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Paper Title

Inspection, Identification and Repair Monitoring of Cracked Concrete structure –An application of Image processing

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Contents

Introduction

- Cracks are major indication of degradation of the concrete structures. It should be treated in the early stages to prevent its future effects.
- Identifying cracks on concrete walls and classifying them into voids , cracks and micro thin cracks was initially done through mutual inspection.
- We find recent trends shifting towards image processing techniques to improve efficiency which was earlier limited by specialist skill set.
- This is done by the integration of an Unmanned Aerial Vehicle or UAV , data acquisition procedures and image processing for crack detection and evaluation of surface degradation.

Prototype Description

- The prototype we present consists of two parts. A quadcopter to capture images and image processing using MATLAB.
- The quadcopter needs to fed information regarding the height of the building and its length and breadth. The ultrasonic sensor on the quadcopter makes sure that the quadcopter is always at certain distance from the wall.
- Images are taken by the camera at a interval of few seconds continuously as the quadcopter moves to cover the entire wall. The captured images are stored on a memory card.
- The images are read on MATLAB. The images are converted to gray format and then thresholding is done. If there are different textures they are separated . If there are cracks they are detected.
- And if there are voids they are shown by circle with center coinciding with center of the image.

Quadcopter

The flight of UAVs may operate with various degrees of autonomy, either under remote control by a human operator or autonomously by onboard computers.

Quadcopter are navigated via their channel control and transmitter; the higher the channel control, the better the user can navigate the quadcopter at a higher speed.

An unmanned aerial vehicle system has two parts, the quadcopter itself and the control system.

The nose of the unmanned aerial vehicle is where all the sensors and navigational systems are present.

The rest of the body is complete innovation since there is no loss for space to accommodate humans and also light weight. The engineering materials used to build the quadcopter are highly complex composites which can absorb vibration which decreases the noise produced.

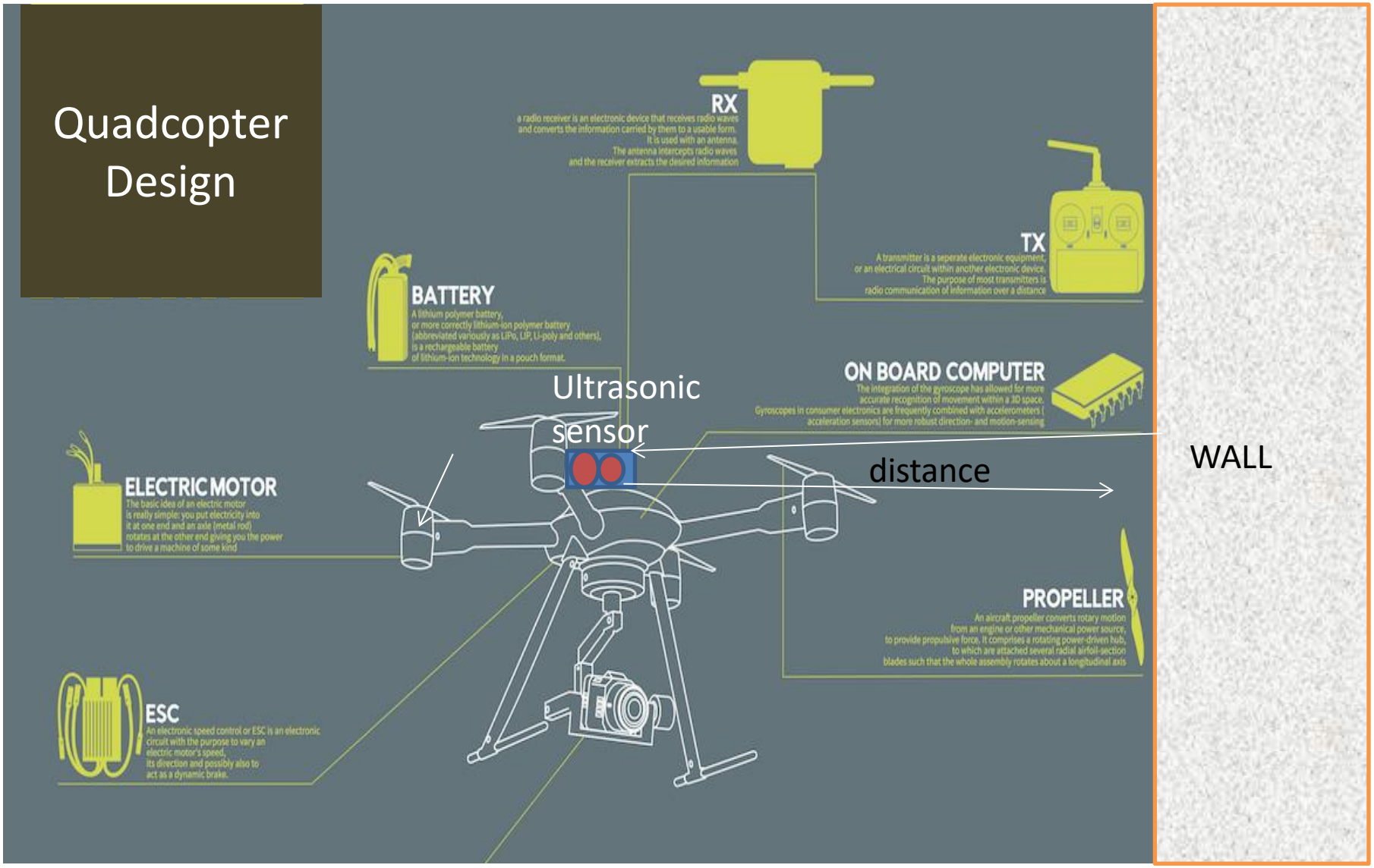
ULTRASONIC SENSOR:

- Precise distance measurement.
- Data from surrounding create a 3D map of environment.
- Detects objects from 3m apart.

Quadcopter prototype design

Fig 1: quadcopter prototype design

Fig 2: quadcopter design



Methodology

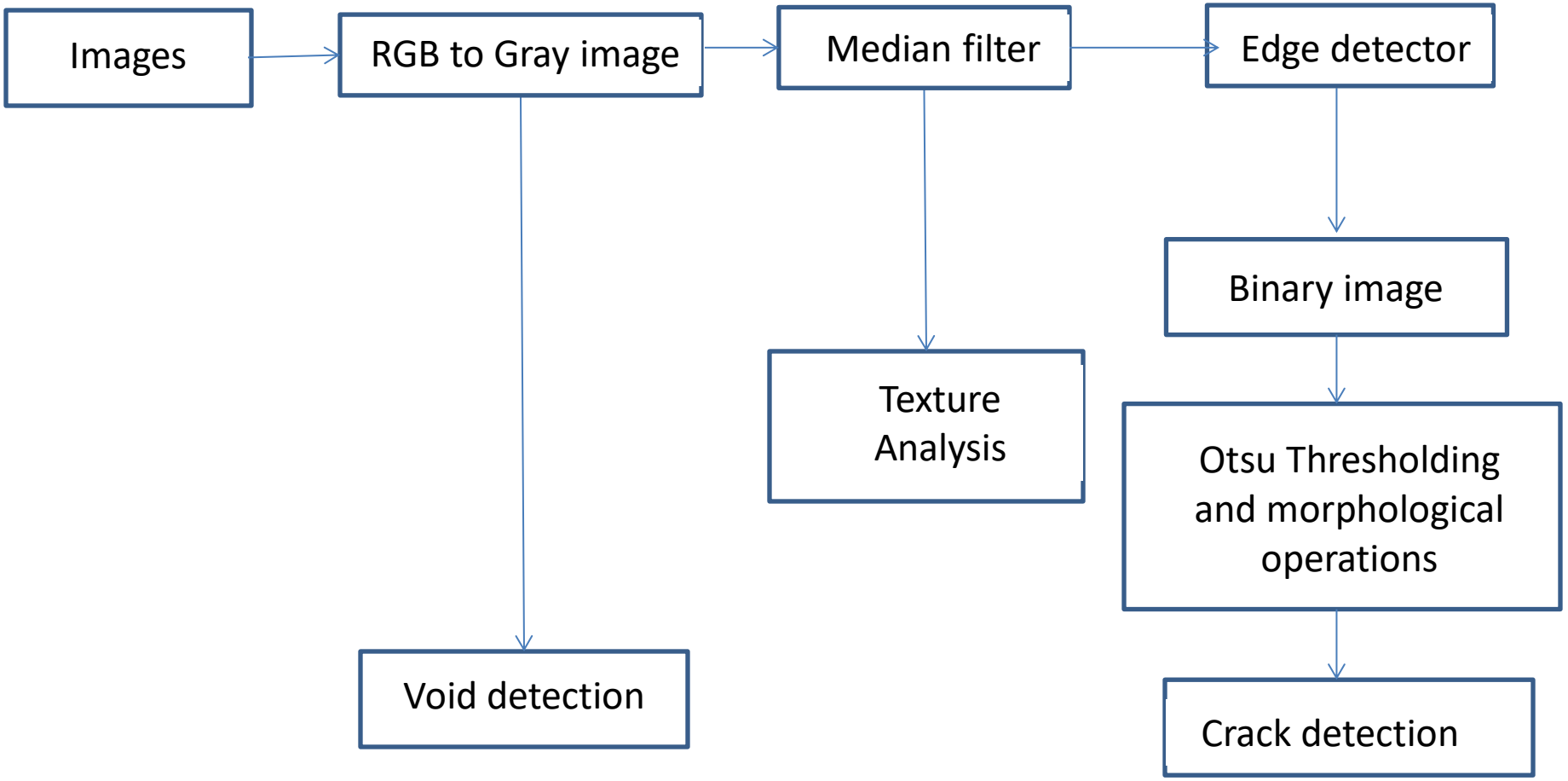


Fig 3: proposed methodology

Principle

The block diagram shows the architecture for crack detection based on the image processing. The steps in the image processing technique are as follows:

(1) initially collect the image of the structure which will be subjected to the crack detection process using the camera or any sources.

(2) After the image acquisition, the collected images are pre-processed within which the methodologies like segmentation are done there by making it an efficient one for the image processing procedure.

(3) In the image processing, some of the techniques are employed to process the deducted image sample.

(4) The crack detection will be noticed here on the structure using the result of the processed image.

(5) Crack feature extraction is the step in which the detected cracks are separated based on the width, depth and the direction of propagation of the crack.

Technology Used

- MATLAB Image processing tool box
- MicroSD memory card
- Card reader
- Ultrasonic sensors
- PIC Camera
- Quadcopter

Simulation Results and Analysis

Image Stitching

- It is not possible to capture the whole structure, say a complete wall, in a single image. Hence, **sections of the wall are captured separately**.
- But in order to examine the damage the complete picture is required. Therefore, image stitching has to be performed.
- Image stitching involves the **boundary pixels to be matched and weaved together.**

Image Stitching

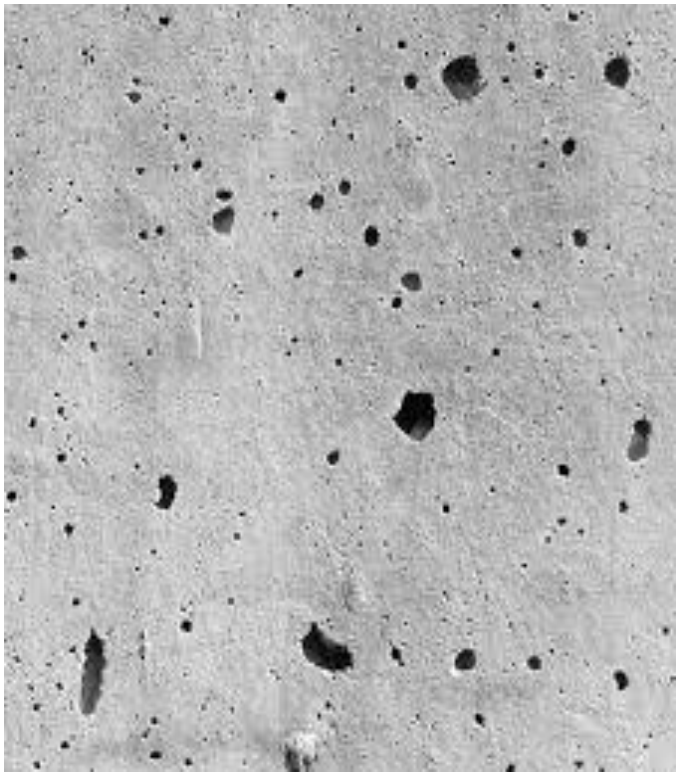
Fig : Images captured by UAV

Fig | Stitched image

Fig 4: Image Stitching

1.Void detection

We use region props in MATLAB to find surface area, centroid, diameter, length etc., to analyze these voids.



Original image

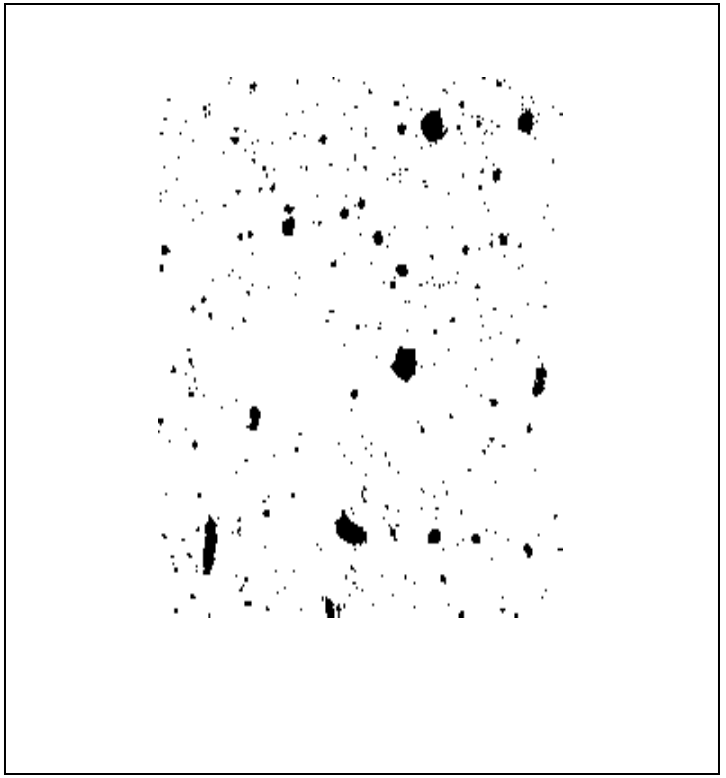


Image after Thresholding

Fig 5: Void Detection

2.Crack detection

- Sobel edge detector is used to detect the edges in the images.
- The edge detection uses convolution products of sobel kernels and the image to estimate the magnitude or approximate strength of the edge and its direction of orientation calculated using the following equations.

$$\sqrt{G_x^2 + G_y^2}$$

$$\arctan\left(\frac{G_y}{G_x}\right)$$

-1	0	1
-2	0	2
-1	0	1

Horizontal

-1	-2	-1
0	0	0
-1	-2	-1

Vertical

Fig 6 kernels used in Sobel- Feldman filters

2.Crack detection

Fig 7: Original image

Fig 8: Crack is detected

Fig 9: Original image

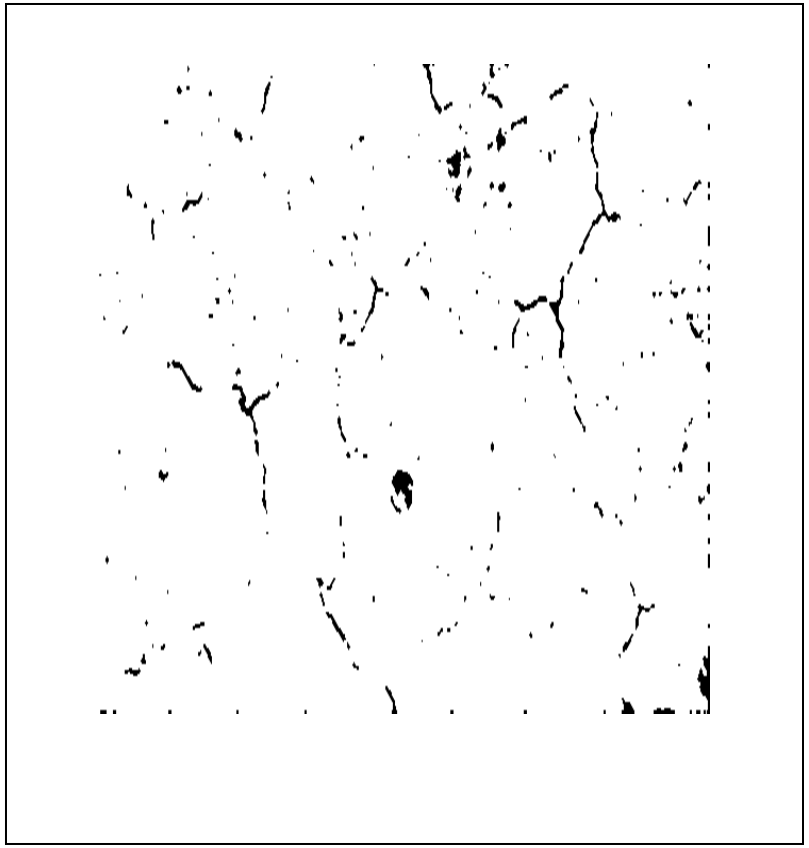


Fig 10: Micro thin cracks detected

3.Texture analysis

Fig 11: Original image

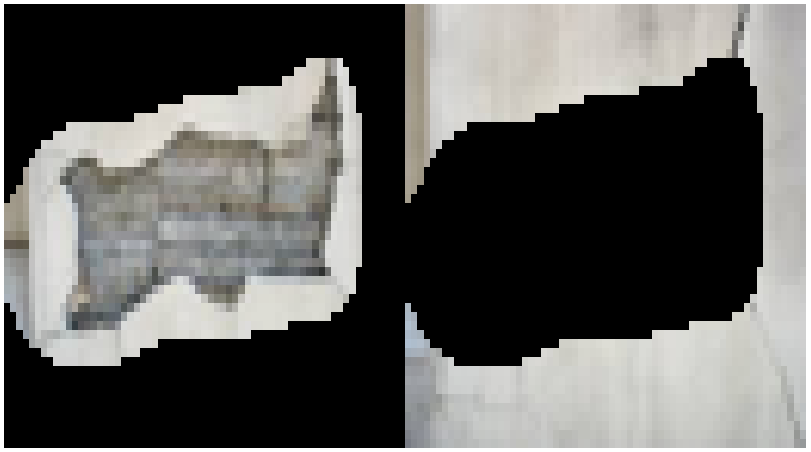


Fig 12: The textures are separated

Results

- The described algorithm was tested on MATLAB 2017a and the following results on the dataset were obtained.

Fig 13: Sample image of crack

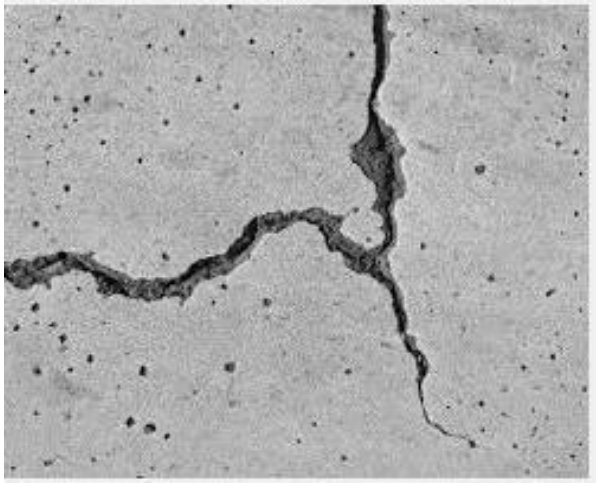


Fig 14: Application of Median Filter

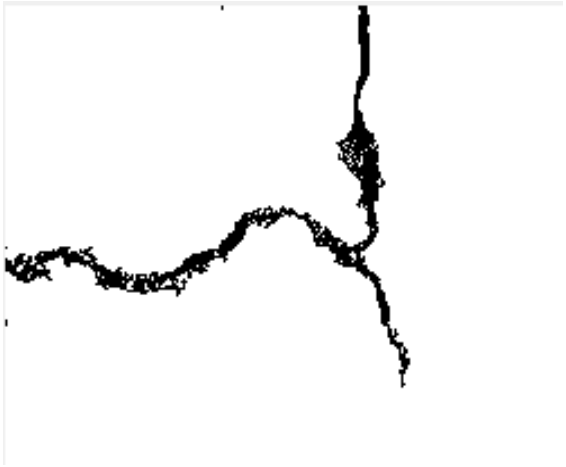


Fig 16: SOBEL filter for sharpening

Fig 16: Otsu thresholding and Binarization

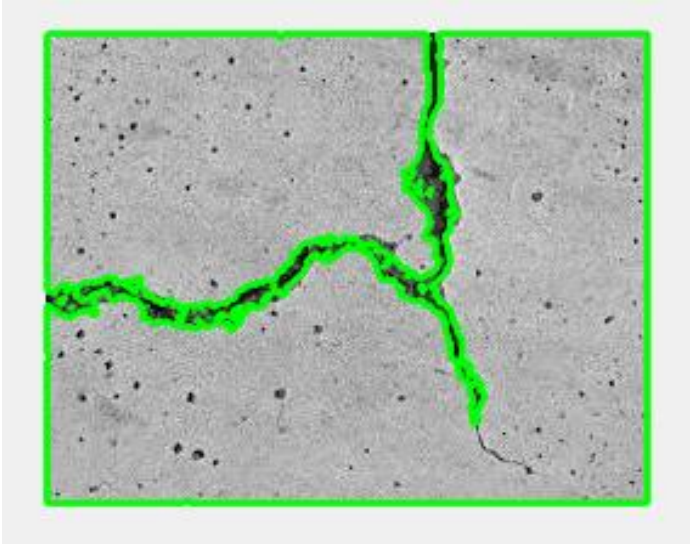


Fig 17: Outlining of the crack (Detection)

Conclusion

- Further we intend to measure the length of the crack to get detailed analysis.
- Using convolutional network will allow deep learning in these images.
- Machine learning can be used for setting the threshold value.
- This technique not only works for concrete structures but also for walls made out of brick and mud, hence offering a low cost rural solution.

Future Scope and Applications

- This proposed method of detection and analysis of the cracks on concrete walls using image processing techniques is useful. in the unreachable regions of the building, exteriors, in the interiors of chimney etc,.
- If these cracks are neglected, then it leads to weakening of the structure. Hence, it should be detected and treated at the earliest.
- This can further be extended by determining the time period up to which the structure can withstand the cracks, and if it requires immediate repair by looking at the condition of it.

Fig 18. A crack in the chimney liner may be caused by several reasons such as improper construction of the chimney, use of cheap and low quality material for construction etc.,

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THANK YOU