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# Automated Flaw Diagnosis on Concrete Surface Images and Performance Evaluation

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**Abstract:** The Paper approaches the flaw detection on the concrete surface using edge detector and morphological operator. The concrete surface or road pavement image is for analysis the crack in the image. An existing system is using the wavelet transform to detect the crack from the image. However, Image segmentation is used for crack detection, but the minor cracks are difficult to detect. The proposed method using distributed canny edge detector and Morphological operator's dilation and closing operator separate the flaw. The algorithm needs less time to execute the operation. The execution time is comparison with median, wiener filtering.

**Keyword:** Crack, Dilation, Distributed canny edge detector, Closing.

## I. INTRODUCTION

The road cracks are identified by the human operators. The cracks are formed due some disasters, weather condition, and heavy traffic which creating the distress on the surface. The survey of road crack is diagnosis by human using vehicle. This is not safe for human and public.

The developing of computer vision system has reducing the human work. The crack detection is important for diagnosis and inspection to maintaining the road structure and building structure. The crack detection method automatic visual inspection system was proposed by image processing techniques. The computer vision system Using images and some algorithms to detecting the crack [1].

The computer vision technology provides the automated version of crack diagnosis. The surface pavement crack diagnosis is important to detect to reduce the accidents and some unwanted problem [1]. The pattern recognition is using sample and reference image. In these two images getting the difference to get the flaw output if present.

The morphological operators are used to detect the flaw in underground pipeline image. These morphological operators are dilation, closing to get the crack in the images. In these method over dilation and closing leads to white pixels.

The pattern recognition method is using sample and reference image. In this method original and reference image difference is to find the flaws or crack in image. The method has giving the result accurate. Yet it is difficult to find minor flaws. Crack detection method using the wavelet transform, Fourier transform and edge detectors methods, and filtering. The Wavelet transform gives the expected result but some image curvature is not predicated.

Canny edge detector is also used for flaw diagnosis on surface crack but its latency time was high. So it cannot implement in real time. The canny edge detector uses the manual thresholding method it increasing the latency time [1].

The other methods for detection of flaw using two pre-processing methods are hessian matrix and image subtraction. However these methods produce different unexpected result for different size image. Watershed segmentation is also one of the methods for diagnosis of crack. If the input image contain noise and other unwanted information getting the over segmentation result.

The capture image containing any type of noise it needs pre-processing steps to process above algorithm. Alaknandaa et al detecting the crack in system using the morphological operators are dilation operator and closing operator. In this approach detect the crack in welding images and it needs the pre-processing steps for clear output [4].

## II. EXISTING SYSTEM

An existing system of flaw diagnosis method using the 2D wavelet transform [2] to detecting the pavement crack on the surface [3, 4, 5]. In general existing system for crack analysis is the image segmentation. Mostly edge detector is suitable for the identification of crack in the image. The edge detectors are classified into two types.

The first one is first order edge detector other is second order edge detector. The edge detector is providing the mask to detect the edges in the image. The first order edge detectors are Roberts, Prewitt, Sobel, and canny edge detector. The Roberts edge detector find the difference between the adjacent pixel values is called Roberts edge. The Roberts kernel mask is given by,

$$G_X = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \qquad Gy = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$$

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(1)

Where $G_x$ and Gy represents horizontal and vertical gradient mask. The Roberts edge detector is very poor results in noisy input image. The prewitt edge detector providing 3x3 kernel to find the edge in image .The prewitt edge detector finds the central difference of images. The prewitt mask is given in equation 2.

$$Gx = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \quad Gy = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix} \qquad (2)$$

The prewitt edge detector gives the good result than the Roberts.

The sobel edge detector is also called 'modified prewitt edge detector'. In this method greater center weight is added in the mask. The sobel edge kernel is given in equation 3.

$$Gx = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \quad Gy = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} \qquad (3)$$

The sobel edge detector better performance in noisy image compared with prewitt edge detector. To improve the better results canny edge algorithm was proposed. The canny edge detector performs the six steps. The first step apply the Gaussian smoothing to filter some noise, second step calculate the gradient value. Third step apply NMS (Non Maximal Suppression) to thin the edge. The low and high threshold value to calculate the edges .The hysteresis thresholding is two level thresholds. It finally maps the high threshold value as the final edge. In these canny edge detector is only suitable for noise analysis. Remaining edge detector is not suitable for noisy image [6].

The second order edge detector is only detecting the zero crossing of an image. The Second order edge detector LOG (Laplacian of Gaussian) and DOG (Differencing of Gaussian),which producing closed contours and it is not realistic[5].

The wavelet transform image curvature is not detected properly, and It creates the false crack. The normal image segmentation method is difficult detect the minor cracks in the Image [2].

The morphological simple operators dilation and erosion was used to detected the surface crack [7].the top hat transform method is also detecting the crack on the surface of the roads. The morphological operator detects cracks, but the minor cracks are difficult to detect [8]. The morphological operator sometimes produces deviated shape in image.

## III. PROPOSED SYSTEM

The proposed method is using the distributed canny edge detector and morphological operation. The distributed canny edge detector is used.

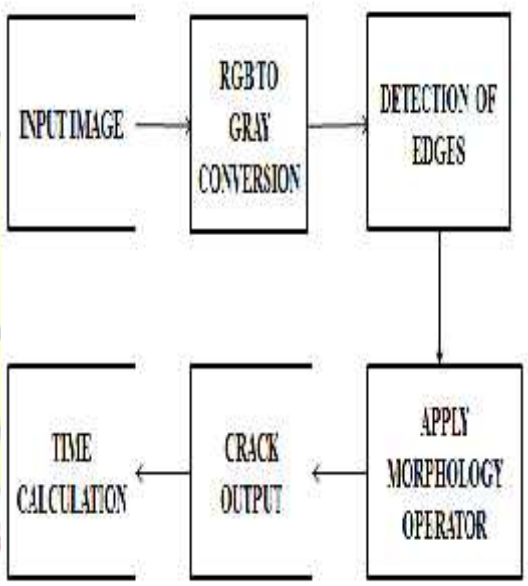


Figure. 1: PROPOSED BLOCK DIAGRAM

The proposed block diagram is shown in figure1.In this figure first module to pick the image from the database file. The second module which converting the RGB to Gray image. Then , to identified the crack in input image to detect the edges on input image using the crack detection algorithm. The crack detection algorithm would be processed in third module. The fourth module is performing the crack by using the morphological operators. The fifth module is to calculate the entire execution time for this process.

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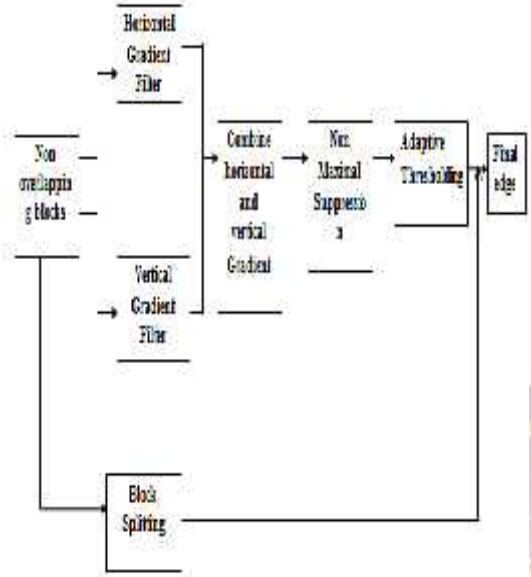


Figure. 2: PROPOSED CRACK DETECTION BLOCK DIAGRAM

In distributed canny edge detector finally hysteresis thresholding has used. The proposed system using instead of hysteresis thresholding morphological extraction is used.

The CXC blocks .Each and every blocks are processed independently. The distributed canny edge detector calculates the horizontal and vertical gradient is calculated and then calculates the magnitude and phase of an image. The magnitude results the edge strength in image. The phase represents the edge direction in the image. The Non Maximal suppression is considering all direction of the edge all possible edges are thin.

The adaptive thresholding is used in the edge detecting and it reduces the manual thresholding calculation problem. The The adaptive thresholding value each block can be divided into smooth, texture, hybrid. The block processing the image can be divided into several blocks. Each block are processed independently and classifies the block according to the adaptive threshold value. Large image the edge detection affects the speed of the process. The block processing reducing the edge detection computational time for larger image and finally combines the blocks getting the final edge of the image. The block classification finds very minor crack were detected and without loss of edge. The block classification process image into blocks and finally combine these block we get the edge of the surface crack.

The proposed block diagram is shown in figure 2.The morphological operator dilation and closing operator extracting the edge information. The morphological operators are using the structuring element to get the crack output. The structuring element having the different shapes that are disk, octagon, rectangular, square and diamond. The proposed method is using the disk shape to process these algorithms. The dilation operator expands object of an image. The closing operators fill the gaps and we will get the accurate output. The block processing has reducing time for execute this algorithm, because the image can be split into small blocks.so easily process large images as soon as possible. Instead of closing operator using median , wiener filtering is used.

***ALGORITHM***

The proposed system algorithm is given below.

- The input image can be picked from the database files and the converting into gray image for purpose of easy analysis.
- Then applying distributed canny edge detector to the image.
- The third step has computing the edge of the image.
- The fourth step the morphological operator extracting image information, and also apply the median, wiener filter to compare the result.
- Finally we are getting the crack output on the surface.

## IV. RESULTS AND PERFORMANCE EVALUATION BASED ON EXECUTON TIME

These algorithms should be implemented in MATLAB (Matrix Lab) 7.10 version. The input image, distributed canny edge detector and the morphological output of various image results are shown below. This algorithm also well suited for the real time application, so it will be used for surface crack quickly. The resultant image shows the closing, median, wiener filtering images are displayed.The surface crack image and gray conversion image, edge detection and crack output given figure3.

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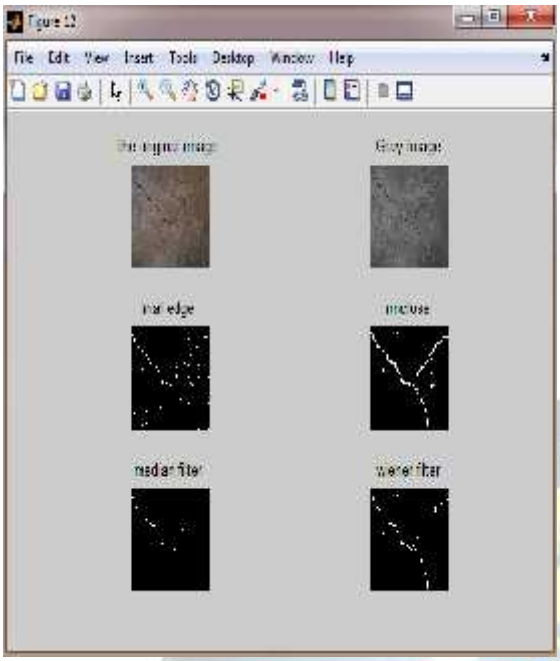

Figure 3: Major crack Detection results

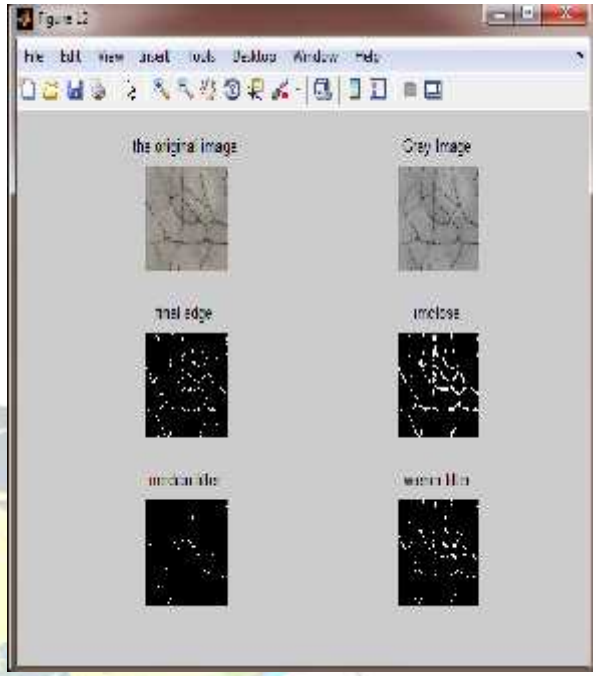

Figure 4: Multiple crack Detection results

The edge detection depends on the size of image. The crack detection time and block unit name are given in table format. It is shown in table1.

TABLE1: Execution Time of Morphological Operator

| IMAGE FIGURE NO | BLOCK SPLITING SIZE | BLOCK UNIT NAME | EXECUTION TIME(Seconds) |
|---|---|---|---|
| 3 | 32x32 | Smooth | 15.7785 |
| 4 | 32x32 | Smooth | 15.4943 |
| 5 | 32x32 | smooth | 19.8687 |

Morphological operator has extracting the edge information from image. In these images single crack can be identified. The proposed algorithm is used for multiple crack in image also diagnosis. It is discussed in figure4.

The crack detection time of median filter and block unit name are given in table2.

TABLE2: Execution Time of Median Filter

| IMAGE FIGURE NO | BLOCK SPLITING SIZE | BLOCK UNIT NAME | EXECUTION TIME(Seconds) |
|---|---|---|---|
| 3 | 32x32 | Smooth | 28.2390 |
| 4 | 32x32 | Smooth | 22.8291 |
| 5 | 32x32 | smooth | 27.1800 |

The figure4 would result minor crack detection on the surface. The proposed algorithm has detecting the minor flaw in the image. These crack detection algorithm is experimentally giving accurate output. A real time implementation possibility is higher than other existing system.

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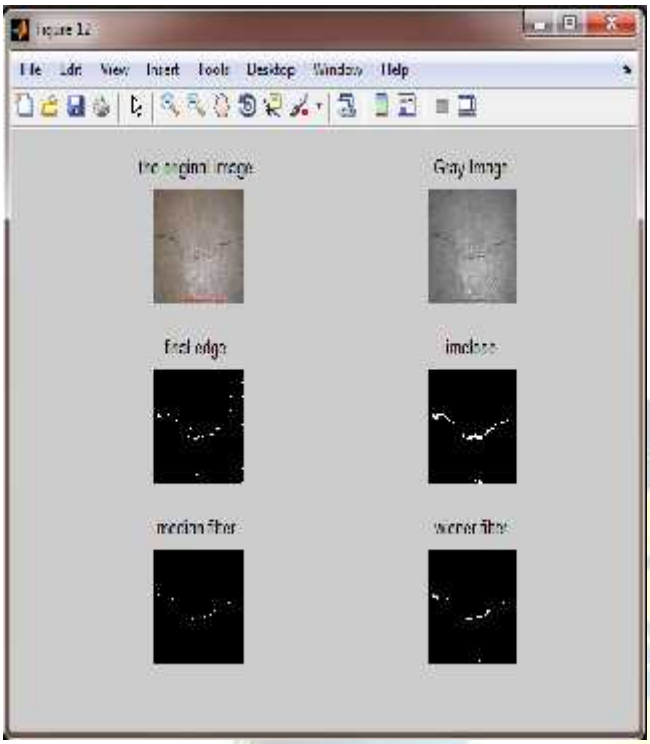


Figure.5: Minor crack Detection results

The crack detection time of wiener filter and block unit name are given in table3.

TABLE3: Execution Time of Wiener Filter

| IMAGE FIGURE NO | BLOCK SPLITING SIZE | BLOCK UNIT NAME | EXECUTION TIME(Seconds) |
|---|---|---|---|
| 3 | 32x32 | Smooth | 18.9335 |
| 4 | 32x32 | Smooth | 24.2251 |
| 5 | 32x32 | smooth | 18.9990 |

Even though the wiener filter gives the flaw separation output equal to the closing operator result and better performance than median filter. The Median filters having high execution time and loss of flaw in the output. To compare wiener filter with closing operator needs less execution time and output.

## V. CONCLUSION

In this paper the crack detection for road pavement is effective for analysis .The proposed algorithm take few seconds to detect the flaw on the surface and filtering methods compare with morphology operator gives less execution time and effective output. These algorithms also used in real time object identification and medical filed. In future scope this algorithm is implemented in robot or FPGA board to detect the crack. There are various image processing algorithm are used for crack diagnosis.

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