Knowledge Acquisition for Image Analysis using a Hypermedia Interface

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Introduction

Knowledge acquisition is a common problem in knowledge based computer vision applications. Approaches in vision knowledge engineering are mainly characterised by manual programming by highly skilled programmers. The domain specific data and structures are described by explicitly declared objects and relations in terms of predicate logic, object oriented or rule based programming. As a result some typical problems have arisen:

- It is almost impossible for the knowledge engineer to follow the structure of a large knowledge base, i.e. a complex outdoor scene description.
- The knowledge base consistency and completeness examination is non-transparent during manual programming and editing of knowledge base contents.
- In most cases some fragments of low-level information, i.e. some metric features like edge length, area of house roof, colour components of tree crown etc., have to be extracted directly from image data.

In this paper we describe an approach to solve knowledge acquisition problems for a variety of image processing and analysis tasks. It provides facilities to obtain interactive image features, build domain oriented knowledge bases, edit already obtained data and support queries on knowledge base contents. A modified World Wide Web browser is used as interface to the knowledge engineer.

This approach was inspired by a number of image analysis applications based on AI techniques and our experiences during the design of an information system for our institute. Typical task domains include 3D modeling and automatic generation of parameters and sequences of image processing operators.

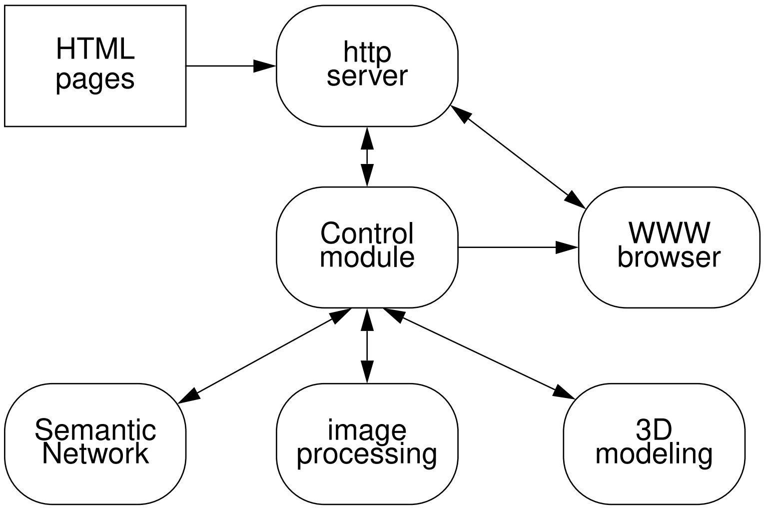

Fig. 1: Structure of the system

Requirements

The facilities which should be provided by a knowledge acquisition tool in the area of knowledge based computer vision systems are:

- to enable direct user access to the images and image features,
- to allow extensive access to explanation information on image processing and domain specific areas,
- to visualise instantly the current stage of extracted geometrical and conceptual knowledge,
- to use domain dependent background knowledge to direct the knowledge elicitation towards the specific application goal,
- to encode elicited knowledge directly into the specific knowledge representation scheme for the application system,
- during the acquisition process to validate the knowledge base consistency using domain relevant constraints and indicate possible incompleteness and incorrectness,
- to allow easy access to knowledge data at all levels for inspection, management and alteration.

Hypermedia Interface

During the knowledge acquisition process the user of a knowledge acquisition tool has to answer a lot of questions and to provide detailed information about the image processing task, about image features and about the application domain. Since it is desireable, that an application domain expert is capable of accomplishing the knowledge acquisition task himself, the interface of a knowledge acquisition tool must provide all information necessare for the user to understand all the questions he may be asked.

In the past few years hypermedia help systems have become very popular. One of the latest developments in hypermedia systems are browsers for the World Wide Web (WWW). These browsers are capable of displaying text, images, video sequences, to play audio files etc. from information sources distributed all over the world in the huge network called Internet. Such, WWW browsers seem to be the perfect help system for nearly any computer software, including knowledge acquisition tools.

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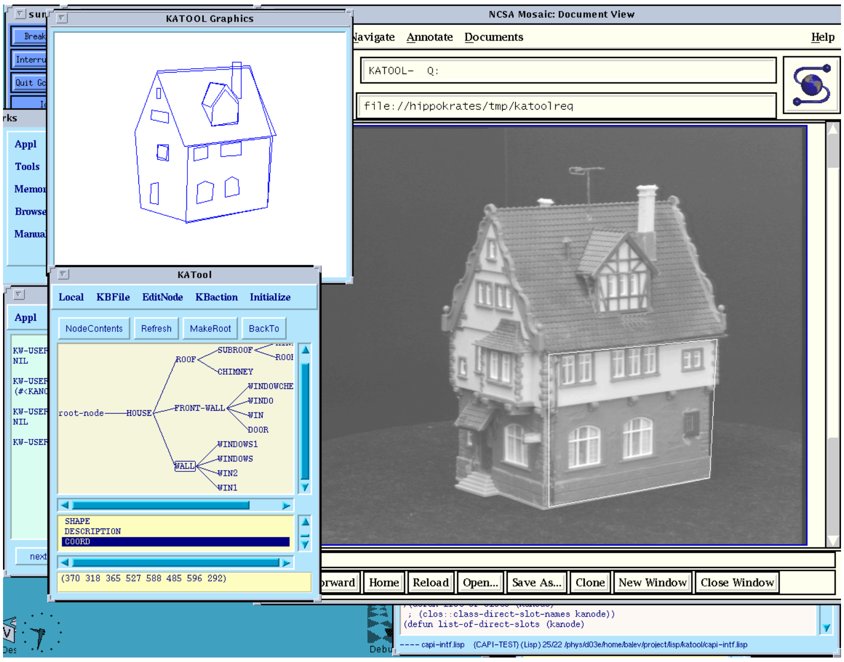

Fig. 2: Snapshot during a knowledge acquisition session

The remaining problem is to link the knowledge acquisition tool and the hypermedia help system together, so that the help system is able to obtain the information needed by the user. To solve this problem we have tried to revert the relation between the help system and the application. The help system is no longer part of the application, but the application ist part of the help system. Such, the help system controls the application.

Structure of the system

The system consists of the following main parts:

- image processing and 3D-analysis modules written in C/C++ (TopPic, Tipi, oGeM),
- a module for storage and retrieval of sematic networks written in CLOS/ LISP (Frames package),
- a central module containing the control knowledge,
- the user interface consisting of HTML pages, an http server and a Mosaic browser.

Application specific knowledge is stored in special image processing functions, in the control knowledge and in HTML pages. The user starts by selecting the appropriate HTML pages for his image processing task. He is then successively guided through the knowledge acquisition phase by the information provided with the HTML pages. During this phase, the system gains all domain-specific knowledge necessary to solve the current task.

The central control module is started automatically by the http-server triggered by the user‘s retrieval of a certain HTML-page. It is activated by the http-server at any time special information from the knowledge bases are needed or special actions, e.g. image processing tasks, shall be performed.

After the domain-specific information is complete, the user starts the current task, e.g. the modeling of a house, by selecting the appropriate options from an HTML page. The results of the task are presented by the WWW browser and special browsers e.g. for textured 3D-models.

Results

Our approach incorporates a knowledge representation environment and a hypermedia help browser. The experiments show, that a hypermedia interface together with well structured help information is a promising way to hide the complexity of a knowledge based system and to guide the user through the knowledge acquisition process.

Experiences have shown, that the main problem of our attempt are limited capabilities of the WWW browsers and servers. For our task we made special extensions to these tools to support several types of selections in images and to support the interaction with the knowledge based system itself. However, a lot of other extensions are needed, e.g. to support 3D input and output and to support visualization of Semantic Networks. Moreover, the technical realizations of the remote control interfaces of WWW browsers have certain limitations, which embarras the access to the browsers from other applications.

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