Object Recognition Using Pattern Analysis

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Abstract: - The proposed research work describes an object recognition system based on Human perception, which is achieved through features (component) extraction and pattern analysis. Both strategies are applied on each subpart. Feature extraction is done through contouring and pattern analysis is achieved through making statistical bins for each pattern of subparts of vehicle. Each bin contains generic and specific measures and every measure posses some weight that contributes in analyzing each bin for making the decision about similarity or dissimilarity.

Key-Words: - Object Recognition, Pattern Matching, Feature Extraction, Human Perception.

1 Introduction

Matching strategy plays a decisive role for the success of any particular algorithm and is one of the most challenging tasks in digital image processing. There are many definitions for matching depending upon the context in which it is being applied. Matching can be defined as the establishment of the correspondence between various data sets, which is also referred as correspondence problem [4].

According to [4] image matching is an ill-posed problem. It is ill-posed because for a given point in one image, a corresponding point may not exist due to occlusion and noise or there may be more than one possible match due to repetitive patterns and the solution may be unstable. A problem is ill-posed, if no guarantee can be given that a unique and stable solution exists with respect to small variation in the input data [4].

The goal of current research is precisely analyze and match patterns under concept of RBC theory of human perception [7]. Implementation of RBC theory is achieved through Feature Extraction and Pattern Matching. Divide and conquers methodology is adopted to solve this problem. It marks the different portions of vehicle and then locates features from these portions and finally pattern matching is applied on these features.

The current research work is extension of previous work done by [11] and its output is taken as input of that work. In current technique load reference image and query image from database, divide object into subparts. Make bin for each subpart then compute their measures, assign the weight to each measure and compare the result for match and mismatch.

There are some assumptions that must be considered. First it is assumed that all the input images are of same size. Second there must be any feature on the vehicle that distinguishes it from others.

Rest of the paper is organized as follows. Section 2 address the method used to separate the parts of vehicle. Section 3 explains the technique used for feature extraction. Section 4 discusses techniques used for pattern matching. Section 5 shows results while section 6 presents the main conclusions and points to future work.

2 Division into Subparts

Preprocessed images with following information are already placed in database.

- Vehicle Class
- Vehicle Model
- Vehicle Make
- Point Information (it gives the x, y coordinates of the points a, b, c…..j of the vehicle).
- Path (Where the image is stored)

For division into subparts the point information from the database is used. A rectangle consisting of point a,b,c,d is for roof, point c,d,e,f for windscreen, point e,f,g,h for bonnet and point g,h,i,j for front The points information is illustrated in the figure 1.

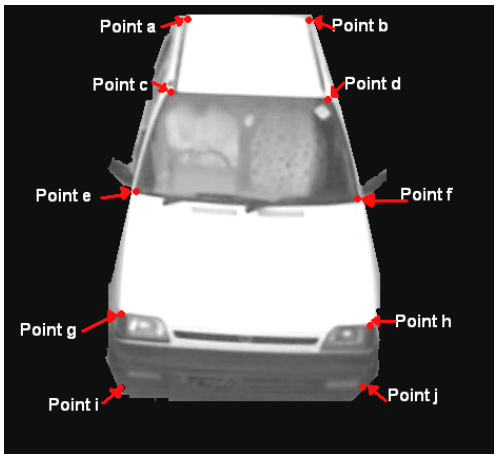

Figure 1: Image of input vehicle specifying the location of point a, b, c, d… j.

3 Feature Extraction

The term "feature" may be described as any sub image, region or node in the image that is of special interest, this suggests that a feature distinguishes itself from the rest of the image in some way.

Feature extraction is an area of image processing which involves using algorithms to detect and isolate various desired portions of a digitized image.

The proposed algorithm starts with thresholding [2] which yields a binary image. A value of alpha for thresholding is 50. Pixels below that alpha value are converted to black background while pixels having value greater than alpha are converted to white .Contouring [3] is applied on binary image to extract features. The resulting contour could be any feature or noise. To select a feature and discard noise calculate area of each contour, there can be two possibilities either area is nearby or greater than one third of subpart or it is too small (less than 1/64th of subpart), in both cases it is discarded. This is done because the size of feature couldn't be so large that it occupies the whole object. For example in case of windscreen any sticker could not lie on whole or half of the windscreen.

Before proceeding there are some important considerations regarding windscreen. There is a portion of windscreen where probability of existence for any feature is unusual, that portion makes a rectangle lies in front of driver and is shown in black color in figure 4. Any feature found there is considered to be a noise factor and should be discarded. There are rare chances of occurrence of any sticker or decoration in front of driver as it hinders driving so any feature that found there maybe due to lightning condition or opaqueness. We observed more than 400 vehicles out of which only 2 have crack on that particular area. So when any feature is found inside that rectangle and it satisfies the conditions, it is considered as noise factor due to opaqueness or image of driver and would be discarded. The conditions that are to be checked are size plus shape of that feature. One more thing is that there could be any decoration hanging on the back mirror but that decoration always lies in the middle of windscreen so any object found in this particular location is considered to be a feature although it lies in that area where any feature is to be discarded.

Figure 4: Windscreen Image, black portion shows that part of windscreen where features are discarded.

After extraction of features of each subpart pattern matching is applied on these features, which is discussed in section blew.

4 Pattern Matching

Pattern matching algorithms have significant importance in image processing because of their use in varying applications. Pattern matching is a technique that quickly finds a reference pattern in an image and calculates a score for each match. The score relates how closely the model matches the pattern found.

Several approaches are used for pattern matching depending upon the nature of problem. Here the term pattern refers to extracted feature. In current scenario every subpart is referred as bin. Every bin may contain some features. Measures are associated with every feature and also with the bin. Measures that are associated to bin are known as generic measures while specific measures are associated with each feature. Features count is example of a generic measure because number of feature are calculated for the subpart while Relative position, Shape detection, feature area and feature subtraction are some specific measures because they are calculated for each feature.

Every measure posses some weight and the strength of weight depends upon the physical characteristics of each feature (in case of specific measure) and bin (in case of generic measure).

The computation of specific and generic measure will be done at the time of feature extraction but the results of pattern subtraction are computed at the time of vehicle matching. It means as a feature is found all of its specific and generic measures are computed and saved but results of pattern subtraction are not computed at that time because for subtraction we need two operands (patterns). So pattern subtraction is done when we are matching two vehicles and we have two patterns.

Organization of weight is illustrated in table 1 while relationship of bins, features and their measures is explained in figure 2.

Table 1: Weight measures.

Measure Type	Weight Assignment
Strong Measure	Total no. of Measures
Weak Measure	1

The methods that are used to compute the specific and generic measure is discussed below.

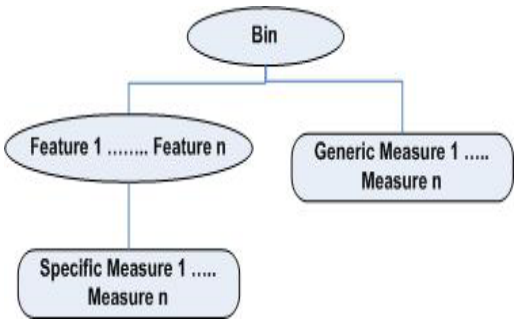

Figure 2: Bins, measure and feature relationship.

As a result of contouring each feature is bounded by a rectangle. For calculating feature area use the coordinates bonding rectangle and find the area by using formula given in equation no 2.

Area = length * width	2

While length refers to the height and width refer to the width of contour bounding rectangle.

For calculation of relative position compute the distance of contour bounding rectangle from the corners of the subparts.

Pattern subtraction is subtraction of one feature from another and count non zero. It actually the difference calculation between two features. Greater the number of non-zero pixels more dissimilar two objects are and vice versa For shape detection calculate number of corner [2]. From the number of corner we can detect the shape of image, if no corner detected it is a circle, for two corners it is a line, for three a triangle and so on.

For matching vehicle compare the measures of every bin (specific and generic) for both vehicles one by one and assign the weight to them. After assigning weight to each bin, vote for match and mismatch. For roof, windscreen and bonnet bin's measures are almost same but bin for front measures are bit different. In case of former defined bins, measures which have an influential role are relative position calculation, boundary detection, features count and while shape detection and pattern subtraction is weak measure. In case of later bin the information is very dense and upper defined measures does not play any substantial role because head lights and mark up of vehicles belongs to same family always exists at same location and have same shape, so if there is any feature like extra lights or any

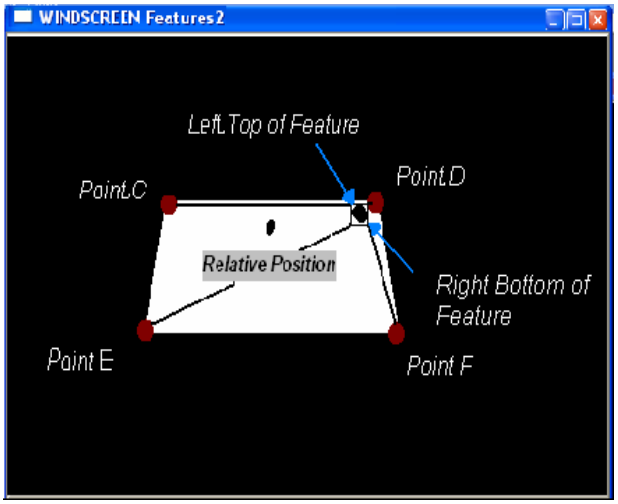

Figure 3: Relative position calculation.

decoration it can only occur on bumper or in the middle of front. We have observed more than 400 vehicles and it proved this hypothesis. The number plate consideration is very much significant. For number plate matching OCR (Optical Character Recognition) is not being carried out because our focus is on pattern analysis rather character recognition. Measures such as shape detection and subtraction do carry a substantial weight value in this case.

For every measure value is assigned to bin depending upon the type of measure. On the basis of measure type weights are assigned to bin and at

the end weights of each bin are compared. On the basis of these weights decision of matching and mismatching is made. In case of a tie when two vehicles have same weights, check the bins for front and windscreen as mostly features lie on windscreen and front contains number plate so both are influential factor and the image with higher weight of front and windscreen is considered to be matched.

5 Experimental Results

We have performed experiments on 250 vehicles. Results of feature extraction are 78%, while results of pattern matching are 85%. In case of results of feature extraction lightning condition does matters a lot because due to lightning factor opaqueness occur that affects results.

Figure 5 represents the roof extracted from reference image while Figure 6 represents the roofs of two query images and figure 7 represents features of reference image that are to be matched and figure 8 and 9 represents features from first and second query image respectively.

Feature count for reference image is 02 while for query image 1 is 01 and for query image 2 is 02.

Weights calculation for measures is shown in table. 2.

Weight for roof bin= specific measures + generic measures.

Weight of roof bin=10+2=12

Results shows that query image 1 has more weight than image 2 and its weight value is greater than the minimum value defined (which is two in this case) so image 1 is matched.

Table 2: Results of weights calculated for measures.

Measures	Query Image 1	Query Image2
Relative Position	4	0
Pattern Subtraction	1	0
Shape Detection	1	0
Area	4	0
Total Weight of Specific Measures	10	0
Generic Measure	2	1
Net Total	**12**	**1**

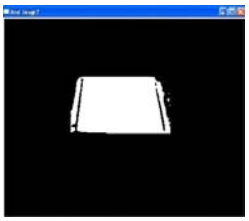

Figure 5: Extracted roof of reference image.

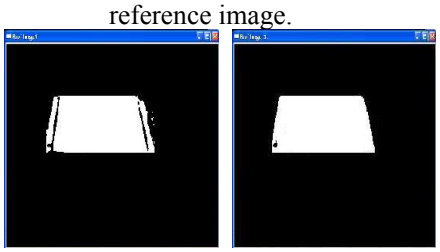

Figure 6: Extracted roofs of two query images.

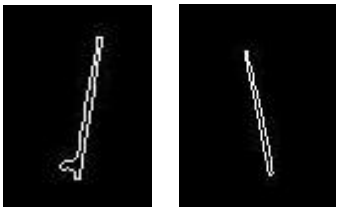

Figure 7: Extracted Pattern from reference image.

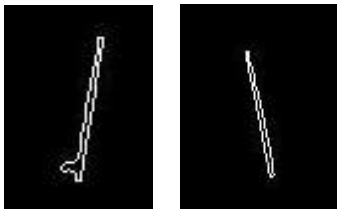

Figure 8: Extracted Pattern from roof of first query image.

Figure 9: Extracted Pattern from roof of Second query image.

6 Conclusion and Future Work

In this paper a novel approach for vehicle matching is presented. A lot of work has been done on matching but as matching is an ill-posed problem so there is no guarantee for solution existence and its correction. Results may differ due to occlusion or any other noise factor. In this proposed technique the purpose of splitting the vehicle into its subparts and

then performing the match is to tackle the problem that occur due to occlusion and any noise factor. If due to occlusion any part suppose the bumper is not clearly visible then on the basis of matching results of roof, windscreen and bonnet we can infer our results.

Also the resolution is low so that's why fine details of the image are not available if high resolution is used then fine details of image would also be available and results would be more accurate.

As a future work recommendation we would be interested in incorporating OCR technique for number plate recognition. For this purpose we just have to change the angle from which image is captured so that number plate could be read easily. We can also take the image rear of vehicle along with front for matching.

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