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Detection of Pedestrian Crossing for Safe Driving

Rutika V. Shinde, Dr.S.D.Lokhande

Department of Electronics &Telecommunication, Sinhgad College of Engineering, Pune, Savitribai Phule Pune University, India.

ABSTRACT: Sudden pedestrian crossing (SPC) has been the major purpose behind person on foot and vehicle crashes. In this paper, concentration is given on identifying SPCs around evening time for supporting an advanced driver assistance system utilizing a far-infrared (FIR) camera mounted on the front-rooftop of a vehicle. In any case, this work focuses on SPC during the hot summer season. For constant handling, firstly the optimal levels of the picture scaling are chosen. Here, proposed strategy is then utilized for recognizing virtual reference lines that are connected with street division without utilizing shading data, and change these lines as per the turning course of the vehicle. Detection of pedestrian is done by utilizing a Cascade Random Forest Classifier with Haar-like features and Oriented Center Symmetric-Local Binary Patterns. The prediction of SPC is carried out by using Kalman Filtering for tracking pedestrians. The proposed method is effectively applied to KMU SPC dataset caught by a FIR camera, and the outcomes demonstrate that its SPC detection is superior to those of different strategies.

KEYWORDS: Cascade random forest, FIR image, KMU pedestrian dataset, sudden pedestrian crossing, Kalman Filter.

I. INTRODUCTION

In this paper, a particular issue is addressed that can hugely affect person's lives, to be particular, the discovery of sudden walker intersection to help drivers in maintaining a strategic distance from mishaps. Our work is energized by two operators. One is that the proposed issue has mind blowing social noteworthiness and the other is application regard. Person on foot-vehicle accidents that occur amid the night are an important social issue far and wide [1]. Advanced Driver Assistance Systems (ADAS) that are outfitted with cameras have been planned to thus dodge such setbacks. Among the distinctive sorts of cameras used as a piece of such structures, far-infrared (FIR) cameras are perfect since they are invariant to edification changes. As needs be, this paper focuses on SPC discovery by using a recursive calculation which is a Linear Quadratic Estimation (LQE) calculation likewise called as Kalman Filtering.

II. LITERATURE REVIEW

P. Vinicius and K. Borges [2] presented effective recognition measurements that consider the way that human development presents particular movement designs. For recognizing people on foot, they utilized the prompts of a cyclic conduct in the direction of blob and an in stage connection between the distinction in blob size and position. The Advantage of the system is that they can be easily applied to no static cameras, as they do not rely on background segmentation. To achieve improvement in performance they combined these features by utilizing the Bayes Classifier. Limitation of using visible light images is that detection of pedestrians in color images is not having the desired effect in environments with poor illumination such as that on rainy days, at night or in darkened tunnels [3]. Broggi, Fedriga and Tagliati [4] proposed “Pedestrian detection on a moving vehicle: an investigation about NIR images”, they created an algorithm which firstly improves luminous areas in the images and encloses them with a rectangular perimeter (bounding box), so that it reduces the areas that will enter the second phase evaluation. It then calculates the contents of such bounding boxes with a weighted combination of the two matching processes.

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On the other hand FIR cameras are precise to the radiations emitted by the human body and therefore are very useful for pedestrian detection especially at night time.

Xu et al. [5] proposed a pedestrian detection and tracking method depending on the idea that the human body looks brighter than the background. Many detection phases are conducted to find the hotspot regions by using a SVM size-normalized pedestrian candidates and the tracking phase is made up of association of Kalman filter prediction and mean shift tracking.

Xu et al. [6] proposed "Detection of SPC's for driving assistance systems"; they proposed a three-level coarse-to-fine video-based framework that perceives in part obvious individuals by walking similarly as they enter the camera seen, with low false ready rate and rapid. Disadvantage is that there is a need to improve classification accuracy.

III. PROPOSED SYSTEM

The general perspective of the walker recognition framework which has been proposed is shown in fig.1 below. Firstly camera is initialized and video is captured. After capturing video it is necessary to extract frames from the captured video because processing needs to be done on each frame.

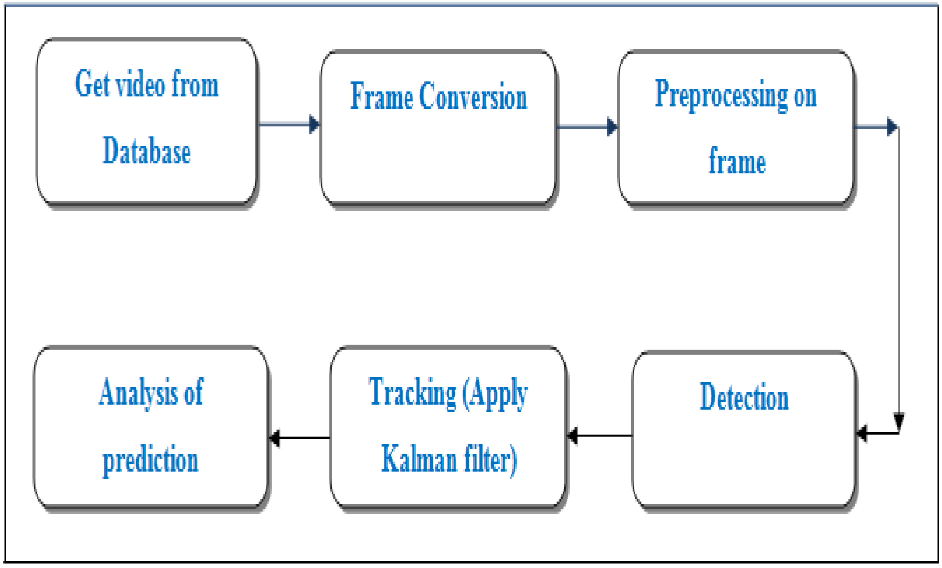

Fig.1: Block diagram of proposed system

Frames depend on the length of video. Frame sizes depend on the pixel value. For Example, Video 1 has:
Format: .avi file
Length: 12 sec
Frames: 307
Frame Width: 640
Frame Height: 480
Resolution: 640*480
Frame Rate: 24 frames/second

Various preprocessing steps such as blurring using gaussian and median filter, dual thresholding etc. are done on each frame. After preprocessing step detection step follows. But before detection stage firstly virtual reference lines are plotted along the road lane which changes according to the turning direction of the vehicle. The primary phase of the recognition framework manages location of people on foot utilizing a checking window with Haar cascade detector, which disposes of the greater part of the non-walkers and second stage, makes the framework more vigorous by approving the recognized walkers with LPB (Local Binary Pattern) identifier and pedestrians are classified as

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pedestrian and non-pedestrian class by using CaRF (Cascade Random Forest) classifier after which tracking is done using Kalman filter.
By using the virtual reference lines and depending on the degree of danger, the detected pedestrians are labeled as caution, warning and normal.
Pedestrian tracking is done to determine the pedestrian correspondences between frames. In order to real-time track moving pedestrian, our approach works in two stages: prediction step and matching step. The prediction step is to determine the search area in which the pedestrian might be seen in next frame. A search window is defined for each precious object, which centers on its predicted centroid and has an area adapted to the scale of the measurement error in the Kalman model. The matching step is to search the corresponding object in the predicted area. The feature vectors of detected pedestrians in the search window are compared. If a matching case is found, the relation between objects in two consecutive frames would be recorded. Disadvantage of using Kalman filter is that it is computationally complex.

IV. EXPERIMENTAL RESULTS

To evaluate the pedestrian detection performance and demonstrate the power of the pedestrian detection regardless of the season, training images from the KMU SPC dataset is taken i.e. the dataset consists of 10 video sequences. For training and testing, 3410 thermal images i.e. frames from ten video sequences are collected for pedestrian detection, including multiple (a minimum of three people) pedestrians together within an image, from the KMU SPC dataset. The pedestrian data included in this dataset contained multiple views: front, back, and left and right side. All experiments are conducted on an Intel Core 3 Quad processor PC with 16 GB of RAM running Windows 10. The proposed KMU dataset was captured from moving vehicles for pedestrian detection and SPC recognition using a moving camera. Therefore, to assess the execution of the proposed calculation we have two types of FIR video sequences, ten for training and ten for testing, while varying the speed and activities of the pedestrians. The video resolution is 640 x 480 and the video images are not stabilized. The height of the pedestrians in the KMU dataset ranges from 155 to 175 cm, and the outdoor temperature is about 30 degree Celsius.

Type I: Seven FIR video sequences containing running and walking pedestrians while driving at 20 to 30 km/h.
Type II: Three FIR video sequences containing running and walking pedestrians while driving at 20 km/h.
For evaluating the performance of SPC detection, the ground-truth location of the SPC is obtained through a manual labeling based on the degree of danger. We define the images as an SPC detection in which one-third of the pedestrian's body overlaps the virtual reference lines and the pedestrian is in a running pose. The level of SPC is annotated as a "warning," "caution," or "normal" according to the pedestrian's velocity, direction, and degree of overlap. For example, if a pedestrian is running in a left or right direction in the middle of the road, a "warning" alarm is declared. Moreover, if ten percentage or more of the pedestrian's body overlaps a virtual reference line and the pedestrian is running, a "caution" alarm is declared. Finally, if less than ten percentage of the pedestrian's body is overlapping a virtual reference line and their movement direction is toward or away from the vehicle, a "normal" situation is declared.
Different types of PYTHON functions have been used to show the results of Pedestrian detection. Various types of parameters are then calculated to classify whether a given frame contains pedestrian or not.KMU data set videos are used as training and testing set. The database of 10 different videos is used for training and testing set. Some frames within them contain pedestrian and some doesn't have. For first video, Total images/frames (n) = 307.
Various steps of execution are shown from fig.2 to fig.7 which includes input frame, Gaussian filtered image and median filtered image, threshold image, LBP image and pedestrian detection output.
Input frame extracted from a video is shown in fig. 2. All the further processing is done on this frame.

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Fig.2: Input Frame

Gaussian filtering is applied to the input frame as shown in fig.3, the obtained image is noise free and with other detailing removed. This also reduces image's high-frequency components.

Fig.3: Gaussian filtered image

After the input frame is Gaussian filtered, it is again filtered by using median filter.
Median filtering is a pre-processing step which helps to improve the results of later processing such as image segmentation. The result of applying median filtering on an image is shown in fig.4 below.

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Fig.4: Median filtered image

Filtering method is then followed by image segmentation method. The simplest method of image segmentation is used here i.e. thresholding method. Thus, here dual thresholding does partitioning of an image into a foreground and background.

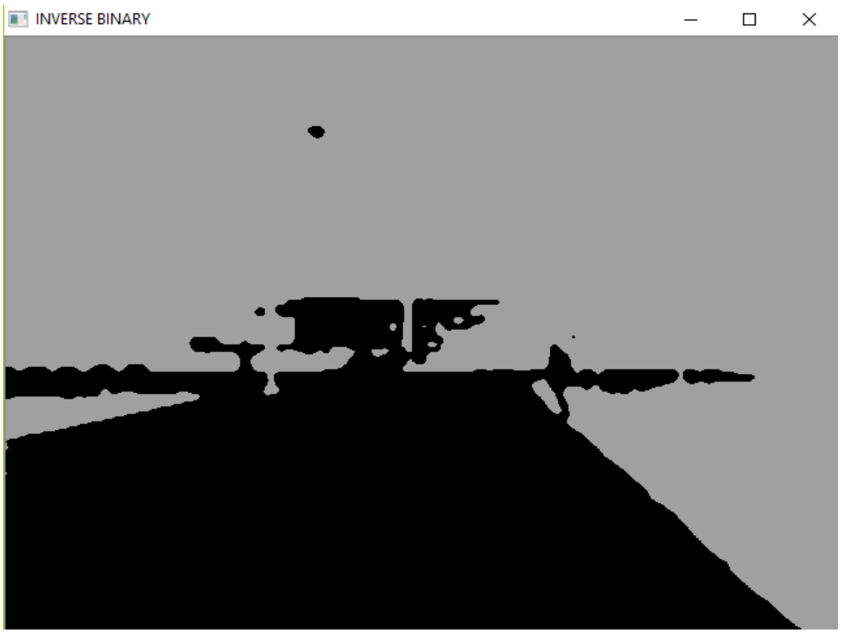

Fig.5: Threshold image

If pixel value is greater than a threshold value, it is assigned one value (i.e. white) else it is assigned another value (i.e. black).Here black color region is our ROI(Region Of Interest).The function used is cv2.threshold, Here the threshold values taken are 60 and 160. Therefore, this method turns an input image into inverse binary image as shown in fig. 5.

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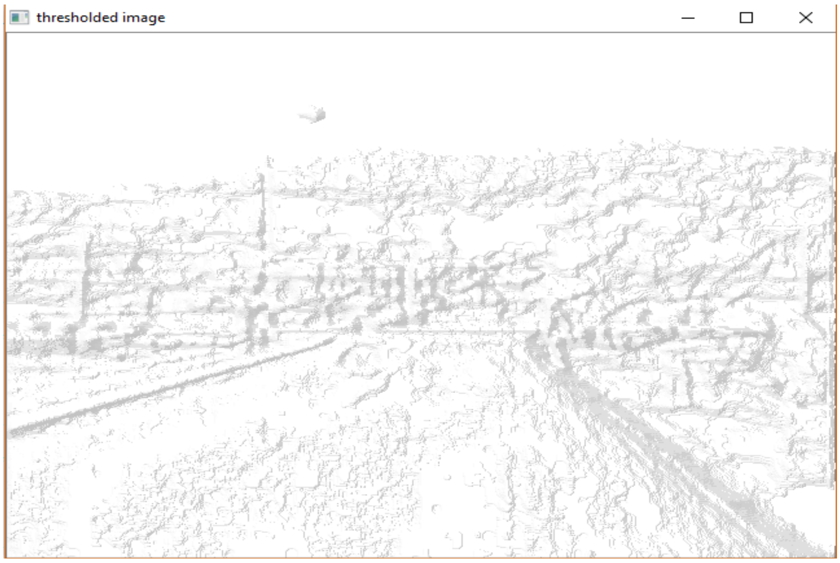

Fig.6: LBP image

For LBP extraction, the center pixel value is taken and threshold against its neighborhood of 8 pixels. If the intensity of center pixel is greater than or equal to its neighbor, then set the value to 1 otherwise, set it to 0.With 8 surrounding pixels, total of 2^8 possible combination of LBP codes are obtained.

From there, the LBP value is calculated for the center pixel, starting from any neighboring pixel and working our way clockwise or counter clockwise, but by keeping the ordering same for all the pixels for all the frames into the video sequences in the dataset. Then binary test is performed on 3x3 neighborhoods which are stored in an 8-bit array, which are then converted to decimal.

The process of thresholding, accumulating binary strings and storing the output decimal value in LBP array is then repeated for each pixel in the input image. The result of LBP extraction on an image is as shown in fig.6.

Fig.7: Pedestrian detection output

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The final pedestrian detection output is shown in fig.7. The kalman filter helps in predicting the future position or location of pedestrians in concurrent frames. The pedestrian shown by red bounding box is detected as warning and its position in next frame is predicted by kalman filter.

The performances are evaluated based on TP (True Positive) and FP (False Positive) rates using the same KMU SPC dataset. Confusion matrix for warning, caution and normal conditions is shown in tables 1, 2 and 3 below. The manual calculations are given below:-
No. of Data set Frames (n):- 307, Positive (P): - The no. of real positive cases in data i.e. which contains pedestrians= 233 and Negative (N): - The no. of real negative cases in data i.e. which does not contain pedestrians= 74.
True Positives (TP): These are the cases in which we detected yes (the test image has pedestrian), and the image really has a pedestrian.
True Negatives (TN): We detected no, and the image has a pedestrian.
False Positives (FP): We detected yes, but the image does not have pedestrian. (Also known as a "Type I error")
False Negatives (FN): We detected no, but the image has a pedestrian. (Also known as a "Type II error")

1) Warning Condition:

Table 1
Confusion matrix for warning condition

	Pedestrian Not Detected	Pedestrian Detected
Pedestrian Detected	FN = 10	TP = 223
Pedestrian Not Detected	TN = 69	FP = 5

1) Accuracy = (TP+TN)/Total = (223+69)/307 = 95.11%
2) Misclassification rate = (FP+FN)/Total = (5+10)/307 = 4.88%
3) True Positive rate = TP/Actual Yes = 223/233 = 95.70%
4) False Positive rate = FP/Actual No = 5/74 = 6.75%

2) Caution Condition:

Table 2
Confusion matrix for caution condition

	Pedestrian Not Detected	Pedestrian Detected
Pedestrian Detected	FN = 33	TP =200
Pedestrian Not Detected	TN = 66	FP = 8

1) Accuracy = (TP+TN)/Total = (200+66)/307 = 86.64%
2) Misclassification rate = (FP+FN)/Total = (33+8)/307 = 13.35%
3) True Positive rate = TP/Actual Yes = 200/233 = 85.83%
4) False Positive rate = FP/Actual No = 8/74 = 10.81%

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3) Normal Condition:

Table 3
Confusion matrix for normal condition

	Pedestrian Not Detected	Pedestrian Detected
Pedestrian Detected	FN = 8	TP = 225
Pedestrian Not Detected	TN = 71	FP = 3

1) Accuracy = (TP+TN)/Total = (225+71)/307 = 96.41%
2) Misclassification rate = (FP+FN)/Total = (3+8)/307 = 3.58%
3) True Positive rate = TP/Actual Yes = 225/233 = 96.56%
4) False Positive rate = FP/Actual No = 3/74 = 4.05%

Table 4
Performance comparison of TP and FP rates in warning, caution and normal conditions

METHODS	PARAMETERS	CONDITIONS		
		WARNING (%)	CAUTION (%)	NORMAL (%)
Existing method[10]	True Positive rate	96	85	96
	False Positive rate	4	15	4
Proposed method	True Positive rate	95.7	85.83	96.56
	False Positive rate	6.75	10.81	4.05

The proposed method showed a higher TP rate for two “caution” and “normal” types of SPCs, 85.83% and 96.56% but lower TP rate of 95.7% for the “warning” case as compared to the existing method as shown in table 4 (Performance Comparison of TP and FP rates). And higher FP rate for warning and normal conditions i.e. 6.75% and 4.05% than of caution which is of 10.81% which is lower FP rate as compared to existing method respectively.

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Fig.8 (a)

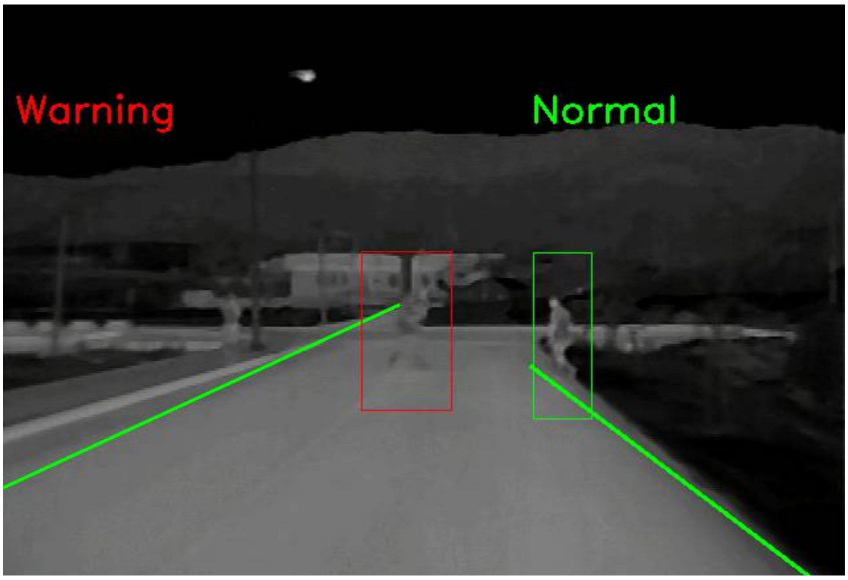

Fig.8 (b)

Fig. 8: Sample SPC detection results using the proposed method showing (a) caution and normal (b)warning and normal examples.

As shown in fig.8 (a) and fig.8 (b), examples of SPC detection when applying our proposed method to the KMU SPC dataset. As shown in fig.8 , the proposed method can detect an SPC regardless of the background or distance from the camera.

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Fig.9 (a)

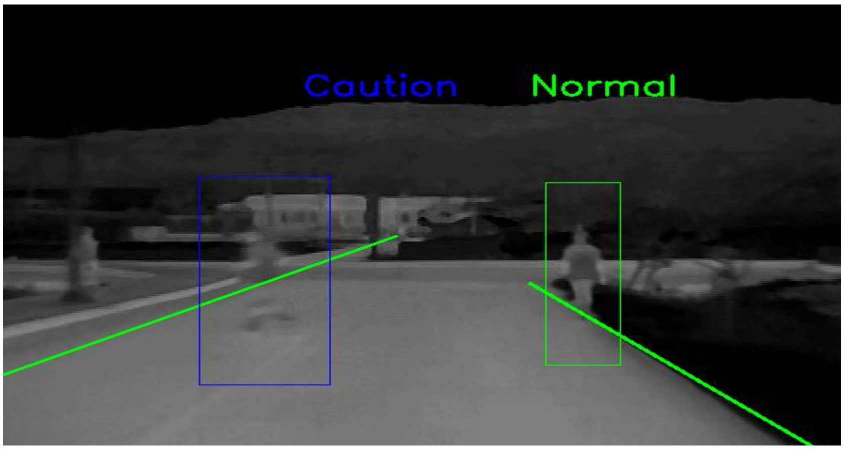

Fig.9 (b)

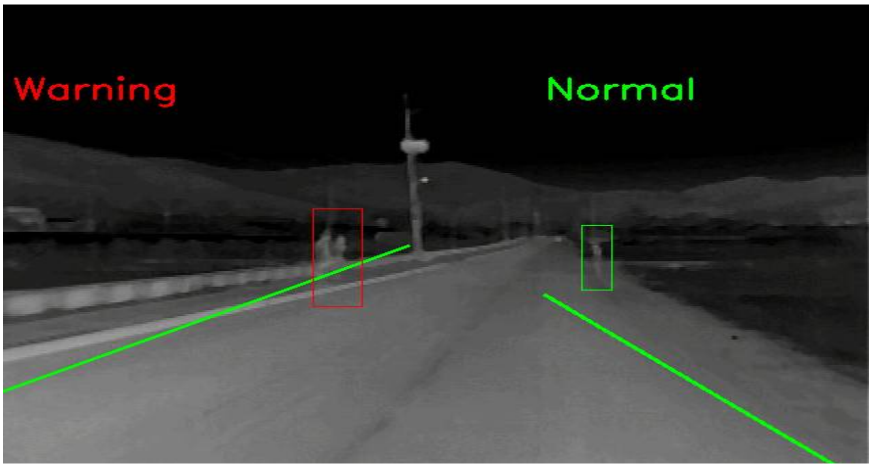

Fig.9(c)

Fig.9: Samples of false SPC detection for various video sequences. (a) misclassification of caution as normal.(b)misclassification of warning as caution.(c)misclassification of normal as warning condition.

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However, our method produces false SPC detections when pedestrians are missed because the road is hot (fig.9 (a)), or when the bounding box of the pedestrian is overlapped with a virtual reference line when the pedestrian is located at a long distance, a pedestrian is detected as a larger bounding box (fig.9 (b)), or the speed of the pedestrian is faster than the center region (fig.9 (c)).

V. CONCLUSION

In this paper, firstly detection of pedestrian is done and then SPC prediction is carried out by using Kalman filtering for object tracking. Also, the proposed system method needs approx. 13.58 seconds of processing time and gives better accuracy due to use of Kalman filter. The proposed method still results in false positive in SPC detection during a rapid change in vehicle direction.

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