A Study of Image Engineering

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INTRODUCTION

Images are an important medium from which human beings observe the majority of the information they received from the real world. In its general sense, the word "image" could include all entities that can be visualized, such as a still image, video, animation, graphics, charts, drawings, even also text, and so forth. Nowadays, "image" rather than "picture" is used because computers store numerical images of a picture or scene. Image techniques, which are expanding over wider and wider application areas, have attracted more and more attention in recent years. Image engineering (IE), an integrated discipline/subject comprising the study of all the different branches of image techniques, is evolving quickly.

From 1969 to 2000, a well-known bibliography series had been developed to offer a convenient compendium of the research in picture processing until 1986, as well as in image processing and computer vision after 1986. This series has been ended in 2000 by the author after a total of 30 survey papers were published (Rosenfeld, 2000a). Some limitations of this series for the termination are (Zhang, 2002b):

1. No attempt is made to summarize the cited references for each year.
2. No attempt is made to analyze the distributions of the selected references from various sources.
3. No attempt is made to provide statistics about the classified references in each group.

Another survey series, but on IE, has been started since 1996 (Zhang, 1996a, 1996b, 1996c, 1997, 1998, 1999, 2000a, 2001a, 2002a, 2003, 2004, 2005). The purpose of this survey work is mainly to capture the up-to-date development of IE, to make available a convenient means of literature searching facility for readers working in related areas, and to supply a useful reference for the editors of journals and potential authors of papers. This new series overcame the weakness of the earlier mentioned one by summarizing the cited references for each year, analyzing the distributions of the selected references from various sources, and providing various statistics about the classified references in each group. This new survey series has already made consecutively for ten years. This article will present an overview of this survey series by showing the idea behind and consideration on this work as well as the comprehensive statistics obtained from this work.

BACKGROUND

Image Engineering

IE, from a perspective more oriented to technique, could be referred to as the collection of three related and partially overlapped groups of image techniques, that is, image processing (IP), image analysis (IA), and image understanding (IU). In a structural sense, IP, IA, and IU build up three interconnected layers of IE as shown in Figure 1. Each of them operates on different elements (IP's operand is pixel, IA's operand is object, and IU's operand is symbol) and works with altered semantic levels (from low at IP to high at IU).

Figure 1. Three layers of image engineering
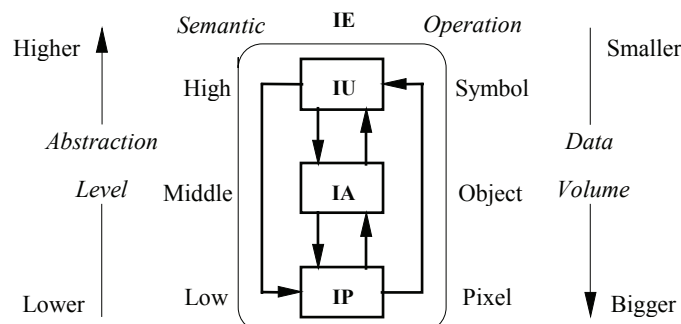
The three layers follow a progression of increasing abstractness and of decreasing compactness from IP to IU.

IP primarily includes the acquisition, representation, compression, enhancement, restoration, and reconstruction of images. While IP is concerned with the manipulation of an image to produce another (improved) image, IA is concerned with the extraction of information from an image. Compared to IP which takes an image as input and outputs also images, IA takes also an image as input but outputs data. Here, the extracted data can be the measurement results associated with specific image properties or the representative symbols of certain object attributes. Based on IA, IU refers to a body of knowledge used in transforming this extracted data into certain commonly understood descriptions and for making subsequent decisions and actions according to the interpretation of the images.

Related Subjects

IE is a broad subject encompassing studies of mathematics, physics, biology, physiology, psychology, electrical engineering, computer science, automation, and so forth. Its advances are closely related to the development of telecommunications, biomedical engineering, remote sensing, document processing, industrial applications, etc. (Zhang, 2002b).

According to different science politics/perspectives, various terms such as computer graphics (CG), pattern recognition (PR), computer vision (CV), scene analysis (SA) (just counted as another name of CV, see Rosenfeld, 2001) *etc*., are (partially) overlapped with IP, IA, and/or IU. A diagram describing the relationship among the earlier-mentioned subjects is given in Figure 2. Images are captured from the real world and processed to furnish the basis for IA or PR. The former produces data that can be visualized by CG techniques while the latter continually classifies them into one of several categories. Results produced by both of them can be further interpreted for human beings to understand the real world. The whole process aims to make computers capable of understanding environments from visual information, which is also the purpose of CV/SA.

THE CURRENT "PICTURE" OF IMAGE ENGINEERING

What is the current "picture" of IE? Answering this question is the foremost intention of the new survey series. For such a purpose, selection of reference source and classification of references according to contents are two important factors. Also for such a purpose, three statistics made by this survey are illustrated in the following.

Classification Scheme

The classification scheme used in the bibliography series should reflect the contents of references. A classification problem can be considered as a problem of partitioning a set into subsets. An appropriate classification of references into groups and/or sub-groups should satisfy the following four conditions:

1. Every reference must be in a group.
2. All groups together could include all references.
3. The references in the same group should have some common properties.
4. The references in different groups should have certain distinguishing properties.

Taking into consideration these conditions and the status of development in the field, a complete and compact classification of the theories and techniques of IE is proposed and listed in Table 1 (Zhang, 2002b). It is easy to verify that these conditions are fulfilled by this classification.

Figure 2. Image engineering and related subjects
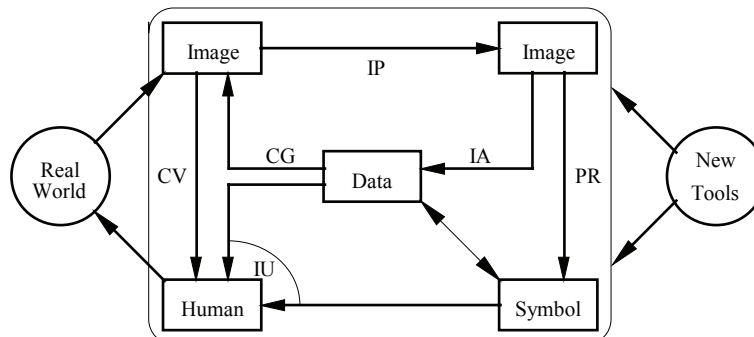
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