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The Study and Literature Review of a Feature Extraction Mechanism in Computer Vison

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Abstract— Detecting the Features in the image is a challenging task in computer vison and numerous image processing applications. For example to detect the corners in an image there exists numerous algorithms. Corners are formed by combining multiple edges and which sometimes may not define the boundary of an image. This paper is mainly concentrates on the study of the Harris corner detection algorithm which accurately detects the corners exists in the image. The Harris corner detector is a widely used interest point detector due to strong features such as rotation, scale, illumination and in the case of noise. It is based on the local auto-correlation function of a signal; where the local auto-correlation function measures the local changes of the signal with patches shifted by a small amount in different directions. In out experiments we have shown the results for gray scale images as well as for color images which gives the results for the individual regions present in the image. This algorithm is more reliable than the conventional methods.

Index Terms: *corner detection, Harris methodology, pattern recognition.*

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I. INTRODUCTION

Extracting the features and identifying the matching region of features in digital image processing is the key technology in the field of computer vision, which establish the feature description and look for the corresponding relationship between the pixels in the same scene through the salient features extracted from the image, and it have a wide range of applications in 3D modeling, pattern recognition, image registration, motion capture and direction.A digital image is denoted as a two dimensional image which contains a finite set of digital values, called picture elements. These picture elements are also known as pixels. Pixel values typically represent gray levels, colors, heights; opacities etc. Remember digitization implies that a digital image is an approximation of a real scene. Processing of image data for storage, transmission and representation for autonomous machine perception some argument about where image processing ends and fields such as image analysis and computer vision start Image registration is an important step of remote sensing image processing, and it is pre-processing of image mosaic, image fusion, relative radiometric normalization, land use classification, and land use change detection, etc. Primary task of the remote sensing image registration is to find correct ground control point correspondences on the base image and the warp image. With the development of the computer science, pattern recognition, artificial intelligence, and image processing technology, many kinds of full-automatic or semi-automatic image registration algorithms are proposed, the key procedures including two aspects: one is to detect ground control point automatically.

Corners are important local features in images. Generally speaking, they are the points that have high curvature and lie in the junction of different brightness regions of images. In a variety of image features, corners are not affected by illumination and have the property of rotational invariance. They are only about 0.05% in the whole pixels. Without losing image data information, extracting corners can minimize the processing data. In other words, Corner is the point which testing function energy is very intense in any direction changes, it is one of the most important feature of the data information. The accuracy and quality of the corner detection directly affect the results of image processing, and can determine the outline features and important information of the image. Corner detection are used for camera calibration, optical flow velocity measuring, motion estimation, measurement and positioning etc., and has become an important tool for image processing. Corner detection can not only keep the useful image information but also can reduce data redundancy and improve the detection efficiency [1]. At present, the corner detection algorithm can be divided into two types: one is based on the image gray data; the other is based on image edge data. The former algorithm firstly compared the size of the template region's gray values with the image regions, and then matches. The accuracy of the algorithm is relatively higher, but it has some drawback such as complex calculations, precision positioning is not high and real-time processing of image data is poor. While the latter algorithm need to encode the image edges, and has great dependence on the edge of the image, the corner detection information will be lost if the image cannot provide completely [2] [3]. In order to take full advantage of the corner information in different scales, this paper obtained the different frequency components of the image by wavelet decomposition. And then, extracts the corner information on each sub-band. Simulation results show that the algorithm can improve the corner accuracy and the extraction efficiency effectively, and has strong anti-noise ability [4].

Therefore, corner detection has practical value and it plays an important role in scale space theory [6], motion tracking [7], image matching [8], building 2D mosaics, stereo vision [9], and preprocessing phase of outline capturing systems [10], image representation and other fields. A substantial number of corner detectors have been proposed by researchers. These methods can be divided into two main classes: contour based and intensity based. Contour based methods first recover image contours and then search for curvature maxima or inflection points along those contours. For example, Masood et al. detected corners for planar curves by sliding set of three rectangles along the curve and counting number of contour points lying in each rectangle [11]. Peng et al. introduced a boundary-based corner detection method using wavelet transform for its ability for detecting sharp variations [12]. The extended curvature scale space corner detectors also belong to the category of contour based methods. Intensity based methods estimate a measure which is intended to indicate the presence of a corner directly from the image gray values [13].

a. RGB Color Model

To get the features from color images, first we need to know about the color models for example RGB, CMYK. The RGB color model is an additive color model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors, red, green, and blue. The main purpose of the RGB color model is for the sensing, representation, and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography. Before the electronic age, the RGB color model already had a solid theory behind it, based in human perception of colors. RGB is a device-dependent color model: different devices detect or reproduce a given RGB value differently, since the color elements and their response to the individual R, G, and B levels vary from manufacturer to manufacturer, or even in the same device over time. Thus an RGB value does not define the same color across devices without some kind of color management. Typical RGB input devices are color TV and video cameras, image scanners, video games, and digital cameras. Typical RGB output devices are TV sets of various technologies (CRT), computer and mobile phone displays, video projectors, multicolor LED displays, and large screens such as Jumbo Tron. Color printers, on the other hand, are not RGB devices, but subtractive color devices (typically CMYK color model).

b. Feature Point Detection

Corner information used as a feature point for a variety of image processing frequently, contains a large number of rich content of the local characteristics and shape feature information. Harris corner detection operator is one of the earlier development of the more mature point feature extraction algorithm. The algorithm only involves the first-order difference calculation of the image gray value. Though the extracted feature points are reasonable and evenly distributed, they are sensitive to noise and have poor positioning accuracy and have poor stability when the image has large scale transformation. In order to extract the feature points with comprehensive information and relatively stable position, this paper improved Harris detection based on the Harris detection operator, and used the modified Harris correlation detection operator to determine the feature points. The mean gradient value of image was reduced when constructed the Harris correlation matrix. The improved Harris correlation detection operator was used to detect the feature points and the obtained feature points are relatively stable and comprehensive

II. LITERATURE WORK

Extracting features are important direction in computer vision, image processing and machine vision, whiles the corner as an important feature of the image has long been a concern, and it also made a lot of research results. Corner is the twodimensional point of rapid change image brightness, or curve maximum curvature point in image edge. Corner is an important local feature of the image, it focused on a number of important information of the shape of the image to reflect the image of the local features, it can match images more reliable. Corner has such rich feature information, so that it hold important features of graphic images and effectively reduced the amount of data information, it improves the speed of operation, it makes easy to a image reliable matching, makes real-time processing possible. It has the rotational invariance and does not change with the light conditions change, so it has important applications in many fields such as matching the images, camera calibration, 3D reconstruction, moving object tracking and pattern recognition.

XintingGao et.al proposed a method called “A novel corner detection method for gray level images based on log-Gabor wavelet transform (WT)”. Has proposed that the input image is decomposed at multi scales and along multiple orientations. The magnitudes of the decomposition are formulated into the second moment matrix. **Yixin Chen et.al.** Proposed “Robust Edge and Corner Detection Using Noise Identification and Adaptive Thresholding Techniques” proposed that a robust, two step method for edge and corner detection in noisy images. First it identifies the type of noise using a new pattern classification approach and then restores the image using a good restoration technique suitable for the type of noise identified. The types of noise considered here include uniform white, Gaussian white, speckle, and salt-and-pepper noise. From the restored image, edge and corner strengths are determined using gradient based techniques, and finally, a fuzzy k-means

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clustering algorithm is used to find adaptive thresholds for detecting the edge and corner points. Yang Bai, Hairong Qi "A corner detection from dual-tree complex wavelet transform (DTCWT)" proposed that in this design author use 2DDWT technique. 2-D DWT decomposes an image into multiple scales. The orthogonal wavelet based decomposition is non-redundant, thus incurring no additional storage overhead. By using the 2-D DWT decomposition, we can find the edges by examining the local extremes of wavelet coefficients along the horizontal, vertical or diagonal directions. Yang Qiao,Yanchao Tang, and Junshi Li "a sub-pixel corner detection based on improved Harris algorithm" proposed that is improved version of Harris algorithm. According to the two basic conditions of demand of sub pixel positioning technology, first, target is not an isolated single point that has some geometric characteristics of the gray; secondly, we should know the specific location of target positioning datum point. Determine the calibration image to meet above two fundamental conditions, and we will have a fair chance of obtaining sub-pixel positioning. Wei-Chuan Zhang1, Fu-Ping Wang2, Lei Zhu1, Zuo-Feng Zhou3 "a contour-based corner detector using the magnitude responses of the imaginary part of the Gabor filters on contours". Proposed that unlike the traditional contour-based methods that detect corners by analyzing the shape of the edge contours and searching for local curvature maxima points on planar curves, the proposed corner detector combines the pixels of the edge contours and their corresponding grey-variation information

This paper [14] uses the concept of excluding the neighboring points by introducing the concept of image sub-blocking where a filter using B-spline is constructed. By comparing it with the Harris method, this improved algorithm can effectively detect the corner of the image and helps in getting a more accurate corner location. [14].A new concept of corner detection has been introduced in this paper. In more general Harris corner detection is used for gray or color images which contain two dimensions. Here, detection has been extended to multispectral images. The experimental results show that the proposed detection algorithm can detect corners of multispectral images moreefficiently. These corners are having significant variations both in spatial domain and spectral domain [15]. In this paper [16], corner detection is used for classifying breast mammograms as normal or abnormal. It is done with the help of the training data set used for Support Vector Machine (SVM). Here, improved Harris Corner Detection produces the output as corner pixels which are the taken as the input for the training set. The result shows that the proposed approach can improve both the accuracy and the performance of computational speed to classify the breast mammogram image as normal or abnormal. [16] Harris corner detection for wavelets has been proposed in this paper [17]. In traditional methods some corner points are omitted based of certain criterion, but this problem is solved here. The motion of the vehicle is estimated based on the algorithm optical flow and multi-scale corner detection. Result shows that even though the camera and vehicle is moving the corner points will remain the same. The tracking algorithm helps in accurately match the feature points with the high real-time performance.[17] Harris corner algorithm is proposed in this paper [18] which end up being robust in changing motion and illuminated lightning conditions.

Applications of Corner Detection

There are many applications where we have to use corner detection processor and those applications are Image matching and mosaic application, face recognition and object navigation leaf recognition etc. We discussed two of these application in this section. To evaluate corner detection algorithm is ultimately to guide utilizations. Image matching, recognizing the homologous pixels between two images or among multiple images by certain matching algorithm, is an important application field of corner detection through which can greatly reduce the matching data. Image matching experiment firstly used SUSAN and Harris corner detector is better than SUSAN, so we use Harris corner detector to complete a future application, image mosaic which is to stitch two or more small images that have overlapping areas with their neighbors into a large, high-resolution synthesis image. The automatic construction of image mosaics is an active area of research in the fields of photogrammetry, computer vision, image processing, and computer graphics. It usually has two basic steps, image matching and image fusion.

III. METHODOLOGY

Harris corner detector is a mathematical operator which can be used to find the features present in the image. Consider the image shown in Figure 1, there are some horizontal and vertical lines in between them. How one can identify the features exist in the image. Let us first define what is the feature detection?It is easy for the human beings to recognize the features present in the image, but for the computer we need to write the program to find the interesting features or patterns present in the image.Well, it is difficult to say how humans find these features. It is already programmed in our brain. But if we look deep into some pictures and search for different patterns, we will find something interesting. For example, consider Figure 2.

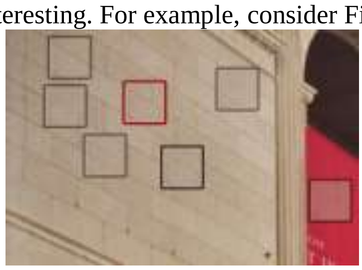


Figure 1: Sample features present in the image.

Here the blue patch is flat area and difficult to find and track. Wherever you move the blue patch, it looks the same. For black patch, it is an edge. If you move it in vertical direction (i.e. along the gradient) it changes. Put along the edge (parallel to edge), it looks the same. And for red patch, it is a corner.

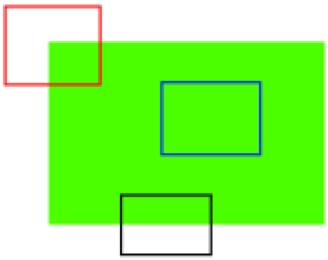
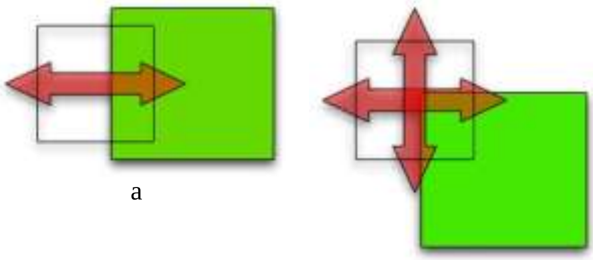


Figure 2: Features- Edges, Corners, Flat regions

Wherever you move the patch, it looks different, means it is unique. So basically, corners are considered to be good features in an image. Such kind of detecting pixels are called. Let us understand the principle of corner detection. Corner detection works on the principle that if you place a small window over an image, if that window is placed on a corner then if it is moved in any direction there will be a large change in intensity. This is illustrated below with some diagrams.If the window is over a flat area of the image then there will be obviously be no intensity change when the window moves. If the window is over an edge there will only be an intensity change if the window moves in one direction.

If the window is over a corner then there will be a change in all directions, and therefore we know there must be a corner.The Harris corner detector, demonstrated above, measures the strength of detected corners, and only marks those above a given strength as actual corners. In Figure 3, we have shown the direction of masks to get the features present in the image



a

b

Figure 3: Directions for feature extraction

The number detected can be altered by varying the value of k. Chris Harris basically finds the difference in intensity for a displacement of ‘u’ and ‘v’ i.e. **(u, v)** in all the directions in his paper entitled “A combined corner and edge detector”. We can express this as shown in the following equation.

$$E(u,v) = \sum_{x,y} \underbrace{w(x,y)}_{\text{window function}} \, [\underbrace{I(x+u, y+v)}_{\text{shifted intensity}} - \underbrace{I(x,y)}_{\text{intensity}}]^2 \qquad (1)$$

Here the window considered either rectangular or Gaussian and it gives the weights to the pixel values underneath. The task is to maximize the function **E (u, v)** to detect the corners exist in the image. Intuitively we have to maximize the second term given in the equation. After applying the Taylor series and some other mathematical steps to the above equation we will get the following resultant equation. Here the other mathematical steps or full derivations indicates that the step by step operations that are applied to the equation can be found in any standard textbooks.

$$E(u,v) \approx \begin{bmatrix} u & v \end{bmatrix} M \begin{bmatrix} u \\ v \end{bmatrix} \qquad (2)$$

We can compute ‘M’

$$M = \sum_{x,y} w(x,y) \begin{bmatrix} I_x I_x & I_x I_y \\ I_x I_y & I_y I_y \end{bmatrix} \qquad (3)$$

Where, I_x and I_y are image derivatives in x and y directions respectively. Later the value of ‘R’ is computed as:

$$R = \det(M) - k(\operatorname{trace}(M))^2 \qquad (4)$$

The ‘R’ value decides that the region is a corner or edge or flat region based on the following condition and these rules are specified in Figure 4. This method can be described in step by step for getting a clear idea on how the actual features or extracted from the image.

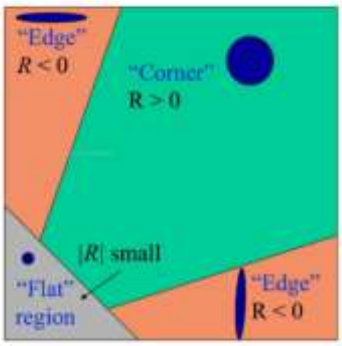


Figure 4: Feature detection using “R” value.

Step 1: The derivatives of the image are computed.

$$I_x \Leftrightarrow \frac{\partial I}{\partial x} I_y \Leftrightarrow \frac{\partial I}{\partial y} I_x I_y \Leftrightarrow \frac{\partial I}{\partial x}\frac{\partial I}{\partial y}$$

Step 2: compute the multiplication of the derivatives.

$$I_x^2 = I_x * I_x \quad I_y^2 = I_y * I_y I_{xy} = I_x * I_y$$

Step 3: compute the covariance matrix ‘M’ using equation (3) and E (u, v) using equation (1)

Here I(x+u, y+v) - I(x, y) is known as the shifted intensity and I(x, y) is known as the intensity. After simplifying the above equation we will get

$$E(u,v) \approx \begin{bmatrix} u & v \end{bmatrix} M \begin{bmatrix} u \\ v \end{bmatrix}$$

From this compute the 'M' value.

Step 4: Calculate the Eigen valuesλ:

If λ is close to 0, then it is not a corner. So look for conditions where it is large.

Step 5: Calculate the corner response function R:

$$R=\text{Det}(M) - \alpha * \text{Trace}(M)^2 = \lambda_1\lambda_2 - \alpha(\lambda_1+\lambda_2)^2$$

WhereDet (M) = $\lambda_1\lambda_2$ andTrace (M) =$(\lambda_1+\lambda_2)$ and α value is between 0.04-0.06. If 'R' < 0 it is considered as an edge and if 'R' > 0 then it is a corner.

IV. RESULTS & DISCUSSION

This section describes about the results of Harris Corner detection algorithm. We have taken two sample images and applied the above algorithm. In Figure 5.a, we have taken an image containing various corners. The algorithm effectively detecting the corners in the image, the result of this shown in Figure 5.c. The dilated gradient of the image is shown in Figure 5.b. Similarly we have taken another example image chess board and applied the same algorithm and the results of this are shown in Figure 5.d to Figure 5.f.

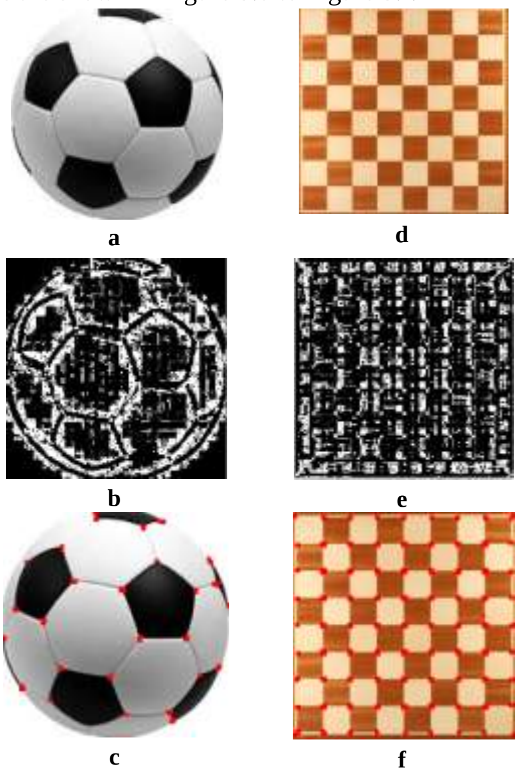


Figure 5. a. Input Image b. Dilated gradients of a. c. output of Harris algorithm.

V. CONCLUSION

This paper gives a clear idea about detecting the corner points in a given image. It explains how Harris Corner detection algorithm will detect for the color images. It also explains how the operations such as AND, OR will work effectively for different kind of images. The traditional methods basically used to convert the color image to the gray scale image, but this algorithm can directly detects the corners in the image and gives the accurate results in less time. In some cases some unwanted corners may be detected where the image contains noise and other related noisy effects. It has wide range of applications such as 3D modeling and video tracking but in case of multimedia and graphics related applications corner detection faces several issues and does not fulfilling the requirements. Detecting corners in the case of noise and with the help of preprocessing techniques such as dual-tree complex wavelet transform and log-Gabor wavelet transform we can further increase the efficiency to wide range of applications and will be consider as the future work.

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