CRACK DETECTION AND ANALYSIS IN BULIDINGS USING IMAGE PROCESSING ALGORITHM

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1.INTRODUCTION

In recent days there are many structural accidents happens in schools, bridges, dams etc., due to fathomless rainfall, floods, earthquakes or construction problems, the crack occurs in buildings. Sometimes it leads to numerous death of human resources. The need of good security is one of the key aspects in day to day life and people needs a system which is very safer. To prevent these accidents we have proposed a method called Crack detection and analysis in buildings using image processing algorithm.

During inspection and monitoring of huge and tall infrastructures have an inaccessible area and limitation due to its geometry. Hence by detecting the cracks using image processing algorithms like Triangulation method. we can measure the location, length, area and width of the crack. So that the earlier prevention of damages can be made. This project is very helpful to the society to prevent hazards in buildings caused by natural disasters, stress and cyclic loading.

2.OBJECTIVE

The main objective of this project is to understand current techniques that are used for crack detection and investigate by using Image processing technique. To analyse and verify the crack by image processing algorithm in bulidings using matlab. To identify the exact location and measure the require measurements.

3.LITERATURE SURVEY

3.1.THE IMPROVEMENT OF CRACK PROPOGATION MODELLING IN TRIANGULAR 2D STRUCTURES USING THE

EXTENDED FINITE ELEMENT METHOD

Jun-Wei Chen, Xiao-Ping Zhou, 3 AUGUST 2018

This system uses extended finite element method to the improvement of crack propogation, a novel geometric method combined with the piecewise linear function to determine the crack tip element and crack surface element. In addition, the triangular mesh is employed in the numerical model when we implement the XFEM. The crack separates the mesh into two parts in a proper range of the mesh. The location of the crack tips must be obtained to determine the nodes that are enriched by the crack tip enrichment. Hence, it can be easily promoted to all the 2D approaches that need to describe the crack. Therefore, the proposed mesh technique can still be an effective way to establish the complicated mesh or to create the microstructure for other works in the future studies.

3.2.DETECTION OF PRECAST CONCRETE BEAM DEFECTS USING FINITE-DIFFERENCE TIME DOMAIN MODELLING

Hui Lin Ng, Mazlan Hashim, Siow Wei Jaw

The large number of death toll and huge financial and economic loss alerted the world about the importance of building structural health assessment. Although the use of precast concrete beam is gaining its popularity in building and construction industry, there are lacks of publication focusing on defects detection of precast concrete beam with GPR. Therefore, this study is conducted to test the capability of 2 GHz high frequency GPR antenna in monitoring the inner structure and detecting defects in precast concrete beam. In this study, FDTD approach was employed to simulate the GPR responses of precast concrete beams without and with defect. Apart from structural health assessment, results obtained from FDTD simulation can be used for differentiation and identification of types of structure defect, including cracks and void. However, interpretational problems such as effects of the antenna coupling may occur, especially in near-surface surveying. Therefore, additional information can be obtained and extracted with FDTD numerical modelling.

3.3.REVIEW AND ANALYSIS OF CRACK DETECTION AND CLASSIFICATION

TECHNIQUES BASED ON CRACK TYPES

SheerinSitara.N,Kavitha.S,Raghuraman .G, International journal of Applied EngineeringResearch(2018)

cracks are very common in building, bridge, road, pavement, railway track. Therefore, automatic crack detection and classification techniques for civil infrastructure are essential.Crack is a complete or incomplete separation of concrete into two or more parts, produced by breaking or fracturing. In this paper, that issue has been addressed with analysis along with partial implementation. This paper is organized into three sections such as crack detection and crack classification techniques based on crack types, implementation of existing system and design of proposed system. Then for crack detection, thresholding, morphological operation and canny edge detection are used. For crack detection, Stereo triangulation technique, least square method, optical flow analysis methods are applied. Most of the existing system uses Otsu's thresholding based method because of its global automatic thresholding principle. Otsu's method is used to detect the crack because it is based on class-invariance principle. The results have to be analyzed using appropriate quantitative metrics of crack detection and classification.

4. A COST-EFFECETIVE METHOD FOR CRACK DETECTION AND MEASUREMENT ON CONCRETE SURFACE.

M.M.Sarkera,T.A.Alib,A.Abdelfatahb, S.Yehiab,A.ElaksherC, NOVEMBER 2017

The detection and measurement of cracks on concrete structures has been of significant interest in recent years. This study aimed at evaluating the feasibility of the new inexpensive depth camera (ZED) for crack detection and measurement. In this method, the width is measured by the brightness of the crack area. Furthermore, stereo vision systems have been implemented to recognise simple building elements, such as beams and columns. Colour and 3D data acquired from stereo vision cameras have demonstrated the potential for detecting and evaluating the nature of structural elements in buildings, especially in high noise and cluttered environments. In addition to that, results obtained by the proposed procedures will be compared to the outcomes of some other NDT techniques, such as Ground Penetrating (GPR).

3.5.DETECTION OF CRACKS IN CONCRETE STRUCTURE USING MICROWAVE IMAGING TECHNIQUE

E.A.Jiya, N.S.N.Anwar, and M.Z.Abdullah, 11 MAY

In this paper, they present the results using the proposed technique for cement based bricks. A total of 16 antennas were mounted surrounding the material producing a fullview configuration. This was achieved by experimentally assessing the performance of the P-Shaped wide-slot antenna as a sensor for cement based application determining the suitable frequency range that gives better signal penetration depth through the brick structure and modeling of the time domain propagation of UWB pulses using the finite difference time domain (FDTD) method.The main aim of using FDTD model is to be able to test and to also verify the capability of the imaging modality in detecting and differentiating cracks of different orientation and sizes from a brick and the constructed structure.

4.FUNCTIONAL BLOCKDIAGRAM

4.1 PROPOSED SYSTEM

The cracked image is given as a input and it is divided into number of blocks. The block wise features were extracted based on mean and standard deviation of the block. Similary for the sample image is divided into blocks. Mean and standard deviation features were extracted from the blocks. The extracted features of plain image and the cracked image is compared. The region which is differ from the plain image were labelled as cracks region while the other regions were labelled as normal regions. If the particular block is detected as crack then the pixels within the particular block were converted to one. The pixels in the non-crack regions were converted into zero. Then the binary image is triangulated to analyse the crack region. The crack are labelled based on the propagation path of the crack present in the image. Finally the parameters of the crack is measured. This method is useful to overcome some of the identified limitations, performs faster than other existing methods, capable of identifying the presence of multiple cracks in a given image, identifying the type of each detected crack, and assigning it a severitylevel.

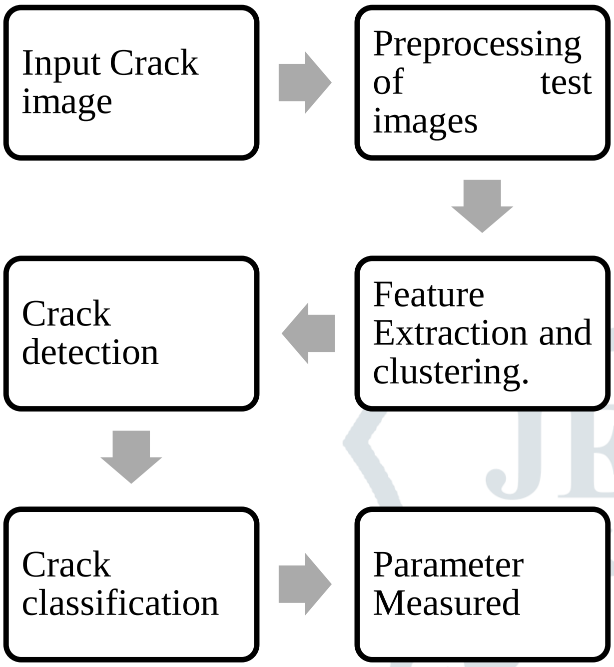
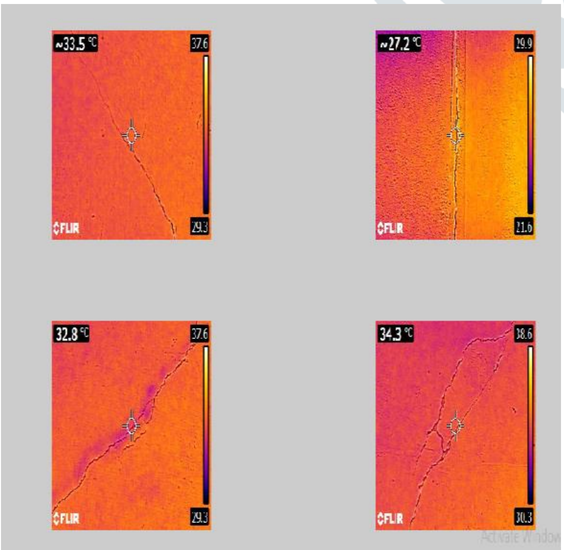


Figure 4.1 Block Diagram of Automatic crack detection and characterization

4.1.1 DATA SAMPLES



4.2 FLOW CHART

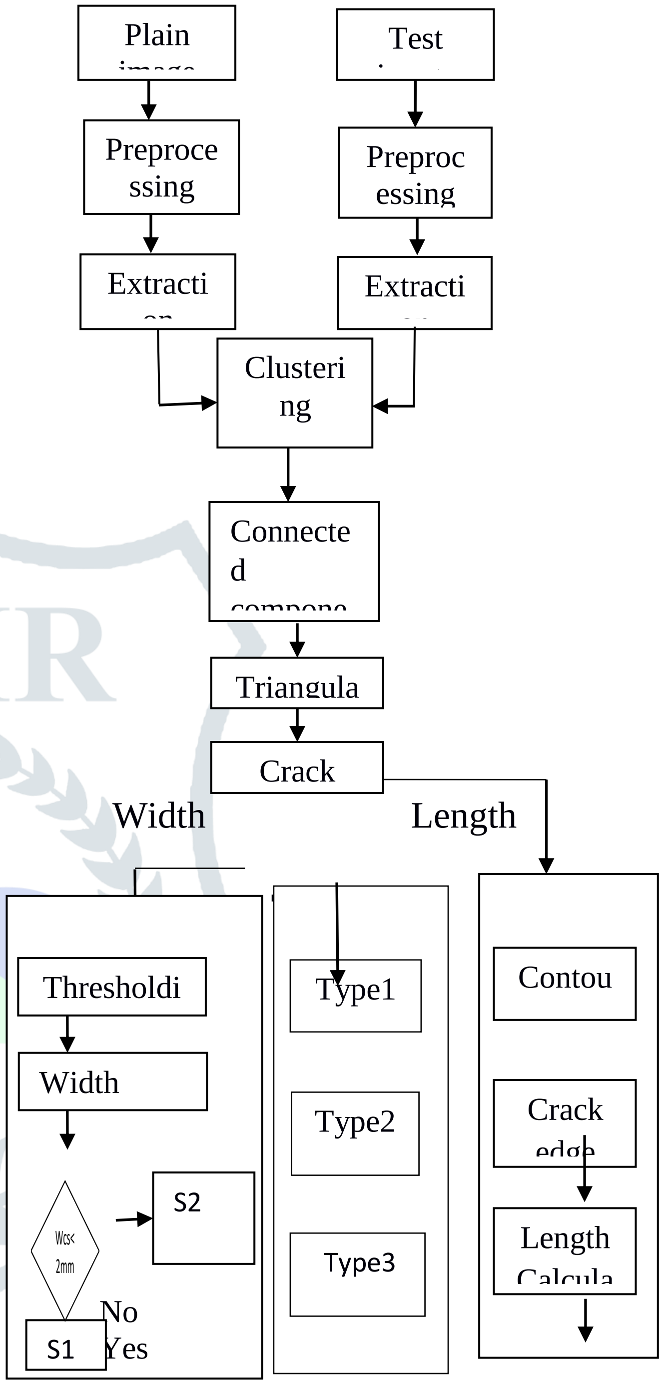


Figure 4.3 Flow Diagram of Crack Detection

Crack Types

1. Longitudinal
2. Miscellanous
3. Transversal

4.3 PREPROCESSING

The crack images have higher pixel value in crack parts than other non crack parts. But sometimes it have higher pixel value in non crack region.This occurs because of reflection. To reduce this average of image pixels is generated and it taken as threshold value(0.4,0.39). Pixels which have higher value than this threshold value, are replaced by threshold value. This process is called pixel saturation. To reduce non uniform background illumination, image enhancement is necessary. To achieve this normalization method is used.

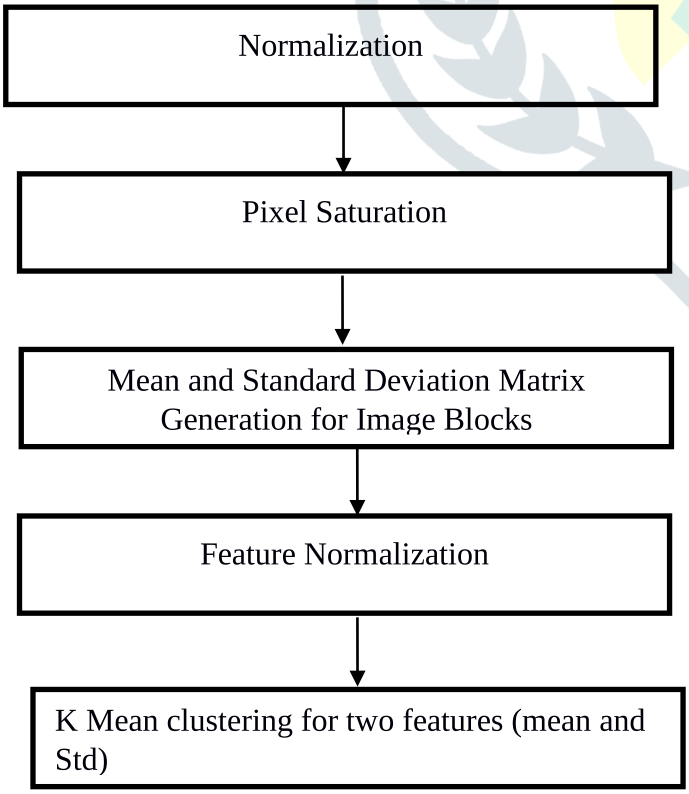


Figure 4.4 Preprocessing and Feature extraction of road images

4.4 LABELING

Crack image of the bulidings is taken using thermal camera. Image is then resized. The plain images(Without crack) were initially divided into blocks of specific size(32*32,64*64). Using formulae for mean and standard deviation, feature(mean and standard deviation)matrices are generated. Similarly the crack image is given as an input. Then it is divided into blocks of specific size(32*32,64*64). Using formulae for mean and standard deviation, feature(mean and standard deviation)matrices are generated. Then the condition for the crack and non crack is checked and based on that cracks regions are converted into one and the other regions were converted into zeroes and then these preliminary binary matrices are combined into single binary matrix. Using connected component algorithm, the longest connected component is identified. Based on that values, images are labelled as Transversal, Longitudinal and Miscellaneous cracks.

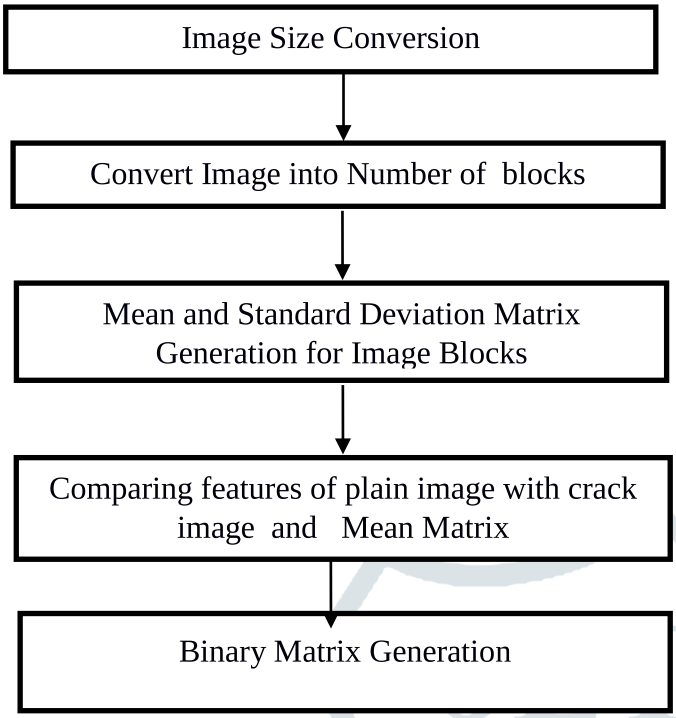


Figure 4.5 Preliminary Labelling of Plain road images

Formulae used here are,

Mean for two dimensional array or image:

$$({}^{1}/{}_{mn})\sum_{i,j=1}^{n} x_{ij}$$

Standard deviation for two dimensinonal array or image :

$$({}^{1}/{}_{mn})\sum_{i,j=1}^{n}((x_{ij} - Mean)^2)^{\frac{1}{2}}$$

4.5 FEATURE EXTRACTION

Crack images are seperated into image blocks. Feature normalization is done for each blocks. For normalized blocks, the mean and the standard deviation values are calculated. Then Kmean clustering algorithm is applied for mean and standard deviation of both images. All the measurements (mean and standard deviation of gray level values within a block) for each image compose a pattern vector **x** and y.

4.6 K MEANS CLUSTERING:

k-means clustering is a partitioning method. The function k-means partitions data into k mutually exclusive clusters, and returns the index of the cluster to which it has assigned each observation. Unlike hierarchical clustering, k-means clustering operates on actual observations (rather than the larger set of dissimilarity measures), and creates a single level of clusters. k-means clustering is often more suitable than hierarchical clustering for large amounts of data. K-means treats each observation in your data as an object having a location in space. It finds a partition in which objects within each cluster are as close to each other as possible, and as far from objects in other clusters as possible. Each cluster in the partition is defined by its member objects and by its centroid, or center. The centroid for each cluster is the point to which the sum of distances from all objects in that cluster is minimized. K-means computes cluster centroids differently for each distance measure, to minimize the sum with respect to the measure that you specify. K-means uses an iterative algorithm that minimizes the sum of distances from each object to its cluster centroid, over all clusters. This algorithm moves objects between clusters until the sum cannot be decreased further. The result is a set of clusters that are as compact and well-separated as possible. You can control the details of the minimization using several optional input parameters to k-means, including ones for the initial values of the cluster centroids, and for the maximum number of iterations.

4.7 CONNECTED COMPONENT ALGORITHM

Connected component algorithm is a fast and very simple method to implement and understand. Once the pixel of a connected component of the crack tip is found, all the connected pixels of the crack can be labelled. Each connected component is defined by assigning an existing domain and converted into blocks. This block is used in composite models. It contains declarations of member components including composite component. Function setup begins and this section relates inputs, outputs, and variables. It can also be used for validating parameters, computing derived parameters, and setting initial conditions.

4.8 CRACK DETECTION

The calculated features were clustered and the cluster centroids were identified. Using subtraction of standarad deviation matrix of database image from query image standard deviation matrix, the crack region is identified and using contouring the boundary of crack region is seperated from no crack region.

4.9 SEVERITY LEVEL ASSIGNMENT

For severity level assignment ,otsu's gray thresholding method is used.Two threshold values are taken (i.e. threshold1 and threshold2) from plain road image crack blocks and test image crack blocks. The values are compared. If check the condition threshold1<threshold2, threshold1 is selected as threshold else threshold2 is selected as threshold. Then

this threshold is applied to test image and binary image is obtained and the connected components are identified. Then the short crack pixels are removed. Next, using skeleton method the skeleton image of cracks is computed.

4.10 CRACK CLASSIFICATION

The cracks were classified based in the distance and width of the detected crack region. Different types of cracks has different distance and the width and based on that the conditions were checked and the types of crack is determined.

- Longitudinal crack
- Transversal crack
- Miscellanous crack

Cracking is a series of interconnected cracks in an asphalt layer forming a pattern, which resembles. The cracks indicate fatigue failure of the asphalt layer generally caused by repeated traffic loadings and this distress allows water to penetrate the surfacing materials and subgrade, which furthers the damage.

4.11 TRIANGULATION

Triangulation is a powerful technique that facilitate validation of data through cross verification from two or more sources. It tests the consistency of findings obtained through different instruments and increases the chance to control, or at least assess, some of the threats or multiple cause influencing our results.

Triangulatio is a set of lines connecting each point to its natural neighbors. A triangulation with the edges constrained to include the boundary of the polygon and the edges of the openings.This process requires the intersection of two known rays in space and is commonly known as triangulation. This will create a triangulation that includes the openings,so you cn then select only those triangles that are inside the bounded region. The properties associated with the trianggulation provided a basics for solving a variety of geometric problems.

5.OUTCOMES

5.1 SAMPLE DATASET

Sample dataset of thermal image of crack detection are show in the figure 5.1

5.2 INPUT THERMAL IMAGE

The thermal image is given as the input. Then it is converted into grey scale image as shown in figure 5.1. The reason for converting is to change the colour image into gray scale for clear identification.

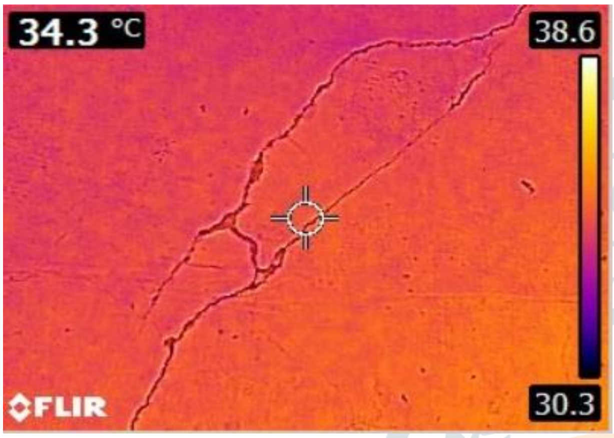


Figure5.1 Input sample images

5.3 BINARY IMAGE

This step converts an input gray scale image to a binary image where the values of a points expressed by 0(black) or 1(white). Both cracks and non-negligible noises can be assigned to the values 1.

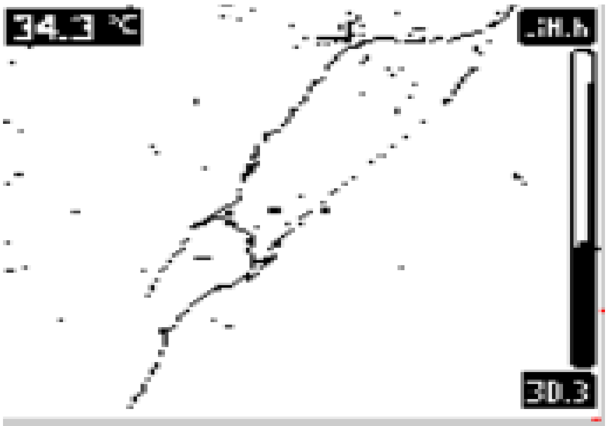


Figure5.2 Binary image

5.4 TRIANGULATED BINARY IMAGE

This step convert binary image into triangulated image .This step seperated image into number of triangles.

Figure5.3 Triangulated image

5.4 SKELETON IMAGE

The skeleton image for crack image is generated. By dividing number of white pixels in binary test image by number of white pixels in skeleton image, the width of crack is identified.

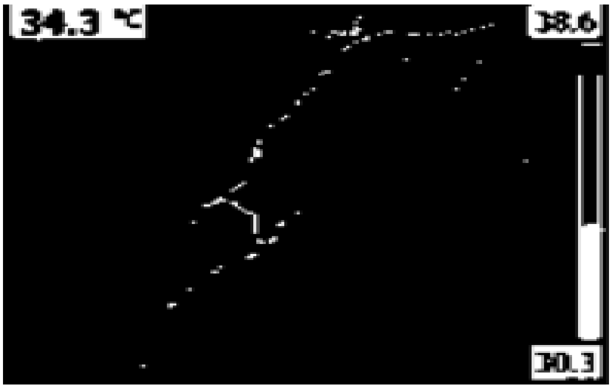


Figure5.4 Skeleton image

Dataset 1

Dataset 1 is a transversal crack that is identified using image processing algorithm and triangulation algorithm that provides binary image,triangulated binary image and skeleton image shown in figure 4.6. Measured length and width are tabulated in Table 4.1.

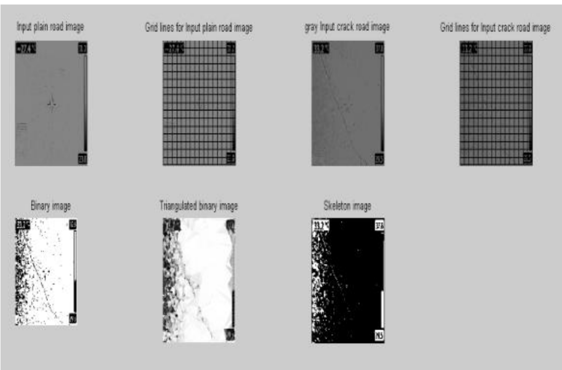


Figure 4.6

Data set	Length(m)	Width(mm)	Type	Temperature
S2	1.0917	1.9451	Transversal	33.2°C

Table 4.2

Dataset 2

Dataset 2 is a miscellaneous crack that is identified using image processing algorithm and triangulation algorithm that provides binary image,triangulated binary image and skeleton image shown in figure 4.7. Measured length and width are tabulated in Table 4.2.

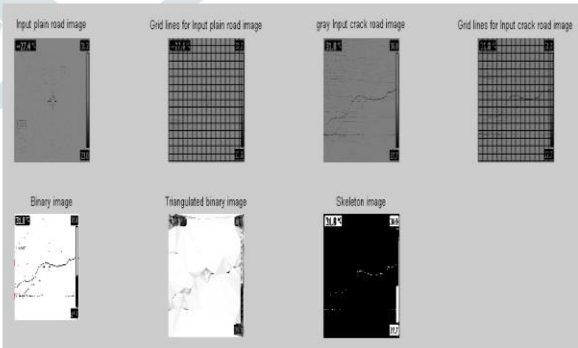


Figure 4.7

Dataset	Length(m)	Width(mm)	Type	Temperature
S3	7.568	1.9076	Miscella	31.8°C

	5		neous	

Table 4.3

6.CONCLUSION AND FUTURE WORK

6.1 CONCLUSION

In order to evaluate the saftey of a concrete structure, a method to detect the cracks from camera image. First, it is possible to visualize the concrete crack easily through the image processing techniques such as filtering and segmentation method and morphological process. Second, the existence of cracks in many images could be automatically identified. Then the cracks are distinguished as longitudinal, latitudinal and miscellanous crack and then the cracks is identified with the length and width. The various optimization methods can be applied to determine optimal parameters required in the image processing. It is important in the visualization of crack and acquisition of the exact crack information.

6.2 FUTURE WORK

This project can be implemented using different algorithms which will facilitate rapid, cost efficient and reliable condition assessment of existing infrastructure to ensure public safety.

7.REFERENCES

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