INTERACTIVE INTERNET-BASED INVESTIGATION OF EXPERIMENTAL AND SIMULATED MULTIMEDIA DATASETS

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ABSTRACT

Interactive presentation and investigation of dynamic rheological experimental and simulated data sets is a complex process, due to the dynamic data interrelation, beyond typical network and synchronization difficulties. Presentation and synchronization problems have already been tackled using computer-game technologies and multimedia databases. We now focus particularly on the case where the application has to dynamically handle changes at runtime, in an attempt to address the problem of direct data interaction. This paper presents a framework and a model which are used to develop a visual interactive mechanism. This, based on visual metadata representations, is directly related to the underlying system-graph formally describing content-connectivity, and it supports discussion-based data combinations, user-driven scenarios and can trigger automated simulation execution for missing content. Under this content a novel user-interaction structure (Multi-Menus) is introduced, allowing valid-only data comparison across the vast number of possible results combinations. To demonstrate system-flexibility, an industrially based multimedia case study is presented, featuring experimental and simulation dough-kneading data sets.

KEYWORDS

Multimedia metadata, Interaction, Internet, Multi-Menus

1. INTRODUCTION

This work introduces a user interface for interactive multimedia presentation of scientific and rheological data. The multimedia content is the end-result of simulation or experimental studies and is provided in visualised post-processed form. Added complication is introduced as data are calculated and delivered by multiple research groups, working in parallel. Each group employs individual methods to represent the data. Experimental and simulation results generate a variety of investigation areas, introducing a large number of variables. Under the current case study, results are generated for model fluids in a two-dimensional (2D) setting. Further investigations included 3D and free-surface modeling. The simulation results at each stage are validated against those obtained from actual kneading experiments. Fully and part-filled cases were considered, in vertical and horizontal mixer orientations.

A substantive goal has been to deliver comprehensive Multi Media System (MMS) functionality, both as a stand-alone system and over the Internet, via a single, multi-purpose implementation termed as “Multi-Menus” (MM). MM is a user-interface construct, superior to alternative content/context-linking mechanisms. From the user perspective this allows the reduction of time and cost of mixing by appropriate adjustment of stirrer design. From the computer-science view, the task combines elements of content-organisation, interactivity, user-interface development and various levels of content-connectivity.

2. FRAMEWORK, MODEL AND MULTI-MENUS

Previous research has introduced a combined multimedia organisation and presentation framework (Deliyannis, 2002a), where interaction is classified between developers, users and observers in the production and use stages of an MMS. An overlapping set-diagram representation describes the relationships between the various groups, while a model describes content-connectivity using dynamically adapted graphs (Deliyannis, 2002b). The model transforms the system specification into an MMS by accommodating the multifaceted presentation requirements introduced with complex scientific-data (Deliyannis, 2006).

MM relies on the Scientific Interactive Multimedia Model (SIMM), which addresses the issue of content and context connectivity through abstraction. Indexes encapsulating multimedia frames are used instead of individual media components and interrelationships between them. Each frame contains multiple media elements, such as text, sounds, images and meta-data, which are created automatically or inserted manually in XML format. At this abstracted level, interrelated content instances appear within the same frame, or across distinct frames. Similar ideas have utilised a complex rule-based approach (Geurts et al., 2001). Compared to previous work (Botafogo and Mossé, 1996), this approach poses multiple advantages:

a) low-level content connectivity is abstracted, due to the direct comparison between multiple streams; hence, the volume of links is reduced,

b) individual media-components are referenced separately, despite being organised within a more general structure, while their ability to form further combinations is not reduced,

c) a frame containing a title and a set of streams provides immediate identification and categorisation of content. This introduces an advanced indexing mechanism.

MM are classified as a user-interface construction structure linked directly to the underlying SIMM of an MMS. Hence, visual media components (icons, text, etc) are used as links-to-frames. Large content domains introduce complications, due to their unmanageable size and complexity in connectivity. This imposes multiple system deficiencies, such as link/interface inconsistency. Therefore, link management protocols are required to allow consistent replication of frame-connectivity through multimedia templates, featuring fully functional external connectivity. When fresh data content is appended, an appropriate template with external links already earmarked reduces programming to amending local-links. MM do not impose constraints in terms of the underlying development environment. The developer is allowed to implement similar system functionality through a pick-and-mix approach. Hence, many technologies may be utilised, such as document-based construction tools (i.e. HTML pages utilizing java applets) and hybrid tool combinations involving XML (Pittarello and Celentano, 2001), ASP, JAVA, and JSP. The only requirement is to support dynamic linking scenarios.

MM utilisation is not limited to 2D. In combination with the SIMM and a virtual environment, MM can be used to construct object-containing virtual spaces. Hence, the user can move across virtual spaces, akin to transition between frames. Connectivity of separate virtual "areas" is achieved through the SIMM or MM linked-objects. Development of MM structures may be established through a content-based or hierarchical approach. Indexing offers a basis for a pre-determined structure, permitting the straightforward identification of hierarchical levels. MM development for the current case study is a typical example of large content-volume. In this respect, indexing is determined initially by vessel-geometry and individual variables.

For MM-based user-interface development it is important to establish a detailed view of content interdependencies. The subsequent building step involves construction of user-interface structures. Here, these act as building blocks for user-interface/interaction. Having prepared all necessary media-components, one must develop the principal frames involved. In order to create a consistent user-interface for all sections, a single instance is developed by programming all the relative links once to all other relevant addresses. This reduces the programming effort as a copy of the complete interface is used as a template for new content. Current selection indication is achieved via setting particular icon-attributes to high-visibility. Visual icon-attributes such as low-visibility are also supported, where reduced visibility implies unavailable links. Having obtained a basis that is fully linked to the other instances, it remains to clone the completed frame. Copying or expanding the convoluted icons to share functionality across distinct frames achieves this. Adding the media-components themselves completes the task. Compared to the re-programming effort required when each multimedia instance is completed separately this is a speedy task. Also, it provides consistent icon-placement. Inherently, it is difficult to place all interface-components manually at the same position within the frame. Further MMS-extension continues as additional icons are developed and that provide access to periphery information. At subsequent stages, completion of linking is performed via global insertion of links to each set of icons.

3. THE CASE-STUDY

The case study introduces an interactive visualisation MMS, enabling user-interrogation and illustration of the key factors that affect the process of dough kneading. The system expands dynamically as data are produced. These are inserted and categorised on a web-based multimedia database and the end-system encapsulates the data together with their descriptions. Internet-based interaction is supported, and the system is actively being used as a research and educational tool. MM are automatically created and positioned in place, enriching user-options, as shown in the figures below.

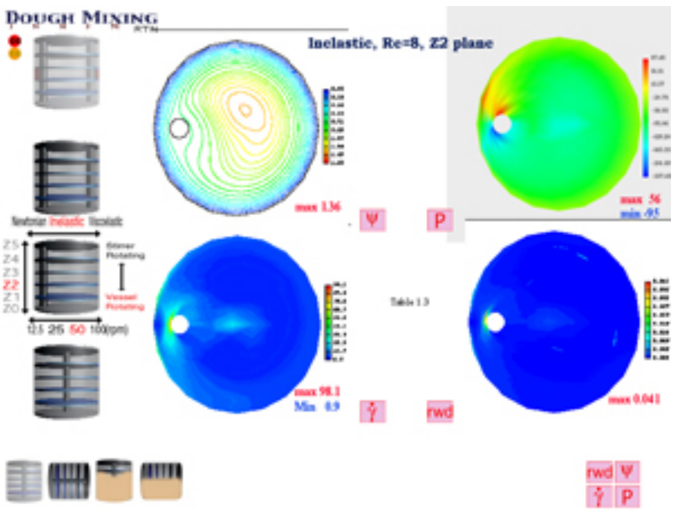

Figure 1. Parameter adjustment using multi-menu visual meta-data construct,one-stirrer geometry.

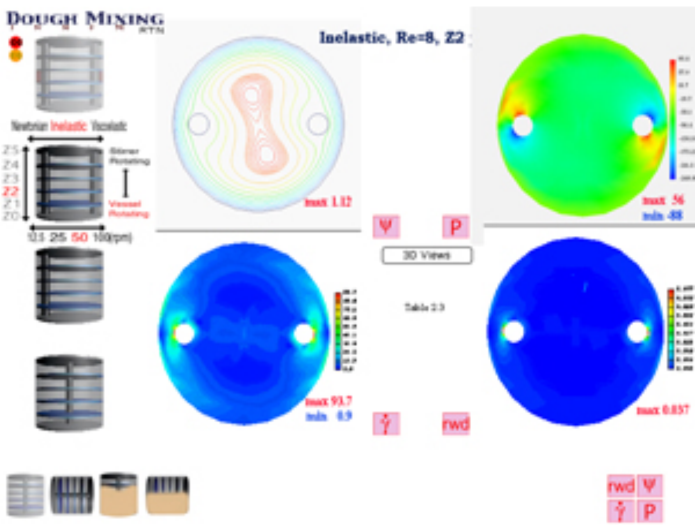

Figure 2. Parameter adjustment using multi-menu visual meta-data construct, two-stirrer geometry.

Evaluating the data is a demanding task for linear presentation organisations. Standard presentation tools organise data in a pre-determined manner, disabling direct interaction between multiple variables. Instead, the utilisation of interactive techniques allows smooth navigation through data sets, enabling on-demand parameter adjustment (Fig. 1 to Fig. 2). The problem was modeled in both 2D and 3D (Ding and Webster, 2000). For fully filled simulated cases, results were generated on five separate horizontal slices through the vessel at equal distances set apart from bottom to top. The free-surface position was calculated separately. A requirement is to navigate in a user-defined order, whilst simultaneously, allowing direct-access to secondary information. MM were required for these large data sizes. This MMS allows for such direct adjustment of variables, and the presentation of interrelated data under an integrated environment.

4. CONCLUSION

MMs are an interaction structure that provides advanced automated and user-defined interaction and offers the ability to present results comparatively, from case to case, or via interactive mode-switching, a highly desirable presentation characteristic, particularly. Research in this interdisciplinary area of interactive multimedia has resulted in the development of a wide range of MMS, destined for courseware, research and industrial applications (Deliyannis, 2002), featuring extensive use of media-rich technologies such as Shockwave commonly used on the WWW.

REFERENCES

Botafogo, R. A. and Mossé, D., 1996. The Capoeira Model for Distributed and Reconfigurable Multimedia Systems. Brazil, Computer Science Department, Universidade Federal Fluminense.

Deliyannis, I., 2002. Interactive Multimedia Systems for Science and Rheology. *Computer Science.* Swansea, Ph.D Thesis, University of Wales.

Deliyannis, I. and Webster, M. F., 2002. Multi-Level Modelling and Interactive Multimedia presentation of Scientific Data over various Media. *IADIS.* Lisbon Portugal.

Deliyannis, I. and Webster, M. F., 2002. WWW Delivery of Graph-Based, Multi-Level Multimedia Systems: Interaction over Scientific, Industrial and Educational Data. *IADIS Int. Conf. WWW/Internet 2002.* Lisbon Portugal.

Deliyannis, I. and Webster, M. F., 2006. A Multimedia Investigation Environment for Rheological Contraction-Flow data-sets. *The Mathematical Review, Hellenic Mathematical Society*.

Ding, D. and Webster, M. F., 2000. Three-dimensional Numerical Simulation of Dough-Kneading. *Rheology 2000 - Proceedings of the XIII Int. Congress on Rheology.* In D.M. Binding, N. E. H., J. Mewis, J-M. Piau, C.J.S. Petrie, P. Townsend, M.H. Wagner, K.Walters (Ed.), Cambridge, UK, BSR.

Geurts, J. P. T. M., Ossenbruggen, J. R. V. and Hardman, H. L., 2001. Application-specific constraints for multimedia presentation generation. *Eighth International Conference on Multimedia Modeling (MMM01).* Amsterdam, Netherlands.

Pittarello, F. and Celentano, A., 2001. Interaction locus: a multimodal approach for the structuring of virtual spaces. *HCItaly.* Firenze, Italy.