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LAYLAB:
A Constraint-Based Layout Manager for Multimedia Presentations

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LAYLAB: A Constraint-Based Layout Manager for Multimedia Presentations

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Abstract

When developing advanced intelligent user interfaces composing text, graphics, animation, hypermedia etc., the question of automatically designing the graphical layout of such multimedia presentations in an appropriate format plays a crucial role. This paper introduces the task, the functionality and the architecture of the constraint-based multimedia layout manager LayLab.

Contents

1 Introduction

Due to the growing complexity of information that has to be communicated by current AI systems, there comes an increasing need for building sophisticated intelligent user interfaces that take advantage of a coordinated combination of different media and modalities, including graphics, canned and generated text, animation, hypermedia, virtual realities etc., to produce a flexible and efficient information presentation. Therefore, to communicate generated multimodal information to the user in an expressive and effective manner, a knowledge-based layout component should be an integral element of each intelligent multimedia presentation system. A layout manager has at its disposal a wide range of multimedia output and will seek to combine these to best effect. In order to achieve a coherent and consistent output, it must be able to reflect certain semantic and pragmatic relations specified by a presentation planner [Rist & André 93].

As with many other interesting AI design problems, the determination of an aesthetically pleasing layout can be viewed as a discrete combinatorial problem. In this paper, we will illustrate the exploitation of advanced constraint processing techniques such as constraint hierarchies, intelligent backtracking mechanisms and incremental compilation by the example of the *LayLab* testbed system [Graf 92], the automatic layout manager of the multimedia presentation system *WIP* (Knowledge-based Presentation of Information, cf. [Wahlster et al. 92,André et al. 93]). LayLab addresses a dynamic adaptation of multimedia presentations to achieve an expressive and effective output with high coherence. Here, we view layout as an important carrier of meaning.

2 Related Research

As graphics hardware becomes more and more sophisticated, computer-based multimedia communication achieves a crucial role in intelligent user interfaces (cf. [Sullivan & Tyler 91,Ortony et al. 92,Catarci et al. 92,Maybury 93]). While much work in this area has been focused on the automatic synthesis of graphics, the automatic layout design of multimedia presentations has only recently received significant attention in artificial intelligence research. Some interesting early efforts focused on rules and design grids to automating display layout (e.g., [Beach 85,Feiner 88]). Recent approaches investigate more sophisticated techniques such as constraint-based and case-based reasoning methods for representing graphical design knowledge (e.g., [MacNeil 90,Graf 91]). The importance of a deeper treatment of multimodal constraints in information presentation in order to address the ergonomic aspects of layout has also been stressed by [Dale 92].

Further representative research related to in this paper entered the area between interactive graphics and constraint systems, e.g., the constraint-oriented simulation laboratory *ThingLab* [Borning 81,Maloney et al. 89] developed at Xerox PARC. Up to now only rudimentary work has been done in the area of layout of dynamic presentations. *Animus* [Duisberg 87] is one of the first systems that allows for easy construction of an animation with minimal concern for lower-level graphics programming. Here temporal constraints are used to describe the appearance and structure of a picture as well as as how those pictures evolve in time. In an application of the *Kaleidoscope* language [Freeman-Benson 90], temporal constraints are used to update the display of graphical objects which are manipulated by mouse actions interactively and maintain their consistency requirements.

The importance of the text layout dimension has also been stressed by recent work at USC/ISI [Hovy & Arens 91] that involves the generation of formatted text exploiting the communicative function of so–called textual devices.

3 Adaptive Multimedia Layout

A fundamental goal of our work is to construct a universal framework for automatic layout management, as an integrated component of a multimedia presentation system, that makes intelligent use of human visual abilities and design parameters whenever arranging multimedia output in any kind of presentation. Thus, from the functional viewpoint the main task of a knowledge-based layout manager is to convey certain semantic and pragmatic relations specified by a presentation planner to arrange the visual appearance of a mixture of multimedia fragments delivered by media-specific generators, i.e., to determine the precise size of the individual layout elements and the exact coordinates for positioning them in the presentation space (see Fig. 1). LayLab deals with page layout as a rhetorical force, influencing the intentional and attentional state of the reader.

One of our major design goals is the generation of highly adaptive interfaces which can be tailored to the needs and requirements of an intended target audience and situation. So, the generation of a layout is controlled by a set of design parameters such as user's layout preferences, presentation type, presentation intention, output mode (incremental vs. complete only), resource limitations, output medium, and more.

4 The Architecture of the LayLab System

The design of LayLab's conceptual architecture follows a modular approach embedding a positioning component, a grid generation module, an intelligent typographer, a document beautifier and an interaction handler (see Fig. 2).

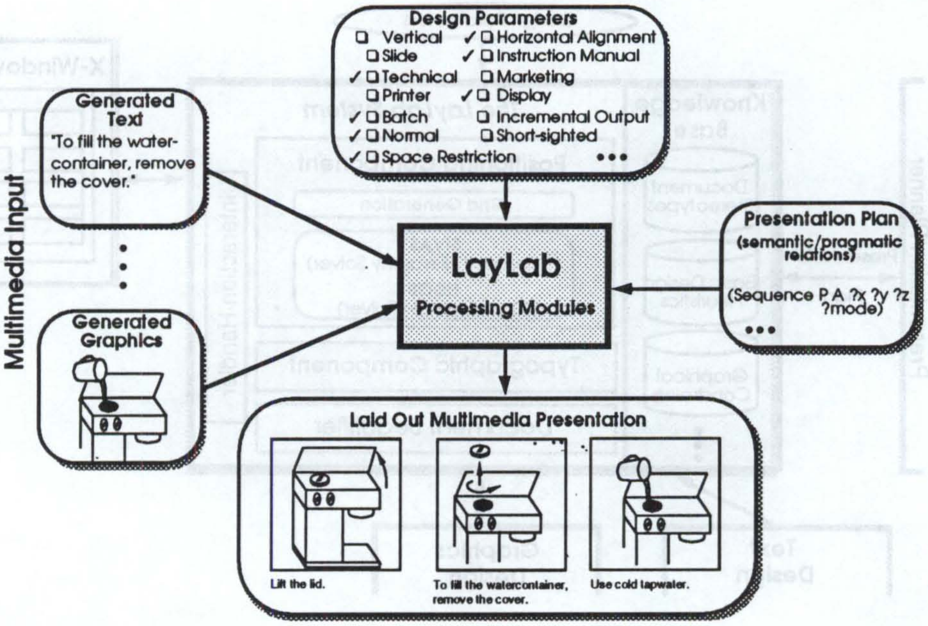

Figure 1: A Functional View on LayLab

A central idea underlying automatic layout of multimedia presentations is the incorporation of application domain-specific knowledge as well as commonsense knowledge about basic design heuristics into the design process, i.e., an encoding of procedural and declarative geometric knowledge (cf. also [Graf 92]). We use automatically generated superimposed grid structures as an ordering framework for efficiently designing functional layouts. As has been proven in previous work (e.g., [Graf 91]), constraint processing techniques provide an elegant mechanism to specify layout requirements in graphical environments as well as to declaratively state design-relevant knowledge about heterogeneous geometrical relationships, characterizing properties between different kinds of multimedia items that can be maintained by the underlying system.

Therefore, Laylab exploits a sophisticated constraint solver model comprising two dedicated solvers for handling different kinds of graphical constraints defined on constraint hierarchies and finite domains. An incremental constraint hierarchy solver based on the *DeltaBlue* algorithm [Freeman-Benson et al. 90] and a domain solver that handles finite domains using forward checking (cf. [Hentenryck 89]) are integrated in a layered model and are triggered from a common meta level by rules and defaults. The underlying constraint language is able to encode graphical design knowledge expressed by semantic/pragmatic, geometrical/topological, and temporal relations. As in interactive graphical environments constraints frequently have only local effects and the constraint solver must be capable of finding solutions without reducing the direct manipulation responsiveness, they have to be incrementally generated by the system on the fly. The text layout problem has also been addressed

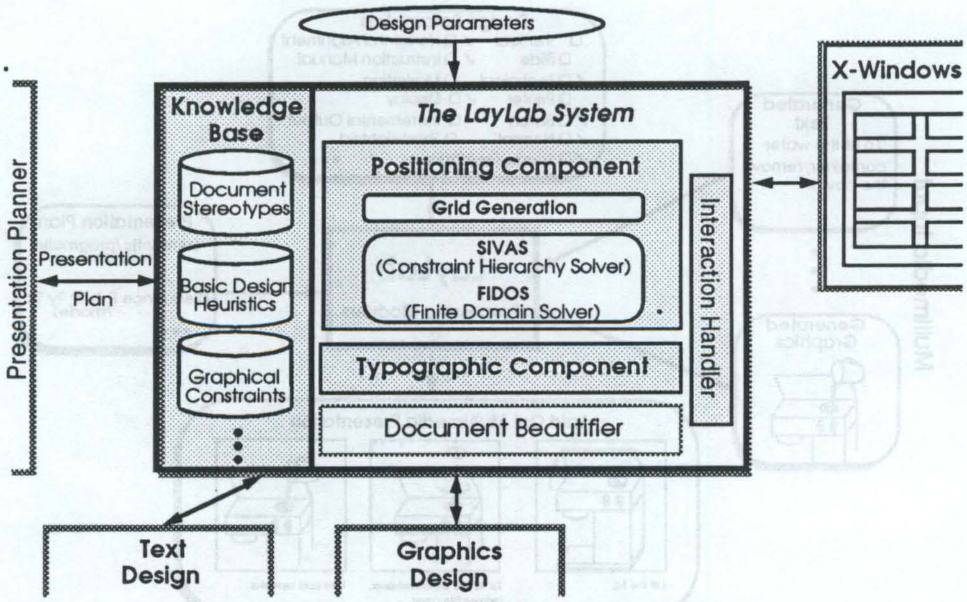

Figure 2: The Architecture of LayLab

by a constraint-based approach. Here, high-level specifications of relations between textual devices are expressed by constraints which can be compiled into low-level text formatting routines.

5 Integration and Implementation

Considering this architecture, a complete layout design is achieved stepwise via a refinement process. So, layout considerations can influence the early stages of the presentation planning process and constrain the media-specific generators. To handle dependencies between content generation and layout generation, WIP enables bidirectional communication to take place between the layout manager and the presentation planner. In case a revision of layout is deemed necessary layout manager and presentation planner must negotiate.

A prototype version of the LayLab system has been implemented on a Symbolics XL 1200 Lisp machine and several MacIvory workstations under Genera 8.0 using Symbolics Common Lisp/CLOS and Flavors for object-oriented interface programming and it is fully integrated in the overall WIP system.

6 Conclusions and Future Work

As a first step towards a conceptual framework for managing layout of multimedia presentations we have outlined the architecture of the multimedia layout manager LayLab. While the previous work has concentrated on constraint formalisms for supporting the layout design of static text-picture presentations, most of our current research is concerned with generalizing this constraint-based approach towards interactive layout design including further modalities like dynamic and canned presentation parts (e.g., hypermedia, animation, video). Here, the layout manager will be concerned with arranging the generated multimedia output as well as managing the interface to the user and the application. Since animated multimedia presentations can enhance the effectiveness and expressiveness of both, the visualization of the incremental layout process and dynamic application scenarios, animated layout is another area of our future research. A next version of the system will allow the user to tailor the interface to his needs by editing incrementally laid out presentations, changing default layout schemata interactively or working on virtual displays.

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