A Developed CNN for 3D Image Reconstruction of Concrete Surface

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1. Problem Description

Characterization of the air-void system in hardened concrete has been a challenge for many years. Currently, the widely used method uses original data of 2 dimensional (2D) image of lapped concrete surface to approximate the values of the air-void system parameters. Given that the air-void system is a 3 dimensional (3D) model, it's intuitive that the application of 3D image can inherently improve the measurement accuracy compared with existing 2D image methods.

Computer stereo vision is the extraction of 3D information from 2D digital images. This method aims to estimate 3D geometry by computing disparities between matching pixels in a stereo image pair. Recently many approaches were introduced to address the reconstruction from 2D image to 3D image, with concentration on memory cost, computation cost, and precision loss [6]. 3D image reconstruction for air-void system analysis particularly has a high requirement for precision. Entrained voids in concrete have diameters from 0.01 mm to 1 mm, and those voids are uniformly distributed throughout the concrete. In order to recognize a majority of the air-voids, a minimum measurement resolution of 0.01 mm is strongly required. For example, for a concrete specimen surface of 40*40 mm, an 3D image with at least 16 megapixel (MP) is needed. This asks for two requirements from the adopted method: 1) be able to process high resolution 2D images within a reasonable time; and 2) be able to produce high precision 3D images.

2. Background

2.1. Literature Review

Stereo matching is one of the most extensively studied problems in computer vision. Matching accuracy and processing efficiency are two trade-off indexes for designing a stereo matching system and finding a balance between these two indexes is a challenging work. Sun etc. proposed a novel propagation-based stereo matching algorithm based on pixelwise line segments and 1D propagation [4]. The proposed method overcomes the inherent problem of error propagation for traditional propagation-based stereo matching algorithm and shows good performance in both efficiency and accuracy. Mei etc. proposed a near real-time stereo system based on several key techniques like AD-Census cost measure, cross-based support regions, scanline optimization and a systematic refinement process [3]. The proposed method presents good performance for the Middlebury data sets, while the sensitivity for noise information is not sure. Markov Random Field models were used by Bleye etc. to solve object level image segmentation [1]. In the past few year, convolutional neural networks (CNN) have been shown to perform extremely well for stereo estimation. Zbontar etc. approached the matching cost computation problem by learning a similarity measure on small image patches using a convolutional neural network which shows great performance in challenging benchmarks, while the computation is expensive [5]. Luo etc. propose a matching network which is able to produce very accurate results in a reasonable GPU computation time [2]. Zhang etc. developed a much more efficient and effective guided matching cost aggregation strategies [6]. Considering the air-void detection system requires a high resolution image to capture 0.01mm diameter air-voids, it is necessary to find a high accuracy stereo matching method with acceptable computation expense.

2.2. Research Object

This research aims to propose a developed CNN for 3D Image Reconstruction of Concrete Surface. A major effort will be focused on improving the precision of 3D image construction with in acceptable computation expense.

3. Research Plan

Task 1 Literature review

Task 2 Adaptability analysis of existing methods

Task 3 A developed CNN for 3D image reconstruction of concrete surface

Task 4 Final paper

References

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