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A Review on Crack Detection and Parameters Estimation on Road Images

Er. Harjit Kaur[1], Er.Rajandeep Kaur[2]
[1]CSE, [2]AP CSE , SBBSU (Sant Baba Bhag Singh University), Jalandhar, India

Abstract: Roads plays an important part in everybody's life. Everyone uses road to reach their destination. So the constant use of roads deteriorates the roads. Crack detection and parameter estimation in roads helps the pavement management in finding the cracks in the roads and estimating the parameters associated with the cracks. If this process will be carried out by the humans manually, it will take more time and become very costlier also. This paper reviews the various techniques for identifying and classifying the cracks in the roads.
Keywords: crack detection, deteriorate, parameter estimation, classifying, pavement.

I. INTRODUCTION

Cracks are found in every part of the system because everything which is frequently used gets deteriorates due environmental conditions like sun, weather, cyclones, tsunamis, earthquakes and the human condition like the constant use of things, ill treatment with the things, poor quality of material etc. A crack is the separation of associate in material into two or more parts under the action of stress. If these cracks are found on the roads, then it could be very dangerous for human beings because the road network plays an important role in the progress of the country. [1]

With the help of road network trading become very easy, transportation of various things become very easy, moreover finance development and social assimilation also become very easy. Road network provides the greatest advantage on scale of economics by providing a line of works and extending of markets. It also provides facilities of transportation for both

people and goods. The commercial transportation of the goods and passengers within India use roads for transportation becomes very common medium over the years. Cracks in roads come due to power axle loads of the vehicles, poor quality of material used, environmental and climatic conditions. Seeing the advantages of road network, maintenance of roads become an important factor, so that we can conveniently take the facilities of the road network for long periods. In the early days, human beings were used for maintenance programs. But it was very costly and time consuming process.

With the advancement in the technology, computerized systems were developed for the maintenance of roads. These systems help in detecting cracks in the roads and also help in calculating the parameters like crack width, length, shape, intensity, etc. These systems take less time for maintenance of roads and also provide very accurate and efficient results. [7]

Various technologies are proposed for crack detection and classification. Some of them are:

Crack detection and classification with the help of Artificial Bee Colony and Artificial Neural Network. [2]

Road crack detection by using Entropy and Dynamic Thresholding. [3]

Crack detection based on the Digital Image Processing. [5] Crack detection and classification on roads using Anisotropy measure.

Crack detection and Classification using Neural Networks and Supervised Learning Algorithm. [11]

Crack detection and classification by using Continuous Wavelet Transform. [18]

Edge detection of cracks in roads with Beamlet Transform. [22]

II. LITERATURE REVIEW

B. Hari Prasath, S. Karthikeyan, et al. (2016), in their paper introduces an automated technique which detects cracks in roads with the help of digital image processing. Some parameters like bad illumination, non-uniform background and complex texture may affect the accuracy of an automatic system. In their novel methodology, they firstly processed the images with the help of gray scale morphological processes. Then they obtained the results by filtering images and after those applying edge detection operations. They use the MATLAB VERSION 7.9 tool for conducting their research. Their System Performance=89% and Recall= 94.5%. [1]

Anan Banharnsakun (2015) in his paper uses hybrid between an artificial bee colony and artificial neural networks for pavement surface distress detection and classification. In his system, he firstly captured pavement images and then segmented it into distress and non-distress region by using the thresholding method. Then the optimal thresholding value is obtained by using an artificial bee colony algorithm. For classification of cracks, he uses an artificial neural network method. Accuracy of this method is 20%

increased when it is compared with other methods. [2]

Henrique Oliveira and Paulo Lobato Correia (2009) in their paper presents a novel method for automatic detection and classification of the cracks by using survey images which are acquired by the high speed vehicle. For enhancement of an image, they used morphological filters which reduce pixel intensity variance. After that a dynamic thresholding technique is applied, which identify dark pixels as compared with potential crack pixels. In achieving entropy block matrix, a second dynamic thresholding is applied, which identify image blocks containing crack pixels. Then the classification system classifies the type of cracks. [3]

Henrique Oliveira and Paulo Lobato Correia (2010) in their paper proposed a novel technique to detect cracks automatically in road pavement, acquiring an image with the help of the laser imaging system. They use posteriori classifier procedure to link different segments of crack region. In the first step, they use an anisotropic diffusion filtering technique which smooths the image texture. Then uses Gaussian function to model histogram for calculating intensities of pixels below some certain value for image segmentation. After that, binary region, which is less relevant are kept only if they linked to the relevant region of cracks. [4]

Aiguo Ouyang, Chagen Luo et al. (2011), analyzed key problems of pavement crack detection like image enhancement, edge detection and image segmentation. For enhancement, they used median filters for removing the noise in images of pavement cracks. For edge detection, they use canny edge detection operator. For image segmentation, they used histogram modification technique. [5]

Suwarna Gothane, Dr. M. V. Sarode (2015) proposed that road networks are preserved if sufficient maintenance can be done at the proper time. Some types of distress on the road surface are potholes, cracks, patches, etc. In their paper, data assessment regarding road distress is reported with the help of data collection regarding distress and the processing of raw data. They analyzed different types of solution using the concept of neural network, fuzzy logic, artificial intelligence, computer vision etc. for automation of process. For monitoring traffic and road conditions GPS and sensor based techniques are used. [7]

Tien Sy Nguyen, Manuel Avila et al. (2009), introduce a method which can not only detect crack size as small or large, but also detects other types of defect like joints and bridged. For capturing road images, the image acquisition system is used. In the first step, the pre-processing step is done to remove the lane marking. After that road defects are detected by calculating an anisotropy measure. Finally, for classifying an image, they use back propagation neural network, which classifies an image into four classes like: defect-free, joint, crack and bridged. They perform experiments on real road images. [9]

Qin Zou, Song Wang et al. (2011), in their paper, develop a fully-automatic technique which detects cracks from a crack pavement images. Firstly, they develop geodesic shadow-removal technique for enhancement, which remove the pavement shadows but preserving the cracks. Secondly, they build a crack probability map using tensor voting to enhance the connection of the crack fragments. Finally, they sample a crack seeds from crack probability map, which represent these seeds by a graph model, derive minimum spanning trees from this graph, and conduct recursive tree-edge pruning to identify desirable cracks. They evaluate the proposed method on a collection of 206 real pavement images. [10]

Akhila Daniel, Preeja. V (2014) in their paper includes that there are several techniques for detection of cracks. But all these techniques accesses the condition of the road based on the type of cracks. Because of different climate conditions, roads suffer from various types of distress like potholes etc. The main goal of their paper is to introduce a technique which determines the road condition. The steps which they follow are Collection of the images, Detection of distress, and Classification of the distress and assignment of the crack's severity which analyze the road performance. [11]

Shi Guiming, Suo Jidong, et al. (2014), states that pavement cracks are a very common damage to roads. Underdevelopment software for image acquisition and hardware technology sometimes achieved pavement images having high noise, which makes difficult to detect low cracks. Their paper focuses on processing of vehicle-mounted crack detection system, which deals with high noisy image. In their novel methodology, they firstly acquire an image, then apply pre-processing, then apply morphological operations and at last determine the optimal threshold. They also use MATLAB tool for conducting their research. [12]

B. Santhi, G. Krishnamurthy et al. (2012), in their paper presented an automated technique which detects cracks in pavement with the help of digital image processing. Their technique can detect the vertical, horizontal and diagonal cracks. Some problems, like bad illumination, complex texture, and non-uniform background of the images may affect the accuracy of an automatic system. So, to overcome from these problems a well organize technique for crack detection was introduced by them. Firstly, they processed the images by using gray scale morphological processing. After that, they obtained final result by applying the Butterworth filtering technique to the images and at last they applied the canny edge detection technique.[14]

Peggy Subirats, Jean Dumoulin et al. (2006), in their paper presented a new technique for developing an automated system for crack detection conducted on the pavement surface images. In their first step, they use a two dimensional continuous wavelet transform

for performing at several scales. From this they built the complex coefficient. After that, they searched the maximum value of wavelet coefficients and analyzed their propagation with the help of scales. Finally, a binary image obtained after post-processing indicates that whether the cracks are present or not on the surface of pavement image. [18]

Ghada Moussa, Khaled Hussain (2011), in their paper presented a novel technique for an automated pavement assessment which is based on machine learning methods and an image processing techniques. The system has an ability to identify cracks, extract the parameters of crack, and report the extent, type and severity of that crack. They use actual pavement images for verifying the performance of their proposed system and the results clearly states that the proposed system was performing its functions very effectively and efficiently. They use mainly four stages for crack detection. Firstly, they perform segmentation of images by using a watershed algorithm. Secondly, they extracted the features in images. Thirdly, they classified the types of cracks using Support Vector Machine. At last, they quantify the cracks parameters. [20]

Ouyang Aiguo, Wang Yaping (2012) in their paper proposed a novel method which is based on Beamlet for extraction of pavement crack images. Firstly, they used Otsu's thresholding segmentation algorithm for transferring the collected images into the binary images. After that, they used Beamlet Transform on the binary images to extract some linear features of the cracks with different kinds of scales and thresholds. Their experiments show that their proposed algorithm could achieve satisfactory performance also in cases of some of low signal to the noise ratios. [22]

Liang Ying (2009) in his paper, proposed method which used a pavement distress method for image enhancement algorithm so that a non-uniform background illumination is corrected by calculating multiplicative factors which eliminates a background lighting variation. He uses Beamlet Transform algorithm for extracting the linear features from a pavement image and the image is divided into small windows. After that the crack segments are linked together then classified cracks into four types: horizontal, vertical, block types and transversal. His results show that the method is an effective and robust for the extraction of the cracks on various pavement images. [24]

III. CONCLUSION AND FUTURE SCOPE

The constant uses of roads for various purpose roads get deteriorate. This review paper provides information about the techniques which are used to detect the cracks on the road. This paper also includes information about the enhancement, edge detection and segmentation techniques. In future, this system can be attached in the vehicles so the driver will able to know about length, shape and other parameters associated with the cracks on the road.

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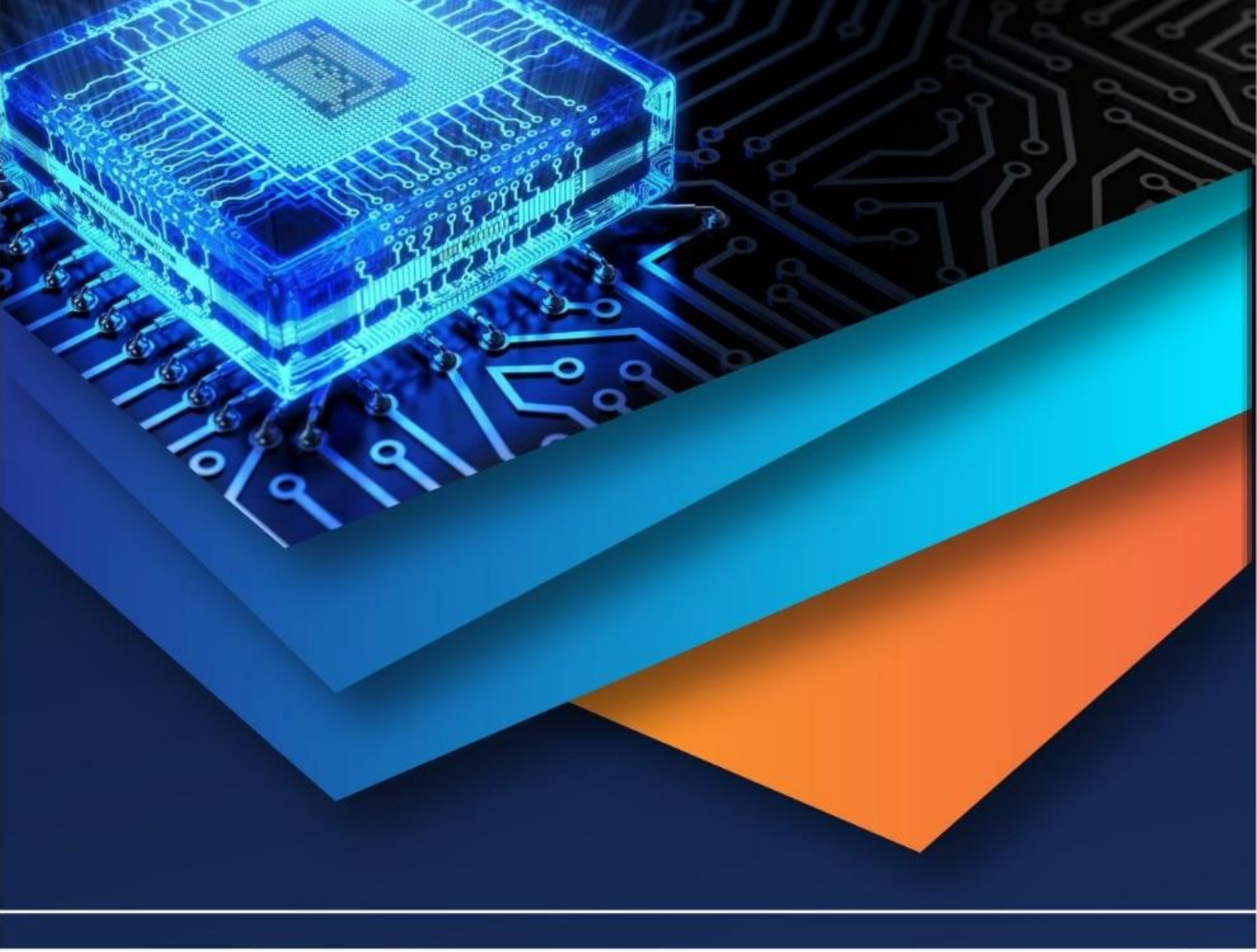

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