LASER RANGE FINDER DEVELOPMENT FOR 3-D VISION

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Abstract

Laser range finders can be used in a variety of geometries to match requirements of applications such as robot vision, inspection, prosthesis fabrication, CAD/CAM, computer graphics, automatic assembly and many others. This paper reviews the development of five prototypes which have specific advantages for a class of applications. One of these is based on the use of a mask with conventional TV camera lens and the others are variations of synchronized laser scanners. We are also describing a collection of 3-D images data base which we make available for computer vision researchers.

Résumé

Les capteurs de distance par laser peuvent être utilisés dans une grande variété de géométries afin de satisfaire les exigences d'applications aussi variées que la vision automatique, l'inspection, la fabrication de prothèses, la CAO/FAO, l'infographie, l'assemblage automatique et bien d'autres. Cette présentation décrit le développement de cinq prototypes ayant chacun des avantages spécifiques pour une classe d'applications. Un de ces prototypes est basé sur l'utilisation de masque à l'intérieur de lentilles de caméra vidéo, et les autres sont des variations d'une approche appelée le balayage laser synchronisé. Nous décrivons aussi une collection d'images 3D, lesquelles sont disponibles pour les chercheurs en vision automatique.

Key Words

Three-dimensional vision, laser scanner, computer vision, range imaging, three-dimensional measurement, robot vision.

Introduction

Why 3-D sensing? Mainly because 2-D pictures are projections of 3-D scenes in a 2-D space. For very constrained situations where most objects of interest are flat and have few stable positions, 2-D imaging can be tuned to extract geometrical features with enough accuracy for manipulation and inspection. Otherwise, the 2-D projections of the 3-D objects are ambiguous. They are subject to modifications with any change of the illumination source, its spectral characteristics, or its orientation relative to the scene and/or camera. The projected contours in 2-D imaging also change with a change in the orientation of the object, a translation in the field of view, and with position of nearby objects which scatter incident light on the object of interest. A change in distance from the camera produces a scaling effect that must be taken into account at the image processing stage. As the processing is based on intensity data, in addition to the geometrical effects, the surface properties such as color and texture will modify the value of each pixel and their relationship to each other.

What motivates research in this direction is that the eye-brain system in humans has resolved the difficulty of 3-D reconstruction and as a consequence researchers know that it is possible to make sense from 2-D imagery. How is it done? Answering this question will require many more years of research. But it must be remembered that the task is complex.

In contrast, 3-D imagery keeps the invariance properties of 3-D objects. The relationship between pixels is invariant with rotation and translation. With structured light approaches, for example, the 3-D data are insensitive to background illumination and to surface color and texture of the object. These invariant properties, combined with the absence of scaling effects, make the image processing tasks easier. Although it seems more difficult, computer processing of 3-D data is greatly simplified.