Study On Crack Detection Using Image Processing Techniques And Deep Learning – Survey

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Abstract: Due to continuous seasonal changes and low quality of development materials, cracks may create in the walls of the building. One of the underlying indications of the debasement of a solid surface is cracks. The manual examination has numerous disadvantages like the imperceptibility of cracks, tedious and prerequisite of master's information. So it very well may be done consequently by utilizing image processing. Deep learning algorithms have been used for the solution of multiple issues in the area of image classification. The purpose of this writing is to study and understand the existing crack detection techniques using image processing. For this purpose, recent research articles have been selected for review. In this writing review, a portion of the ongoing papers on crack identification have been evaluated and the investigation of the audit is being done on image processing strategies. It is concluded from the literature that deep learning performs much better in crack detection.

Keywords: cracks detection, Fuzzy logic, Convolution neural network, Deep learning, Computer Vision, supervised learning, unsupervised learning

I. INTRODUCTION:

Crack detection is a process of detecting crack from building especially walls, roofs, and other concrete surfaces. This process can be carried out in two ways which are destructive and nondestructive. If we look on the manual crack detection mechanism, it's very difficult due to multiple reasons like expert's availability, time-consuming, etc. due to these reasons, automated mechanism for detection of cracks from buildings is adopted. This system performs much better than manual systems in the context of speed, efficiency, and accuracy. The accuracy of the automated system is increased due to applying image processing techniques. This paper survey is conducted on the papers published under the domain of crack detection using image processing techniques and neural networks which may be applied to images.

Multiple image processing techniques[1] have been introduced by researchers but these techniques could replace the visual methods because these are not developed as the on-site environment. Detecting cracks by image processing may face multiple difficulties due to factors like quality of image, size of the image, pixel combination of images, noise on images, blurring of images and irregular images taken by the camera. Lighting effects on images also cause problems in image processing techniques. It affects the accuracy of techniques because lighting effects disturb the quality of the image. Deep learning[2] is derived from broader family machine learning methods which are based on artificial neural networks and boltmanz machines. Deep learnings can be scattered into following ways:

- Supervised learning
- Semi-supervised learning
- Un supervised learning

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Deep learning algorithms are very much useful they can be used for multiple tasks like voice recognition, signal processing, and image processing.

II. LITERATURE REVIEW:

1. Detection of Crack by Image Processing

Steps for detection cracks using image processing techniques are given in Figure 1which are Database, Pre-processing, detection, Classification.

Figure 1: *Steps of Crack Detection*

Preprocessing[3] phase is a universally adopted technique, which is used to enhance the results as per desire. During this phase, multiple smoothing and filtering techniques are used and detection phase run with multiple ways like otsu methods, statistical approach, threshold methods, and classification can be done using deep learning algorithms like CNN (convolutional neural networks, fuzzy logic

[4] have introduced one method for crack detection from the noisy image with the help of mathematical morphology and curvature evaluation. In this study, they were focused on crack detection. For that purpose, they performed filtering and segmentation. With the help of geometrical features of crack surfaces, they tried to find out the sequential crack irregularities. A real dataset of images was used for accuracy judgment. As per the judgment, it was conclude3d that their system provides almost 70% accuracy. The reason behind this less accuracy was the bad implementation of the algorithm.

[5] developed a method for crack detection from the surface. This method was consists of three steps.

1) Conversion of the image to greyscale
2) Using filters (SOBEL) for detection of crack
3) Categorization of processed images into foreground and background.

After these steps, the Sobel filter was used for noise removal and then the Otsu method was used for crack detection from the surface. In that case, real datasets of images were used and their efficiency was 85%.

For the width, detection cracks one method was introduced by [6] The reason behind this proposition was to detect crack from the surface. For that purpose, they used high-resolution cameras for recovering coordinates of edges of cracks. For obtaining image coordinates they used canny Zernike algorithms. For knowing about the width of the crack, technique namely minimal crack edge was used. They used real image datasets and their efficiency was almost 85 to 90%. The drawback of this algorithm was that lighting effects were not considered. A picture analysis method was presented by [7]for the purpose of detection of cracks. They have limited the necessity for pen marking in strengthened cement basic tests. Their goal was to locate the cracks. They have utilized the examinations like break profundity forecast, split example acknowledgment dependent on fake neural systems, applications to miniaturized scale cracks of rocks and productive sub-pixel width estimation. They received a stereo triangulation technique in view of cylindrical equation guess and picture correction. Their perception was that once the rectified yield was acquired, the outside of the watched areas could be unfurled and displayed in a plane picture for dislodging and through distortion analysis, the break was examined. They have utilized a genuine dataset and the precision was less than90 percent. The drawback of their work was that the strategies were not appropriate for thin cracks, which don't present clear dull lines in pictures. The new method was developed depending upon sparse representation [8]. This model is developed for detecting cracks from the floor surface and reconstruct the main floor. Their goal was to locate the cracks from the surface. The key for separation from the fundamental profile depended on the highlights of the blended over complete lexicon, which was divided into two categories. One was for cracks representation and another for main profile representation. In their research, particles in trapezoidal Capacity was embraced to speak to cracks and exponential capacity for the primary surface profile. As per the results of this study, they claimed that this strategy would detect the cracks very well when matched and wavelet and middle channel without harming the data of the fundamental profile signal. Experiments were carried out by them, demonstrated that this technique had the capability to recognize the location of crack productively just as remake the principle profile. A new approach for detecting the edges of crack was introduced by [9] for the purpose of detecting cracks on the surface. As per this research, a novel symmetry-based crack enhancement filter was used for crack detection. For the purpose of crack detection, they used the geometric properties of cracks such as line-like and local symmetry across the center lines from 2D images. From the cross-section of cracks edges of cracks were identified. As per the results of this method they claimed that time taken for detection of edges from the image was very less than existing technologies. The efficiency of this method is as this method can detect crack very minor cracks precisely. This method can be used to calculate the width of cracks with some enhancements in it. The method proposed by [10] used non-Linear imaging for detecting cracks In this method two acoustic signals were originated at different frequencies, first was a photo acoustically by heating through intensity-modulated scanning and second was by the piezoelectrical transducer. The acoustic signal at mixed frequencies generated due to system nonlinearity has been detected by an accelerometer. The contrast of the images obtained at a mixed frequency was compared with the obtained linear photoacoustic images. CNRS was used for the purposed methods and accuracy was about 90%.[11] propose a novel approach for the purpose of detecting cracks from the surface. Statistical filter design was developed for cracks identification. This technique was based on two steps. In the first step feature selection process is carried out and after that images used are fused. In the second step, with the help of cleaning linking, they defined the cracks. They used real images data set for experimentation. As per the results of these techniques, accuracy was less than 90%. The drawback of this technique was that the randomness of cracks causes difficulties in detection. [12]proposed automated system for crack detection. The main focus of this research was to identify the length of cracks. In this method, experimentation is based on four steps. Two steps were in data preprocessing and two were in the detection phase. For removing shadings and emphasizing on cracks they used median filter and multi-scale linear filter with the Hessian matrix respectively. They used real data set and accuracy is about 95%. Limitation in their task is that they used 60 images of crack surface for checking the robustness and accuracy of their system. In the research by Leo [12] they experimentally proved that when a number of layers in the network will increase it will help in increasing the accuracy of the method. As we increase the layers in the network it will go deeper and learn more about the features, as the features will be increasing accuracy of method goes on increasing. They used real data set and accuracy was more. The limitation of this work was the maximum time taken in training time.

2. Deep Learning-based Crack Classification.

a) Back Propagation:

Backpropagation[13] is a simple algorithm, in this algorithm output generated by the neural network is compared with the desired output. If both inputs are matching up as satisfactory level, some modifications between layers are carried out and the whole process is repeated till we got the desired result. The main purpose of this algorithm is to reduce errors by selecting suitable weights. This approach is commonly used in reducing the errors function by gradient method. Fine-tuning is a technique that is in practice to be used for enhancing the stacked autoencoders. Fine-tuning treats all layers as a single model and when a single iteration is made it enhances all the weights at once.

b) Fuzzy Logic Based DNN.

A fuzzy logic management model is developed by [12] which may result in helping tin the demonstration of human information in a very targeted area of application and reasoning there with information to create helpful inferences or actions. A symbolic representation of the framework comprises of 4 sections. A fuzzifier changes over knowledge into fuzzy knowledge or Membership Function (MFs). The fuzzy rule base contains the relations between the output and input. The fuzzy illation technique joins MFs with the managerial standards to determine the fuzzy yield and in this regard the deffuzifier changes over the fuzzy numbers back to a fresh worth. There are two reasons which represent the logic frameworks. These two reasons are as follows: Fuzzy frameworks are best for uncertain or rough data and that they grant higher the cognitive procedure with measurable

qualities underneath inadequate or then again uncertain information. By utilizing a fuzzy framework to adaptively change the preparation parameters of the neural system with regards to the MSE error, it is conceivable to reduce the opportunity of overshooting all through the preparation technique and encourage the system to escape a territory least.

Following are four parameters adapted for producing the principles for the symbolic logic management system;

- Relative error (RE),
- Amendment in relative error (CRE),
- Sign amendment in error (SC)
- Accumulative total of sign amendment in error (CSC)

c) Deep Fuzzy Neural Network Training

[14] has given that deep multi-layer neural systems have multiple levels of non-dimensionality allowing them to concisely speak to very non-linear and extremely variable functions. The training section of the neural network is divided into two sections first is a data format and the second is fine standardization. The data format is a major step for deep learning. A stronger robust data format strategy might facilitate the neural network to converge to a good local minimum more efficiently. The fine-tuning step licenses to precisely alter the parameters inside the neural system in a much-regulated manner to upgrade the segregate capacity of the ultimate feature.

d) CNN Based Crack classification

[15] it is concluded that crack detection by CNN is a much better application of neural networks.

For that purpose following steps are included

Data Preprocessing

Data preprocessing[3] is an initial step for crack detection. In this step, some operations like smoothing, converting to greyscale, cropping, etc. are performed less processing time.

Design and train the CNN

In this step, CNN is trained with datasets for the desired output. In the architecture of the CNN pooling layer, the convolutional layer and fully connected layers must be there. The dropout method was used between two fully connected layers and the rectified linear units as the activation function.

Evaluate the performance

Convolutional Neural network (CNN) performance may be compared with methods like SVM. As per the study, it is concluded that the Convolutional Neural network CNN needs fewer data preprocessing as compared to the Support vector machine (SVM). While the Convolutional Neural network needs the max amount of data in the training phase which may maximize training time but this issue is resolved by using the high-performance machine.

III. CONCLUSION

In this study, multiple crack detection techniques using image processing techniques and deep learning are studied. Image processing techniques have imparted a vital role in analyzing the defects on the surface by using different methods. Some of the methods which are used in the image processing technique are as Otsu method, median filtering, Gaussian filter, Sobel filter, etc. All the techniques have their own merits and demerits. Some techniques have high processing time and their efficiency is not accurate. Some techniques have high accuracy but they are not efficient in terms of processing. For the purpose of real-time implementation at the industry level, high processing and high accuracy are both important. As per this survey study, it is concluded that each technique is best for some specific defects detection. So it can be said that there is not a single technique that can be used universally on each category of cracks. From this, it also concluded that if the depth of neural network is increased, its performance is enhanced because as the network will go deeper it will learn more features from the image which results in high accuracy but when networks learn or train for more feature, its processing time will be increased. In future techniques using deep learning may introduce which overcomes the issue like overfitting, under fitting and minimum training time.

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