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Traffic Violation Detection using Digital Image Processing

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***Abstract*—** Road accidents are one of the main causes of human deaths. Among the different types of road accidents, two wheeler accidents are common and cause severe injuries. The helmet is the motorcyclist's main headgear. In most of the countries governments have made it punishable offense to ride a bike without helmet and have adopted manual strategies to catch the rule violators which has some limitations, but many people fail to obey the law for various reasons. Hence we developed a system using image processing for finding motorcyclists who are violating helmet laws. The system detects helmet using blob analysis.

Keywords- *helmet detection, blob analysis, image processing*

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I. INTRODUCTION

After the development of computers and later on of fast processing software's, video processing has found a vital place in the area of research. Highway traffic control has been a challenging problem for the government on a global scale. According to reports, a total of around 1.3 million crashes happen all over the world each year; a majority of them caused by over speeding of vehicles and not wearing helmet on highways.

So, observing the usefulness of helmet, Governments have made it punishable offense to ride a bike without helmet and have adopted manual strategies to catch the violators which has some limitations of speed. Using video surveillance of the street, the proposed system detects if the bike rider is wearing a helmet automatically without manual help.

Although many researchers have developed some systems for traffic-violation detection in action and taking photography of incidents for records. Those systems comprised of many hardware devices such as induction coils, radar, ultrasonic, laser, video detection, etc. So, in comparison with the traditional traffic violation detection technology, the video-based image processing method for traffic violation detection has many advantages, for example easy maintenance, high accuracy of detection, long life service, real-time detection and inexpensive.

In the proposed system we gave a traffic video as an input to the MATLAB software. Further, various frames were extracted from the inputted video. Then foreground detection is done in every frame. After that some noise is removed using morphological operations. Then using blob analysis helmet has been detected.

II. LITERATURE SURVEY

A Hybrid Approach for Helmet Detection for Riders Safety using Image Processing, Machine Learning, Artificial Intelligence by M. Swapna Tahniyath Wajeeh Shaziya Jabeen, they have detected moving vehicles by thresholding and then classified into motorcyclists and non-motorcyclists by area and aspect ratio. If in case motorcyclist is detected without a helmet, the number plate of motorcycle has been read and noted. The recognition of number plate algorithm has five parts: image procurement, preliminary processing, fringe detection and segmentation, feature extraction and recognition of character number plates using suitable machine learning algorithms. Also the database has been generated with the records to identify every offender accurately and arrest of suspect's vehicle, imposing helmet violation fines, the system has been implemented using pure machine learning in order to identify ever type of helmet [1]

Automatic detection of motorcyclists without helmet by Romuere Silva, Kelson Aires, Thiago Santos, Kalyf Abdala, Rodrigo Veras, André Soares, they have used a hybrid descriptor for features extraction is proposed based in Local Binary Pattern, Histograms of Oriented Gradients and the Hough Transform descriptors [3]

Automatic Helmet Detection on Public Roads by Maharsh Desai, Shubham Khandelwal, Lokneesh Singh, and Prof. Shilpa Gite used background subtraction and optical character recognition for fall detection and for helmet detection they have used background subtraction and Hough transform descriptor [4]

Detection of Motorcyclists without Helmet in Videos using Convolutional Neural Network by C. Vishnu, Dinesh Singh, C. Krishna Mohan and Sobhan Babu, they have used adaptive

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background subtraction on video frames to get moving objects. Later convolutional neural network (CNN) has been used to select motorcyclists among the moving objects. Again, they applied CNN on upper one fourth part for further recognition of motorcyclists driving without a helmet. The performance of the proposed approach has been evaluated on two datasets, IITH Helmet 1 contains sparse traffic and IITH Helmet 2 contains dense traffic, respectively [6]

Automatic Traffic Rule Violation Detection and Number Plate Recognition by Amey Narkhede, Vikrant Nikam, Akshay Soni, Abhishek Sathe and Prof. G.G.Chiddarwar, they proposed a model which includes an automated system which uses IR sensors and camera based on Arduino to capture video. The project presents Automatic Number Plate Recognition (ANPR) techniques and other image manipulation techniques for plate localization and character recognition which made it faster and easier to identify the number plates. After recognizing the vehicle number from number plate the SMS based module has been used to notify the vehicle owners about their traffic rule violation. An additional SMS also has been sent to Regional Transport Office (RTO) for tracking the report status [16]

III. PROPOSED SYSTEM

Following figure shows the flowchart of our proposed system.

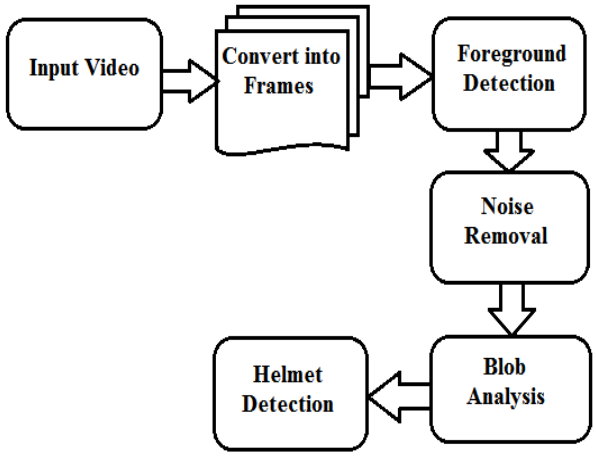

Fig 1. Flowchart of Proposed System

Here, in our proposed system a video is given as an input to the MATLAB software for the further processing. This video which is given as an input is then converted into number of frames for the further operations.

A. *Foreground Detection*

Foreground detection is the major tasks in the field of computer vision and image processing whose aim is to detect changes in image sequences. Background subtraction is any technique which allows an image's foreground to be extracted for further processing in a video (object recognition etc.).

Many applications do not need to know everything about the growth of movement in a video sequences, but it only require the information of changes in the scenes, because an image's regions of interest are objects (humans, cars, helmet etc.) in its foreground. After the stage of image preprocessing which includes image denoising, post processing like morphology etc. object localization is very much required in every stage which may make use of this technique.

Foreground detection separates foreground from background based on these changes taking place in the foreground. It is a set of techniques that typically analyze video sequences recorded in real time with a stationary camera.

B. *Noise Removal*

Mathematical morphological operations are based on set theory which can be used to process and also to analyze the images. It also provides an alternative approach to image processing based on the shape concept stemmed from set theory. In mathematical morphology images are treated as sets, and morphological transformations which derived from Minkowski addition and subtraction are defined to extract features in images. Further the image which will be processed by mathematical morphology theory must be changed into set and represented as matrix.

Structuring Elements are the elements used in morphological theory, which can be also represented as matrices. Structuring element is one of the characteristic of a certain structure and features for measuring the shape of an image and also used to carry out other image processing operations. The shape and size of the structuring element (SE) plays very crucial role in an image processing and is therefore chosen according to the condition of an image and demand of the processing.

The basic mathematical morphological operations which are dilation, erosion, opening and closing are used for detecting, modifying and also for manipulating the features which are present in an image based on their shape. In the following, some basic mathematical morphological operations of gray-scale images are introduced.

Let I (x, y) denote a gray-scale two dimensional image, SE denote structuring element. Dilation of a gray-scale image I(x, y), by a gray-scale structuring element SE (a, b) is denoted by,

$$(I\ SE)\ (x, y) = \max \{I\ (x-a, y-b) + SE\ (a, b)\} \quad (1)$$

Erosion of a gray-scale image I (x, y) by a gray-scale structuring element SE (a, b) is denoted by

$$(I\ SE)(x, y) = \min \{I\ (x+a, y+b) - SE\ (a, b\ )\} \quad (2)$$

Opening and closing of gray-scale image I (x, y) by grayscale structuring element SE (a, b) are denoted respectively by,

$$I \circ SE = (I\ SE)\ SE \quad (3)$$

$$I \bullet SE = (I\ SE)\ SE \quad (4)$$

Erosion basically decreases the gray-scale value of an image by applying shrinking transformation, while dilation increases the gray-scale value of the image by applying expanding transformation. But both of them are very sensitive to the image edge whose gray-scale value changes. Erosion technique filters the inner image while dilation filters the outer image. Opening is erosion followed by dilation and closing is dilation followed by erosion. Opening technique generally smoothes the contour of an image, breaks narrow gaps. As contrast to

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opening, closing tends to fuse narrow breaks, eliminates small holes, and fills gaps in the contours.

C. Blob Analysis

Image segmentation used in this research is BLOB analysis which a basic technique in image processing aims to analyze the special characters in an object, therefore, this method is suitable in differentiating and then extracting the shape and size of the object to be detected with its environment.

Blob Extraction

The main objective of BLOB extraction is to isolate the BLOB or an object within its binary image. A BLOB consists of a group of connected pixel and to determine which one is neighbor pixel, and which one is not. There are two most certain used types of connectivity. The 8-connectivity is more accurate, however, the 4- connectivity requires fewer computation, hence faster image processing, than 8-connectivity. Fig 2 shows the difference of the 4 and 8 connectivity. The second step is by using the template matching where each and every feature are compared with the features of assigned type. Template matching is used to find the matching area within an image with the template image or patch. By applying this method, BLOB detection can be acquired faster. The features used for template matching are dots, lines, edges, and detected area. The steps for template matching are as follow:

1. Overlay the template on an initial image position (0,0).
2. Calculate the sum of squared differences (SSD) and the sum of absolute differences (SAD) for the overlaid area and then store it in a correlation matrix.
3. Move on to the next image position and repeat step 2 until the final image position is reached.

Blob Features

After the process of BLOB extraction, the next step is to classify the different BLOBS. The first step of BLOB extraction is distinguishing each BLOB by representing it with a number of characteristics and denoted features. Feature extraction converts each

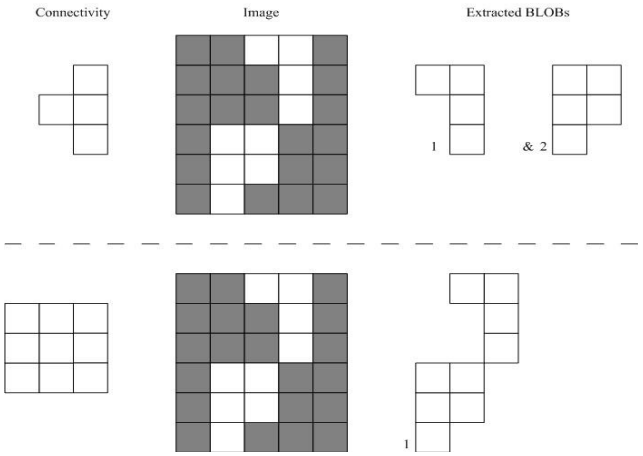

Fig 2. 4 and 8 connectivity

BLOB into representative numbers, in which only the relevant information is considered and ignore the rest. The very first thing to do is excluding every BLOB connected to the border of an image since generally there is no information about any object outside the image. The number of a BLOB is only the number of pixels within that BLOB. This feature is used to select the BLOB size, therefore, too big or too small BLOB can be ignored. Drawing a bounding circle, box, or convex hull are the way to show the detected BLOB. In this paper the bounding circle to show the detected image or an object. The bounding box of a BLOB is defined as the minimum rectangle within a BLOB and used to remove the too big or too small BLOBs from an image. The rectangle is drawn by going through all the pixel for a BLOB, and finding four pixels with the minimum x value, maximum x value, minimum y value, and maximum y value. The bounding box is drawn by taking the width given by x max x min and the height as y max y min. The bounding box is also known as the ROI (Region of Interest). Bounding box ratio of a BLOB is defined as the height of the bounding box divided by the width.

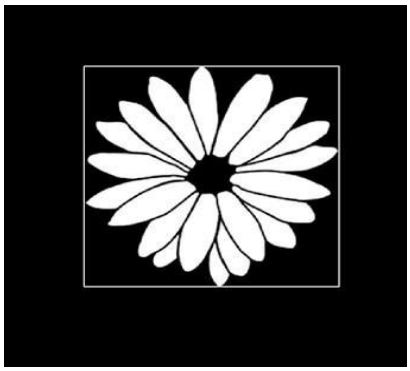

Fig 3. Bounding Box around BLOB

Compactness of a blob is defined as the ration of the BLOB's area to the area of the bounding circle and used as a way to distinguish the compact BLOB from the non-compact ones. The compactness of a blob is calculated by,

$$\text{Compactness} = \frac{\text{Area of a BLOB}}{\text{width} \cdot \text{height}}$$

Center of the mass of a binary image is the center point to balance the image, the average of x and y position of the binary object. It is defined as a point whose x value and y value are given by,

$$x_c = \frac{1}{N}\sum_{i=1}^{N} x_i \quad , \qquad y_c = \frac{1}{N}\sum_{i=1}^{N} y_i \quad .$$

Center of the bounding box is a fast approximation of the center of mass and given by,

$$x_{bb} = \frac{x_{min} + x_{max}}{2} \quad , \qquad y_{bb} = \frac{y_{min} + y_{max}}{2} \quad .$$

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The perimeter of a BLOB is the length of the counter within a BLOB found by scanning along the counter of an object and summing the number of pixels encounter.
Hence, in this way Helmet is detected.

IV. RESULTS

In this section, following figures shows some experimental results. Our proposed detection and tracking technique is implemented in MATLAB software. The proposed technique correctly detects the helmet and tracks continuously.

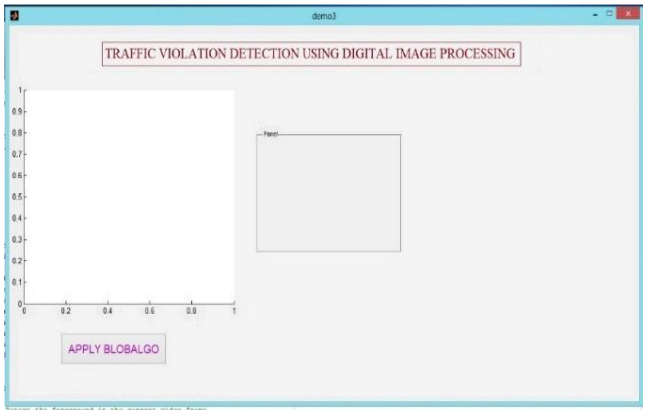

Fig 4. GUI Window

Fig 4 shows the GUI window which is the graphical user interface that allows users to interact with electronic devices through graphical icons and audio indicator such as primary notation, instead of text-based user interfaces, typed command labels or text navigation. The actions in a GUI are usually performed through direct manipulation of the graphical elements. Here, in our proposed system the outputs are shown in GUI window itself. In the left graph the video which is given as an input is shown while in the panel section the riders head part is snapped.

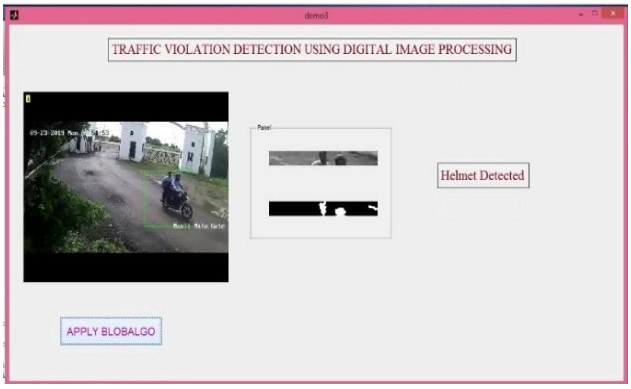

Fig 5. Helmet Detected

Fig 5 shows that the bike rider is detected with Helmet on his head. Hence, in the panel section the only head area of the bike rider is cropped and converted from RGB to Gray scale image. Further this gray scale image is converted into binary image from which we can say that Helmet is detected.

Fig 6. No Helmet Detected

Fig 6 shows that the bike rider is detected without Helmet on his head. Hence, in the panel section the only head area of the bike rider is cropped and converted from RGB to Gray scale image. Further this gray scale image is converted into binary image from which we can say that No Helmet is detected.

Hence, from the above shown figures we can say that our proposed system properly detects the traffic rule violators using image processing with the help of blob analysis algorithm.

V. CONCLUSION

The objective of this research was to develop a system for enforcing helmet wearing using image processing. In this paper, we proposed a framework for real-time detection of traffic rule violators who ride bike without using helmet. So our, proposed work was divided into three phases such as detection phase, tracking phase and evaluation phase. Here a foreground detection is used for extracting foreground section. The best thing in our proposed work was applying Fuzzy based Morphological Filtering for reducing noise and achieving exact result by retaining the features of morphology operation and fuzzy theory. Moving object like helmet are tracked by blob detection. Features were extracted from the processed frames. Thus, the developed system aims to help law enforcement by police, and eventually resulting in changing risk behaviors and consequently reducing the number of accidents and its severity.

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