Performance Analysis of Different Feature Detection Techniques for Modern and Old Buildings

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Abstract

Building detection and feature detection are nowadays significant research fields in the area of computer vision. In the human eye perspectives, it is very easy for separating the old and modern buildings. In the computation aspect, differentiation of the old and modern buildings depends on feature detection. The different building structures contain different characteristics and features. Various methods of feature detection concept are being used for collection of the features. This research paper presents four computational methods for detecting the feature of several modern and old buildings. In this experiment, we have analyzed Canny Edge Detection, Hough Line Transform, Find Contours and Harris Corner Detector techniques for the modern and old buildings. After conducting these techniques, we have analyzed the performance of feature detection for the modern and old buildings. In this manuscript, we have also shown that, why these four techniques are suitable for detecting the features of modern and old buildings.

Keywords: Building Detection, Computer Vision, Image Processing, Feature Detection.

1. Introduction

Object detection is right now an imperative research territory in the field of computer vision and image processing. A few kinds of identification approaches are utilizing the present application and research. Building Detection is one of them. In recent years, some experiments have been revealed, where computer vision approaches are utilized in ancient architecture and modern architecture segments.

A detection technique is used in damage and collapsed buildings, which are based on digital surface models [MYLY18]. Another detection method focuses on "Light Detection & Ranging" (LiDAR) method and detected the building by using feature compressor [NSS+18]. A manuscript has been presented a building detection approach using shadow, shape, and color features of a building [GJ18]. A feature acknowledgment method has been utilized in an ancient structure which depends on deep learning [ZWZZ18]. Here, the analysts have proposed a technique to distinguish the few highlights of the old structure by utilizing a neural network system. Another ongoing strategy centers on acknowledgment and perception for antiquated Maya symbolic representation [COG18].

After viewing the above literature review, feature detection of a building seems to be a very significant research area and recent trends in Computer Science. Furthermore, these former experiments have not disclosed any combined concepts about the performance of different feature detection techniques for modern and old buildings. Moreover, the structures of the modern and old buildings are not in the same aspects. In addition, the performance or execution of feature detection techniques are displayed in different activities for modern and old buildings.

According to the above research gaps, we have instituted this research, where we have shown the diverse performances of different feature detection techniques for modern and old buildings. To construct our research, we have utilized the Canny Edge Detector [CCWT18], Hough Line Transform [TWBW18], Find Contours [SMNC18] and Harris Corner Detector [SIV18] techniques. After utilizing these techniques, we have shown different performances for the different modern and ancient buildings. Finally, in this paper, we have exposed a percentage rate of these four feature

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detection techniques for modern and old architectures or buildings.

2. Feature Identification for Buildings

In the computer vision aspects, there are variant types of ideas for feature identification [GPP15], such as corners, points, edges etc. [TG16]. In our experiment, we have applied some techniques for collecting the building features of modern and old dimensions.

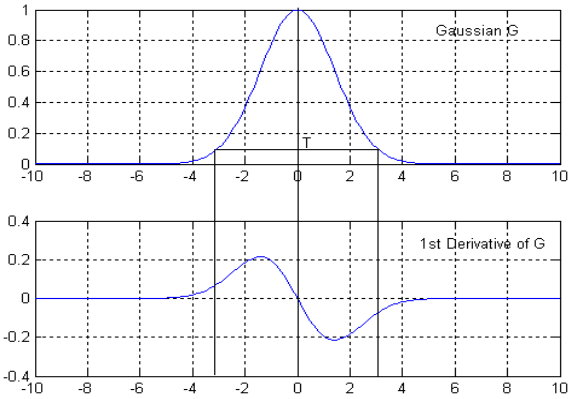
2.1 Canny Edge Detection

Edge identification covers a decent variety of scientific process that's objectives is at distinguishing the focuses in a picture. In our test, we have utilized the Canny edge detection strategy. This technique was used for recognizing an extensive variety of edges from the picture. Various researches agree with the Canny technique to displaying the best results in edge detection [MA09] [KS16]. Here, the horizontal (G_x) and vertical (G_y) directions were sifted by finding the gradient intensity of a picture. We organized the edge angle [MK13] for every pixel as taken after. After implicating this approach, the gradient was always standing to edges and also rounded to the angles for the vertical, horizontal and diagonal directions.

$$Edge\_Gradient\ (G) = \sqrt{G_x^2 + G_y^2} \qquad (1)$$

$$Angle\ (\theta) = \tan^{-1}\left(\frac{G_y}{G_x}\right) \qquad (2)$$

After implicating these equations, the gradient was always standing to edges and also rounded to the angles for the vertical, horizontal and diagonal directions. Figure 1 has illustrated the output of the Canny method for modern and old buildings and its simulation graphs.



Simulation of Canny Edge Detection


Original Image of Modern Building


Canny Image of Modern Building


Original Image of Old Building

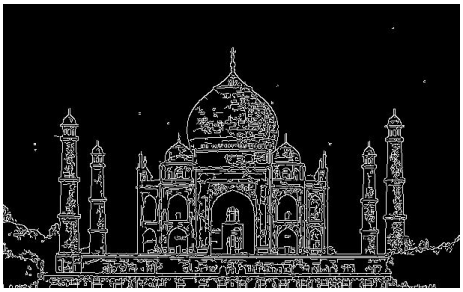

Canny Image of Old Building

Figure 1: Canny edge detection for different aged buildings.

2.2 Hough Line Transform

This is a feature extraction technique. It was respected with the lines identification in a shape on the images. Here, the line can be illuminated by two variables [Open17]. We have denoted the variables m and b for Cartesian coordinate method and variables r and θ for Polar coordinate method [AOL+92]. These two methods are utilized in Hough Line Transform technique for identifying the line among the buildings (See Figure 2). In our research, a line has been denoted as y where,

$$y = mx + b \tag{3}$$

In parametric form,

$$r = x \cos \theta + y \sin \theta. \tag{4}$$

Figure 3 has been shown as the input and output of the picture in this technique. Hence, the applied equation of this technique is as follows:

$$y = \left(-\frac{\cos\theta}{\sin\theta}\right)x + \left(\frac{r}{\sin\theta}\right) \tag{5}$$

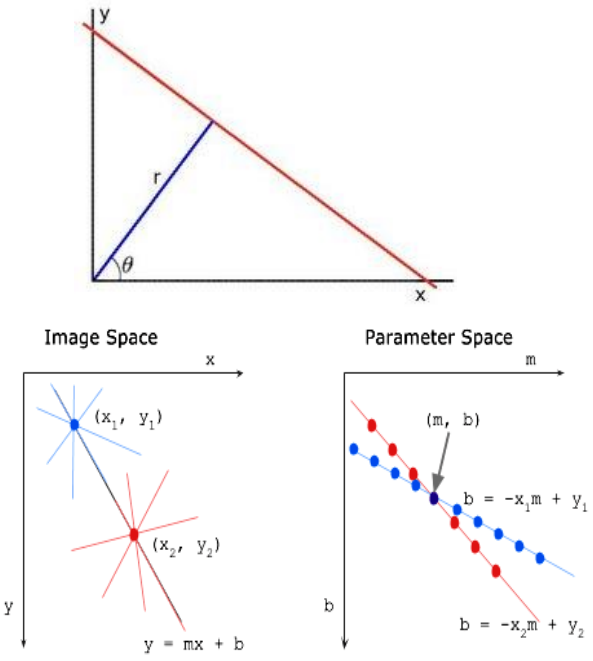
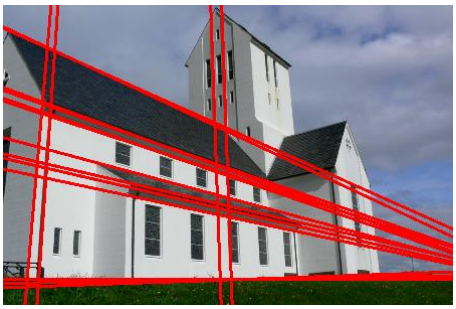


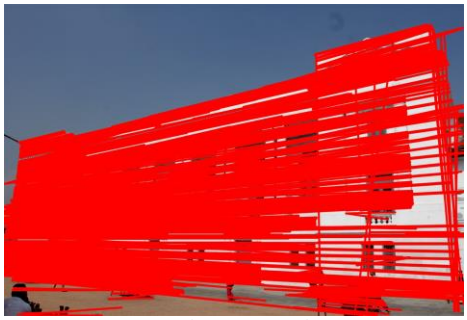
Figure 2: Hough line transform in image

Original Image of Modern Building



Hough Line Transform Image of Modern Building

Original Image of Old Building



Hough Line Transform Image of Old Building

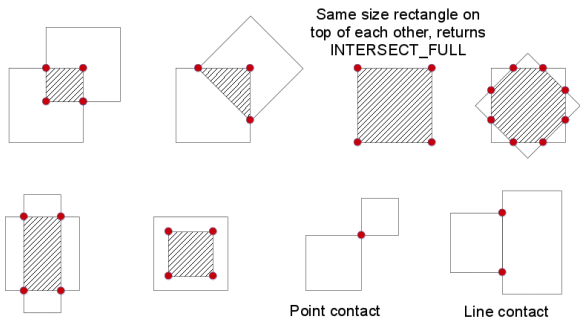
Figure 3: Hough line transform for different aged buildings.

2.3 Find Contours Technique

Contours can be stated as a curve or inclination for joining all the points' border and having the same color. This method was utilized for shape analysis and object detection in a building image. In our experiment, we have used Image Moment [ZWSP15] approach for finding the counters of the different aged buildings. The spatial moment of an image is denoted as m_{ij} where *i* and *j* are nested "for loop" order. The image moment [Open14] computed as:

$$\mathtt{m_{ji}} = \sum_{\mathtt{x,y}} \left(\mathtt{array(x,y)} \cdot \mathtt{x^j} \cdot \mathtt{y^i}\right) \qquad (6)$$

Figure 4 has been illustrated in several types of counter-detection, which are used in our experiment. In this technique, we have used *cv2.findContours( )* function for stimulating the Find Contours process, where we have denominated the inner shape as a child and outer shape as a parent. Figure 5 has been shown as the feature detection of buildings by using find contours method.



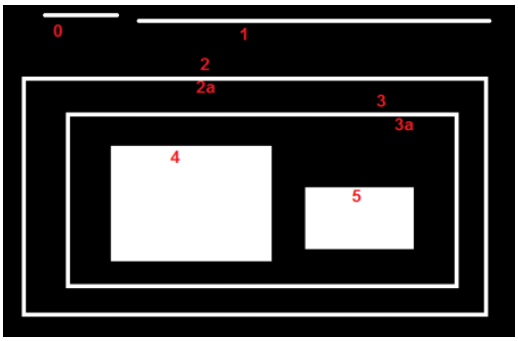
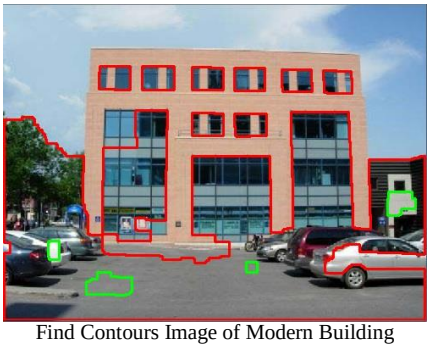
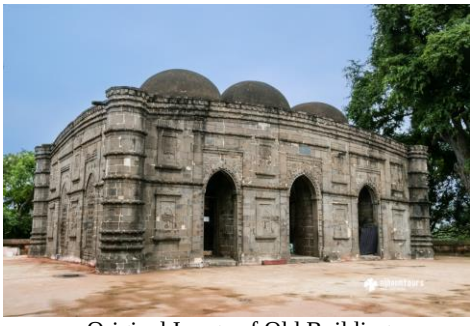


Figure 4: Find Contours theorem.

Original Image of Modern Building



Find Contours Image of Modern Building



Original Image of Old Building

Find Contours Image of Old Building

Figure 5: Find Contours technique for different aged buildings.

2.4 Harris Corner Detection

Corner identification is a method used to extract the corner features of an image. In computer vision, a corner can also be noted as a point. Harris corner detection technique extracts the corners from an image. It commonly finds the intensity of an image for a prolapse of *(u, v)*. In this approach, there is a Gaussian window function and gives weights to pixels down. The mathematical structure of this technique [Nelli17] is given below which is utilized in our experiment.

$$E(u,v) = \sum_{x,y} w(x,y)[I(x+u,y+v) - I(x,y)]^2 \quad (7)$$

Here, *E* is the variety between the original and moved Gaussian window. The window's dislocation in the direction *x* is *u* and *y* direction is *v*. Window *w(x, y)* is at position *(x, y)*. The image intensity is *I*. Window's intensity is *I(x+u, y+v)*, the original intensity is *I(x, y)* and *w(x, y)* is a window Gaussian function. At OpenCV, the harries corner detector function has been entitled as *cv2.cornerHarris( )*. Here, Harris technique has been improved by using its directional differentiations and also covered the high threshold values (See Figure 6) [CZZD09]. In Figure 7, we have displayed the Harries approach for modern and old buildings.

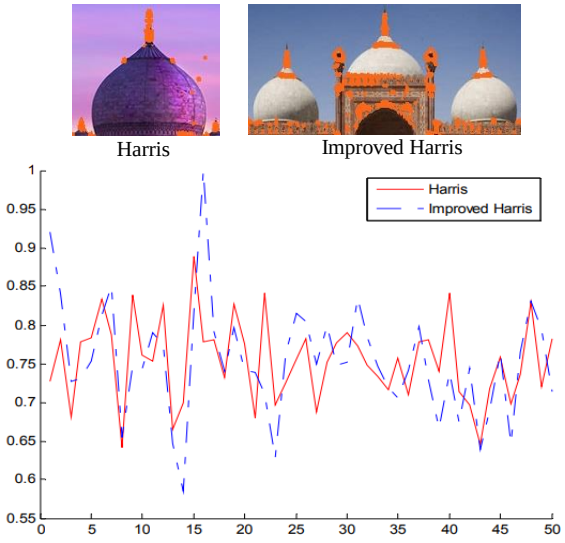
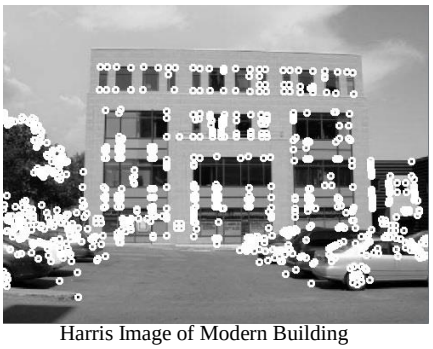


Figure 6: Simulation of original Harris and improved Harris techniques.

Original Image of Modern Building



Harris Image of Modern Building

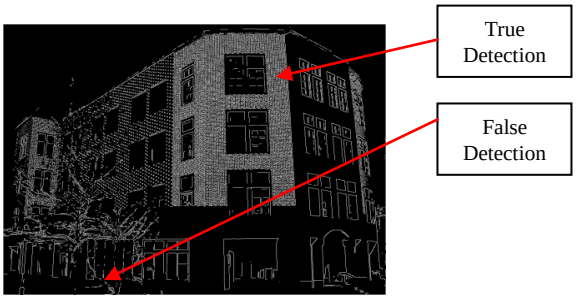
Original Image of Old Building

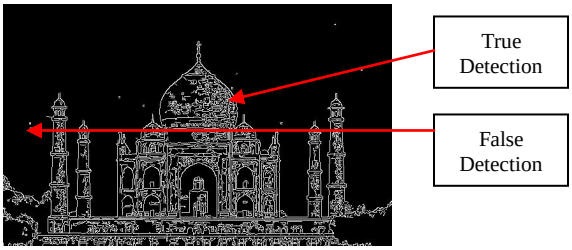
Harris Image of Old Building

Figure 8: Conner identification of different buildings by using improved Harris technique.

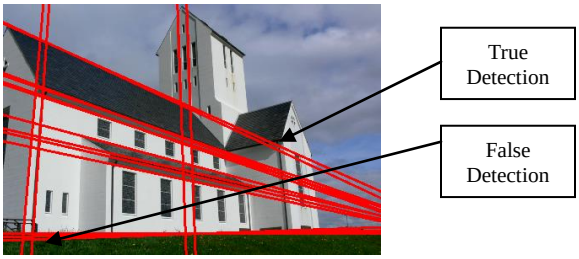
2. Result and Analysis

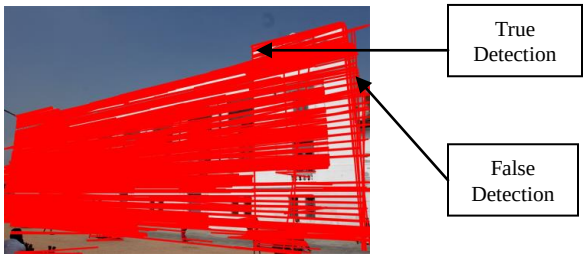
By using Canny Edge Detection, Hough Line Transform, Find Contours and Harris Corner Detector techniques in modern and old aged buildings we have got different performances. We have done this experiment on several old and modern buildings' images. Figure 9 has illustrated the false and true feature detections among the images and Table 2 has demonstrated the accuracy percentage of false and true feature detection rates.



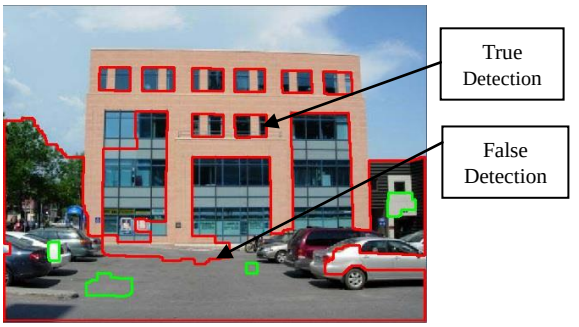


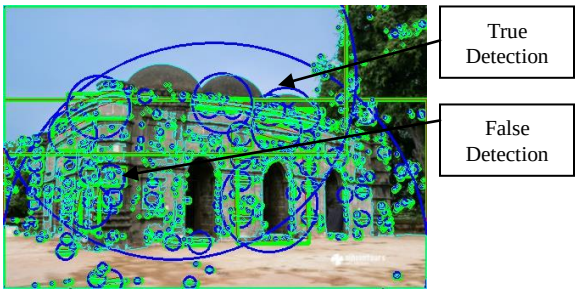
True and false feature detection in Canny images



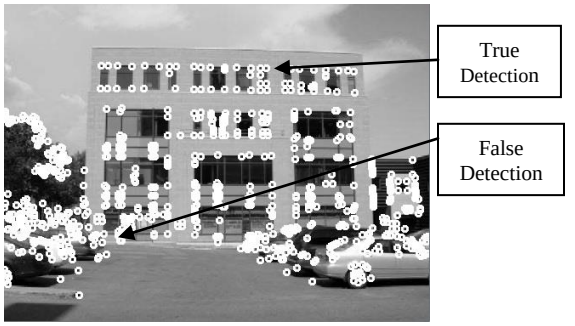


True and false feature detection in Hough Line Transform images





True and false feature detection in Find Contour images



True and false feature detection in Harris image

Figure 8: True and false feature detection of modern and old buildings.

Table 1: Percentage of Feature Detection Accuracy

Methods	Feature Detection Accuracy (%)					
	Modern Building			Old Building		
	Detection Type		Suitable	Detection Type		Suitable
	True	False		True	False	
Canny Edge Detector	98%	2%	Yes	98%	2%	Yes
Hough Line Transform	94%	6%	Yes	30%	70%	**No**
Find Contours Method	92%	8%	Yes	90%	10%	Yes
Harris Corner Detector	90%	10%	Yes	95%	5%	Yes

3. Conclusion and Future Works

Our exploration has delineated an application based analysis which has shown the performance of feature detection techniques in feature recognition of isolated aged buildings. This examination is fundamentally centered on the period distinguishing proof by utilizing highlight location. The examination is as of now being worked on in the viewpoint of Deep Learning. These are key research for better nearness about component location and period recognizable proof at continuous in our future activities. The ongoing situations idea can be changed into Machine Learning based model by using Feedforward Neural Network (FNN).

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