

摘 要

二维图像中隐含的深度信息是计算机需要获取的一类有价值的信息,它不仅可以帮助计算机理解图像中场景的三维结构,而且可以在计算机做出某些判断时为其提供空间依据。从二维图像中恢复深度信息是计算机视觉的一个主要研究方向。

本文主要研究从单幅图像中恢复场景的深度信息。我们用马尔科夫随机场(Markov Random Field)来融合从待处理图像中提取出的多种深度线索,实现对该图的深度预测。基于此单幅图像深度预测算法,我们实现了图像编辑中深度一致的物体插入功能。

(1) 本文提出了一种新的深度线索——重复模式。图像中普遍存在着一些重复出现的模式,这些信息展示了图像中场景的深度变化。基于特征点检测和聚类,本文实现了区域级上的重复模式提取。重复模式深度线索通过对特征相同且位置共线的一组感兴趣点(区域)的深度与尺度之间的关系进行建模来获取。实验结果表明,在包含重复模式的图像中,加入重复模式信息能有效提高场景的深度估计性能。

(2) 本文提出了用马尔科夫随机场来融合单个区域深度线索、相邻区域深度线索和重复模式深度线索。单个区域深度线索由每个区域的自身特征和与其相邻的区域的一些特征组成;相邻区域深度线索利用每两个相邻区域的特征相似性和边界信息来获取;重复模式深度线索则利用了不相邻但深度相关的区域之间的信息来获取。本文算法以单个区域特征和区域间关系为深度线索,兼顾了图像的区域特性和整体结构,使图像中场景深度变化的延伸性和连续性在预测结果中得以体现。实验结果表明,融合多种深度线索可以提高单幅图像深度预测结果的准确性和平滑性。

(3) 本文实现了在深度一致基础上的物体插入图像编辑功能。用户可以通过界面选择目标图像和源物体,完成在一幅目标图像中插入一个或多个新物体的操作。目标图像的深度图由本文单幅图像深度预测算法计算得到。源物体在插入目标图像时,其成像大小由用户在目标图像中指定的插入点的深度决定。实验结果表明,被插入的源物体在深度和三维结构上与目标图像中的场景基本一致,合成图像表现了平滑自然的视觉效果。

关键词: 深度预测, 重复模式, 马尔科夫随机场, 物体插入

Research on Depthmap Estimation from a Single Image with Multiple Cues

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The depth information hidden in images is valuable for computer to catch. It not only helps computer understand 3-D scene structure of the images, but also provides some useful messages on 3-D space for computer. It is one of dominating research directions in computer vision that restoring depth information from 2-D images.

The primary content of this paper is restoring depth information from a single image. We integrating multiple depth cues extracted from an image with Markov Random Field to estimate depthmap of the image. In addition, we implement a function of image editing that inserting new objects into a target image with our depth estimating algorithm.

(1) Repetitive data proposed in this paper is a novel kind of monocular cue. The data occurring repetitively exists universally in 2-D images. This kind of data presents the depth change of scene in the image. Based on detecting and clustering of points of interest, extraction of repetitive data on the level of region is implemented in this paper. A cluster of points of interest with similar features and colinearity are reserved as a cluster of repetitive pattern here. The depth cue of each cluster of repetitive pattern is formulated by modeling the relation between depth and scale of the points in a cluster. Our experimental results indicate that estimated depthmap of the image that contains repetitive data is improved significantly with repetitive pattern.

(2) In this paper, Markov Random Field is proposed to integrate the depth cue of individual region, that of neighboring regions and that of repetitive patterns. The depth cue of each region is composed by features of the region and that of its neighbors. The depth cue of each pair of neighboring regions is extracted with feature similarity and boundary information of the two regions. The depth cue of repetitive pattern is extracted with the relationship among regions that are not immediately adjacent but are correlative on depth. Our algorithm uses both features of individual region and relationships among regions as depth cues, and takes both regional character and whole structure of image into account. The stretching and continuous of depth change in images are presented in our estimating depthmaps. Our experimental results demonstrate that integrating multiple depth cues will improve accuracy and smooth of result for depth estimating from a single image.

(3) A function of image editing that inserting new objects into a target image with consistant depth is implemented in this paper. Through the interface, users could choose target image and source object to complete inserting operation. Our method allows users to insert one or more new objects into a target image. The depthmap of target image is calculated by our depth estimating algorithm. When a source object is inserted into a target image, 2-D size of

the object is determined by depth value of the insert point figured out by user in target image. Our experimental results show that depth and 3-D structure of the inserted object are consistent with that of the target image, and that synthetic images are visually smooth and natural.

Keywords: depth estimating, repetitive pattern, Markov Random Field, object inserting