Development of Image Engineering in the Last 20 Years

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INTRODUCTION

In recent years, images become more and more an important medium for human beings to observe the information of the real world around. Images can be obtained by using different observing and capturing systems in various forms and manners. The human visual system is just a typical example of an observation system. 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 animations, cartoons, charts, drawings, graphics, paintings, even also texts and visual patterns, etc. In the early days, images were called pictures. Nowadays, with the progress of information science and society, the term "image" rather than "picture" is generally used because computers store numerical images of a picture or scene.

Image techniques are those techniques that have been invented, designed, implemented, developed, and utilized to treat various types of images for different and specified purposes (Zhang, 2009b). The researches and applications based on images are turned out to be a hot spot in the modern information society. 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, has been evolved very quickly. Image engineering is now a very broad subject encompassing mathematics, physics, biology, physiology, psychology, electrical engineering, computer science, automation, etc. Its advances are also closely related to the development of telecommunications, biomedical engineering, remote sensing, surveying and mapping, document processing, industrial applications, etc.

Twenty years ago, a bibliography series on IE have been started. With a set of carefully selected journals and a thoroughly reading on the papers published, several hundreds of papers related to IE are chosen each year for further classification and statistical analysis. This work has been made already for consecutive 20 years (Zhang, 1996a; Zhang, 1996b; Zhang, 1997; Zhang, 1998; Zhang, 1999; Zhang, 2000; Zhang, 2001; Zhang, 2002; Zhang, 2003; Zhang, 2004; Zhang, 2005; Zhang, 2006; Zhang, 2007; Zhang, 2008a; Zhang, 2009a; Zhang, 2010; Zhang, 2011; Zhang, 2012; Zhang, 2013; Zhang, 2014a; Zhang, 2015). The last summary of this survey series can be found in (Zhang, 2014b).

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 series summarize the selected papers for each year, analyzes the distributions of the selected papers from various sources and provides various statistics about the classified papers in each subject group. This paper will present an

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overview of this survey series by showing the ideas behind and considerations on this work, as well as the comprehensive statistics obtained from this work. Some insights from it are also discussed.

BACKGROUND

For image engineering that is a new discipline, its scope is first described.

IE, from a perspective more oriented to techniques, could be referred to as the collection of three related and partially overlapped groups of image techniques, that is, Image Processing (IP) techniques (in its narrow sense), 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.

STATISTICS ON IMAGE ENGINEERING LITERATURES

After many years of development, IE (including IP, IA, and IU) has been greatly progressed. What is the current "picture" of IE? Answering this question is the foremost intention of this survey series. For such a purpose, the selection of suitable reference sources and the classification of selected references according to their contents are two important factors. Also for such a purpose, two statistics made by this survey are illustrated in the following.

Selection of Reference Source

As with any other emerging discipline, a large number of references related to IE have been published worldwide. They appear in books

Figure 1. Three layers of image engineering