LABEL RELAXATION TECHNIQUE APPLIED TO THE STABLE ESTIMATION OF A TOPOGRAPHIC PRIMAL SKETCH

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ABSTRACT

The basis of the topographic primal sketch consist of segmenting range images into surface patches according to categories defined by differential geometry operators such as the Gaussian and mean curvatures. From the sign of these invariant functions of directional derivatives, one can generate categories such as peak, pit, ridge, ravine, saddle, flat and hillside. From this initial classification, we can group these categories to obtain a rich, hierarchical, and structurally complete representation of the fundamental range image structure. In the paper, we present a novel technique where an initial estimate of the categories full of inconsistent labelling du to noise is transformed into a consistent one by label relaxation technique. We also discuss the problem of numerical stability of the Gaussian and mean curvatures and study the effects of different operators on these estimates.

KEYWORDS: Vision, Label Relaxation, Topographic primal sketch, Range image, Segmentation

Introduction

Segmentation of range images is one of the most important step in a three-dimensional object recognition system. Unlike grey scale images, segmentation of range images has a direct relationship to the properties of object surfaces. Using differential geometry Haralick [Hara 83] and more recently Besl [Besl1 86] [Besl2 86] were able to describe local properties of a surface using invariant parameters such as the Gaussian (K) and mean (H) curvatures. Using the sign of the Gaussian and mean curvatures one can segment a range image into regions corresponding to one of the eight fundamental surfaces such as peak, pit, ridge, flat, valley, saddle ridge, minimal surface and valley (see Table 1). This segmentation produce a labeled image called by Haralick a topographic primal sketch. One of the problems related to the computation of this primal sketch is the production of a stable and consistent estimation of each region as a function of noise and shadow effects inherent in any 3D sensor [Rioux 84]. In this paper we will first describe how to compute an initial estimate of the primal sketch using a mean squared evaluation technique. We will also describe how to evaluate the two thresholds for which K and H are considered to be zero. After the initial estimation of the topographic primal sketch, we will demonstrate how it is possible to further improve the sketch by using certain label consistency rules. Using relaxation labelling we will demonstrate on real range images that a stable estimation of a topographic primal is possible.

	K		
H	+	0	-
-	7 Peak	4 Ridge	1 Saddle Ridge
0	8 (none)	7 Flat	2 Minimal Surface
+	9 Pit	6 Valley	3 Saddle Valley

Table 1. : Table of surface shapes and labels from Gaussian (K) and mean (H) curvature signs.