Location and Classification of Moving Objects Using Critical Area Analysis and Template Matching

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Abstract: - The aspiration of current research work is the automation of orientation and object recognition techniques by applying digital image processing and pattern analysis. The research work comprises of III phases. Phase I explains the capturing of image of interest from video frames. Phase II addresses the technique of object (vehicle) location and finally the phase III discusses the technique of Classification of object. Capturing the frame of interest (i-e query image) from video frames is achieved through Critical Area Analysis while Location is achieved through contouring. For Classification we have to recognize the extracted object (Recognition is achieved through template matching) then on the basis of recognition results we classify the object (vehicle).

Key-Words: - Location and Classification, Critical Area Analysis, Template Matching.

1 Introduction

Object location and classification is helpful in different areas of image processing applications. The proposed system locates and classifies vehicles from a video stream. The main use of this system is vehicle tracking, traffic monitoring, measuring the number of vehicles, assisting road surveillance, traffic flow estimation and prediction, security purposes and also providing the information about the vehicle such as make and model. For automated traffic monitoring and analysis system, the information about vehicle type is very important. According to [5] [6] [7] recent Image Tracking Systems (ITS) require detailed traffic parameters. Current research work proposes a technique of vehicle-type classification which requires minimal input information, less computation power and is robust against small variations such as rotation, scaling and difference of color. A system is developed for vehicle-type classification which focuses attention on the structure of vehicles and needs only global information .

The idea behind is to make the training images of each family of vehicle by taking the point information and then saving the images and information in database. It selects the frame of interest and locates object (vehicle) in that frame and finally classifies the object. We have observed more than 400 vehicles of different families, for all the vehicle distances between their boundary points are different. For vehicles of different companies like Nissan, Toyota all distances are different. So we categorize vehicle in classes. Class A consists of large size vehicles like jeeps, wagons etc and class B consists of medium size vehicles like Honda Civic, Toyota Corolla etc and class C consists of small size vehicles like Suzuki, Alto and Hyundai Santro etc.

Rest of the paper is organized as follows. For template matching there are some predefined training images and matching is performed against these training images.. Section 2 elaborates the steps for the template creation. Section 3 address the method used to capture frame of interest (Query Frame) using Critical Area Analysis. Section 4 explains the technique used for location of object. Section 5 explains the technique used for classification. Section 6 shows results of a set of experiments made with typical images and also presents a comparison with few commercial products while section 7 presents the main conclusions and points to future work.

2 Template Creation Process

For template creation load the image and click on the boundary points and get x, y coordinates of these points. For creating templates simply calculate the distances between points. Figure 1 shows the points and table 1 illustrates the formula for calculation of distance at the time of saving and retrieval. For example the distance of x coordinate of point ‘a’ and point ‘b’ is same so its constant only y coordinate is changed and calculating the difference between y coordinate of point ‘a’ and point ‘b’ name it as ydist , value of y dist will give the distance between y coordinates. So to locate point ‘b’ add ydist value to y coordinate value of point ‘a’. For point ‘a’ and point ‘c’ value of x coordinate is different so compute xdist by subtracting value of x of point ‘a’ from point ‘c’. For computation of point ‘c’ add xdist to x of point ‘a’.

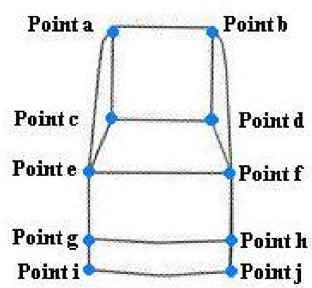

Figure 1: Image showing the points marked for template creation.

Table 1: Showing the formulas for point calculation at the time of saving templates and matching template

S#	Points	Saving		Retrieval	
		x	Y	x	y
1	Atob	Constant	b.y-a.y	Constant	a.y+ydist
2	Atoc	c.x-a.x	c.y-a.y	a.x+xdist	a.y+ydist
3	Atod	d.x-a.x	d.y-a.y	a.x+xdist	a.y+ydist
4	Btoc	c.x-b.x	c.y-b.y	b.x+xdist	b.y+ydist
5	Btod	d.x-b.x	d.y-b.y	b.x+xdist	b.y+ydist
6	Ctod	Constant	d.y-c.y	Constant	c.y+y dist
7	Ctoe	e.x-c.x	e.y-c.y	c.x+xdist	c.y+ydist
8	Ctof	f.x-c.x	f.y-c.y	c.x+xdist	c.y+ydist
9	Dtoe	e.x-d.x	e.y-d.y	d.x+xdist	d.y+ydist
10	Dtof	f.x-d.x	f.y-d.y	d.x+xdist	d.y+ydist
11	Etof	Constant	f.y-e.y	Constant	e.y+ydist
12	Etog	g.x-e.x	g.y-e.y	e.x+xdist	e.y+ydist
13	Etoh	h.x-e.x	h.y-e.y	e.x+xdist	e.y+ydist
14	Ftog	g.x-f.x	g.y-f.y	f.x+xdist	f.y+ydist
15	Ftoh	h.x-f.x	h.y-f.y	f.x+xdist	f.y+ydist
16	Gtoh	Constant	h.y-g.y	Constant	g.y+ydist
17	Gtoi	i.x-g.x	i.y-g.y	g.x+xdist	g.y+ydist
18	Gtoj	j.x-g.x	j.y-g.y	g.x+xdist	g.y+ydist
19	Htoi	i.x-h.x	i.y-h.y	h.x+xdist	h.y+ydist
20	Htoj	j.x-h.x	j.y-h.y	h.x+hdist	h.y+ydist
21	Itoj	Constant	j.y-i.y	Constant	i.y+ydist

3 Critical Area Analysis

This section explains the technique used to select frame of interest from a video stream. Frame of interest is that frame which contains the complete image of vehicle. As we are taking input from a video stream and he vehicle is moving so we only need that frame which has the image of complete vehicle and critical area analysis is used to locate that frame. It starts with the identification of Critical Area (CA). CA is the area where if any vehicle is found the frame is discarded and next frame is considered based on the occurrence of object position in the next frame area. CA is divided into two halves, after identification of CA; analysis is based on following factors:

The subsequent change in the frame is determined through background subtraction [2] [3] and if the result contains a subsequent amount of non-zero pixels it means that an object is found. We will do thresholding in Critical area and during thresholding we came to know that where the vehicle occurs, and we came to know that it lies in first half or second half. If it is found in first half it will be discarded but if it is found in the end of the first half then immediate next frame is considered. If it is found in the second half we will then check that in which portion it falls on the basis of results we finally conclude that either this frame or immediate next frame should be selected for further processing.

4 Location of Object

The resultant image after background subtraction is shown in figure 2 and it may contains some noise which is distinguished from the object of interest by thresholding [7]. For thresholding alpha value is selected which is 50. Every pixel of input image is checked if its value is equal to or near to the value of alpha it is selected otherwise its value is converted to 0 (changed to black background pixel).

To locate vehicle, apply contouring on resultant image. The technique which is used finds 4-8 adjacent pixels of every candidate pixel, there can be two expected values of the adjacent pixels, it could be the same as previously marked portion of one object or it contains different value so it belongs to the different object [1]. Extracted object is always bounded by a rectangle. After contouring there could be more than one object, not all of these objects are of our object of interest so three criteria are used to locate the object of interest from the scene.

- No. of pixels
- Area covered

- Dimension

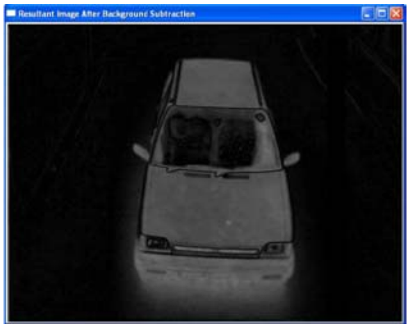

Figure 2: Resultant image after background subtraction.

5 Object Classification

Once we have a vehicle then we have to recognize that vehicle. This section describes the algorithm used to categorize the vehicle into different classes and it is achieved through template matching.

5.1 Template Matching Process

After the extraction of object next task is to locate the points. To locate the points raster scanning is started, on finding the first non-zero pixel, the pixels are checked in their forward and downward direction and are marked as seed pixel. Figure 3 indicates the expected locations of seed pixels which are drawn in red color. There could be four possibilities. If the points are found in next row and column like down stair case effect towards right and then check either seed pixel lies near left top of the bounding rectangle then it is point ‘a’ and the vehicle is left rotated. In second case points are found below and before seed pixel like down stair case effect towards left and the seed point is located near right top then this is point ‘b’ and vehicle is right rotated. In the third case pixels found below towards right and left the seed pixel , check the distance of seed point from left top and right top, compare the distance and traverse towards that side whose distance is lesser than other if it is near to left top then it is point ‘a’ like down stair case effect towards right. In last case pixels are found next to the seed and the point found is ‘a’ and expected distance is added to compute point ‘b’.

When the vehicle is rotated right draw a tangent at point ‘b’ drop a perpendicular at point ‘a’ and the intersection point is named as ‘i’, make a right angle triangle and compute the angle of rotation by

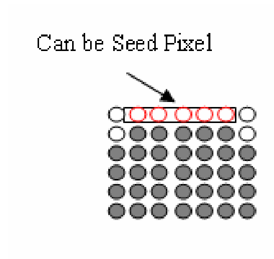

Figure 3: Indicating the expected location of seed pixel

applying the formula given below, figure 4 indicates the angle of rotation.

$\theta = \tan^{-1} P/B$ 1

Where $P = a.x - i.x$ 2

$B = b.y - i.y$ 3

In case of left rotation, draw a tangent at point ‘a’ and drop a perpendicular at point ‘b’ at point ‘i’ and make right angle triangle, then compute angle of rotation by applying following formulas. Equation 1 remains same in both cases while the value of perpendicular and base changes so these could be calculated by using formulas in equations 4 and 5.

$P = b.x - i.x$ 4

$B = a.y - i.y$ 5

After the computation of theta, image is rotated back to its normal position this is done by applying equation 6 and 7 on the image.

x=((x*cos(theeta))-(y*sin(theeta))) 6

y=(y*cos(theeta))+(x*sin(theeta))) 7

After locating point ‘b’ go for point ‘c’. If point ‘c’ is found then go for point‘d’. Distances of points are saved in database for every class of vehicle, we just have to get the expected distance value and find the next point at expected position. Point ‘a’, ‘b’, ‘c’,‘d’ helps in classification of vehicles in to classes(A,B,C) while rest of the six points help is determination of family of the vehicle (Toyota, Honda etc) . After matching point ‘d’ class of vehicle is determined, to find its family search for point ‘e’ then for point ‘f’, ‘g’, ‘h’, ‘i’, ‘j’. After class determination for every match hit counter is incremented and on the basis of number of hits class and family of vehicle is determined. For locating any point if it is not found at expected position a circle with radius of 4 pixels is drawn in order to locate it as shown in the figure 1.

If the vehicle is not recognized then it is considered to be an anonymous vehicle. Matching is always started from class A we then move on to next classes because class A consists of large size vehicles so all distances of class B and C lies within the distances of class A therefore all points of vehicles of class B and C match with class A and are considered to be the member of class A.

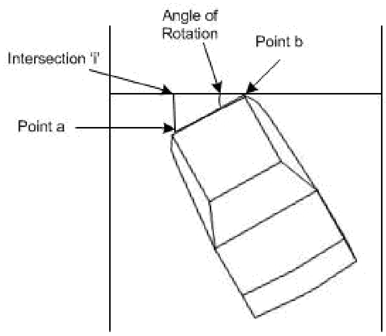

Figure 4: Image indicating the angle of rotation in case of right rotation.

Scaling problem is automatically catered through critical area analysis as it decides on the basis of results whether the frame is to be captured or the next. The technique for frame selection uses critical area analysis to grab the frame only when the vehicle is at its interested position to remove any problem of scaling. This procedure is explained in details in section 3. Figure 5 shows the image after template matching. Points that match are plotted on

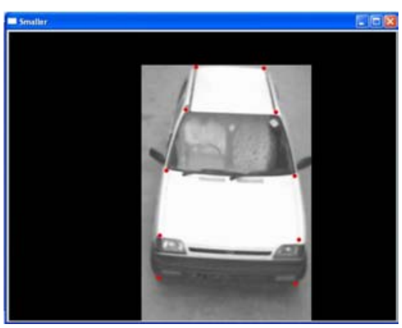

Figure 5: Image after template matching.

6 Results

We have performed tests on 50 static vehicles belonging to different families and results of location are 85% and results of classification are 83% but in case of video frames we performed experiments on 16 vehicles and out of which 12 are located and classified correctly and results are 75%.

7 Conclusion and Future Work

A novel approach for object location and classification is presented in this paper. A lot of work has been done on object recognition and most of them deal with static images [4][5][6]. Proposed technique deals with video streams which locates a moving object of interest from a video stream and then categorizes that object using template matching. For categorizing purpose it uses global features. The advantage is that it doesn't require extensive low-level information. In case of any noise and lightening condition if certain information is not clearly visible it still yields good results

For future work, I would like to recommend that to enhance the efficiency of object classification add the local features as well.

8 References

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