GrabCut+D

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1 Introduction

GraphCut is an image segmentation technique originally introduced by Boykov and Jolly [1]. This segmentation technique assigns to the image a graph structure, and finds the optimal labelling of pixels (foreground-background) that minimizes an energy function using a MaxFlow-MinCut procedure [2]

Based in the principles of GraphCut, Rother *et al.* [3] proposed **GrabCut**. This new algorithm operates in two steps:

- A Gasussian Mixture Model (GMM) is fitted to the colour distribution of the foreground and background pixels. In the initialization, this is done with the pixels (seeds) which the user identified as foreground and background.
- The energy function, which depends of the GMM, is minimized implementing a minimal cut procedure. The new labelling of foreground and background pixels is updated.

This process is iterated in order to improve the correctness of the GMM and getting the desired labelling.

GrabCut has shown good results even in complex images (where the colour distribution of foreground and background overlaps), but in most cases it still requires posterior user interaction (i.e., brushing some zones of pixels incorrectly labelled, and running the algorithm again).

2 Objectives

The information of pixel's depth (which is provided by RGBD systems like kinect) gives a powerful tool to develop accurate algorithms for image segmentation. The central objective of this project is precisely improving the performance of Grabcut introducing and adjusting a depth variable to the current model. Therefore, I expect to develop the following stages along the project :

(a) Original (b) Grabcut [1] (c) Background Removal[2]

Figure 1: Image segmentation by Graph Cut algorithms

- **Preliminary Experience**: Build a simple graph-cut algorithm whose energy function depends only on the depth information of the scene. Implement other segmentation algorithms strictly based on the depth information (e.g., gradient of depth) and compare their performances.
- **Intermediate Experience**: Explore algorithms for image segmentation which operates in two steps: A fist segmentation based on the colour distribution of scene (i.e, the standard GrabCut), and a refinement of the results applying a second segmentation based on the depth information of the scene. Algorithms inverting the order of segmentation will also be studied.
- **Final Experience**: Design and implement a segmentation algorithm (based on GrabCut) which simultaneously evaluate the depth information and the colour distributions of the foreground and background objects of a scene. In order to do this, it is necessary to compare different ways of including the depth variable in the current energy function (for instance, extending the GMMs to include depth information), and experimenting to adjust the parameters of the model.

3 Schedule

- *September 20:* Study the theoretical background of GrabCut (i.e, MaxFlows-MinCuts, Gibb's Energy Functions, GMM). Explore the software tools developed to manipulate Kinect (OpenNI, Processing) and adjust Grabcut to this environment(taking as starting point previous implementations). Develop the Preliminary Experience.

[1] Lu Wangs implementation: http://graphics.usc.edu/ luwang/research.html
[2] Tool based in GrabCut and distributed in MS Office 2010. Technical Report[4].

- *September 20 to October31:* Design a simple interaction model (based on the skeleton tracking feature of Kinect) that let the user identify the object to segment and its background (i.e., the seeding process).Implement the Intermediate and Final Experiences
- *October 31 to November 15:* Develop an interactive application that let the user specify to Kinect the object he wants to segment and implement the algorithm developed to do it. (It would be great if the application lets the user differentiate between segmenting a complete object,a component or a plane surface).
- *November 15 to November 29:* Analyse the obtained results. Build the webpage and prepare the presentation.

References

[1] Y. Boykov and M-P. Jolly. *Interactive graph cuts for optimal boundary and region segmentation of objects in N-D images.* Proc. IEEE Int. Conf. on Computer Vision, 2001.

[2] Y. Boykov and V. Kolmogrov. *An experimental comparison of min-cut/max-flow algorithms for energy minimization in vision.* IEEE Trans. on Pattern Analysis and Machine Intelligence, volume 26, pages 11241137, 2004.

[3] C. Rother, V. Kolmogorov, and A. Blake. *Grabcut interactive foreground extraction using iterative graph cuts.* Proc. ACM Siggraph, 2004.

[4] C. Rother, V. Kolmogorov, Y. Boykov, and A. Blake. *Interactive Foreground Extraction using graph cut.* Microsoft Technical Report:MSR-TR-2011-46.