MATHEMATICAL MORPHOLOGY APPLIED TO RANGE IMAGE PROCESSING

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ABSTRACT

Methods of low level image processing have predominantly been derived by generalizing one dimensional signal processing methods to 2 dimensions. Although much progress has been made using Fourier domain analysis, it is still unintuitive and inflexible for many types of applications. This paper reviews mathematical morphology as a basis for low level image processing, and demonstrates that image domain transformations can be applied usefully to various types of images. Specifically, range images are processed using grey scale morphology to extract various features used in three dimensional analysis of a scene. This type of scene analysis has broad potential for applications in quality control and automated manufacturing.

RESUME

Le traitement primaire d'image a traditionellement été inspiré des méthodes de traitement de signaux en les généralisant pour deux dimensions. Le traitement basé sur l'analyse dans le domaine de Fourier a permis d'important progrès mais défie l'intuition et demeure trop peu flexible pour nombre de problèmes.

Nous faisons ici un compte rendu des applications de la morphologie en tant que base d'analyse primaire de l'image en l'appliquant a diverses classes d'images. Plus précisement, des images tri-dimensionelles sont traitées par la méthode morphologique en tons de gris pour extraire divers éléments propres à l'analyse de scenes tri-dimensionelles.

Cette classe d'analyse ouvre un large éventail de possibilités dans les applications de contrôle de qualité et de fabriquation assistée par ordinateur.

I. INTRODUCTION

The arrival of mathematical morphology for image processing has allowed North Americans to reconsider their approach to image transformation. Transform domain techniques, like the Fourier transform, used to decompose an image into constituent spatial frequencies, grew out of classical one dimensional signal processing where the dominant analytical theme is linear transformation. Conventional image processing extended the subject base to two or more dimensions, but the paradigm remained one of filter design for removal of noise and enhancement of visual fidelity.

A morphological approach allows the designer of vision systems a ubiquitous tool to perform image transforms in the image domain, using the algebra of shapes. Although the morphological treatment of images has been studied for more than 50 years, its recent popularization is due mostly to Serra (1), and Sternberg (2) (3), the latter introducing greyscale morphology.

The use of mathematical morphology has overcome several obstacles in the development of industrial vision systems. Mathematical morphology is first of all a mathematics of image transformation and analysis, thus it forms the basis for a powerful language of image processing. This language is not only powerful, it is intuitive, and can be understood visually while developing image processing algorithms interactively. As a general purpose method of image transformation, all types of images can be processed regardless of the sensor used to collect the image. Satellite, microscope, x-ray, T.V., ultrasound, tactile array sensors, laser range finder images, etc., can all be transformed productively using mathematical morphology. This paper describes the basic operations of how to transform an image with a shape, calling on the readers intuition instead of the mathematical basis of the transformations which are exhaustively described in (1) and (4). We will demonstrate, using figures, transformations on binary and grey scale images, including images acquired using a laser range finder. It will be pointed out that these morphological transforms can be used for low level (data driven), and high level (model driven) aspects of industrial applications.