Image Analysis of Concrete to Detect the Potential of a Sequential Rift

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Abstract. Concrete cracks in the construction world is a common phenomenon that occurs in all types of concrete structures. Due to our ignorance of damage to concrete structures, small cracks are often ignored. In fact, a small crack can cause a big disaster. Therefore, early detection of cracks in concrete itself is very important that is expected to minimize the disaster caused. In detecting cracks of the concretesurface,a structure is done by several methods. The purpose of this research is to detect the potential of cracking on the surface of the concrete image with sequential digital image processing. In this research, crack detection is applied to the concrete surface of concrete test result done by applying grayscale function, noise filter, edge detection, threshold, followed by comparing the sequential image with image subtract method. Based on the research data, the methods applied are able to detect the potential of crack in the sequential image with the percentage of the result of True Positive Rate equal to 76.2% and False Negative Rate of 23.8%. The applied methods can be used as one of the approaches to detect the potential of cracking on the surface of concrete images in concrete press concrete sequentially.

1 INTRODUCTION

In the construction world, concrete is a composite building material made from a combination of aggregates and cement binders. In a concrete structure, cracking is one of the serious problems (Nishikawa, 2012). Although cracks are on the surface, it is difficult to be visually detected if the crack is small (Broberg, 2013). Each crack model will result in damage and failure of various models on concrete structures (Litorowitz, 2006). Each concrete structure will surely have a crack, which needs to be noticed is whether the crack can be tolerated and is not at risk or cracks that harm the overall structure of the building or not. Some of the techniques used to check for cracks in concrete include electron microscope scanners, fluorescent optical microscopes. Percolation technique based on liquid-based infiltration phenomena is based on image processing (Yamaguchi, 2010). In recent years, Micro-Computed X-ray Tomography (Micro-CT) has emerged as a characterization tool because of its ability to provide non-destructive three-dimensional high-resolution images (Yu, 2016).

In this study, in detecting the potential of sequential rupture, the authors applied a method based on previous research on digital image processing to detect cracks, then using subtract image method to detect the potential of the crack.

2 MATERIAL AND METHOD

The implementation of the research begins by identifying the problem and establishing the research objectives. In the Research Design the Median Filter method, Sobel edge, Otsu Threshold, Filter Area, and Image Subtract Method are used. The observed crack is a crack image that occurs on the specimen when loaded by a compressive test machine. The observed variables are image changes that occur from the image comparison results during the test.

Sample data collection is done based on the problem solved. The calculation of the sample data test is required to obtain the performance results of the applied method and draw conclusions.

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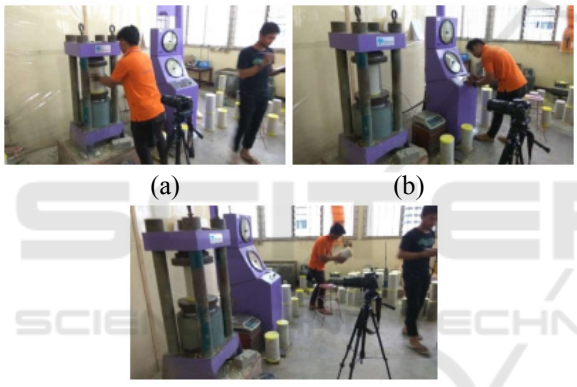
2.1 Data Collection Process

The sample of concrete surface observed was cylindrical concrete with diameter 15 cm, height 30 cm with concrete quality FC 41,5 (500 Kg / cm2). FC 37.35 (450 Kg / cm2), FC 33.2 (400 Kg / cm2), FC 29.05 (350 Kg / cm2) which is the material available at the time of the study.

The data taken is the concrete surface image of the compressive test, using Canon 60D DSLR Camera with auto mode, equipped with external tripod and shutter by sampling 1 frame in 2 seconds. Data collection is done in the morning until the afternoon from 10:00 to 15:00 pm in a laboratory room with sunny weather conditions. The data taken is expected to be static for each frame. The distance between the camera and the test object is about 1 meter with sufficient lighting levels. The data collection process is shown in Figure 1.



(a) (b)

(c)

Figure 1: Data collection process (a) Thespecimen put into the test machine, (b) The process of loading the load onto the specimen, (c) The process of retrieving the image of the specimen.

2.2 Data Processing

Conducted data entry in the form of image t_0 and image $t_1$arethen processed through Processing Citra with the application of functions and methods used for data processing. Performingcomparison of pixels per pixel between image t_{+1} with image t, to find any change in both images with a predetermined threshold is done. If there is no change then re-infiltrated is conducted until the final image, or until the image changes above the specified threshold. Then the changed image is saved and displayed. The Data Processing Process can be illustrated through the workflow diagram in Figure 2.

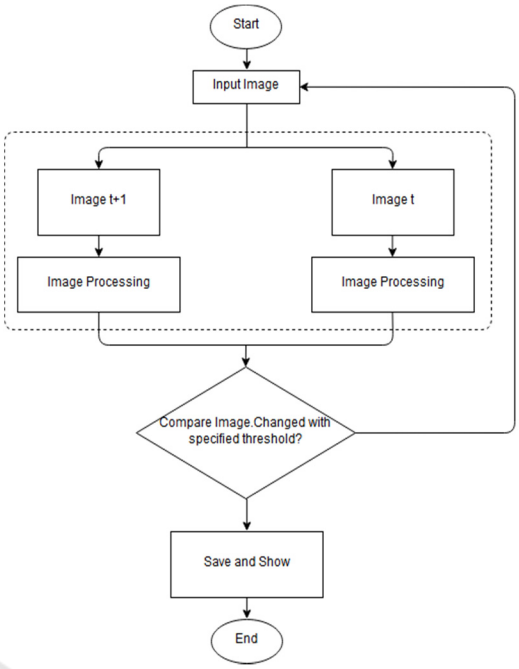


Figure 2: Diagram of the stage of data processing.

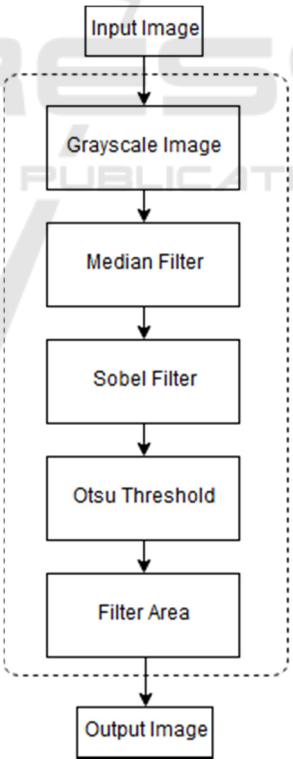


Figure 3: Diagram of image processing.

2.3 Image Processing

From Sattar's research (Sattar,2016), in his Processing method it is seen that the input image in cropping or image cropping process at certain coordinate is considered as a workarea and then converted into a grayscale image, then re-processed by noise filter that is by Median Filter method to reduce noise on the image; then processed again for edge detection using Sobel Filter, continued to Otsu Thresholding with Filter Area. Image Processing Process Diagram is shown in Figure 3.

2.4 Input Image

The input image is a digital image of a concrete surface photo with a color image kernel (RGB) in JPEG format with dimensions of 5184 x 3456 pixels. The input image is shown in Figure 4.

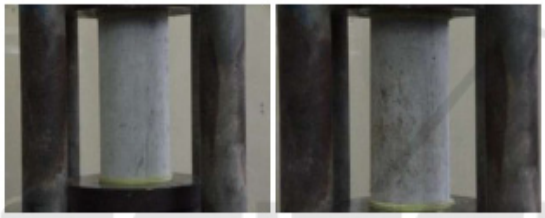


Figure 4: Input Image.

2.5 Grayscale Image

A grayscale image is a process done on a digital image to change the original color of the image into gray color. Input image in the form of the digital image has 3 colors in each pixel: Red, Green, and Blue, each with a different value. An illustration of the RGB pixel values in the input image is shown in Figure 5 and Figure 6.

Figure 5: The RGB value of the input image.

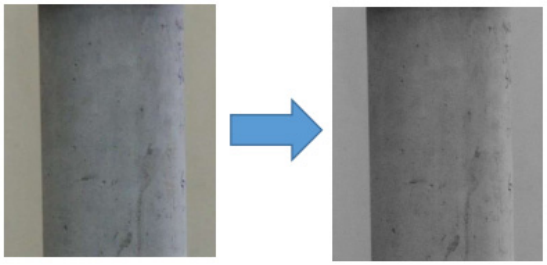


Figure 6: Grayscale changes in the input image.

2.6 Otsu Threshold

The next step is to determine the threshold using this Otsu method. The Otsu method divides the image into two groups, namely: target pixels and background pixels (Sattar,2016 and Huang, 2015). This method selects a threshold value based on the minimization of intra-class variants (the variants in the class). Minimizing intra-class variants is the same as maximizing inter-class variants (Otsu 1979).

2.7 Measurement Parameters

The measurement of the performance results of the method uses two parameters. The first parameter is the True Positive Rate, i.e., the ratio of the number of data features successfully detected, exactly divided by the total number of sample data tested. The second parameter is the False Negative Rate, which is the ratio of the amount of data that is wrong or failed to be detected by the total number of sample data tested. Performance measurement results of this method will be the conclusion of how the success rate of the system is applied in research.

3 RESULTS AND DISCUSSION

The data used as the test sample are the drawings of 21 cylindrical concrete with the quality of FC 41.5, FC 37.35, FC 33.2, FC 29.05 obtained from laboratory tests taken sequentially with digital cameras.Each concrete data has 15 or more images taken in sequential. Before the image comparison process is done, the sample data is a cropping process or image cutting process at a certain coordinate which is considered as a work area; then proceeded to the image processing consisting of grayscale process on the original image, filtering on the grayscale image by using a median filter, edge detection using Sobel and Otsuthreshold and filter area to sample data shown in figure 7.

The test is performed on 21 test data, wherein each test data has a sequential image data image where objects with the number of an area less than 700 pixels are detected, considered as noise, then the objects are removed. The value of the first test result is obtained, considered an image that has the potential to crack.

Table 1 and Table 2 show the test results of some concrete by comparing the image after the image before sequentially using the subtract image method and the addition of the area filter function.

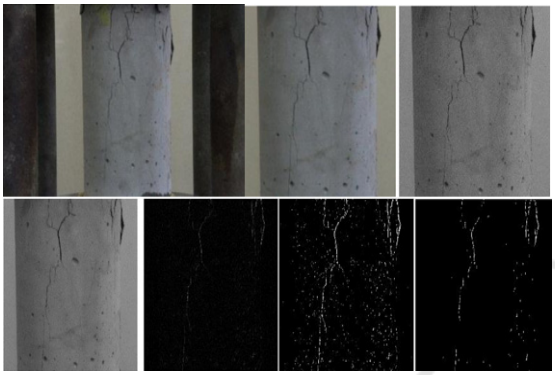


Figure 7: Results Process Image Processing(a) the original image, (b) cropping the image for the work area, (c) the grayscale image, (d) the image of the median filter, (e) the filter result image, (f) the Otsu threshold image, (g) filter area results.

Table 1: Results of concrete testing 1.

Concrete	Time	Number of Pixels	Image Subtract	Testing with area filter> 700
Con crete 1	t0	887	-	0
	t1	1103	1631	0
	t2	971	1395	0
	t3	1816	2751	0
	t4	983	867	0
	t5	1115	1576	0
	t6	1116	1607	0
	t7	1106	1470	0
	t8	898	1127	0
	t9	1020	1413	0
	t10	754	1000	0
	t11	875	1209	0
	t12	1672	2867	1299
	t13	1436	1053	0
	t14	1270	1190	0

Table 2: Results of concrete testing 4.

Concrete	Time	Number of Pixels	Image Subtract	Testing with area filter> 700
Con crete 4	t0	2152	-	0
	t1	3154	5258	0
	t2	3400	5352	0
	t3	2964	4413	0
	t4	2973	5159	0
	t5	2913	4730	0
	t6	2447	4081	0
	t7	2897	5230	0
	t8	31421	64865	45068
	t9	40358	64307	18133
	t10	32173	44134	2522
	t11	33265	50945	8938
	t12	40813	59743	7734
	t13	38260	51123	2385
	t14	38299	54510	6793
	t15	27825	39672	0

Table 3: Concrete Test Result.

Concrete	Total Image	Test Result	Description
1	15	True	
2	15	True	
3	15	False	The system does not detect any cracks, but cracks are seen in the image t=13
4	16	True	
5	16	True	
6	16	True	
7	16	False	The system detects a crack in the image t=5, but no visible cracks
8	16	True	
9	18	True	
10	17	False	
11	18	True	
12	18	False	The system detects a crack in the image t = 8, but the crack is seen in the image t = 6
13	15	False	The system does not detect any cracks, but the crack is seen in the image t = 12
14	15	True	
15	18	True	
16	18	True	
17	18	True	
18	15	True	
19	18	True	
20	18	True	
21	18	True	

Based on Table 3 of the test results on 21 concrete, the results show the success of the succession shown in Table 4

Table 4: Percent of Success.

Amount of sample data	Number of Testing True	True Positive	False Negative
21	16	76,2 %	23,8 %

From Table 4 based on the test data taken, the result of the applied method is the ability to detect precisely the potential of cracking in sequential image with the percentage of result of True Positive Rate equal to 76,2% and False Negative Rate equal to 23,8%, where from 21 concrete tested, the number of tests considered correct is 16 concrete.

4 CONCLUSION

From the research results obtained, the conclusionsare as follows:

1. Methods in the research can be used as a potential approach to the detection of cracks in the image data sequentially concrete compression test results.
2. From the research data, the applied method resulted in a True Positive Rate is 76.2% and from the 21 concrete tested, the correct test amount is 16 concrete.
3. The method used can be applied to research data with good image quality, adequate lighting and static image of each frame of data retrieval during research.
4. The success rate of detection depends on the image capture process, as well as the quality of the test image. The image quality and illumination of the bad image will influence the research result.

REFERENCES

B Yu, R S Bradley, C Soutis, and P J Withers, 2016. A comparison of different approaches for imaging cracks in composites by X-ray microtomography, in *Royal Society Publishing,*

Broberg P, 2013. Surface crack detection in welds using thermography, in *NDT&E International, vol. 57, pp.69-73*.

Dorafshan Sattar , Maguire Marc , and Qi Xiaojun, 2016, Automatic Surface Crack Detection in Concrete Structures Using OTSU Thresholding and Morphological Operations, in *CEE Faculty Publications*.

EkaDodiSuryanto, 2015, EkstraksiFiturHaralickMenggunakan Citra Mikroskop Digital TrinocularUntuk Proses IdentifikasiCacingPenyakit Kaki Gajah, in *TeknikElektro, FakultasTeknik, Universitas Sumatera Utara*.

Litorowicz A, 2006, Identification and quantification of cracks in concrete by optical fluorescent microscopy, in *Cement and Concrete Research, vol. 36, pp. 1508-1515*

Nishikawa T, J Yoshida, T Sugiyama, and Y Fujino, 2012. Concrete Crack Detection by Multiple Sequential Image Filtering, in *Computer-Aided Civil and Infrastructure Engineering, vol. 27, pp. 29-47.*

Sony NuryadinSyarifuddin, 2006, Analisis Filtering Citra DenganMetode Mean Filter dan Median Filter, in *JurusanTeknikInformatika, FakultasTeknikdan IlmuKomputer, UniversitasKomputer Indonesia,*.

Yamaguchi Tomoyuki and Shuji Hashimoto, 2010, Fast crack detection method for large-size concrete surface images using percolation-based image processing, in *Machine Vision and Applications, pp. 797 809*.

Zhangcan Huang, Fan Xi, Liu HaiMing A.M.A. Talab, 2015, Detection crack in the image using Otsu method and multiple filtering in image processing techniques, in *Optik - Int. J. Light Electron Opt*.