Computing Axis of Symmetry Using Constrained High Curvature Points Matching

T. Rachidi A. Amar
Computer Science and Mathematics Division
School of Science and Engineering
Al-Akhawayn University in Ifrane
PO.BOX 104, Ifrane, 53 000
Morocco
rachidi@alakhawayn.ma

Abstract

Finding the axis of symmetry of two curves is posed as a correspondence problem between points of significant curvature along these curves. First, a novel and simple algorithm for computing points of significant curvature is developed. Its main strength is that it does not compute curvature values as such, but computes a robust indication of them. The detected points are then fed to another algorithm which integrates the computation of the parameters of the axis of symmetry (ρ, θ) in polar coordinates into the correspondence algorithm. The latter is simple and intuitive. It uses natural ordering of points of significant curvature along curves, together with constraints on the parameters ρ, and θ to establish the correspondence. The parameters of the axis (ρ, θ) are then evaluated from the positions of the corresponding pairs of points of significant curvature. This technique is robust and copes particularly well with noise as shown by the experimental results.

Keywords: *Axis of symmetry, Correspondence, Matching, Curvature, High Curvature Points, Curves.*

1 Introduction

A very widely used characteristic of objects are their symmetry sets. They have been used in image description, object recognition, stereoscopic matching, viewpoint-invariant representations [12], and as shape descriptors in model based recognition [6], *et cetera.* Axis of symmetry, in particular, have been used to segment MR images of the brain into the left and right hemispheres [11]. They are also used in Robotics for picking up objects.

In this paper we present two algorithms: The first one is a fast technique for computing points of significant curvature. The second one is a robust algorithm for computing axis of symmetry of an object, and which uses the points of significant curvature detected by the first.

2 Previous techniques

Previous techniques for computing symmetry axes can be divided into two catgories: those that use segmented images and those that don't. In [1] a voting technique is applied to non-segmented images to determine axes of skewed symmetries using local skewed symmetries. This technique suffers, however, from the number of steps necessary to yield the parameters of axes. More importantly, it suffers from the use of curvature values which are known to be sensitive to noise. In [9], moments of objects in segmented images are used to compute the axis of symmetry. Relative invariants computed from bitangents in objects are used to determine symmetry in [10]. One way of extracting symmetry sets, in general, and axes of symmetry, in particular, of segmented images is presented in [4], it consists of computing the locus of centers of circles bitangent to a plane curve. Our technique uses boundaries/curves in segmented images to determine axis of symmetry of objects.

3 Estimating curvature

Points of maximum curvature are commonly believed to be the most perceptually significant points on digital curves, and as such have been used as shape features in both 2-D and 3-D object recognition by many researchers.

In real Euclidean plane, curvature is defined as the rate of change of slope as function of an arc length $d\theta/ds$ where θ is the slope and s is the arc length. For the curve $y = f(x)$ this may be expressed as: