A Global System for Matching 3-D Range Data Objects

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Abstract:

Experimental results for matching 3-D range data objects based on a global approach is here presented. The obtained invariant parameters used for matching purposes are functions of the geometrical dimensions of the object, the second and fourth order central moments of both the object depth and the contour of its base silhouette.

A separate set of invariant parameters are calculated and stored into the matching library for each stable position for each used object. The matching system is tested on a number of real objects and was found to be fast and robust.

1. INTRODUCTION

Recognition and matching of three dimensional (3-D) objects from camera views is an important problem in image recognition. It has wide applications for robotic vision systems.

The basic idea in 3-D object recognition and matching is to describe the object by a set of parameters (primitives) and to match these parameters with sets of stored parameters for model objects. Such parameters are to be invariant under object translation, plane rotation and if possible under change of scale.

Many of the 2-D object recognition methods are extended to the recognition of 3-D objects, such as the Fourier descriptors [1,2] and the method of invariant moments [3-10]. There are also classical global methods based on the object shape and size [11-14].

Classical approaches for recognition and matching of images are not new. See for example Bacus and Gose [11] for medical application using binary images and Darling and Joseph [12] for scene analysis using gray level images. Classical statistical approaches are also used with other techniques for texture recognition. See for example Hawkins [13] and Gonzalez and Wintz [14].

In the present work, we apply a classical global approach to the problem of matching 3-D range data objects. The obtained invariant parameters used for matching purposes are functions of the shape and size of the object. We report experimental results concerning the reliability and robustness of this approach.

1.1 The invariant matching parameters

For matching purposes we calculate the following 10 invariant parameters.

(1) The volume of the object,

(2) The maximum height of the object,

(3) The object base area or its mean height,

(4) The standard deviation of the object surface depth,

(5) The standard deviation of the x and y coordinates [8] of the object surface,

(6) The (relative) maximum or the (relative) minimum moment of inertia of the object surface about axes through the point $(x_{mean}, y_{mean}, 0)$. By relative maximum or relative minimum, we mean the maximum or minimum moment of inertia divided by the volume of the object. See section 3 below.

(7) The radius of the sphere of center $(x_{mean}, y_{mean}, 0)$ which fits the object surface in a least squares sense. (x_{mean}, y_{mean}) are the (x,y)-coordinates of the object surface centroid.

(8) The standard deviation of the x and y coordinates of the contour of the base silhouette,

(9) The relative maximum or the relative minimum moment of inertia of the contour of the object base silhouette, about axes through the contour centroid. Again, here by relative we mean the maximum or minimum moment of inertia of the contour of the base silhouette divided by the number of points of the contour of the base silhouette. See section 3 below.

(10) The radius of the circle of center (x^c_{mean}, y^c_{mean}) which fits the contour of the base silhouette in a least squares sense. Again, (x^c_{mean}, y^c_{mean}) are the (x,y)- coordinates of the centroid of the contour of the object base silhouette.

Parameters 1-3 are functions of the object shape and size. As we see in section 3 below, parameters 4-6 and 8-9 are functions of different second order moments of the object surface and the contour of its base silhouette. Also parameters 7 and 10 are functions the second and fourth order central moments of the object coordinates and those of the object base silhouette respectively.