. MySQL has been used as back-end application tool. Latest version of python anything higher than 3 can be used.

3.2 NON-FUNCTIONAL REQUIREMENTS

3.2.1 Performance Requirements

- System can work optimal or faster on 8 GB or more of RAM.
- The system is targeted to be available all time. Once there is a fatal error orsystem down, the system will provide understandable feedback to the user.

3.2.2 Safety Requirements

- The system is designed in modules where errors can be detected.

3.2.3 Software Quality Attributes

- **Usability:**

This relates to how easily people can use app/website. A measure of us- ability could be the time it takes for end users to become familiar with my app/website functions, without training or help.

- **Reliability:**

  This can be defined as the available time or UP time of software.

- **Performance:**

  This is essentially how fast app/website works. A performance requirementfor the app/website could be start in less than 20 seconds.

- **Security:**

  Say that app/website saves all the previous code and lets you reuse a savedcode.

3.3 database open which is mainly a RDBMS i.e., relational database management system. As a database server, primary function of this soft- ware is to storing a-source nd retrieving data as requested by other from end software ap- plications like java which may or may SYSTEM REQUIREMENTS

3.3.1 Database RequirementsMySQL Database

MySQL is on not run either on the same computer or on different computer. This can be across the network either in internet or intranet.

3.3.2 Software Requirements

1. **Operating System:** Microsoft Windows 7 and Above
2. **Programming Language:** Python
3. **IDE:** Python IDLE

3.4 HARDWARE DESIGN

3.4.1 Hardware Requirements

1. **Processor:** Intel Core I3 or Higher
2. **RAM:** 4 GB or Higher
3. **Hard Disk:** 100 GB (min)

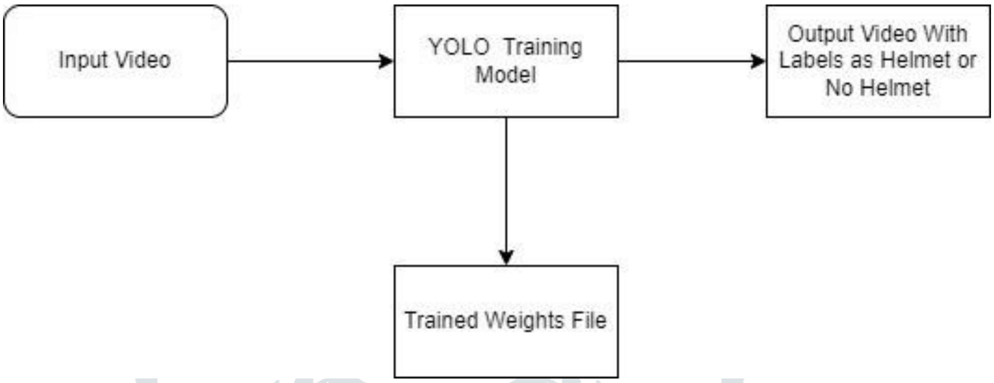
3.4.2 Hardware Interfaces

A hardware interface is needed to run the software. Python, Keras, Numpy com-patible hardware is required which is minimal requirement.

CHAPTER 4 SYSTEM

DESIGN

4.1 SYSTEM ARCHITECTURE



5.2ALGORITHM DETAILS:

Algorithm:

5.2.1 YOLO

YOLO is an algorithm that uses neural networks to provide real-time object detection. This algorithm is popular because of its speed and accuracy. It has been used in various applications to detect traffic signals, people, parking meters, and animals.

The YOLO framework (You Only Look Once) on the other hand, deals with objectdetection in a different way. It takes the entire image in a single instance and predictsthe bounding box coordinates and class probabilities for these boxes. The biggest advantage of using YOLO is its superb speed – it’s incredibly fast and can process 45 frames per second. YOLO also understands generalized object representation. This is one of the best algorithms for object detection and has shown a comparativelysimilar performance to the R-CNN algorithms

YOLO integrates the candidate region extraction and classification and regres-sion tasks of object detection into an end-to-end deep convolutional network. That is, the input image is inferred once, and the positions and categories of all objects andthe corresponding confidence probabilities can be obtained. The backbone networkof the YOLO network is similar to GoogLeNet . The inception structure is removedto make the backbone network simpler. Input the image into the YOLO model to obtain a feature map with a size of 7 × 7, which divides divide the image into 7 ×7 regions. Each area has the confidence of the target, the position of the bounding boxes, and the category information. The YOLO network is simple, the detection speed is fast, and the background false detection rate is low, but the detection ac- curacy is not as good as the R-CNN detection method, and YOLO is not accurate enough in object positioning.

YOLOv2 [uses a new backbone network called Darknet-19, which is the sameas the VGG16 model design principle. The network mainly adopts the 3 × 3 convo-lution and the 2 × 2 maximum pooling layer. After passing through the maximum pooling layer, the height and width of the feature map are halved, and the number of channels of the feature map is doubled. YOLOv2 still has the advantage of fast speed. However, its backbone network is not deep enough, it is difficult to recognizemore abstract image semantic features, and the bounding box predicted by each grid

cell is too less, which is not effective in predicting targets with large-scale changes.YOLOv3 draws on the idea of Resnet , introduces the residual structure, and establishes a deeper Darknet-53. And compared to YOLOv2, the downsamplingmethod of the pooling layer is canceled, but the feature map is downsampled byadjusting the step size of the convolutional layer to obtain more fine-grained fea-tures. YOLOv3 uses multiple-scale fusion methods to make predictions. Similar toFPN, YOLOv3 integrates feature maps of three scales and simultaneously detectsmultiple-scale feature maps. The small size of the feature map is used to detectlarge-size objects, and the large size of the feature map is used to detect small-sizeobjects. Compared with YOLOv2, YOLOv3 uses multiple scales to predict at thesame time to make the bounding box more, cover a richer object size, closer to the

real object size, and also strengthen the detection effect of small objects.

However, YOLOv3 still has low utilization of features and poor detection per-formance for small objects and object-intensive images. In the application of ac- tual helmet wearing detection, small objects and dense objects are very common. Therefore, we need a network with better performance to make the helmet-wearingdetection system more robust.

What is YOLO?

YOLO is an abbreviation for the term ‘You Only Look Once’. This is an algorithm that detects and recognizes various objects in a picture (in real-time). Object detection in YOLO is done as a regression problem and provides the class probabilities of the detected images.

YOLO algorithm employs convolutional neural networks (CNN) to detect objects in real-time. As the name suggests, the algorithm requires only a single forward propagation through a neural network to detect objects.

This means that prediction in the entire image is done in a single algorithm run. The CNN is used to predict various class probabilities and bounding boxes simultaneously.

The YOLO algorithm consists of various variants. Some of the common ones include Why the YOLO algorithm is important

YOLO algorithm is important because of the following reasons:

Speed: This algorithm improves the speed of detection because it can predict objects in real-time.

- **High accuracy:** YOLO is a predictive technique that provides accurate results with minimal background errors.
- **Learning capabilities:** The algorithm has excellent learning capabilities that enable it to learn the representations of objects and apply them in object detection.

How the YOLO algorithm works

YOLO algorithm works using the following three techniques:

- Residual blocks
- Bounding box regression
- Intersection Over Union (IOU)

Residual blocks

First, the image is divided into various grids. Each grid has a dimension of S x S.

there are many grid cells of equal dimension. Every grid cell will detect objects that appear within them. For example, if an object centre appears within a certain grid cell, then this cell will be responsible for detecting it.

Bounding box regression A bounding box is an outline that highlights an object in an image.Every bounding box in the image consists of the following attributes:

- Width (bw)
- Height (bh)
- Class (for example, person, car, traffic light, etc.)- This is represented by the letter c.
- Bounding box center (bx,by)

The following image shows an example of a bounding box. The bounding box has been represented by a yellow outline.

YOLO uses a single bounding box regression to predict the height, width, centre, and class of objects. In the image above, represents the probability of an object appearing in the bounding box.

Intersection over union (IOU)

Intersection over union (IOU) is a phenomenon in object detection that describes how boxes overlap. YOLO uses IOU to provide an output box that surrounds the objects perfectly.

Each grid cell is responsible for predicting the bounding boxes and their confidence scores. The IOU is equal to 1 if the predicted bounding box is the same as the real box. This mechanism eliminates bounding boxes that are not equal to the real box.

there are two bounding boxes, one in green and the other one in blue. The blue box is the predicted box while the green box is the real box. YOLO ensures that the two bounding boxes are equal.

Applications of YOLO

YOLO algorithm can be applied in the following fields:

- **Autonomous driving:** YOLO algorithm can be used in autonomous cars to detect objects around cars such as vehicles, people, and parking signals. Object detection in autonomous cars is done to avoid collision since no human driver is controlling the car.
- **Wildlife:** This algorithm is used to detect various types of animals in forests. This type of detection is used by wildlife rangers and journalists to identify animals in videos (both recorded and real-time) and images. Some of the animals that can be detected include giraffes, elephants, and bears.
- **Security:** YOLO can also be used in security systems to enforce security in an area. Let’s assume that people have been restricted from passing through a certain area for security reasons. If someone passes through the restricted area, the YOLO algorithm will detect him/her, which will require the security personnel to take further action.

CHAPTER 6RESULTS

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6.1 SCREENSHOTS

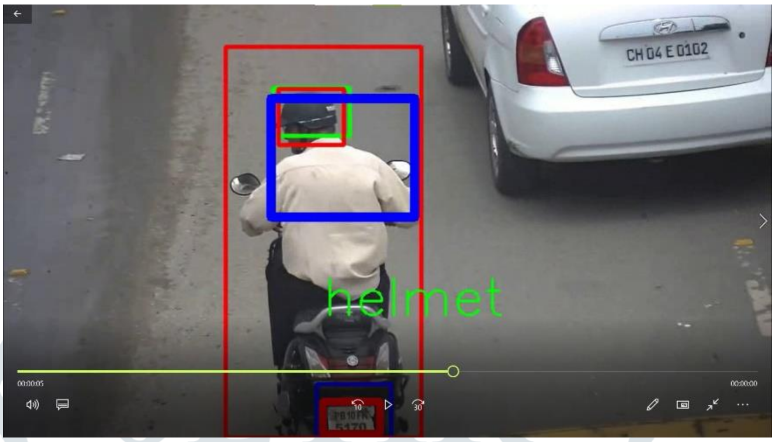

Figure 6.1: With Helmet

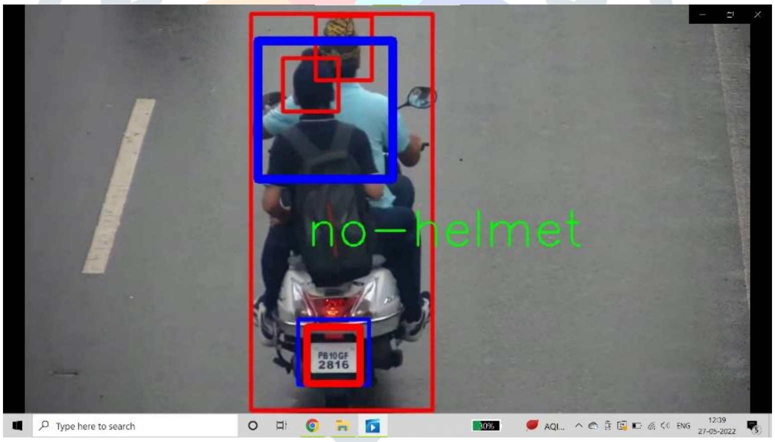

Figure 6.2: Without Helmet

CONCLUSION

Thus, we have developed a system for automatic helmet detection using image processing using python. The project will be developed as a prototype model forhelmet detection using python.

7.1 APPLICATIONS

1. Schools
2. Colleges

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