A Knowledge-Based Approach To Computer Vision Systems

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Abstract

In designing and constructing computer vision systems, many crucial issues need to be addressed. Foremost of these are the control and organization of the visual information processing tasks involved, and the representation and usage of both knowledge and data. As computer vision systems have evolved, growing in complexity and size, these issues have become increasingly important to their overall success. In this paper, a recent and increasingly popular approach to image understanding, the knowledge-based system, is presented as a framework in which to deal with these issues. The engineering of a computer vision system as a knowledge-based system and these issues, in the context of our evolving system is discussed.

Résumé

Lors de la conception et de la mise en oeuvre d'un système de vision par ordinateur, plusieurs questions critiques doivent être considérées. Principalement, il s'agit du contrôle et de l'organisation des tâches de traitement d'information visuelle ainsi que de la représentation et de l'usage des données et des connaissances. Parce que les systèmes de vision par ordinateur ont évolué en grandeur et en complexité, leur succès dépend de plus en plus de ces questions. Dans cet article, une approche nouvelle et de plus en plus populaire à la compréhension d'images, le système basé sur les connaissances, est présentée en tant que cadre de travail pour traiter ces questions. La réalisation d'un système de vision par ordinateur par le biais d'un système basé sur les connaissances ainsi que ces questions sont traitées dans le contexte de notre système en évolution.

1. Introduction

A visual technology capable of replicating human vision is the ultimate achievement for computer vision. To be able to accomplish such a feat would require a far superior understanding of the functioning of the human visual system. Moreover, this would require the embodiment of intelligence in a machine. Undaunted by these severe limitations in understanding, computer vision has developed over the past twenty-five years in a somewhat ad hoc fashion. The growth of this infant technology in conjunction with its maternal science of artificial intelligence has led to the emergence of computer vision systems. Albeit they are far from being general vision systems [+] they are at present the best and only available artificial approximation.

The earliest computer vision system, pioneered in the mid 1960's by Roberts [Roberts65], was capable of analyzing simple polyhedral scenes and matching the located polyhedra to stored models. Since then, computer vision systems have attained greater complexity due to the increasingly complex scenes being analyzed, as witnessed in the prominent systems of today. (See [Binford82] and [Shapiro83] for surveys on some of these systems.) In association with this increase in complexity, the control and organization of these systems have evolved from simple sequential bottom-up or top-down mechanisms into complex structures involving many levels of cooperative processes, as the amount of knowledge required to reason about the analysis increases. As these complex visual information processing systems become more ambitious, it is clearly evident that the organization and control aspects will also become increasingly more significant to their overall success.

Control of vision systems have tended to be heavily embedded within the organization of the visual processes. Such procedural methods are reliable and fast, but are very rigid in that they are application specific. Subject to variations in the goal description or the task domain, the appropriate alterations to the procedural knowledge may become a major task. Also, if the images to be analyzed consist of complex structures and great intra-class variations, a sequence of analysis cannot be reliably predetermined. Thus the analysis is necessarily data-driven, implying the need for a flexible and adaptive control struc-

[+] By general it is meant in the same sense as the human visual system, capable of multiple objectives in a dynamic, unconstrained and complex visual environment.