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DETECTION AND INDICATION OF PEDESTRIAN CROSSING ON THE ROAD USING ACF AND KALMAN FILTER

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Abstract

When utilization of vehicles expands, the number of fatalities due to car accidents increases. One of the principle reasons of most lethal crashes are results from Sudden Pedestrian Crossing (SPC). The main purpose of this system is to implement the real time detection of the sudden pedestrian crossing for assisting drivers in avoiding accidents. The proposed technique is mainly proposed video based detection of pedestrian crossing in various poses and with different kinds of clothing are first recognized by Aggregated Channel Features (ACF) detector. At that point, it is precisely localized them with the utilization of a Kalman filter estimator configured as a tracker to detect pedestrian. On identification of pedestrians, the position of the foot of the persons identified and their crossing status shall be determined to signify the pedestrian on the road. Advanced pedestrian crossing detection system proves performance as accuracy and processing speed with high resolution videos while running at a frame rate of 25 frames per second captured from moving vehicle. The target detection algorithm is realized by MATLAB programming language.

Keyword: d: Aggregated Channel features(ACF), Detection, Kalman filter, Sudden Pedestrian Crossing(SPC)

1.INTRODUCTION

Detecting pedestrian system has been a major research topic in computer vision, especially an important system to assist the driver. To avoid and control the accidents of vehicles, it is also challenging to accurately detect pedestrians. Mainly the computer vision research is concerned with the development of theories and methods for the detection of pedestrian crossings.

Joko, H. and Kang, H. J proposed the detection of pedestrian crossing road [1]. It was described the detection of pedestrians by using single camera, therefore it is classified as SPC or not and evaluated based on public datasets. The proposed technique described that a walking human was assigned as the ratio of the width to the height of the identified bounding box. The performance result showed that the correct pedestrian detection was 99.50% and its disadvantage as 0.09 false positive per image.

An automatic crosswalk detection method based on the image of a vehicle-mounted mobile surveying and mapping system was proposed, and its cons were analyzed by Xinyi, L, Yongjun, Z and Qian, L [2]. The system was considered for crosswalk detection in *various conditions and lighting cases. With the help of a* vehicle-based Mobile System, the proposed SPC and the analysis of the disadvantages of the system contributed to the three dimensional street type, therefore as for maintaining the damaged transportation facilities in time [3]. In the remainder of the paper, Section 2 explains research methodology, Section 3 describes proposed system design. Results and Discussion are presented in section 4. Section 5 is the conclusion.

2. RESEARCH METHODOLOGY

The fundamental methods and theories underlying the detection of SPC are presented in this section.

2.1. Datasets

In this research, it is used self-dataset namely MyanM dataset including 360 videos which is collected from entering the view of the car-mounted camera in Myanmar as shown in Figure 1.

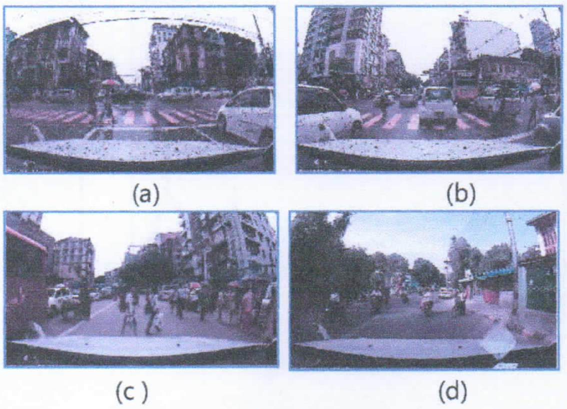


Figure 1. (a), (b), (c) and (d) Some of Pedestrian Crossings Dataset, namely MyanM Dataset

It is recorded wider pedestrian and crowd human within five feet from ground recorded by a vehicle in Yangon and Mandalay. Table 1 is shown the details of the MyanM dataset.

Table 1. Descriptions of MyanM Dataset

Backbone	Train Data	Experiment	Lane
MyanM (Driving speed : 20-40 km/hr)	WiderPedestrian +CrowdHuman (25 frames/sec)	CityPersons (5 feet)	2

2.2. Aggregated Channel Features (ACF) Detector

The research is proposed a method that Aggregated Channel Features (ACF) detector to extract a cross-sectional area of the pedestrian crossings. The Annotated training images are processed by ACF detector that include the bounding boxes of the ground truth of the object. There are two results of the ACF object detector, positive and negative image. A bounding box area that significantly overlaps the ground truth area is positive image and the remaining images are negative images.

ACF detector [7] is used a combination of features including the LUV color space, a normalized gradient channel and a six-channel histogram of oriented gradient (HoG) that is arranged in boosted tree.

2.3. Kalman Filter Tracking

In real-time situations, moving objects are tracked by using the Kalman filter as estimation upon the state vectors. Equation 1 is calculated for the prediction and estimation.

$$\tilde{x}_k = \emptyset\hat{x}_{k-1},\ \hat{x}_k = \tilde{x}_k + K_k(z_k - H\tilde{x}_k) \qquad (1)$$

Where ~ is denoted by prediction and ^ is assigned by estimation and in the estimated position and velocity, K_k is the Kalman gain that is used for minimization the errors. K_k is evaluated in equation 2.

$$K_k = \tilde{P}_k H^T\left(H\tilde{P}_k H^T + R\right) \qquad (2)$$

Where P_k denotes the covariance matrix of errors described in equation 3.

$$\tilde{P}_k = \emptyset\hat{P}_{k-1}\emptyset^T + Q,\ \hat{P}_k = \tilde{P}_k - K_k H\tilde{P}_k \qquad (3)$$

2.4. Indication of Crossing Pedestrian

In this paper, a pedestrian crossing event is defined by calculating of foot position and crossing status. The foot position of pedestrian is defined as:

$$foot = round(y + h) \qquad (4)$$

where y is the top left corner y position of detected pedestrian object and h is the height of the bounding box of detected pedestrian and foot range is also calculated to determine the rang of foot position within virtual reference rectangle region.

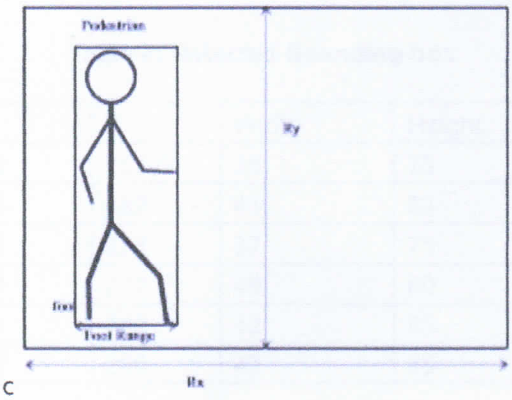
$$footRange = round(x + w) \qquad (5)$$

where w is the width of bounding box of detected pedestrian. After that, it needs to determine the detected pedestrian will cross the road or not by calculation of status of foot called footStatus:

$$footStatus = ((footRange) \geq R_x)\&\&((footRange) \leq R_x + w)\&\&((foot) \geq R_y - R_h)\&\&((foot) \leq R_y) \quad (6)$$

where the value of 1 of footStatus indicate the detected pedestrian may cross the road and the value of 0 of footStatus indicate the detected pedestrian may not cross the road, and R_x and R_y are calculated as foot and footRange equations using top left corner position, width and high of bounding box of virtual reference square shape area.

Virtual reference square shape area



c

The crossing status of pedestrian is calculated using bounding boxes of detected pedestrian and virtual reference rectangle.

$$crossing = \frac{(R_y+R_{width})-y}{(R_{width})} \quad (7)$$

$$crossingStatus = \begin{cases} 1 & if\ crossing > 0.25 \\ 0 & otherwise \end{cases} \quad (8)$$

where R_{width} is the width of the virtual reference rectangle. Thus the final result for indication of pedestrian crossing is as follow:

$$\text{Indicate} = \text{footStatus}\ \&\&\ crossingStatus \quad (9)$$

where the value of indicate is 1 or 0. If the value of indicate is 1, the indication is performed for detected pedestrian, that means the pedestrian is surly to cross the road. Otherwise, the indication is not performed.

3. PROPOSED SYSTEM DESIGN

The efficient system of the detection for pedestrian crossings has been proposed as shown in Figure 2.
There are three fundamental parts in the design of the system. Initially, the system is mounted the camera for capturing the video. Then, it is extracted the necessary frames for further processing. At this condition, frames depend on the length of video.

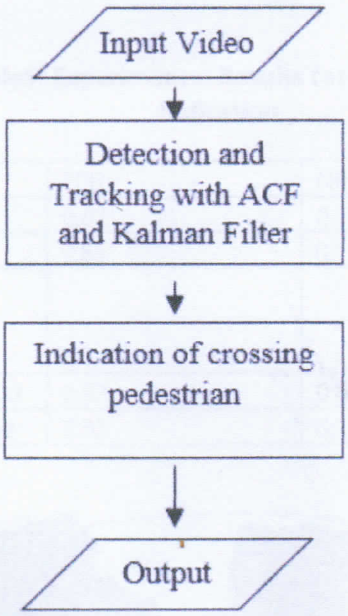


Figure 2. The System Design

Secondly, after extract frames, detection of pedestrian crossings in various poses and with different kinds of clothing are first recognized by Aggregated Channel Features (ACF) detector. At that point, it is precisely localized them with the utilization of a Kalman filter estimator configured as a tracker to detect pedestrian.

Finally, on identification of pedestrians, the position of the foot of the persons identified and their crossing status shall be determined to signify the pedestrian on the road.

4. RESULTS AND DISCUSSION

The efficiency and ability of Pedestrian detection are evaluated and demonstrated for obtaining the training images from the MyanM dataset including 360 videos approximately. In this experiment, 25 images i.e. frames from 360 video sequences are collected to test for training. There are various kinds of pedestrian movements, especially walking forward and backward, and crossing and standing the road are considered SPC recognition for capturing pedestrian crossings in this system. Video resolution is 640x480 but may vary. The distance of the pedestrians and car in the MyanM dataset ranges around 5 feet from ground

simultaneously changing speed with the movement of pedestrians. The detection perform on different video frame is shown on figure 3(a) and (b).
In experiment, it is used 100 videos for testing and measure true positive rate (TPR) and negative positive rate (NPR) described as Table 4 and 5.

Table 2: Detected Bounding box

X	Y	Width	Height
564	262	38	75
812	282	41	83
461	253	37	75
737	277	40	80
751	282	42	85
770	280	42	85

Table 3: Ground Truth Bounding box

X	Y	Width	Height
870	282	23	54
498	264	27	65
870	301	32	77
453	268	46	109
461	268	46	109
557	259	46	109
811	285	46	109
726	270	60	142

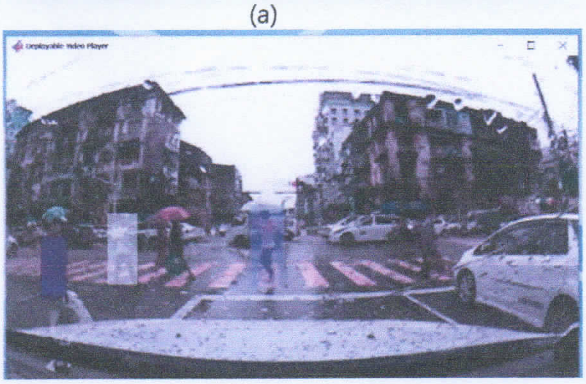
Table 4: Experimental Results for Pedestrian Detection

Video	TPR	NPR
Test-1	0.76	0.24
Test-2	0.68	0.32
- - -		
Test-100	0.82	0.16
Average	0.80	0.20

Table5: Experimental Results for Pedestrian Indication

Video	TPR	NPR
Test-1	0.82	0.18
Test-2	0.85	0.15
- - -		
Test-100	0.92	0.8
Average	0.83	0.17

(a)



(b)

Figure 3. (a) and (b) Pedestrian Detection Using ACF and Kalman Filter

Based on the ground truth, pedestrian detection is calculated upon the count of real crosswalks detected. The pedestrians are detected by using ACF and Kalman filter. Therefore, wrong detection can occur because some objects have some physical shape like person such as tall tree or tall street lamp.
Nevertheless, the indication of crossing status has acceptable results and performance because virtual

reference rectangle is the region where the people crossing the road as shown in Figure 4 and 5. The true positive (TP) or Precision for each frame is used as [TP/(TP+NP)]. The negative positive (NP) for each frame is used as [NP/(TP+NP)].

The average TP rate (TPR) is 80%, while the average NP rate (NPR) is only 20%. In addition, the average TPR is 83%, while the NPR is only 17%.

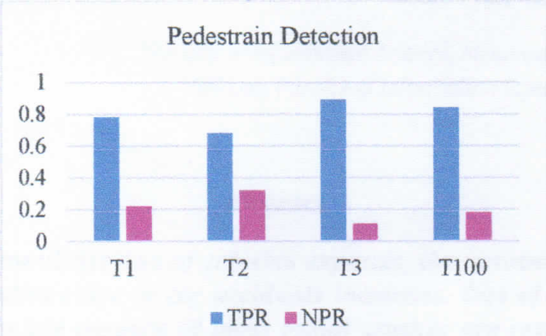


Figure 4. Experimental Result for Pedestrian Detection

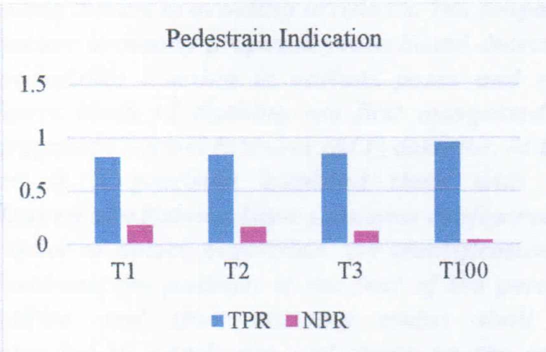


Figure 5. Experimental Results for Pedestrian Indication

5. CONCLUSIONS

In this research, it is presented a detection for pedestrian crossings by utilizing ACF and Kalman filter. The test result shows that it can achieve a good compromise between accuracy and speed of the MyanM test data for the pedestrians. Even proposed system can detect pedestrian in different environment and get high true positive rate, some miss detections are still exit. For future plan, automated navigation system is going to be considered to identify the location of pedestrians relative to the car and then annotate it as a warning.

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