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Zebra Crossing Rule Violation Recognition Using Fisher Vector Representation

Priyankka Chaurasia
Department of Computer Science & Engineering
Sagar Institute of Research & Technology
Bhopal, Madhya Pradesh, India
edu.researchscholar@hotmail.com

Arun Jhapate
Department of Computer Science & Engineering
Sagar Institute of Research & Technology
Bhopal, Madhya Pradesh, India
arunjhapate11@gmail.com

***Abstract*— In a modern era of road safety and traffic management there are several signals and markers have assigned for pedestrian and vehicles, zebra crossing is one of them. Zebra crossing is used to provide a way where pedestrian can cross the roads as per the traffic signal regulations. It appears as stripes with alternating black and white lines as zebra looks. It is very necessary to draw it for pedestrian safety because there are so many casualties happen due to pedestrian crossing while in traffic. It can be finding around traffic signals where vehicles do not possess to cross zebra marking until the signal becomes green. But people violate this rule against zebra crossings that may culpable for them and procreate inconvenience for pedestrian. This violation can be recognized at real time and action can be taken accordingly to penalize violators. It can be done through Fisher Vector Representation statistical classifier that classifies the vectors as per the statistical data pertained from the input image. It can be used for vector representation with regression and classification. Fisher kernel is able to classify whether zebra crossing rule has been violated or not as per the sets of statistical situations.**

Keywords*— *Zebra Crossing, Dense Classifier, Fisher Vector Representation, Statistical Data, Pedestrian Classification.

I. INTRODUCTION

Zebra crossings have been designed for pedestrian safety transition within a dense traffic due to increasing in personal vehicles day by day. Vehicles are required to stop their vehicle before the zebra crossings for proper and efficient flow of traffic among pedestrian. But zebra crossing rule violation get increases day by day due to man power based surveillance system. Man power is not capable enough to maintain the traffic with all rules and regulations. It is required to implement some automated system that can recognize rule violation automatically and notify at real time. Fig. 1 shows the zebra crossing rule violation by vehicles that comprise pedestrian transition and safety. Traffic law infractions are now a big problem for most emerging nations in the modern, changing world.

Fig. 1. Rule Violation [1]

Now a day, vehicles are getting increased very fast and on the other hand rule violations are also getting increased which is required to control for road and safety purpose. It plays a very important role for securing people from getting smashed [2].

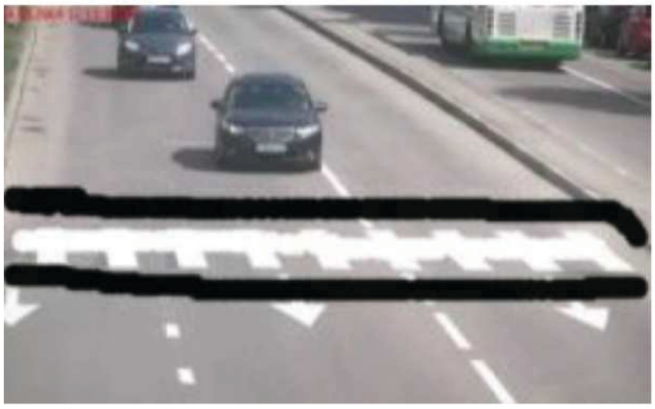


Fig. 2. Zebra Crossing Detection [2]

Fig 2 represents zebra crossing marks over the road surrface where vehicles are not supposed to overlay.

II. Related Works

A. Literature Survey

There are a lot of researches intended to acquire better option to recognize zebra crossings and violations for the same. Darlis Herumurti et al. [3] proposed a method which is based on high resolution aerial image and DSM data. The intension of this paper is to extract road from dense city and assist on Google map. It is hard to acquire high definition aerial image and detection is also difficult because of wide angles with respect to the distance that makes harder to precisely recognize zebra crossing or any other object. S. Alvarez et al. [4] evicted a model for intellectual system that controls the traffic management. It also uses the camera calibration method for better computer vision application. The motive of this paper is to monitor principal and vanishing points on the basis of zebra crossing detection. Zebra crossing has been detected using bimodal histogram from binary image that classifies white stripes as zebra crossing marks. But it is difficult to classify zebra crossing on the basis of color or binary patterns. Color always distract due to luminance and today's dense population. Dragan Ahmetovic et al. [5] proposed a system which is based on EDLines algorithm that intended to recognize zebra crossings for safety transitions of pedestrian. It has been suggested to use the zebra crossing as per the signal regulate and execute the crossing as soon as possible for repelling any casualties. The system uses rectification method for making it easier for human or pedestrian and if any of people violating the rule then it indicates the violations and it draws the geometry with respect to the violators. System uses mobile device for detecting and giving assistance over that for safe and efficient transition at real time with high precision rate. But detecting zebra crossing using hand held devices do not met the violations and safety transitions. System is processed through image processing tentative with rectification computation matrix that recognize zebra crossings at real time for better guidance or assessments. Md. Khaliluzzaman et al. [6] revised zebra crossing rule violation system by using Gabor filter. Author uses Gabor for removing the background noise from the image and he also uses Sobel edge operator for identifying the zebra crossing from the road. There is a particular geometry for zebra crossing through which it can be easily identified and it makes easier for system too to detect it and recognize the violation accordingly. There are several methods available for detecting the edge but it can be considered as the sobel is the better one to detect the shape of the objects. Zebra crossing pertains simple geometry such as horizontal lines with white and black color texture. So, it is easy to recognize the zebra crossing. But edge detection method misleads the system when brightness is weak or heavy. It means that it changes due to high changes in luminance. Samir Ibadov et al. [2] proposed CNN based zebra crossing rule violation system. Motion detection and the Kalman filter have been used to detect pedestrians. The algorithm employs several-step processes. Zebra detection, automobile detection, and pedestrian detection are what they are. We employ a quicker R-CNN deep learning method for car detection. A system based on IR sensors for zebra crossing detection and OCR for automatic number plate recognition was proposed by Amey Narkhede et al. [7]. Utilizing K closest classification, the system detects edges in binary images using a Gaussian filter. The k-nearest neighbours formula (k-NN), which can be used for classification and regression in pattern recognition, is a non-parametric approach. Each time, the feature area's k nearest coaching examples make up the input. Whether or not k-NN is used for classification or regression will affect the results: The output of k-NN classification could be a category membership. An object is categorised by a majority vote of its neighbours, and is then put into the category that its k closest neighbours find to be the most representative (k may be a positive number, usually small). The thing is simply put into the category of the one nearest neighbour if k = 1. The accuracy is bit lower as compare to the earlier proposed systems and intention is not up to the marks. OCR is not a effective appraoch for character recognition.

A M Muntasir Rahman et al. [8] suggested a system that uses an Arduino -UNO to detect zebra crossings in real time. Ultrasonic sensors were used to measure the parameters needed for the system, and tests on the system indicate that there is a 1 in 200 chance that it will be defeated.

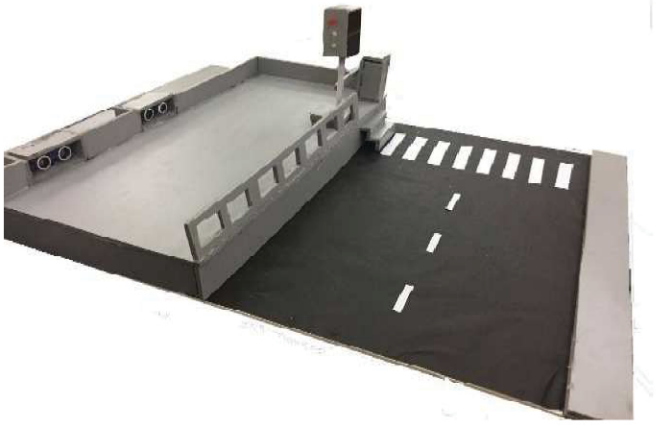
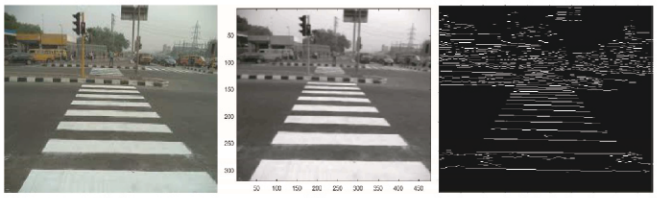


Fig. 3. Experimental Setup [7]

III. Problem Identification

According to a literature review, several studies have been conducted in the area of zebra crossing identification but few studies have been conducted for rule violation detection. In a crowded setting, it is challenging to spot a rule infraction in progress and take appropriate action. Here, a system based on geometric features and vertical disappearing points is employed to detect zebra marking, and it has been thought that zebra crossings have distinctive white striping patterns. Gabor filer has been emphasized for zebra crossing extraction without any ambition why it has been detected. Detecting white lines according to the shape is not a good idea for real time armatures where crucial decision is required made effectively [6].



(a) (b) (c)

Fig. 4. Shows an example of edge detection processing Images of a zebra crossing, a gabor filter, and a horizontal edge are shown in [6].

Edge detection is not suitable for rule violation detection especially at dense or crowded area even at real time. Sobel is a good edge detection technique but vehicles edges pertain distinct ratio that creates confusion while detecting violation at real time.

IV. Proposed Work & Implementation Details

Here the objective of the system is to detect zebra crossing rule violations with better level of precision. System is based on fisher vector representation that classifies zebra crossings as well as vehicles from dense population of vehicles and pedestrian. System also classifies pedestrian by analyzing its aspect ratio and separate using motion detection. It has been analyzed that is there is a motion over zebra crossing; it means that pedestrian occupies it that should not be recognized as rule violation. System is capable enough to understand that situation and take decision accordingly. If a vehicle crosses zebra crossing or stop line then it can be recognized by the system at real time and action can be taken accordingly. If there is a motion over zebra lines then it is considered as pedestrian and detection can be activated only in stable or unchanged state. If changes occur in zebra area; it means that there is pedestrian and no need to detection violation over there at that time.

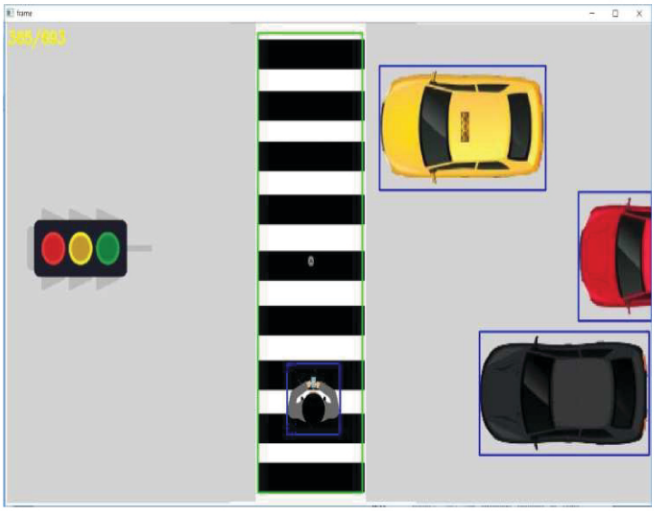


Fig. 5. Pedestrian Motion Detection

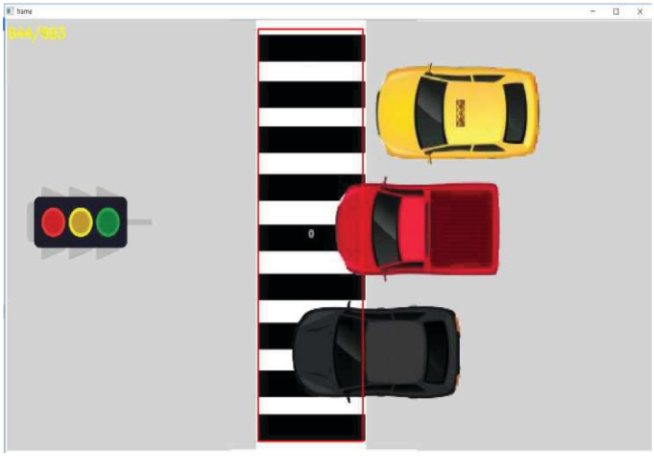


Fig. 6. Violation Detection

Fig. 5 shows the pedestrian motion detection over zebra crossing that implies no violation detection because of no steady state of other vehicles. In other hand fig. 6 show the violation detection because of steady vehicle detection over zebra crossings that can be recognized indeed for true acceptance or true recognition. Here the system has been tested with animated video as well as real armatures. Here the proposed method is based on fisher vector where feature vectors get extracted using local pooling that depicted the descriptor based classification. Similarly, system has been tested for real world video also, video has been acquired from Indian city Bhopal where traffic congestion is severe problem. Green blob shows there is no zebra crossing violation detected from that particular frame where as red shows violation detection. Fig. 7 & 8 represent system proceedings over a real world video or frames.

Fig. 7. Violation Detection from Real World Frames

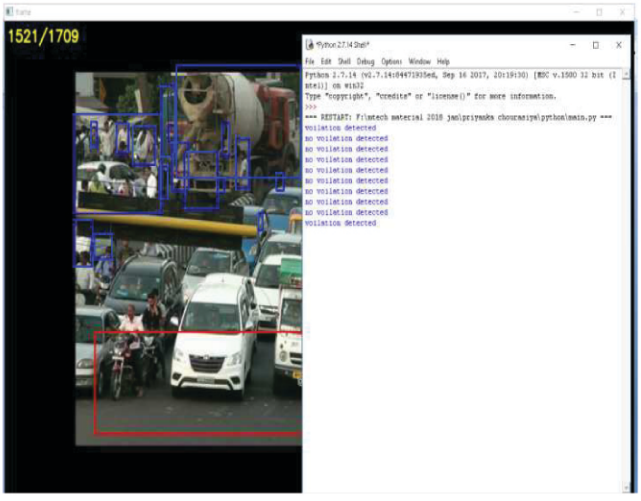


Fig. 8. Result Console

The Fisher Vector (FV), a particular, approximative, and enhanced case of the generic Fisher kernel, is a representation of an image created by pooling local image information. The Gaussian-Mixture-Model component k's mean and covariance deviation vectors are also stored in the FV encoding along with each component of the local feature descriptors.

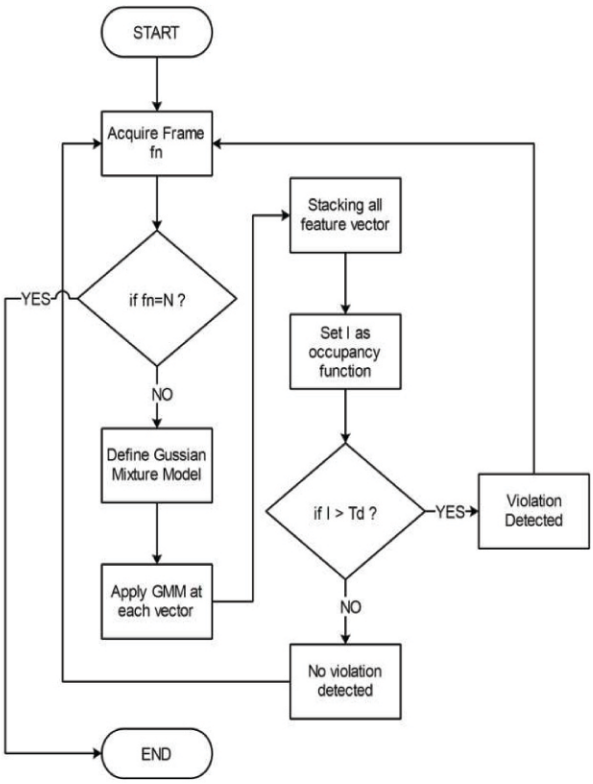


Fig. 9. Flow Chart

As per the flow chart, first of all; a frame will be acquired till current frame is equal to the last frame. After that Gussian Mixture Model has been defined to apply at each feature vector and stacking all of them, then resulting a occupancy function I. If I is greater than the threshold value, it means that violation is detected over that particular frame otherwise no violation will be detected and loop will work till last frame. Let it be more precise with algorithm.

A. Fisher Vector Algorithm –

Require – I as D dimensional feature vectors, T_d as threshold value, f is a current frame, F_N is the last frame.
Input: 2 dimensional input frame
Output: Fisher vectors
Step 1: Acquire 2D input image
Step 2: let Input = (x_1, x_2, x_3…..x_N) D dimensional set of feature vectors
Step 3: Let $\theta = (\mu_k, \sum k, \pi k : k = 1 \dots k)$ as a parameter model distribution.

$$\text{Where } q_{ik} = \frac{exp\left[-\frac{1}{2}(x_i - \mu_k)\sum_k^{-1}(x_i - \mu_k)\right]}{\sum_{t=1}^{k} exp\left[-\frac{1}{2}(x_i - \mu_k)\sum_k^{-1}(x_i - \mu_k)\right]}$$

$$u_{ij} = \frac{1}{N\sqrt{\pi k}}\sum_{i=1}^{N} q_{ik}\frac{x_{ij} - \mu_{jk}}{\sigma_{jk}}$$

$$v_{ij} = \frac{1}{N\sqrt{2\pi k}}\sum_{i=1}^{N} q_{ik}\left[\frac{x_{ij} - \mu_{jk}}{\sigma_{jk}} - 1\right]^2$$

where j = 1, 2 ….. D span vector dimensions
Step 4: Feature vector of an image I is the stacking of vectors, u_k and v_k for each k mode

$$I = \begin{bmatrix} u_k \\ v_k \end{bmatrix}$$

Step 5: Set I as occupancy function
Step6: while $f \neq F_N$ do
If I > T_d then
Violation detected;
Else
No violation detected;
end else
end if
end while
Step 7: if (f = F_n) then
End frame sequence;
End if
Step 8: End
The objective of the algorithm is to extract feature vector for density calculation whether the density occupied the zebra crossing blob or not. If it is occupied then it will consider as rule violation otherwise no violation will be detected. The FV is simple to define explicitly even though it may be derived as a particular, approximative, and enhanced case of the general Fisher Kernel framework.

V. Result Analysis

Here the system has been tested with animated as well as real world video and the result has been recorded accordingly. The total no. of frames is 2402 for both animated and real one. 1709 frames for real world video and 693 frames for animated one.

Table 1 Result Analysis for Real World Video

	Proposed
Total No. of Frames	1709
True Recognition Frames	1695
False Recognition Frames	14
True Motion Detection Frames	1709
Precision	99.18 %
ERR	0.82 %

Table 2 Result Analysis for Animated Video

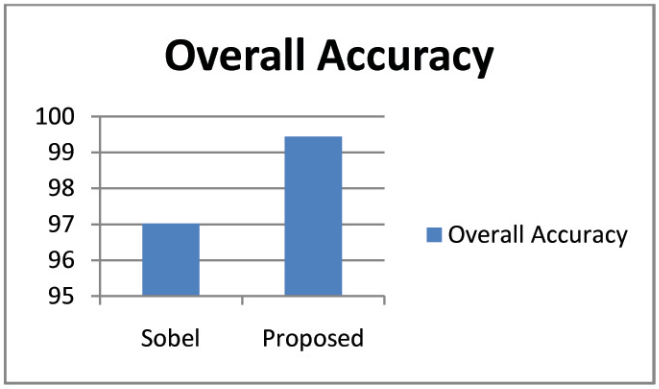
	Proposed
Total No. of Frames	693
True Recognition Frames	691
False Recognition Frames	2
True Motion Detection Frames	693
Precision	99.71 %
ERR	0.29 %

Table 3 Result Comparison

Method	**Accuracy in %**	
Sobel & Gabor [6]	97.02	
Proposed	Real Video	99.18
	Animated	99.71

Here the system acquired two accuracies, one from real world video and another from animated one which are bit higher than the earlier one. System accuracy is also affected by OpenCV which is a modern era of computer vision library through which higher precision can be achieved.

Graph 1 Result Comparison



VI. Conclusion & Future Scope

Detecting zebra marking is not big deal but violation detection on the basis of pedestrian and motion detection is important. If there is a motion detected over zebra crossing, it means that there are pedestrian crossing zebra lines but there is no motion over marks, it means that vehicles occupied the lines and violation should be detected with better level of precision. System is able to detect rule violations over zebra lines using fisher vector representation and OpenCV and achieved high precision rate. System tested with two types of input, one is animated and another is real world video and accuracies are recorded as 99.71 % and 99.18 respectively. System is more capable enough to detect violations with good precision rate. In future, system can be implemented for other rule violation detection as per the traffic rules at real time that can manage traffic regulation properly and effectively with high precision rate.

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