The application of workflow management to digital heritage resources

Abdullah Al-Barakati [a,*], Martin White [b], Zeeshan Patoli [b]

[a] Department of Information Systems, Faculty of Computing and Information Technology, King Abdulaziz University, Jeddah, Saudi Arabia
[b] Interactive Systems – Department of Informatics, University of Sussex, Brighton, United Kingdom

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ABSTRACT

Recent years have witnessed a noticeable proliferation in Digital Library Systems (DLSs) and their specialized form represented in Digital Heritage Resources (DHRs). DHRs usually manage a complex and varied mix of digital heritage objects of different types and formats. They tend to be complex in nature and usually involve complex, simultaneous and intersecting workflows. As a result, DHRs impose implementation challenges on any solutions that aim to manage their workflows. Thus, despite the proliferation of DHRs, it is a noteworthy trend that there is a general lack of workflow management solutions that can be utilized in such systems. As a research area that is rarely covered, this paper therefore presents the design and development of a novel Workflow Management System (WfMS) built to integrate with DHRs specifically, and DLSs in general. In this context, an experimental WfMS aimed to test the validity of workflow management integration with DHRs. The devised WfMS was built as a workflow management solution that can adequately address the specific hurdles imposed by DHR implementations. Additionally, a novel DHR implementation framework called DISPLAYS (Digital Library Services for Playing with Antiquity and Shared Heritage) is presented as a test bed for the proposed WfMS.

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1. Introduction

The advent of Digital Library Systems (DLSs) plus their specialized form focusing on digital heritage objects, known as Digital Heritage Resources (DHRs), has been made possible by modern advancements in software and hardware innovations including networking, multimedia, and databases (Bennett, 2009; Martin White, 2013; Wei Zhang, 2009). These innovations allowed for wider possibilities in terms of digital content management, distribution and sharing. Such advancements were accompanied by a noticeable proliferation in digital data formats and standards to serve the needs of data preservation, exchange, retrieval and presentation across different platforms. A platform can be a desktop application, the Internet, or a mobile application for instance.

DHRs often find it necessary to expand their digital object collections by means of sharing and exchanging data with other DHRs. Digital museums, for example, are in continuous need of enhancing and expanding their digital heritage data collections to make them wider and more diverse (Xiaowu Chen, 2004). However, the sharing process is not straightforward due to a number of practical and technical obstacles. These obstacles include challenges arising from different data formats, disparate systems, and incompatibility (Wei Zhang, 2009).

The complexity of sharing diverse and isolated digital records for museums for example, stems mainly from the different storage, management and indexing conventions used (Günter Waibel, 2010; Victor de Boer, 2012). The sharing process is further convoluted by the rich and diverse digital data storage formats that include text, images, videos, audio, and 3D models. Additionally, varying standards are used in DHRs including XML, relational databases, and flat files. Furthermore, direct data exchange is further complicated by the fact that DHRs use their own database and collection management systems. This diversity necessities the provision of tools that can act as mediums for data exchange, archiving and presentation (Abdullah Albarakati, 2008; Wei Zhang, 2009). Such tools are meant to be shared between the bodies attempting to share their collections and are usually represented in the form of distributed DHRs.

Adding to the complexity of DHRs are the intersecting processes that are usually associated with simultaneous user sessions and intensive data-oriented operations (Zeeshan Patoli, 2007). This, plus the factors mentioned above, combines to necessitate the development of a system for effective management of the complex services and components of DHRs.

This paper therefore, examines the concept of utilizing Workflow Management Systems (WfMSs) in distributed DHRs. The developed solution was designed to integrate with existing digital

* Corresponding author. Tel.: +966 534433113.
E-mail addresses: aaalbarakati@kau.edu.sa (A. Al-Barakati),
M.White@sussex.ac.uk (M. White), M.Z.Patoli@sussex.ac.uk (Z. Patoli).

heritage infrastructure while operating as an encapsulated workflow management middle layer so as not to interfere with its components. The main objective is to create a solution whereby digital museums are able to exchange their data seamlessly while being managed by a WfMS. In this respect, appropriate data exporting and exposition tools are needed to pave the way for effective data sharing and distribution. Such tools should also be complemented with appropriate presentation mediums to display the aggregated data in a common interface.

The work presented in this paper therefore also outlines the structure of a novel DHR implementation called Reanimating Cultural Heritage (RCH) (Basu, Reanimating Cultural Heritage, 2007; Wei Zhang, 2009). RCH was developed from scratch based on a proprietary DLS implementation framework called Digital Library Services for Playing with Antiquity and Shared Heritage (DISPLAYS)[1] (Wei Zhang, 2009; Zeeshan Patoli, 2007). RCH was created as a proof-of-concept DHR used to validate the proposed approach of integrating WfMSs with existing DHRs. This integration aimed to improve their performance and efficiency including speed, scalability, expandability, reuse, modularity, and service orientation.

The workflow management components and approach presented in this paper build on the authors' work under (Abdullah Albarakati, 2008, 2009; Michael Gkion, 2009; Wei Zhang, 2009; Zeeshan Patoli, 2007, 2008, 2009).

2. Goals and objectives

Despite the rapid growth that WfMSs have witnessed over the recent years in terms of their efficiency and availability, it is a noticeable trend that their utilization within DHRs is still minimal (Abdullah Albarakati, 2008, 2009). This limited use can be attributed to a number of implementation challenges, including the unique nature of each DHR that requires carefully customized solutions to meet its needs (Wei Zhang, 2009; Zeeshan Patoli, 2007). Moreover, the hurdles caused by the very environment on which DHRs operate, require systems that can adequately adapt to their different operational scenarios.

This paper therefore, illustrates the practical steps, results and impact of utilizing a custom-built experimental WfMS within an actual DHR (RCH). The main goal is to test the underlining validity of effective workflow management on the complex processes that exist in DHRs. Based on that, the objectives of the developed set of tools are as follows:

- The development of a novel WfMS implementation model to suit the very nature of DHRs in particular and DLSs in general.
- The provision of a solid framework on which unique individual WfMS implementations can be based to meet the needs of varied ranges of DHRs.
- To examine and validate the concept of integrating a WfMS within an existing DHR that is shared between a number of real life cultural heritage institutions.
- To empower the data exchange and sharing aspects of DHRs through effective management, control and monitoring capabilities enabled by WfMS integration.

3. The adopted DHR framework

In its simplest form, a DLS can be thought of as a system that stores, manages and manipulates materials in digital format

(Greenaway, 2006). Typically, DLSs offer a huge range of digital content including multimedia such as video, audio, images, plus text, 3D models, and digital documents (Armand Brahaj, 2013; Jie Lu, 2004). The need to handle complex and varied digital data objects make DLSs complex by nature where a number of heterogeneous fields intersect (Airi Salminen, 2014; Hannah Tarver, 2013; Leonardo Candela, 2007). DHRs can be considered as specialized types of DLSs where the focus is to manage digital heritage objects, such as cultural artefacts (Zeeshan Patoli, 2007).

To validate the WfMs implementation approach presented in this paper, a DHR was developed based on a novel framework called DISPLAYS (Zeeshan Patoli, 2007). DISPLAYS provided an effective framework for a number of core digital heritage management functionalities including Digital Content: Creation (DCC), Archival (DCA), Exposition (DCE), Presentation (DCP) and Interaction (DCI) services (Zeeshan Patoli, 2007).

The created DHR that was developed utilizing DISPLAYS, was called RCH (Reanimating Cultural Heritage) (Basu, Reanimating Cultural Heritage, 2007; Prabhat Pandey, 2014; Wei Zhang, 2009). Three main components work collaboratively within RCH, to achieve digital heritage preservation and sharing. These components are the Archival, Retrieval and Presentation components, which were mapped to the corresponding DISPLAYS conceptual services. These RCH components were then hosted as managed workflows as will be detailed further below.

The structure of the DISPLAYS Framework is highlighted in Fig. 1. Each of the services provided by DISPLAYS has a number of tools oriented towards performing the processes that a typical DHR may need (Zeeshan Patoli, 2007). For example, the DCC contains a number content creation tools such as 3D modelling tools and image editing software. Furthermore, the DCA has archival oriented tools which comprise mainly database management software. The DCI has in turn a number of interaction tools such as touch screens, and website interfaces.

4. The adopted DHR implementation

4.1. Architecture of the DHR components

RCH was developed based on a number of digital heritage Service Oriented (SO) components (Zeeshan Patoli, 2007). It was built based on the conceptual DLS services manifested by the DISPLAYS Framework, involving three interrelated components: the Archival, Presentation and Retrieval Components. While working independently to achieve their own functionality, all the RCH components work in coherence with each other on a pure SO approach (Wei Zhang, 2009; Zeeshan Patoli, 2007).

The RCH components were modelled as hosted workflow services to test the validity of workflows in DHRs. These components were implemented on a classic Model-View-Controller (MVC) (Marston, 2010) design pattern. These three components provided a suitable level of complexity to act as a good testing case for validating the application of workflows within DHRs. The architectural details of these components are detailed in Sections 4.1.1, 4.1.2, 4.1.3 and 4.2.

4.1.1. The archival components

RCH was devised to enable museums to share and exchange their digital heritage data (Zeeshan Patoli, 2007). The core functionality of the Archival components revolved around the archival process of Create, Read, Update and Delete (CRUD). In this respect, a number of challenges had to be overcome to achieve the goals of the archival process. Three museums shared RCH which are: the British Museum, Brighton Museum and Art Gallery, and the Glasgow Museum.

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[1] DISPLAYS framework was created in the 'Interactive Systems: Computer Graphics Centre' in the University of Sussex. Authors of this paper contributed to its development and validation (Zeeshan Patoli, 2007).