17 Perceptions of Non-planar Surfaces

17.1 Introduction

A novel technique for automated perception of a non-planar surface is covered in this chapter. From the camera image, the area of interest is extracted first using the curve tracing method and next the nature of the curve is predicted by using a piecewise linear approximation method.

17.2 Methods of Edge Detection

An edge is a contour of pixels that separates two regions of different intensities. It can be defined as a contour along which the brightness in the image changes abruptly. A very simple method for finding edges is to evaluate the directional derivatives of $g(x, y)$ in the x- and y-directions, which is known as a gradient filter; g_1 and g_2 respectively denoted as follows:

$$g_1 = \frac{\partial g(x, y)}{\partial x} \quad \text{and} \quad g_2 = \frac{\partial g(x, y)}{\partial y}$$

The resulting gradient can be evaluated by the vector addition of g_1 and g_2 and is given by

$$g = \left[g_1^2 + g_2^2\right]^{1/2} \quad \text{and phase} \quad \phi = \tan^{-1}\left(\frac{g_1}{g_2}\right)$$

A pixel is said to lie on an edge if the gradient g is above a specified threshold. Based on this concept, various types of edge detection filters are available in the literature [Clark, 1989; Gonzalez, 1993; Heijden, 1995; Fram, 1975; Marr, 1980]. The gradient filter, compass filter and Laplace filter are a few among them. The common gradient filters such as Prewitt, Sobel and isotropic filters compute horizontal and vertical differences of

local sums and reduce the effect of noise in the image data. All these filters have desirable properties of yielding zeros for uniform regions.

Computer vision systems often demand the segmentation of a scene into constituent objects, which is based on the object boundaries. The object boundary is represented by the edge, which is nothing but an abrupt change in the gray levels. A spatial derivative of the image *f*(x, y) assumes a local maximum in the direction of an edge shown in Fig. 17.1, which is used to measure the gradient of *f* along *r* in a direction θ.

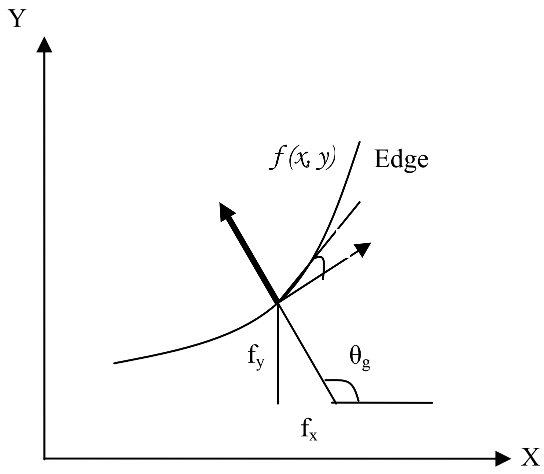

Fig. 17.1. Finding the directional derivative of the curve *f(x, y)*

$$\frac{\partial f}{\partial r} = \frac{\partial f}{\partial x} \cdot \frac{\partial x}{\partial r} + \frac{\partial f}{\partial y} \cdot \frac{\partial y}{\partial r} \qquad (17.1)$$
$$= f_x \cos \theta + f_y \sin \theta$$

The maximum value of $\frac{\partial f}{\partial r}$ is obtained when $\frac{\partial}{\partial \theta}\left(\frac{\partial f}{\partial r}\right) = 0$, i.e.