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Study and Recognition of Pattern by Algorithm for Paper Currency Using Soft Computing

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ABSTRACT

Many decades have already passed but still paper currency recognition is always an important area of research in soft computing as well as in image processing some system also developed in order to recognize the currency automatically so that the manual efforts can get lesser.

To recognize the patterns in various types such as currency, leaves, face etc. some algorithms are used which is then classified into be into six types such as Statistical Techniques, Structural Techniques, Template Matching, Neural Network Approach, Fuzzy Model, and Hybrid Models. In the following article, we study the proposed bank note recognition system which is based on Scale Invariant Feature Transform algorithm (SIFT).

KEYWORDS: Booknote, Currency recognition, Gaussian filter, keypoint.

1.INTRODUCTION

In today's world of digitization paper currency still is backbone of society. All over the world there are 180 currencies as legal tender which can be used in various activities. And recognition of banknotes is very important aspect when we want to perform transactions.

Some techniques which are used in the SIFT algorithm are explained here such as Gaussian filter [1] with is used to reduce the noise and clear the image properly so that we can also smooth the edged of our image which we are going to process. And the technique used in image processing is Gaussian blur method also called as Gaussian smoothing [1].

Gaussian scale-space [2] used to find scale invariance in SIFT. So, in following article we are going to understand the actual working parameter of SIFT in order to recognition of paper currency.

2.SCALE INVARIANT FEATURE TRANSFORM ALGORITHM SIFT

It's a computer vision algorithm to study and understand various feature in an image, invented by [3] and obtained result stored in the database for further use.

It is the technique for detecting salient, stable feature points in an image. For every such point, it also provides a set of "features" that "characterize/describe" a small image around the point. We will perform the image matching process but the feature must not change with scale, lights, object pose / position and minor's the image artifacts / noise / blur.

A. Key-points Detection

As stated, before scale-space is first step of SIFT algorithm it is also called key points detection as well as detection of point of interest. The image of paper currency which is captured by camera is manipulated with Gaussian filters and then the difference of successive Gaussian blurred images is taken [5]. Difference of Gaussians (DoG) is used for calculating multiple keypoints [4], and then keypoint is selected as maxima/minima. The DoG is obtained by subtracting one blurred Gaussian image which is obtained by original from the less blurred image of original image. We can obtain Gaussian blur image by following formula [6].

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (1)$$

x is distance on the x axis from the origin,
y is the distance on y axis from the origin,
and σ is the standard deviation.

A DoG image D(x, y, σ) is given by

Where

x = data plotted on graph related to x-coordinate,
y = data plotted on graph related to y-coordinate,
σ = summation or standard deviation of kernels

And further the DoG equation elaborated as follow; [5]

$$D(x, y, \sigma) = L(x, y, ki\sigma) - L(x, y, kj\sigma) \quad (2)$$

Where,

L(x, y, kσ) is the twist and curls of the original image I(x, y) with the Gaussian blur G(x, y, kσ)

$$L(x, y, k\sigma) = G(x, y, k\sigma) * I(x, y) \quad (3)$$

In SIFT first paper currency is captured and manipulated in different Gaussian blurs with different angle. Then the octave is obtained, octave is term when we double the value of σ, which is variable of Gaussian kernel.ki is chosen such that fixed number of convolved images per octave. Then the processing of DoG we get the key-points as local minima/maxima.

The local minima/maxima obtained by the image across the scales.

Keypoint is obtained by comparing each pixel in the DoG images with two different criteria that is to its 8 neighbors at similar scale and other with 9 corresponding neighboring pixels in each of the neighboring scales [5]. The candidate key- point [5] is obtained if the value of particular pixel is higher or lower among remaining pixel values.

B. Keypoint Localization

The next step is to obtain a perfect fit to nearby data for location, scale and ratio of selected keypoint. The points which have low tolerance to noise and highly unstable is avoided.

There are various steps involved in keypoint localization such as interpolation of nearby values of candidate key so that we can find the actual value of the desired key. Another step is removing low contrast key-points so that the unwanted data is removed.

C. Orientation Assignment

Key points which we obtained in previous steps get orientation depending upon the original image gradient direction, as we already understand that image gradient is direction or color change in an image.

In SIFT algorithm the Gaussian- smoothed image which we obtained by Gaussian blurring is L(x, y, σ) at the key-points of a scale of σ is considered.

By taking an image sample of L(x, y) at a scale of σ, the magnitude of image gradient represented by m(x, y) and the orientation is θ(x, y),is obtained by different pixels.

$$m(x, y) = (L(x + 1, y) - L(x - 1, y))2 + (L(x, y + 1) - L(x, y-1))^2 \quad (4)$$

take the square root of the obtained equation.

$$\sqrt{(L(x + 1,y) - L(x - 1,y))2 + (L(x,y + 1)- L(x,y-1))^2} \quad (5)$$

So, we calculate L that is Gaussian blur image for each and every pixel and also study the magnitude and direction for the gradient are calculated for every pixel in a neighboring region around the key-point.[5]

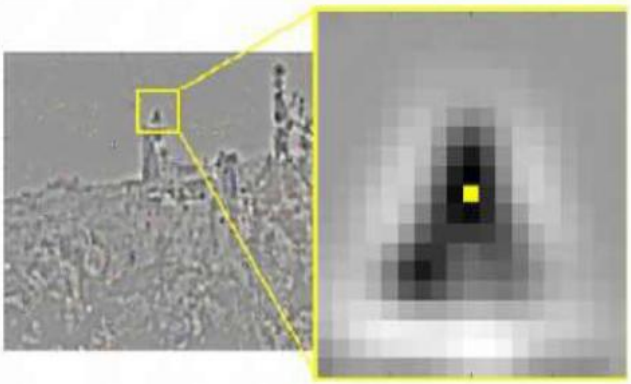

Figure 1- A particular keypoint

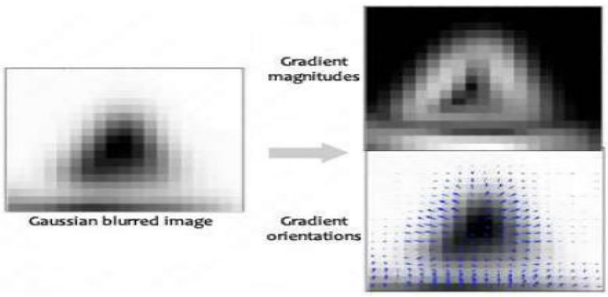

Figure 2- Gradient magnitudes and orientation from Gaussian-blurred image [5]

When we approach the larger are of orientation of image, we are able to collect larger key point and there surrounding are by which we can cover maximum Gaussian blur points by which we can compare more and more keypoints with each other so that recognition of image can be possible.

An orientation histogram consisting of 36 bins is formed with each covering 10° [5]. We obtained the data by calculating Gaussian weight circle. The weighting should be a Gaussian-weighted circular window with a sigma of 1.5.

The histogram which bars reaches the peaks, when the respective histogram is filled, the

Orientations regarding the highest peak and the local ones that are within 80% of the highest peaks are assigned to the key-point [5].

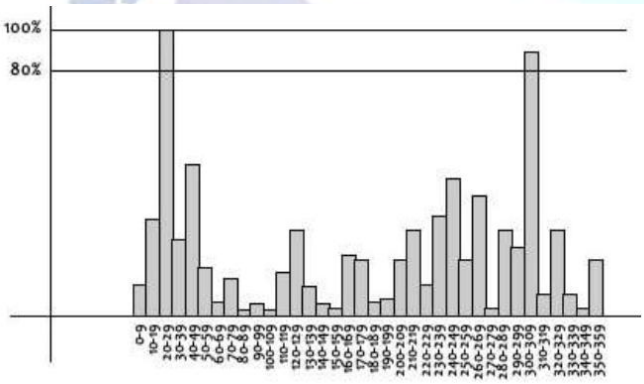

Figure 3- Histogram with 36 bins [5]

D. Key-Point Descriptor:

Once the orientation is done then the descriptor of those points is done, this step is performed upon the image nearest to the scale of key-point's scale. As we go further the firstly obtained histogram from the data calculate the region and the keypoints near it.

Then the Gaussian function sigma "σ", we used to further increase of weight. And by using this we can obtain a scale invariance to understand the image similarity.

3.APPLICATIONS OF SIFT ALGORITHM IN PAPER CURRENCY RECOGNITION

As we already studied the working parameter of SIFT algorithm that how it captures image blur it reduces the noise smoothen the edges and find the key point into the particular area and match their intensity with other points in the original image reaming scales. and where the maximum similarity is obtained it recognizes as area of consideration in which we find the resemblance.

Steps to recognize paper currency-

i. Create a data base of paper currency.
ii. Capture the image of paper currency which we want to compare with images in data base.
iii. Then we blur the image smoothen its curve and select a keypoint and area around it.
iv. After that we compare it with the banknotes which are already existed in our system and then by matching the keypoints on the original image with the captured image we can recognize the paper currency.

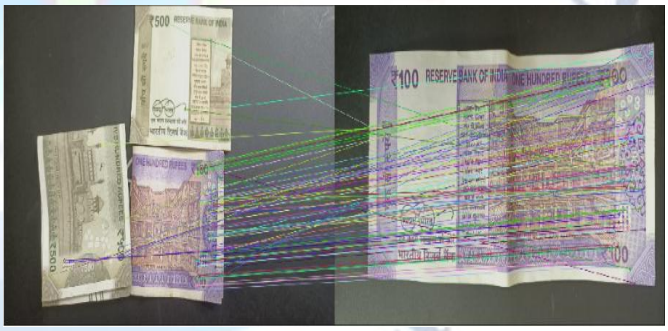

Figure 4- Keypoint comparison of targeted currency with original currency. Adopted from Google images

4.FUTURE SCOPE AND CONCLUSION

We can review the above article and conclude the basic mechanism provided by SIFT algorithm which is dependent upon its property of Gaussian blurring, keypoint finding, analyzing the features of the bank notes. We can easily recognize the images of paper currency and can make easy move toward the study of different external and internal similarities of currency appearances.

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