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Obstacle Detection Using Local Shape Context Descriptor on Railway Track

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ABSTRACT*:*This paper describe about a novel feature based on Local Shape Context descriptor for the obstacle detection on Railway tracks, this shape context descriptor is widely used algorithm in the object recognition, but it does not match for the object complex situations. Why because it does not consider the edges orientations. To address this issue, this present work add the edge based orientation information to the shape context descriptor. For that, this work first compute the image gradient in the nine directions and it can be extract the shape context descriptor in each direction. Finally it can be put the feature vector to linear SVM for training. Then it test this descriptor's performance on the real-time video captured by the thermal night vision camera. The experimental results show that this work achieved a high detection rate and had fewer dimension than the other descriptors.

KEYWORDS*:*Thermal Night Vision, Local Shape Context Descriptor, SVM.

I. INTRODUCTION

Railway accidents happen every year frequently and about 30% of them are related to pedestrian collision. This is especially true in the unmanned level crossing and also the crossover roads. Sometimes it may cause by the loco pilots lack of concentrations most prime obstacle detection studies were based on the daytime environment [2,3]. The main concept of obstacle has better performance and it robustness. As compare with the daytime, night-time obstacle detection is more difficult as a result of contrast, image blur and image noise.

Most of the thermal day-and-night vision camera users the NIR (Near-Infrared) or FIR (Far-Infrared) camera [4,5,6], while others are based on the thermal image. Normally the process of night-time obstacle detection includes two stages: ROI (Region of Interest) segmentation and candidate verification. The core idea of segmentation is to reduce the seamed area for the next stage. While on candidate verification, the approaches of detection can dived into two types: Appearance Feature Extraction and temple matching. Nanda and Dasis [7] has introduced a effective idea of probability based obstacle detection methods just like HOG (Histogram of oriented gradients) features [8,9], is also used as in this present work very often Cao[10] proposed a modified LBP (Local Binary Pattern) feature extraction method for the pedestrian detection is both day and night environment.

These methods are complex and having large number of feature vector dimensions, As a result of these this work proposes a new descriptor for night-time obstacle detection inspired by the shape context and HOG descriptor.

II. PROPOSED ALGORITHM

Present work introduce the whole system structure, in the real-time obstacle detection system. The entire process is divided into four major regions as shown below Fig.1. Normally it consists of image preprocessing, region of interest selection, feature extraction and finally candidate verification. This paper only focuses the night-time obstacle detection (Humanbeing, Animal & Vehicle). Offline training user linear SVM classifier to train the proposed feature extraction for the collected input information from the Thermal night vision camera. On this ROI selection stage, the system uses a simple adaptive dual threshold segmentation algorithm that is proposed by Ge [11] for the original images.

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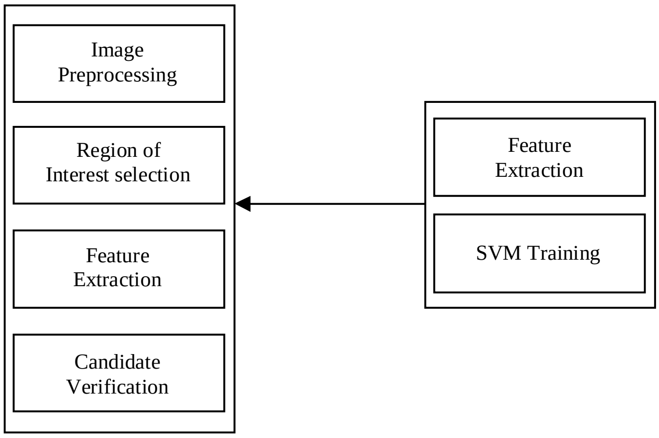

Figure 1. Architecture view of proposed work

III. FEATURE EXTRACTION OVERVIEW

A. *Context Descriptor Extraction:*

The entire object appearance and shape can be well characterized by the shape context [12,13] descriptor but it does not here the orientation functionality of edges, because the basic shape context descriptor does not include the gradient information.

HOG feature [8], the proposed work proposes a new descriptor based on the basic shape context that the system find a way to add gradient orientation information. The feature is extracted in four steps that are described below

1.Gradients Computations:

The gradient computation is sensitive to the detector performance. And this work had tested with different kinds of mask and found that the simplest mask [-1,0,1] turned to the best mask for gradient computation the gradient is computed as

$$E = \sqrt{dx^2 + dy^2} \quad (1)$$

.

$$\theta = \arctan\left(\frac{dy}{dx}\right) \quad (2)$$

Where, E - Edge

θ – Edge Direction

Compute dx and dy by scanning all pixels in image by the use of the mask [-1,0,1]

$$S_x = [-1,0,1] \quad (3)$$

$$S_y = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix} \quad (4)$$

Where, S_x- Horizontal Mask

S_y- Vertical Mask

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2. Vote for Nine Orientation:

This is the essential part of the whole descriptor extraction first it sliding compute an orientation histogram of 8x8 pixel block with a four pixel stride (hence 4pixel fold coverage of each block) in 64x128 pixel image. There are nine orientation bins starts from 0^O to 180^Oin each histogram. In the every block, each pixel calculated a weighted vote for an edge orientation histogram channel, and the vote were summed together into its orientation bin. Here the system have nine 15x31 image as showing in Fig.2. the used orientation range from 0^O to 180^Oinstead of oriented of orientation from 0^O to 360^Orange, because signed gradients decrease the performance. To increasing the number of orientation bins improve the performance up to 9bins at each pixel votes two bins contrast in both orientation and position.The proposed system tested the different size of scanning block with different stride of blocks shown in Fig. 2.

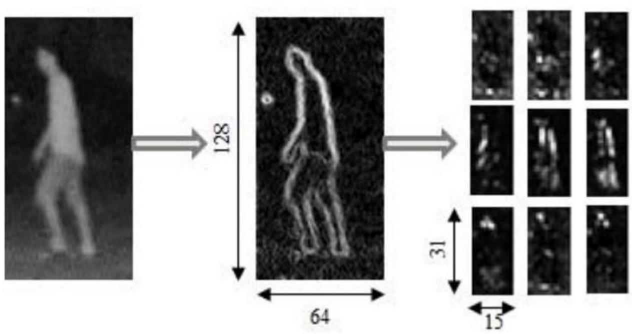
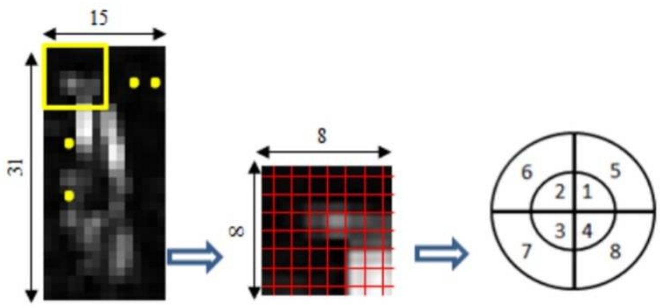


Figure 2. Edge energy on Multi-orientation

3. Extract Shape Context:

From the Fig. 3, can clearly give the 8x8 block in nine 15x31 orientation bins by the proposed work extracted by shape context descriptor. The distribution of local normalized gradient orientations captured in a log-polar histogram. The log-polar bined was to the tolerant to small changes in the rotation of the body parts. The present system used twobins for location and four bins for gradient orientation, which generates a 2x4=8 dimensions descriptor for each block.

The experiment results shows that the 4 pixel improve the performance significantly, by the result of that 21x8=168 dimension vector found for each orientation bin. So an finally 168x9=1512 dimensions descriptor for each 64x128 image.



(a) (b) (c)

Figure 3. (a) One orientation bin; (b) 8x8 block; (c) Eight bins of gradient orientation and location.

4. Normalization:

Normally normalization was used to reduce the illumination variability. While extracting a shape context descriptor, the different block normalization schemes for the LSC descriptor

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$$p \rightarrow p/(|p|_1 + \varepsilon) \quad (5)$$

$$p \rightarrow p/\sqrt{(|p|^2_2 + \varepsilon^2)} \quad (6)$$

Where, p- Normalized descriptor vector
$|p|_1$- K-norm for k=1, 2 and ε
ε – *Small constant*

B. *Candidate Verification:*

Finally after extracting the LSC descriptor, the system did the dot produce in-between the feature vector and the weight vector trained by the SVM [14], the result can be determined as

$$R = \begin{cases} 1 & Obstacle \\ 0 & Non-obstacle \end{cases}$$

Where I – dot product result
T – Threshold value

Fig. 4 shows the final detection result in the proposed system.

Figure 4. Blob Detection image after merging

IV. Experiment Results

A. *Dataset:*

The datasets are captured from the thermal camera using real-time magnification software and that can be converted into images by the object cascading forms. And normally it has 898 images with 64x128 positive samples shown in Fig.5.

Figure 5. Some of the selected obstacle samples on Railway Track

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B. *Experimental Results:*

For the testing part, the proposed work has been tested by the SVM with LIBLINEAR SVM [15]. When the system compute gradients, the different masks were tested by the descriptor and finally found the mask values as [-1,0,1]. It resumes more details then the other masks. This proposed work did lots of experiments by changing the parameters including size of the block, step and normalization methods, Fig. 6 describe about the resultant images after the windows merging operation.

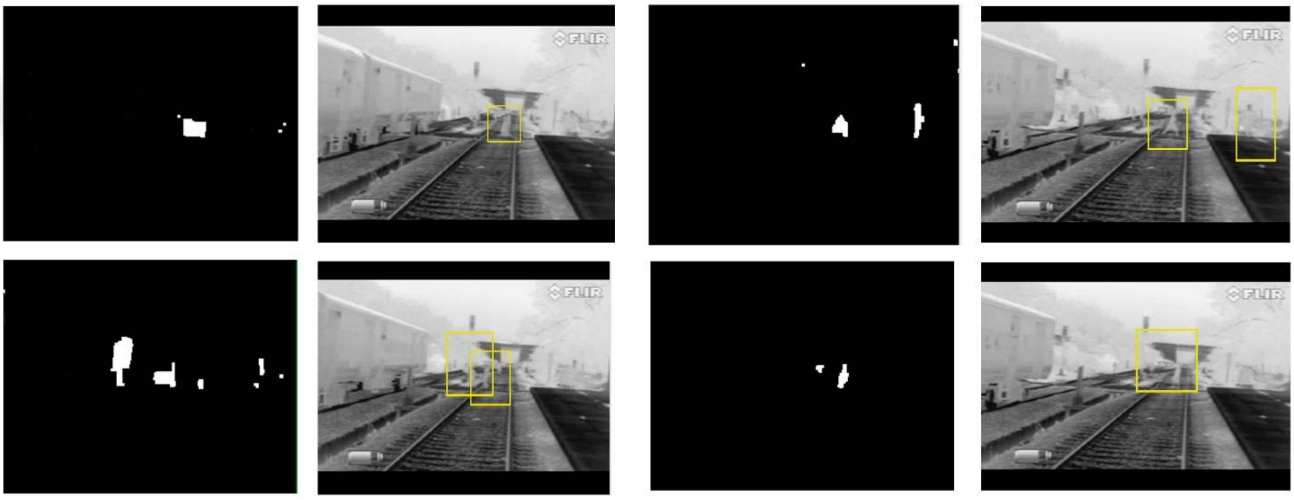

Figure6. The Resultant images after the algorithm performed

The resultant value using the different block size is shown in Fig. 7 an orientation histogram in 64x128 pixel image. By using a 10x10 pixel block with a 5 pixel image can give a quality outcome about 18% and it creates less-dimension vector.

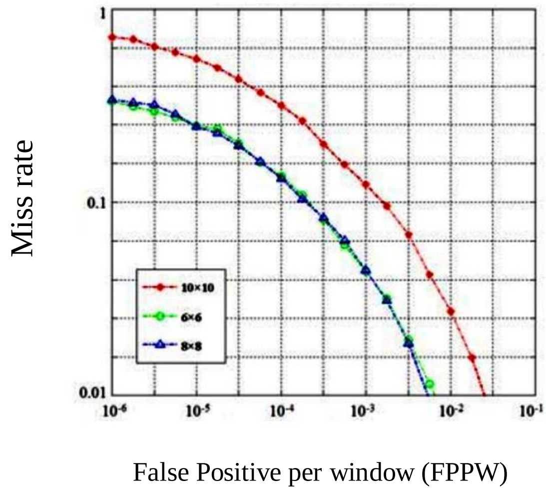

Figure 7. Different Gradient normalization methods at orientation bins using stages.

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V. CONCLUSION

As based on the experimental result shown above the proposed LSC (Local Shape Context) has a good performance on the obstacle (pedestrian, animal & vehicle) detection. And this work had varieties of image dimensions and outcome of it is a complex one to handle it. So that this work had a very strong gradient normalization, local contrast normalization and better block threshold method for the Region of Interest (ROI) selection and mean shift windows. The resultant outcome has given a clear view of good performance. The difficult is to handle the obstacle detection on night time has been achieved successfully, and it emphases the real-time problem on the future work.

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BIOGRAPHY

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