Research Proposal for Master Thesis

- High-Quality Depth Maps Recovery from a Video Sequence Accelerated with CUDA

by

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Abstract

Stereo reconstruction of dense depth maps from video sequence has long been one of most active research problems in Computer Vision. Many applications can benefit from it, such as 3D modeling, layer separation, depth-based segmentation, image-based rendering and video editing, etc. While with essential significance, high quality depth maps recovery still poses a changeling problem due to several inherent factors, such as image noise, large textureless regions and complex occlusions.

The task of dense depth recovery is to assign a distinct and consistent depth value to each pixel of an image sequence. It has been formulated as an optimization problem. First local then global schemes have been applied to minimize an objective energy function that encodes the matching cost. In traditional stereo method, photo-consistency constraint and smoothness constraint usually serves as two basic roles in the definition the energy function. Color segmentation prior has been incorporated to regulate depths in large untextured regions; however, it can introduce errors in estimating textured regions. As for handling occlusion, some explicit visibility labeling techniques have been proposed. Even though, promising result has been difficult to produce until the geometry coherency constraint was incorporated into the energy function definition.

In this proposal, we introduce a state-of-the-art technique called bundle optimization to recover high-quality consistent dense depth maps from a video sequence taken by free-moving hand-hold cameras. The bundle optimization can produce high-quality depth maps. But minutes or even dozens of minutes are consumed for a single frame in average. New acceleration techniques are necessary to be able to process video. We observe that there exist a lot of parallel computation in stereo matching, and GPGPU programming becomes easy with the emergence of CUDA. The trend becomes more and more obvious to use CUDA to accelerating algorithms in Computer Vision. Naturally, we consider leveraging the great parallel computing power to speed up the reconstruction of depth maps from video sequences.

Keywords: stereo correspondence, multi-view stereo, depth maps recovery, bundle optimization, depth-level expansion, augmented reality, CUDA

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