Statistics on Image Engineering Literatures

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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 by human eyes, such as a still image or picture, a clip of video, as well as graphics, animations, cartoons, charts, drawings, paintings, even also text, *etc*. Nowadays, with the progress of information science and society, "image" rather than "picture" is used because computers store numerical images of a picture or scene.

Image techniques are those techniques that have been invented, designed, developed, implemented and used to treat various types of images for different and specified purposes (Zhang, 2009b). They are expanding over wider and wider application areas. They have attracted more and more attention in recent years with the fast advances of mathematic theories and physical principles, as well as the progress of computer and electronic devices, etc. Image engineering (IE), an integrated discipline/subject comprising the study of all the different branches of image techniques, which has been formally proposed and defined around 20 years ago (Zhang 1996a; Zhang 1996c) to cover the whole domain, is evolving quickly.

In the history, a well-known bibliography series to some related image techniques had been developed to offer a convenient compendium of the research in picture processing from 1969 till 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, 2000). Some limitations of this series are (Zhang, 2002b):

1. No attempt was made to summarize the cited references for each year.

2. No attempt was made to analysis the distributions of the selected references from various sources.
3. No attempt was made to provide statistics about the classified references in each group.

Another survey series, but on IE (with more wider coverage in the contents), have been started since 1996 and have been made already for consecutive 18 years (Zhang, 1996a; Zhang, 1996b; Zhang, 1997; Zhang, 1998; Zhang, 1999; Zhang, 2000a; Zhang, 2001; Zhang, 2002a; Zhang, 2003; Zhang, 2004; Zhang, 2005; Zhang, 2006; Zhang, 2007; Zhang, 2008a; Zhang, 2009a; Zhang, 2010; Zhang, 2011a; Zhang, 2012, Zhang, 2013). The summaries for several stages of this survey series can be found in (Zhang, 2000b; Zhang, 2002b; Zhang 2002c; Zhang 2008b; Zhang 2011b).

The main purpose of this survey work is triple, that is, 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 overcome the weakness of the above-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 subject group. This new survey series has already made consecutively for eighteen years. This article will present an overview of this survey series by showing the ideas behind and consideration on this work, as well as the comprehensive statistics obtained from this work. Some insights from it are also discussed.

BACKGROUND

For image engineering, a new discipline, the scope and related subjects are first described.

Scope of IE

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) techniques, Image Analysis (IA) techniques and Image Understanding (IU) techniques. In a structural sense, IP, IA and IU build up three inter-connected 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, via middle at IA, and to high at IU). The three layers follow a progression of increasing abstractness (left up arrow) and of decreasing compactness (right down arrow) from IP to IA to IU.

The techniques covered by IP primarily include 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, the techniques covered by IA are more concerned with the extraction of information from an image (especially from the objects in it). Compared to IP that takes an image as input and outputs also images, IA takes also an image as input but outputs data extracted from input. Here, the 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 the data into certain commonly understood descriptions, and for making subsequent decisions and actions according to the interpretation of the image contents.

Related Subjects

IE is a broad subject encompassing studies related to mathematics, physics, biology, physiology, psychology, electrical engineering, computer science, automation, *etc*. Its advances are closely related to the development of telecommunications, biomedical engineering, remote sensing, document processing, industrial applications, *etc*. (Zhang, 2002b; Zhang, 2013).

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 above-mentioned subjects is given in Figure 2. Images are captured from the real world and processed (with IP techniques) 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.

Figure 1. Three layers of image engineering
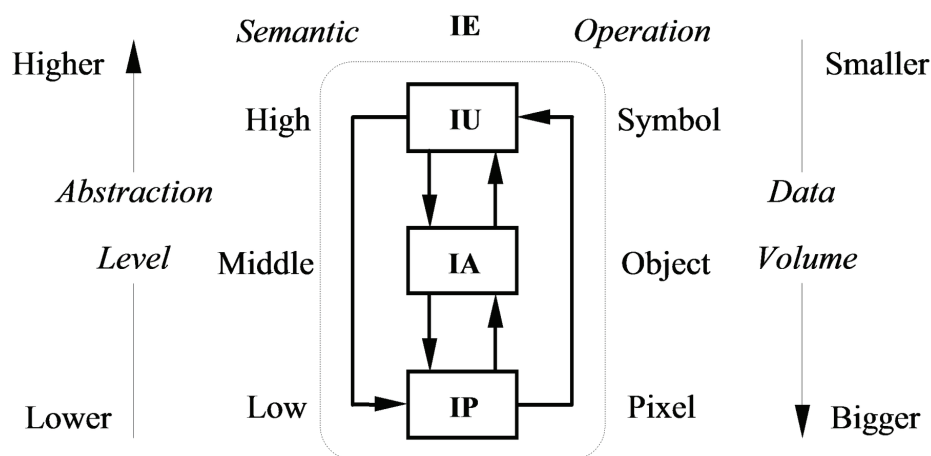
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