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Survey on Crack Detection

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ABSTRACT

Automatic crack detection technique was developed for potholes detection on roads for fast and reliable surface defect analysis. Automatic Pixel level Technique is used to identify cracks on the Bridges. With the development of information technology, the digital image processing has the characteristics of strong permeability, large use of action and good comprehensive benefits. It promotes the development of the digital image processing technology in the detection of structural engineering. It is conducive to the development of intelligent, refined and networked structures. Bridge Crack is the most common threat to the safety of industry. Based on the structure of the digital image processing and the structural characteristics of the design engineering, this pre analyses the practical application value of the digital image processing technology in the crack identification of machine tools structures and established a bridge structure health monitoring system based on the digital image processing technology. On this basis, this project also studied a digital and intelligent industrial crack detection method to improve the efficiency of human safety diagnosis and reduced the risk factor. We implement this project using MATLAB.

Keywords: Image Processing, Crack Detection, Internet of Things,Pothole detection, MATLAB

1. INTRODUCTION

Digital image processing is the use of a digital computer to process digital images through an algorithm. It allows a much wider range of algorithms to be applied to the input data and may avoid problems like the build-up of noise and distortion during processing. Since images are defined over two dimensions, digital image processing may be modelled in the form of multidimensional systems.

Internet of things is an important topic in technology industry, policy, and engineering circles and has become headline news in both the specialty press and social media. This technology is embodied during a good spectrum of networked products, systems, and sensors, which take advantage of advancements in computing power, electronics miniaturization, and network interconnections to provide new capabilities that were previously not possible.

Automatic Pixel-Level crack detection technique using information of Multi-Scale neighbourhoods is proposed for bridge crack . Based on the structure of the digital image processing and the structural characteristics of the design engineering, this pre analyses the practical application value of the digital image processing technology in the crack identification of machine tools structures and established a bridge structure health monitoring system based on the digital image processing technology , this project also implements a digital and intelligent industrial crack detection method to improve the efficiency of human safety diagnosis and reduced the risk factor.

2. LITERATURE SURVEY

In paper 1, Fan Yang[1] , Lei Zhang, Sijia Yu[2], Danil Prokhorov[3], Xue Mei[4], and Haibin Ling[4] proposed network integrates context information to low-level features for crack detection in a feature pyramid way, and it balances the contributions of both easy and hard samples to loss by nested sample reweighting in a hierarchical way during training. In addition, we propose a novel measurement for crack detection named average intersection over union (AIU). To demonstrate the superiority and generalizability of the proposed method, They evaluate it on five crack datasets and compare it with the state-of-the-art crack detection, edge detection, and semantic segmentation methods

In paper 2, Jerome Combaniere[1], Peter Cawley[2], Kevin McAughey[3], and Jochen Giese[4] discussed The interaction between SH0 guided waves and easy defects is well understood and documented, and therefore the SH0 and related torsional guided waves are commonly utilized in inspection. However, tilted and branching cracks, that vertical notches are a poor approximation, are found in some environments, particularly when pipes are buried in alkaline soils. They studied the interaction between SH0 guided waves and tilted, surface-breaking cracks, investigating the effect of the lean and depth of the fault. The incident wave interacts with the tilted crack to urge a transmitted wave, a reflected wave and a wave trapped below the crack. it's shown that the direction of the lean of the crack relative to the incident wave direction doesn't affect the scattering behavior. Additionally, the axial extent of the crack plays a significant role within the reflectivity of the crack, leading to transmission nulls in some configurations. These transmission nulls appear for all crack depths, the frequency range over which the transmission is significantly reduced increasing with crack depth. This behavior is shown to be analogous to the acoustic energy flow during a duct when a Helmholtz resonator is introduced. The null isn't seen above the SH1 cut-off because the propagating signals aren't any more mono-modal. The existence of a transmission null and corresponding reflection maximum is promising for the detection of small defects and measurement of the frequency at which the null occurs will assist with defect characterization. Experimental validations of the key results are presented.

In paper 3, Qiang Wang[1] , Yanfeng Xu[2], ZhongqingSu[3], Maosen Cao[4], and Dong Yue[5] discussed A Lamb wave and linear piezoelectric lead zirconatetitanate (PZT) array-based monitoring method for the detection and quantification of crack damage is presented during this paper. Because existing PZT array arrangements aren't suitable for quantitative monitoring of crack damage both in orientation and long , a sparse linear PZT array is introduced and applied to gather crack reflections. supported this new array, how for estimating crack orientation is proposed. An amplitude spectrum as a function of angle is mapped using time delayed and summed signals. By finding the peaks within the spectra, the central actuator element and corresponding orientation angle are determined. Furthermore, the time of flight imaging method is modified to display and evaluate cracks quantitatively. Validating experiments are conducted on a T6061 aluminum plate, monitoring and evaluating single and connected cracks with various orientations in several locations. As suggested by the experiments, the orientation of most cracks are often well recognized and each one cracks are often quantitatively displayed by the proposed methods.

In paper 4, Haifeng Li[1] , Dezhen Song[2] , Yu Liu[3], and Binbin Li[4] disscussed about Pavement crack detection from images could also be a challenging problem because of intensity inhomogeneity, topology complexity, low contrast, and noisy texture background. Traditional learning based approaches have difficulties in obtaining representative training samples. They proposed a new unsupervised multi-scale fusion crack detection (MFCD) algorithm that does not require training data. First, they developed a windowed minimal intensity path-based method to extract the candidate cracks within the image at each scale. Then they discovered the crack correspondences across different scales. Lastly they developed a crack evaluation model supported a multivariate statistical hypothesis test. They approach was successfully combined strengths from both the large-scale detection (robust but poor in localization) and thus the small-scale detection (detail-preserving but sensitive to clutter). They analyzed and experimented the computational complexity of our MFCD algorithm. They implemented the algorithm and have it extensively tested on three public data sets, including two public pavement data sets and an airport runway data set. Compared with six existing methods, experimental results show that our method outperforms all counterparts. Specifically, it increases the precision, recall, and F1-measure over the state-of-the-art by 22%, 12%, and 19%, respectively, on one public data set.

In paper 5, Takahiro Yamaguchi[1] , Tsukasa Mizutani[2], Minoru Tarumi[3], and Di Su[4]disscussed about ground-penetrating radar (GPR) for infrastructural health monitoring, because radar images contains many reflected waves which are difficult to interpret. Furthermore, the spatial resolution of system isn't enough considering the thickness of target damages, cracks, and segregation are millimeter-to-centimeter order while the wavelength of ordinary GPR ultrahigh-frequency band is over 10 cm. to deal with these problems, for the aim of sensitive damage detection, we propose a replacement algorithm supported deconvolution

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utilizing a superb high-frequency (SHF) band system. First, a distribution of reflection coefficient is inversely estimated by 1-D bridge slab model. Because concrete is found to be a lossy medium at SHF band, we consider the attenuation of signal in deconvolution. The algorithm is known as "time-variant deconvolution" during this paper. After the validation by simulation, the results of the algorithm and waveband on damage detection accuracy are evaluated by a field experiment. Though the results show a 1-mm horizontal crack isn't detected by measured waves, when it's full of water, it's detected by time-variant deconvolution. Moreover, the 1-mm dried crack is detected only by time-variant deconvolution at SHF band, which greatly emphasizes the peaks of the reflection coefficient of the crack.

In paper 6, Qing Li[1], and Steven Y. Liang[2] proposed a totally unique approach supported nonconvex sparse regularization (NSR) denoising and adaptive sparse decomposition. The most work are often divided into two areas: (1) raw signal denoising and (2) repetitive impulses isolation. In particular, for the raw signal denoising, the augmented Huber function is proposed as penalty function, and thus the convexity of the target cost function (OCF) was often maintained, meanwhile, the answer of the proposed OCF are often solved using forward-backward splitting algorithm. Compared to some state-of-the-art methods like L1-norm fused lasso optimization (LFLO) and maximum correlated Kurtosis deconvolution (MCKD) method, the results demonstrate that the proposed approach can effectively extract the weak fault frequency and its harmonics, and thus the shortcoming of the systematic underestimation of LFLO method has also been greatly improved.

In paper 7,Youfa Cai[1], Xing Fu[2], Yanna Shang[3], Jingxin Shi[4] discussed so as to enhance the efficiency of crack detection of concrete bridge structures, a replacement method supported computer vision technology and coordinate mapping is proposed. during this research, this crack measurement system is integrated mainly with a high magnification image acquisition system, a two-dimensional electric cradle head device and a laser ranging system. it's a group of observing frame of reference. Firstly, the marking points' image coordinates are mapped to the observation coordinates. Secondly, according to the marking points' observation coordinates, the measured crack's coordinates are mapped to a same world coordinates so on realize the spatial location of the measured cracks no matter different test cycles or instrument's setup positions, which may be a great convenience for the review detection of surface cracks of concrete bridge structures. In they showed this method is efficient and convenient. It can automatically locate the measured cracks within 16 s, and therefore the deviation isn't quite ± 0.07 °. At a distance of 100 m, the measurement accuracy of crack is best than ± 0.12 mm.

In paper 8, Meiping Song[1], Dongqing Cui[2], Chunyan Yu[3], Jubai[4] were Aiming at detecting cracks in photovoltaic images, a crack detection algorithm of photovoltaic images supported multi-scale pyramid and improved region growing is implemented during this paper. Firstly, suppress noise from the crack area, the image is subjected to a filtering process. Then, the multi-scale pyramid is used to extract the fracture characteristics of photovoltaic images on different scales. There are obvious noise disturbances within the extracted cracks that do not conform to the characteristics of the cracks, which can be removed through an optimization process. Finally, they focused on an improved directional region growing algorithm to complement the detected cracks. For comparison, the wavelet modulus maximum method is tested too. The results show that the proposed method features a far better performance on noise suppression, suspect crack removing, and crack integrality.

In paper 9, Zhang Yiyang suggests a glass crack detection algorithm supported digital image processing technology, obtain identification information of glass surface crack image by making use of pre-processing, image segmentation, feature extraction on the glass crack image, calculate the target and perimeter of the roundness index to guage whether this image with a crack. make use of Visual Basic6.0 programming language to impolder the crack detection system, achieve the function of each part in crack detection process.

In paper 10, Na WEI[1] , XiangMo ZHAO[2] , XiaoYu DOU HongXun SONG[3], Tao Wang[4] discussed The complex nature of road images and weak signal make the detection of pavement cracks particularly difficult. An algorithm for pavement cracks detection supported Beamlet Transform is proposed. Beamlet transform could also be a replacement tool for top dimensional singularity analysis. initial, the pavement surface image was segmented into unit image and transformed to binary image. Then beamlet transform was performed. Experimental results show the proposed method is effective in detecting line features with any orientation, location and length in pavement images. Compared with traditional edge detectors, the proposed method has the facility of anti-noise and linear connection.

Table 1: Comparison On Various Methods Used In Crack Detection

S.NO	Paper	Technique	Result	Issues
1.	Feature Pyramid and Hierarchical Boosting Network for Pavement Crack Detection.	A feature pyramid and hierarchical boosting network (FPHBN).	The generalized FPHBN is obtained with higher accuracy.	The effectiveness of the crack is not upto the excepted result.
2.	Interaction between SH0 guided waves and tilted surface-breaking cracks in plates	propagating and evanescent higher order modes to determine the scattering obtained from a step discontinuity, a wedge-shaped crack and a strip of another material rigidly coupled to the surface of the plate	The key result of this paper, the transmission null, was observed in the case of a highly tilted notch and the measured value for the location of the transmission null agreed well with the predictions.	The interaction between guided waves and these more complex defects needs to be addressed.
3.	An Enhanced Time-Reversal Imaging Algorithm-Driven Sparse Linear Array for Progressive and Quantitative Monitoring of Cracks	A Lamb wave and linear piezoelectric lead zirconate titanate (PZT) array-based monitoring method	The orientation of most cracks can be well recognized and all cracks can be quantitatively displayed by the proposed methods.	A crack model cannot simply assume that the damage is perpendicular to the propagation direction of Lamb wave

4.	Automatic Pavement Crack Detection by Multi-Scale Image Fusion	Combined strengths from both the large-scale detec- tion (robust but poor in localization) and the small-scale detec- tion (detail-preserving but sensitive to clutter). complexity of MFCD algorithm.	A crack evaluation model was built, and the crack was selected as the detected crack if it passed statistical hypothesis test.	Pavement crack detection from images is a challeng- ing problem due to intensity inhomogeneity, topology complexity, low contrast, and noisy texture background.
5.	Sensitive Damage Detection of Reinforced Concrete Bridge Slab by "Time-Variant Deconvolution" of SHF-Band Radar Signal	Ground-penetrating radar (GPR) for infrastructural health monitoring, especially for the monitoring of reinforced concrete (RC) bridge slab.	The algorithm restores the resolution of the system by greatly emphasizing the peaks of the reflection coefficient distributions of the target crack.	The magnitude of the sidelobe is large, causing the difficulty in specifying the depth of the crack and the existence of water in the crack.
6.	Weak crack detection for gearbox using sparse denoising and decomposition method	Diagnosed by the extraction of the periodic transient impulses (PTI), Nonconvex sparse regularization (NSR), adaptive sparse decomposition, genetic algorithm (GA), periodic transient impulses (PTI).	Shortcoming of the systematic underestimation of LFLO method has been greatly improved.	The detection results are invalid using methods such as MCKD, signal RSSD.

7.	**Methods for Long-Distance Crack Location and Detection of Concrete Bridge Structures**	**Using location and detection method for long-distance cracks, which is based on the combination of computer vision technology and coordinate mapping.**	**Improving the efficiency of crack measurement on the surface of concrete bridge structures and to meet the needs of fast location and detection of cracks within 100 m**	**Cracks are one of the common diseases of concrete bridges, tunnels, buildings and other structures and if cracks on the surface of concrete bridges are generated or extended regularly or irregularly, and then to carry out a certain defense or repair can effectively reduce the adverse effects of disease on the health of bridge structures**
8.	**The Design of Glass Crack Detection System Based on Image Preprocessing Technology**	**a glass crack detection algorithm based on digital image processing technology**	**Manage and analyze the glass crack image, then get the parameters to judge crack image.**	**the system is still a kind of divorced from reality,with further research,it is believed that the technology will more improve and perfect**
9.	**Crack Detection Algorithm for Photovoltaic Image Based on Multi-scale Pyramid and Improved Region Growing**	**A crack detection algorithm of photovoltaic images based on multi-scale pyramid and improved region growing.**	**reasonable balance between noise reduction and edge location.**	**Noise disturbances in the extracted cracks that do not conform to the characteristics of the cracks, which can be removed through an optimization process.**
10.	**Beamlet Transform Based Pavement Image Crack detection**	**Beamlet Transform is proposed.**	**Ability of anti-noise and linear connection.**	**The complex nature of road images and weak signal make the detection of pavement cracks particularly difficult.**

3. CONCLUSION AND FUTURE WORK

In this project, we present a strong bridge crack detection algorithm that's both accurate and computationally efficient. To achieve greater disparity transformation efficiency, we used Iot and Automatic pixel-level cracks detection image processing technology. The successful detection accuracy of the proposed system is around 88.7% .We were able to identify cracks as minor or major. In future, this system can be improvised to detect different types of cracks.

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