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RECONSTRUCTING WHITE WALLS: MULTI-VIEW, MULTI-SHOT 3D RECONSTRUCTION OF TEXTURELESS SURFACES

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ABSTRACT:

The reconstruction of the 3D geometry of a scene based on image sequences has been a very active field of research for decades. Nevertheless, there are still existing challenges in particular for homogeneous parts of objects. This paper proposes a solution to enhance the 3D reconstruction of weakly-textured surfaces by using standard cameras as well as a standard multi-view stereo pipeline. The underlying idea of the proposed method is based on improving the signal-to-noise ratio in weakly-textured regions while adaptively amplifying the local contrast to make better use of the limited numerical range in 8-bit images. Based on this premise, multiple shots per viewpoint are used to suppress statistically uncorrelated noise and enhance low-contrast texture. By only changing the image acquisition and adding a preprocessing step, a tremendous increase of up to 300% in completeness of the 3D reconstruction is achieved.

1. INTRODUCTION

The reconstruction of the 3D geometry of a scene based on image sequences has been a very active field of research. The joint effort in the development of keypoint detectors, matching techniques, path estimation methods, bundle adjustment, and dense reconstruction has resulted in very successful solutions that are able to robustly and accurately reconstruct a 3D scene from given images. Nevertheless, there are still existing challenges in particular for difficult acquisition circumstances (e.g. inhomogeneous or nonconstant lighting), difficult objects (e.g. with homogeneous or reflective surfaces), or certain application scenarios (e.g. facade reconstruction). One especially critical example are weakly-textured parts of objects, where the lack of correct matches leads to holes and topological errors within the 3D point cloud.

This paper proposes to enhance the 3D reconstruction of weakly-textured surfaces by using standard cameras as well as a standard multi-view stereo (MVS) pipeline. Only changing image acquisition and adding a preprocessing step enabled a tremendous increase in completeness of the achieved reconstruction.

The underlying idea of the proposed method is based on the insight that in the real world there is no such thing as a textureless surface. What is usually meant with this phrase is that the existing physical texture is either too fine-grained to be captured by the spatial resolution of a given camera, or that it has insufficient contrast. Especially the latter causes the contribution of the physical texture to the measured signal to fall below the contribution of the measurement noise, which makes a distinction of the two close to impossible. Consequently, all that is necessary to exploit the existing texture in this case is to enhance the signal-to-noise ratio. Based on this premise, this paper proposes to use multiple shots per viewpoint to suppress statistically uncorrelated noise and enhance low-contrast texture. It models the measured signal as a mixture of truly random as well as fixed-pattern noise and leads to a significant improvement of image quality and (more importantly) of the completeness of the reconstruction. An example is shown in Figure 1, where 3D points are color coded depending on how many images per viewpoint were at least necessary for their reconstruction (1=blue to 30=red).

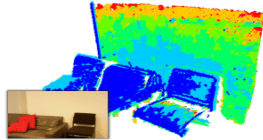


Figure 1. Exemplary reconstruction: 3D points are color coded depending on how many images per viewpoint were at least necessary for their reconstruction (1=blue to 30=red)

2. RELATED WORK

The principle idea to increase the image quality to ease the task of 3D reconstruction is not new. Previous approaches can be coarsely divided into two groups: Exploiting multiple images or using local enhancement methods based on a single image.

There are rarely any 3D reconstruction pipelines that explicitly use multiple images from the same viewpoint. On the contrary, many state-of-the-art approaches seek to automatically reject images that have a too small baseline, since these image pairs do not provide strong constraints on the estimated depth. One of the seldom examples that does use multiple images is High Dynamic Range (HDR) imaging. The lowest and highest light intensity of real-life scenes can easily reach a ratio of 500,000 : 1 (Debevec and Malik, 1997). This high dynamic range can usually not be handled by standard cameras leading to a clipping of dark areas to zero or bright areas to 255 and therefore a loss of details in these regions. HDR imaging has been proposed as a solution to this problem by combining multiple images with different exposure times or shutter speeds to a single radiance map capturing a large dynamic range (Mann and Picard, 1995; Debevec and Malik, 1997; Robertson et al., 1999; De Nève et al., 2009).

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set-up for the experiment of tree discernibility . 31 .. composed of small trees with relatively small volumes, their. It is important to know cutting and filling volumes in many survey, engineering and mining works. Volume 1.

INTRODUCTION. Cutting and filling volume calculation are important issues in bundles of observation rays from different image planes (Ii) .. [14] Slama, C. C., The Manual of Photogrammetry, 4th Edn. American. shop service manual cd blazer suburban ton ton 1 ton c k g p 4x2 4x4 k5 k10 k20 k30 c10 business calculator manual, soccer iq vol smart players, oaa rain service manual, heart development and regeneration 2 volume set, lexus ipod integration kit manual, digital photogrammetry a practical course, medieval and early. VOL. , No 4, , CODEN PDBIAD. /pb ISSN To evaluate the quality of the generated DSM, an agreement assessment with manual stereo over analytical to digital photogrammetry (1, 2). During this .. When performing the IO, two sets of parameters have to.

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