ADVANCED DEEP LEARNING FOR CRACK DETECTION AND QUANTITATIVE ANALYSIS IN ENGINEERING MATERIALS

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Abstract - Here we introduced a system which detects crack on wall by using image processing. As image is susceptible to noise, we used some image preprocessing steps to detect crack more accurately. System works on most image formats. System more focuses on intensity value. This is done for sake of accuracy. System removes all undesirable noise. To detect crack, image is binarized and holes are filled so that image is clearer to detect cracks. All small insignificant blobs are removed. Using blob analysis methodology, we detect number of connected objects. Based on the connected components system detects whether image contains crack or not. System is able to detect deeper as well as minor cracks. System uses many images processing steps to detect the cracks. Once the crack is detected by the system, System applies bounding box technology to display the crack to user. Thus, this is an innovative approach to detect crack on wall. We used image preprocessing steps as well as crack detection method to get accurate result. The proposed system is able to detect deeper cracks with 80% success rate and minor cracks with 50-60% accuracy. As image is susceptible to noise, we used some image preprocessing steps to detect crack more accurately. System will detect deeper as well as minor cracks. All small insignificant blobs are removed. Based on the connected components system detects whether image contains crack or not. System works on most image formats.

Keywords – CNN, Fuzzy, Bounding Box Technology.

I. Introduction

Edge Detection techniques came into picture for identifying the objects boundaries which are useful features for segmentation, registration and object identification in scenes. Edges are pixels of images where brightness changes suddenly. The edge is calculated from the image function behavior in a neighborhood of the pixel. Every pixel of the image has both quantities i.e. scalar quantity which is related to magnitude of the gradient and vector quantity which is related to the direction of the edge. Edge information is useful because of image important feature which can be extracted from the edges of an image. Such as corner, curves and lines, etc. System is able to detect deeper as well as minor cracks. System uses many images processing steps to detect the cracks. Once the crack is detected by the system, System applies bounding box technology to display the crack to user. Thus, this is an innovative approach to detect crack on wall. We used image preprocessing steps as well as crack detection method to get accurate result.

II. Existing Technology:

Civil engineering is the profession used to build, design, maintain and improve the structure of roads, multi-story buildings, dams, canals, bridges, etc. Due to continuous changes in the atmosphere, there are many possibilities to form cracks on the walls of the building. It is very difficult to find and detect the cracks to engineer to keep the maintenance of the walls of building. In existing system, it fails to work properly on poor quality images. Wall crack detection is the process of identifying and evaluating cracks in walls, which may be caused by age, normal wear and tear, or other factors. Several methods are employed to detect cracks in walls, including surface cracking, penetrating power ultrasonic, thermography, and acoustic emission testing. Depending on the specific needs of the project, one method may be more effective than others. It's important to consult with a professional or research thoroughly before choosing a wall crack detection method for your project.

III. Proposed System

It proposed a system on infrared thermal image processing frame work based on super pixel to detect the crack. The segmentation was done based on the Fuzzy c-means clustering. The super pixels were selected from the raw gray image as well as high pass filtered image. with the help of edge detection technique software and vertical take-off and landing flying robot can be used to identify the cracks on the walls. There are many methods used for edge detection such as, frequency domain, neural network, fuzzy logic techniques, etc.

Proposed approach for crack detection based on the results of the literature analyzed. The proposed approach is divided into 5 steps:

(1) Image collection/ dataset creation: The first step in the approach is to gather crack images and create a dataset.

(2) Pre-processing: The next step of the approach includes pre-processing of the images with smoothing, gray scaling, and noise reduction.

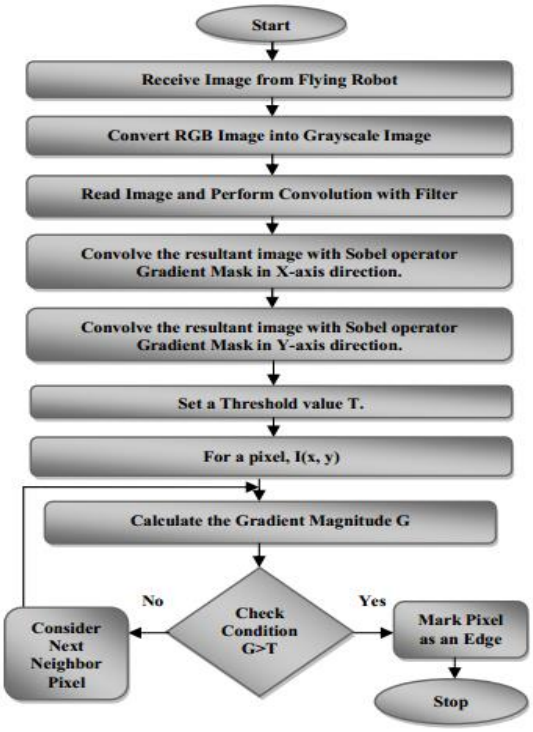
(3) Segmentation: This step includes segmentation of the images using Otsu thresholding for inserting into the detection process.

(4) Crack detection: In this stage, detection algorithm such as Convolutional Neural Networks can be used to detect either crack or non-crack images.

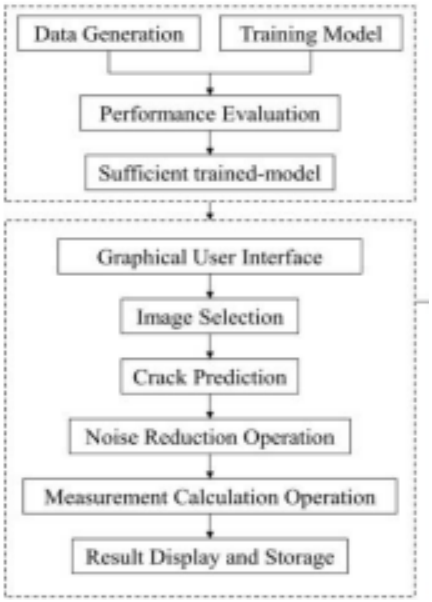
(5) Detection of crack attributes: The final step involves using classifiers again for the purpose of detection of crack length, width and depth.

IV. Methodology

System Design



Flow Chart



A. Training types of edges

In Step edge, intensity of image changes suddenly from particular one pixel value on one side of the discontinuity to a different pixel value on the opposite side. In ridge edge, the image intensity suddenly changes due to change in its pixel value but then returns to the initial value within some small distance. In roof edge, A Ridge edge where the intensity of pixel value changes slowly i.e., situation is occurred due to intersection of two surfaces

B. Gradient Base Operator

As Edge is going to be detected by using first order derivative then, the gradient of the image at location is the vector which can be calculated. The gradient represents the vector dimension of the highest variation in intensity of the image**.** The intensity of image may change in vertical, horizontal or generic gradient. The direction of the edge at any location of image pixel is perpendicular to the gradient vector at that pixel point. There is various classical detector used for edge detection such as Robert operator, canny operator, pewit operator, Sobel operator, etc. In this paper, it is going to discuss working of Sobel operator used for edge detection]. For each pixel the gradient is calculated, based on a 3x3 neighborhood around this pixel.

C. Sobel Operator

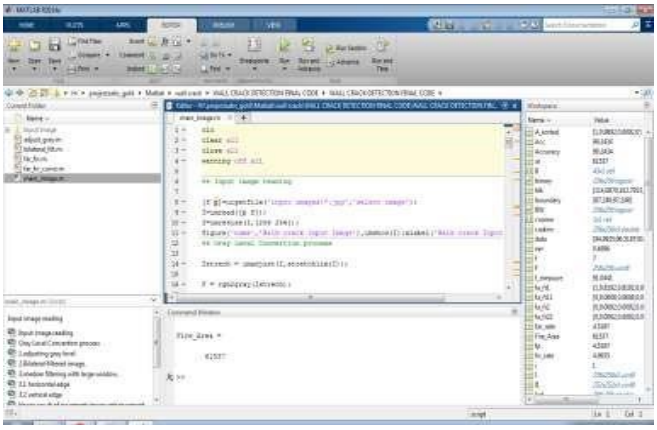
The Sobel operator performs 2-D spatial gradient measurement on an image which give special important to the high spatial frequency that corresponds to the edge of an image. Sobel operator is used to find the magnitude of the gradient at every point in an input grayscale image. It is very easy for calculating edge detection by using this method because it easily detects 2-D images. It works on first order derivative. It is used only when there is maximum variation in scene intensity, discontinuities in image surface orientation & depth as compare to other methods.

D. Edge Detection

Start a flying robot vertically, horizontally, up and down or too and for, along the vertical wall of building using remote control. Transmit signal through computer system to flying robot with the help of remote control. Capture the image of vertical wall of the building. Receive image from the flying robot and convert RGB image into grayscale image. Read converted grayscale image and perform convolution with filter for noise reduction. Take convolution with resultant image along with Sobel operator and gradient mask in x-axis direction. Take convolution with resultant image along with Sobel operator and gradient mask in y-axis direction. Set a Threshold value T for a pixel (x,y) of image I(x,y) and calculate the gradient magnitude G**.** If magnitude gradient G is greater than the pixel threshold value then, mark pixel (x,y) as an edge. Otherwise, consider next neighbor pixel. Repeat the above steps till the process of edge detection is not complete. After complete edge detection, stop the process.

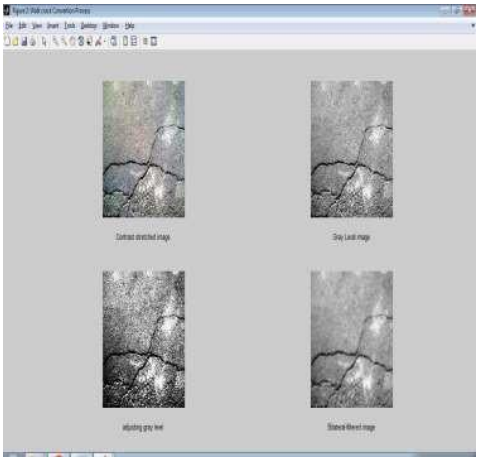
V. Results:

CODE

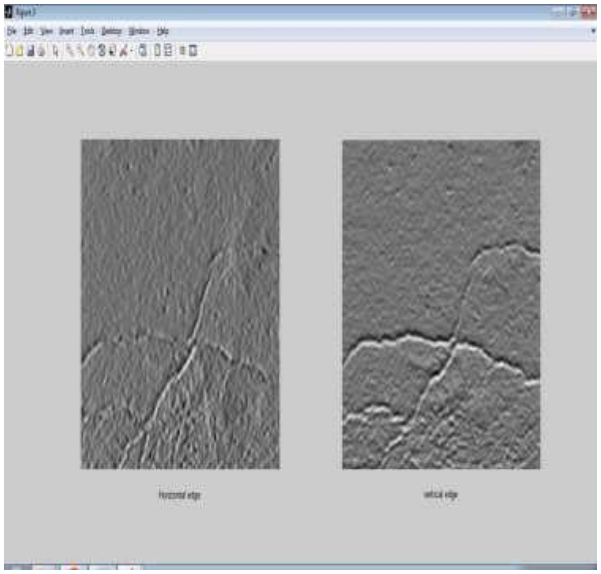


INPUT IMAGE

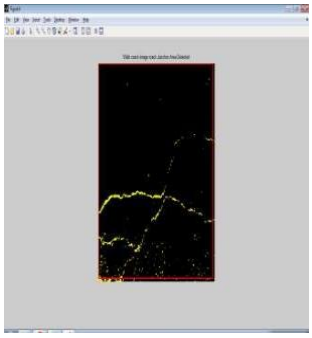
WALL CRACK CONVERSION PROCESS



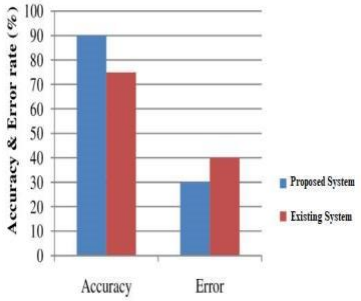
HORIZONTAL AND VERTICAL



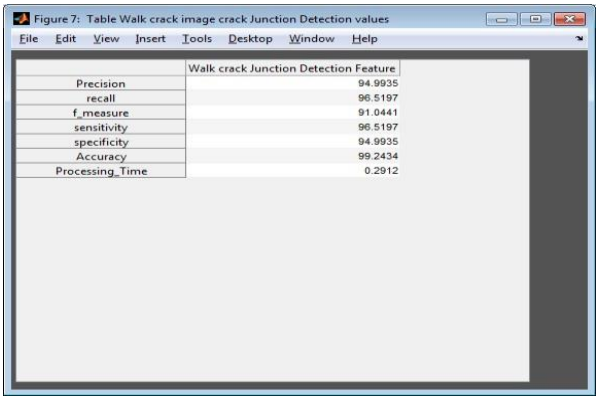
AREA DETECTED



RESULT ANALYSIS

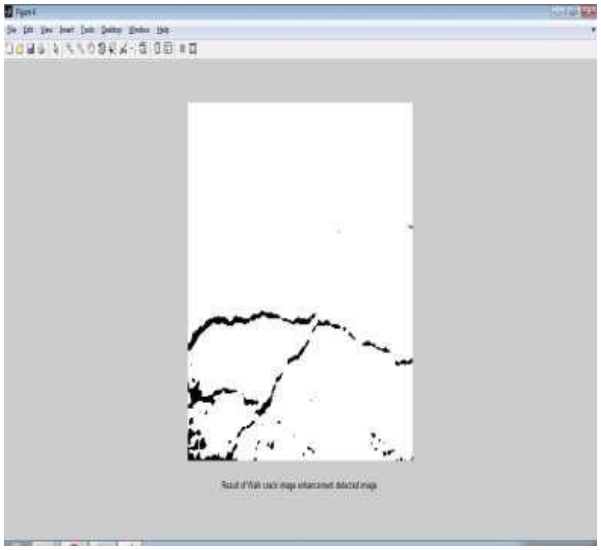


ACCURACY

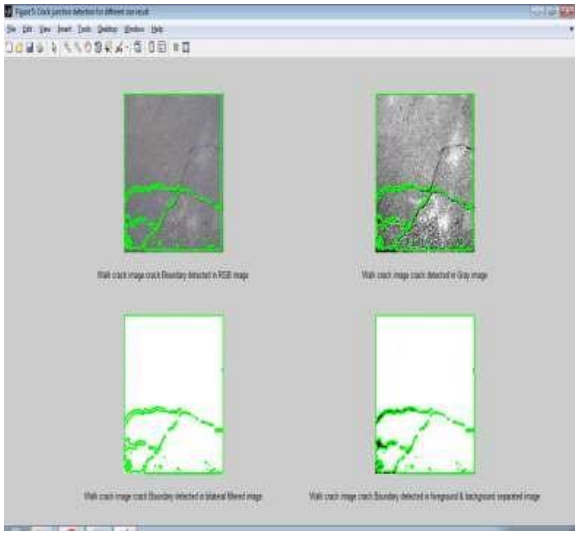


	Walk crack Junction Detection Feature
Precision	94.9935
recall	96.5197
f_measure	91.0441
sensitivity	96.5197
specificity	94.9935
Accuracy	99.2434
Processing_Time	0.2912

RESULT OF CRACK IMAGE



CRACK DETECTION



VI. Conclusion:

This project explains edge detection techniques using sobel operator used for identification of cracks on the vertical wall of the building. It also explained the working of sobel operator. It explained the change in intensity of wall image changes maximum by using Sobel operator. It is very easy useful to compute an approximation of gradient of image intensity function for edge detection of wall image. As Sobel operator has large kernel, so it is less sensitive to noise which helps to smoothing the wall image. By local averaging within the neighborhood of mask, rate of occurring error is reduced. It will be useful to keep the maintenance of building, dams, etc. due to effect of noise.

VII. Future scope:

In the realm of future enhancements for Advanced Deep Learning for Crack Detection and Quantitative Analysis in Engineering Materials within a MATLAB project, several avenues hold promise for further development. Firstly, integrating real-time processing capabilities would be instrumental in enabling on-the-fly analysis of materials, facilitating rapid decision-making in engineering applications.

Additionally, incorporating multi-modal data fusion techniques could enhance the robustness and accuracy of crack detection by leveraging complementary information from diverse sources such as visual imagery, thermal imaging, and acoustic signals. Moreover, the adoption of self-supervised learning approaches could alleviate the reliance on annotated data, enabling more scalable and cost-effective model training.

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