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Histogram based Image Searching using Fuzzy Sets

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Abstract: Histogram search characterizes an image by its color distribution. It represents a popular mean of feature representation in computer vision. In This paper, we developed an efficient algorithm for image searching based on matching of Histogram using fuzzy sets. We used Fuzzy Sets in This paper for performing Image searching efficiently. We investigated histogram search methods in two different color spaces. The global color histogram indexing method, which is partly used in this paper, correlates to the image semantics well. This histogram matching algorithm simply uses the frequency of occurrence of each color of the histogram within the image.

Keywords: Color space, Fuzzy rule based system, Histogram, Histogram Matching, Image Database, Image Searching.

Introduction

Although fuzzy methods are not a solution to all problems, they are useful in situations in which the concepts (features, criteria, or rules) are vague. This is often the situation in computer vision. There is uncertainty in many aspects of image Processing and computer vision. Visual patterns are inherently ambiguous, image features are corrupted and distorted by the acquisition process, object definitions are not always crisp. Moreover, knowledge about the objects in the scene can be described only in vague terms, and the outputs of low level process provide vague, conflicting, or erroneous inputs to higher level algorithms. Fuzzy set theory and fuzzy logic are ideally suited for dealing with such uncertainty.

Histogram search characterizes an image by its color distribution, or histogram. Many histogram distances have been used to define the similarity of two colour histogram representations. The drawback of a global histogram representation is that information about object location, shape, and texture is discarded. The global colour histogram indexing method, which is partly used in this paper, correlates to the image semantics well. But, images retrieved by using the global colour histogram may not be semantically related even though they share similar colour distribution.

Fuzzy Rule Based Algorithm

When performing image understanding, we need to represent properties and attributes of image regions and spatial relations among regions. Fuzzy rule based systems are ideally suited for this purpose. For example, a usual rule in a rule-based scene understanding system could be:

IF brightness of a pixel is high
AND the granularity within a 3x3 window, centred in the pixel, is medium
THEN the pixel belongs to . . .

Terms as brightness, high, granularity and medium are intrinsically vague. Fuzzy set theory provides a natural mechanism to represent such vagueness effectively. Flexibility and power provided by fuzzy set theory for knowledge representation makes fuzzy rule-based systems very attractive, when compared with traditional rule-based systems. Furthermore, rule-based approaches must address the problem of conflict resolution when the preconditions for several (partially) conflicting rules are simultaneously satisfied. There are sophisticated control strategies to solve this problem in traditional systems. In contrast, with fuzzy rule-based classifier systems, problems such as these are attacked by manipulating certainty factors and/or firing strengths to combine the rules. In computer vision applications, membership fictions are not always subjective evaluations of vague concepts, but rather a means to model the uncertainty contained in the input information such as images and/or features extracted from images. Therefore, to get appropriate methods for membership function generations it is important that they formalize expert's knowledge and its uncertainty.

Histogram

An image histogram is type of histogram, which acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value. By looking at the histogram for a specific image a viewer will be able to judge the entire tonal distribution at a glance. Histograms are frequently normalized by the total number of pixels in the image. Assuming a *M* x *N* image, a normalized histogram

$$p\,(r_k) = n_k\,/\,MN,\ k = 0,1.........L\text{-}1$$

is related to probability of occurrence of r_k in the image.

Histogram Processing

The histogram plots the number of pixels in the image (vertical axis) with a particular brightness value (horizontal axis). Because the information contained in the graph is a representation of pixel distribution as a function of tonal variation, image histograms can be analyzed for peaks and/or valleys which can then be used to determine a threshold value.

Figure 1: Image and it's corresponding histogram

Histogram Intersection Method

Histogram-based image matching algorithms try to measure the similarity in contents via their histograms between a model image and any images in database, i.e., target images, in order to properly classify or retrieve images. Histogram intersection (HI), proposed by Swain and Ballard, is a straightforward method to calculate the matching rate between two histograms for this purpose. Assume the histograms of a model image and a target image are H_M and H_T respectively, and each contains n bins. Swain and Ballard [9] defined the intersection HI of two histograms as:

$$HI = \sum_{i=1}^{n} \min\,(h_M(i), h_T(i)$$

where the subscripts "M" and "T" denote for "model" and "target" respectively, and both H_M and H_T are normalised, i.e.,$P_{n\ i=1}\ h_M(i) = 1$ and $P_{ni=1}\ h_T\,(i) = 1$.
The resultant fractional matching value between 0 and 1 is actually the proportion of pixels from the model image that have corresponding pixels of the same colour in the target image. A higher histogram matching rate indicates higher similarity between model image and target image.

Design Of Software Architecture To Solve The Above Problems

In this paper, we have designed and developed a system which has following features:

- It imports two images. One is target image, which is the small piece of model image and the other is the model image.
- The system measures the histogram of both the images.
- The system splits the model image into the small pieces, which have same height and width as that of the target image.
- After split up, the system compares the histogram value of every piece of the model image with target image.
- After finding a perfect match with a pieces and target image, it can mark out the region of the model image.

Searching Process

The images shown below are the model image and the target image. Here each square represents a pixel of this image.

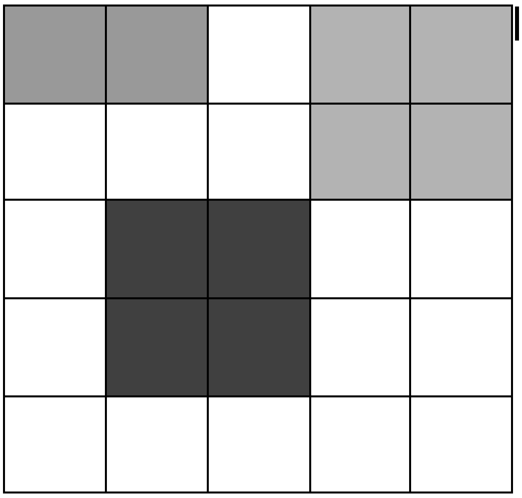

Figure 2: Model Image

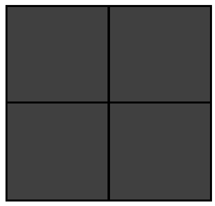

Figure 3: Target Image

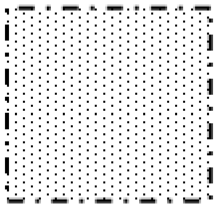

Figure 4: Scanned area

Assume that the Figure 4 is a 5x5 pixel model image and the target image is Figure 5 of 2x2 pixels. The height and width of scan area block (2x2 pixels) is same as target image.

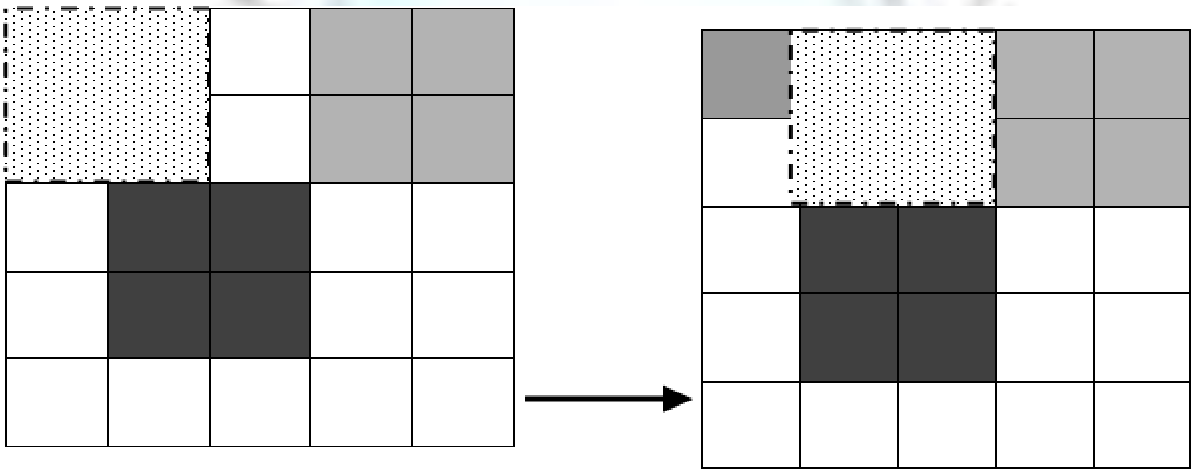

Figure 5: Step-1

The scan block starts scanning from the very first pixel of the model image [area scanned by the scan block is formed with pixel (1, 1) to pixel (2, 2)]; if the match is not found then it scans the very next block [pixel (1, 2) to pixel (2, 3)]] which has same size as that of target image. The scanning process will go in this way to the last column pixel of the model image, from where it can form the area corresponding to the scan block.

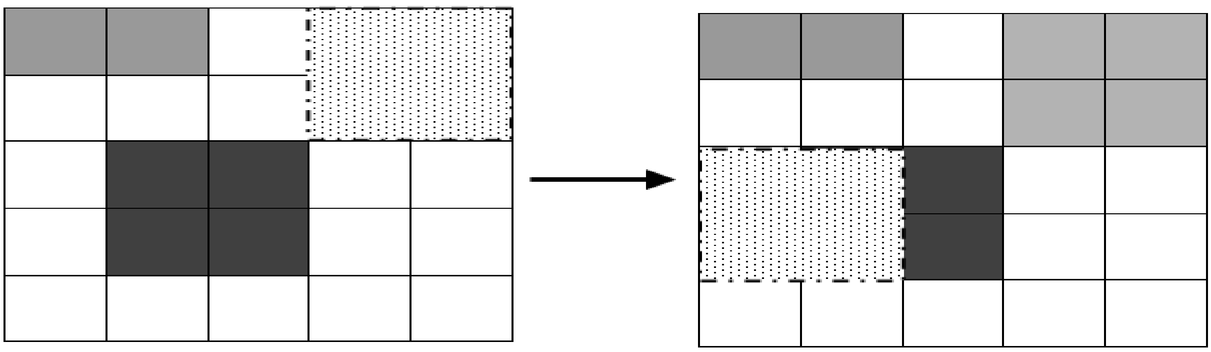

Figure 6: step-2

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After reaching the last pixel of the model image (Figure 1), the scan block starts scanning from next pixel row (2, 1). Next, it continues as step-1.

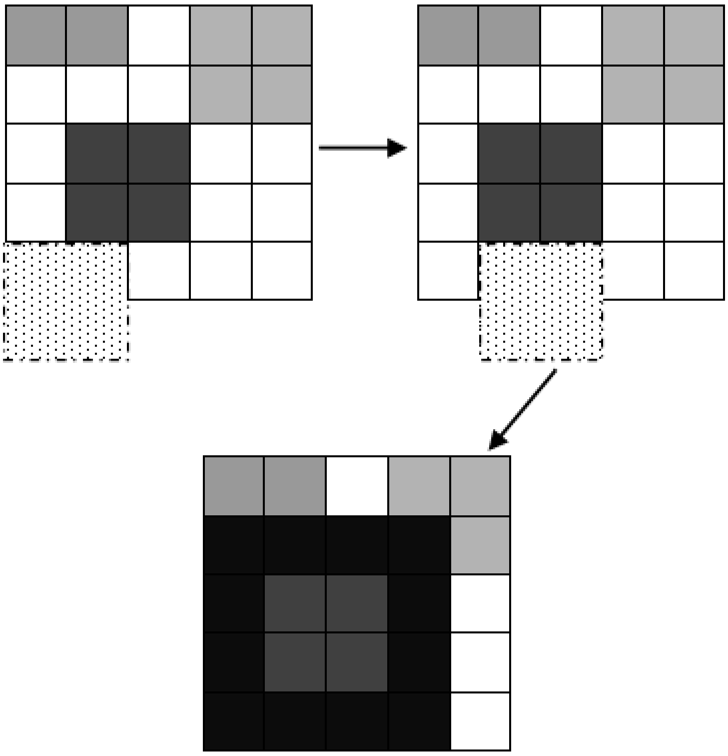


Figure 7: Step-3

Dataset and Its Results after Searching

Following are the data set and their corresponding results:-

- M denotes the model Image.
- T denotes the Target Image
- R denotes the Results After Searching

Image Dataset-1

M

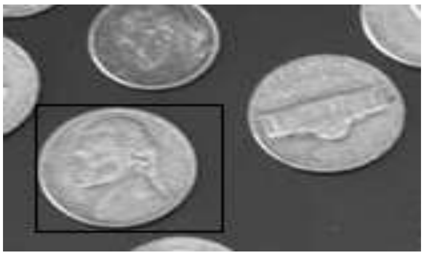
T

R

Image Dataset-2

M

T



R

Conclusion

The present paper emphasizes on the design and development of an image searching system based on histogram matching. We have tried to formulate a working solution to build up such a system and are successful in developing it.

Table 1: Time Used For Computing Image Matching Using Histogram Intersection Method

DATA SET	Time (in millisecond)
Image Dataset-1	931
Image Dataset-2	942

In this paper, the preliminary results show that the image piece can be successfully found by using the algorithm from a large image. The present work is capable of finding a small part of a large image and it also highlights the matching area. So this approach can be considered as an image searching system based on histogram matching.

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