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Survey on Local Color Image Descriptors

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Abstract - *Image descriptor is an important topic in the field of image processing. Image descriptors are used to have the characteristics of an image. Global and local descriptors can be extracted according to the needs. Global descriptors consider image as a whole whereas a local descriptor describes a patch within an image. Multiple local descriptors are used to match an image. Traditional descriptors are extracted from each color channel separately or from vector representations. Color characteristics can be included using the Quaternionic representation. A detailed study in the field of local descriptors and Quaternionic representation has been done.*

Keywords*: Quaternionic Representation, QLRBP, QWLD, QMD, SIFT*

1.INTRODUCTION

In the fields of image processing, computer vision, and pattern recognition, image descriptor is an active research topic. From the earlier geometric moment descriptor and Fourier descriptor to the later wavelet descriptor, orthogonal moment invariants, projection descriptor, and all kinds of local descriptors, a large number of image descriptors have been proposed. Its applications are in areas, such as image retrieval and matching, texture classification, face recognition, and many others. With the introduction of modern imaging equipment and devices, its applications in daily life has increased. This has increased the demand of color image descriptors as well. To extract a descriptor from the color image, two methods are there, that is either converts the color image into the corresponding gray-scale image or simply use one color component for further processing. Here, some color information has been ignored as we are not considering the color image as a whole. Extract the descriptor from each color component of a color image respectively or from a vector representation of the color image, in order to address this problem.

Thus, a color image representation, called Quaternionic representation (QR), has been developed and used in order to represent the three separate color channel values into a single quaternion. QR encodes all color components of a pixel using a quaternion number. The advantages of QR over RGB representation are:

(1) QR combines all color channels of an image,
(2) Relatively lower computational complexity is achieved compared to other vector approaches,
(3) QR has an implementation of vector cross correlation,
(4) Transformations in 3D or 4D space is performed
(5) QR has quaternion algebra theories which can be used in color image processing.

2. LITERATURE SURVEY

The multiresolution approach to gray-scale and rotation invariant texture classification based on local binary patterns [1] is very simple, and efficient. The method recognizes uniform local binary patterns, which are fundamental properties of local image texture. For detecting the uniform patterns for any quantization of the angular space and for any spatial resolution it derives a generalized gray-scale and rotation invariant operator presentation. Thus a method is proposed to combine multiple operators for multiresolution analysis. Advantage of the system is computational simplicity as the operator can be realized with a lookup table and a few operations in a small neighborhood. In terms of gray-scale variations, the system is very robust since the operator is, by definition, invariant against any monotonic transformation of the gray scale, e.g., by changes in illumination intensity. If the gray-scale properties of the training and testing data are different, Gray-scale invariance is also necessary. The basic 3x3 LBP operator provided better performance in experiments. System presents a rotation invariant and gray-scale texture operator based on local binary patterns. Rotation invariance is achieved by recognizing the gray-scale invariant operator that incorporates a fixed set of rotation invariant patterns. The uniform appearance of the local binary pattern is referred by the term uniform, i.e., in the circular presentation of the pattern, there are a limited number of discontinuities or transitions.

The advantage of the multiresolution approach is that, it is very robust in terms of gray-scale variations and it is invariant against monotonic transformations. But whole color information is not considered as it is converted in to gray-scale.

The evaluation of Color Descriptors for Object and Scene Recognition [2] is based on the access visual information. So far, at salient points, for feature extraction, intensity-based descriptors have been widely used. Color descriptors have been proposed to increase illumination invariance and discriminative power. The system studies the distinctiveness and invariance properties of color descriptors in a structured way.

Histograms: The RGB histogram is composed of three 1D histograms which are of R, G, and B channels of the RGB color space. Hue becomes unstable near the gray axis for HSV color histogram. The certainty of the hue is inversely proportional to the saturation. The hue histogram is made more robust. In

rghistogram, r and g, the chromaticity components, describe the color information in an image. With respect to light intensity, scale-invariance and shift-invariance is achieved by normalizing the pixel value distributions.

Color moments and Color moment invariants: All generalized color moments up to the second degree and the first order is used by the color moment descriptor. From generalized color moments Color moment invariants can be constructed.

Color descriptor based on SIFT: The SIFT descriptor is proposed by Lowe. Using edge orientation histograms, local shape of a region, describes SIFT. The image gradient is shift-invariant i.e., while the derivative is taken, it cancels out offsets. As the SIFT descriptor is normalized, on the final descriptor, the gradient magnitude changes have no effect. As the intensity channel is a combination of the R, G, and B channels, the SIFT descriptor is not invariant to light color changes. Even though the color channels are considered independently, the addition of color descriptors over SIFT improves category recognition.

The QLRBP system [3] proposes a local descriptor called Quaternionic local ranking binary pattern (QLRBP) for color images. Unlike traditional descriptors that are extracted from each color channel separately or from vector representations. QLRBP uses Quaternionic representation (QR) of the color image that encodes a color pixel using a quaternion. QLRBP handle all color channels directly in the Quaternionic domain thus include their relations simultaneously. It applies Clifford translation to QR of the color image and it uses a reference quaternion to rank QRs of two color pixels. Then it performs a local binary coding on the phase of the transformed result in order to generate local descriptors of the color image. It reveals the stereo characteristics of the original color image and also possesses robustness to different variations. LBP and its improvements are analyzed, and a new perspective came out that these LBP methods can be converted into a scheme for designing a proper ranking function that determines the ordering between two pixels. In QLRBP system the image is converted into QR and Clifford translation of quaternion is applied to QR of the color image. Thus the phase of the CTQ result determines the order of two color pixels and its physical meaning is easily interpreted. LBP coding is then applied to the phase image and a QLRBP coding image is obtained. The dense local histograms are then extracted as the local image descriptor. The proposed QLRBP is evaluated by applications such as person reidentification and face recognition problems. QLRBP outperforms LBP as it is more robust to variations in expression, illumination and pose. Matching rates of QLRBP increases as the top ranking number increases. Provided comparison results from the experiments show the effectiveness of QLRBP.

The QWLD system [4] describes a simple but effective framework, named Quaternionic Weber Local Descriptor (), for color image feature extraction. It integrates Quaternionic representation (QR) of the color image and Weber's law (WL). Thus QWLD is able to possess both their superiorities. It uses Quaternionic representation in which all the color channel values are converted into quaternions and thus preserves its relations. WL is then applied. It ensures the derived descriptors to be robust and discriminative. Using the QWLD framework, two descriptors are developed: the Quaternionic Increment Based Weber Descriptor (QIWD) and Quaternionic Distance Based Weber Descriptor (QDWD. Both are based on different strategies in order to describe the increment and intensity of WL in the Quaternionic domain. Using different applications, experiments are carried out to evaluate the proposed descriptors and comparison results show their effectiveness. Main contributions of the experiments are as follows: For color image feature extraction, the system proposes the Quaternionic Weber Local Descriptor (QWLD) framework. The system further develops two novel descriptors, QIWD and QDWD, derived from the QWLD framework. They are derived by considering WL from different perspectives. To evaluate the performances of the proposed descriptors, the system conducts a number of experiments on different color image recognition problems by comparing with several state-of-the-art local descriptors. QWLD is compared with a Quaternionic local descriptor QLBP, which is an extension of LBP in the Quaternionic domain. It can obtain several QLBP features by performing CTQ to QR of the color image with different reference quaternions. Advantage of the framework is that it provides effective results in different color image recognition problems.

The QMD system [5] develops a powerful framework called quaternion-Michelson descriptor to extract local features for color image classification. Traditional local descriptors extracts features directly from the original image space while QMD is derived from the Michelson contrast law and the Quaternionic representation (QR) of color images. QR is able to handle all the color information of the image holisticly and preserves the interactions among different color channels while the Michelson contrast is a stable measurement of image contents from the viewpoint of human perception. Thus QMD integrates both the advantages of Michelson contrast and QR. Two novel Quaternionic Michelson contrast binary pattern descriptors are proposed based on the QMD framework from different perspectives. To evaluate the QMCBP performance extensive experiments are carried out for different color image classification applications. The comparison results show that the proposed QMCBPs outperform several other local descriptors. QMCBP is compared with the QLRBP. Both uses CTQ and LBP operations to derive local descriptors, but the use of Michelson contrast yields following differences:

1) QMCBP uses the phase to determine an ordering relation for Michelson contrast extraction while QLRBP directly uses the weighted L1 phase as the input for the LBP encoding.

2) The weighted L1 phase used in QLRBP is directly derived from the pixel intensity values. Compared to weighted L1 phase, the Michelson contrasts contain more discriminative characteristics. QMCBP are simple features extracted from the local region. For feature extraction, they provide more useful information. QMCBP extracts more local

characteristics of images than QLRBP. In QLRBP, all pixels of the image, with the three channels red, green and blue are processed by CTQ with separate reference quaternions for each channel. This global transform of the original image may hinder the performance of QLRBP. The QMCBP is able to overcome this limitation of QLRBP. QMCBP needs fewer parameters when compared to QLRBP. The performance of QLRBP depends on finding the appropriate weights to calculate the phase while there are no such parameters in QMCBP. So it is more convenient to be used for many applications.

3. CONCLUSIONS

Image descriptor is an important field in image processing. Quaternionic representation includes the color characteristics of an image. Among several local descriptors proposed for color images, many are extracted from the Quaternionic representation of a color image that offers another perspective of the color image. Several Quaternionic operators, like rotation, phase, and Clifford translation, have been applied to process color images in the Quaternionic domain. QR considers more image color characteristics and shows more robustness to different variations. Applications including pattern recognition, matching e.g. Person reidentification, Face recognition etc. is used to evaluate different descriptors. This paper provides an outline of color images descriptors extracted from Quaternionic domain.

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