ABSTRACT

Web Information System (WIS) should provide information with complex and specific details throughout its domain structure. It has significant information compositions such as its domain processes, users’ interactions, content structures, navigation access elements, and user interface presentation. Therefore, special attention should be placed on how interaction design took place in the overall design process when developing a WIS. In this paper, we will concentrate our discussions on two interaction design perspectives – navigation information and user interface presentation. It has been shown that specific modeling elements are important and required to facilitate designers in organizing and integrating specific information at high level views to produce expressive user interface presentation for each WIS page. We will describe in detail how our approach can be used to map navigation information into user interface presentation throughout the design models, in order to highlight the internal strengths of our approach.

Keywords


1 INTRODUCTION

In tandem with the growth of web applications, Web Information Systems (WIS) have become very important in web environments, such as web portals (e.g. a university’s website), interactive learning management systems (e.g. e-LMS), interactive web information services (e.g. airlines systems), e-commerce applications (e.g. online banking systems), interactive hypermedia courseware (e.g. e-books), etc. The integration of various interactive forms of information and navigation elements on the web such as text, menus, graphics, icons, and animations, which presented interactively, makes WIS one of the most popular approaches for providing detailed information in a richer and more natural form to the web users.

Web interaction techniques have become one of the most important features in WIS since they mainly focus on how users can browse and access information in a short period of time. The main purpose of WIS is to provide information with higher aspects of interactivity, including flexible and powerful facilities for non-sequential and explorative navigations. Moreover, such interactions must also be capable of providing higher quality layout presentation of the user interface, and varied forms of information structure content between web users and the applications [1,2]. Thus, efforts in designing effective web interactions have raised a number of design issues in modeling activities, such as navigation access structures, activities and transactional workflows, and user dependent processes [3,4]. To cope with these issues, several web design methods with different design features and modeling concepts have been proposed such as UML-based Web Engineering [5,6], Object-oriented Hypermedia Design Method [7], Website Design Method [8], and Object Oriented Hypermedia [9]. However, more design efforts are required to support more complex and complicated interactions including their application domain structures, perhaps using a more comprehensive and systematic design.
aspect. Concerning into those aforementioned factors, considerable attention has been given to successfully manage the diversity and complexity of WIS in order to avoid potential failures that could contribute into a more serious interaction implications [3]. Therefore, designing interactions in WIS are not a trivial task; and hence, it has become one of the big challenges for today’s web engineering industry. Based on the current literature, there is a strong interest and much enhancement works to be considered in the area of Human Computer Interaction (HCI). Research on this topic is still evolving to ensure that all aspects in web interaction design become more effective and fine-grained, especially in a larger scope involving higher complexity applications [10].

This paper is organized as follows. In Section 2, we briefly describe the principles of web interaction design of WIS in the context of navigation processes and user interface presentation. Section 3 will describe in detail the navigation design processes for supporting web interaction. This will also include the navigation information about the modeling elements used in the particular design methods. Then, in Section 4, we clearly demonstrate and discuss how the navigation information can be translated into user interface elements. This will be according to the use of mapping formulation from navigation information to the user interface modeling elements. The end results should provide some idea of the web page layout that comprises several numbers of logical user interface elements. Finally, Section 5 provides a summary and conclusion about the overall works of our approach.

2 WEB INTERACTION DESIGN

Several web design methods have been proposed in the past few years to model and support the design and development of Web Information System (WIS). Research works in this field have found that most of the methods are model driven and consist of a number of design processes [4,11]. The effort of these design processes are normally being done in iterative and incremental approach. For each design process, models are constructed to present the application design. In other words, models constructed should able to present higher level descriptions and structures of particular application domain. Some design methods use their own notation for constructing models, while others conform to existing notations such as the Unified Modeling Language (UML) [12]. Generally, web design practices involve with three design stages, namely Information Requirements and Modeling (conceptual modeling), Navigation Design, and User Interface Design [4, 13]. This can be illustrated in the following Figure 1.

Interaction design of WIS starts with Navigation Design process. It should be able to provide navigation facilities, thus to model navigation structures and links according to the navigation preferences [14]. During this stage, it is assumed that the application domain structure and information objects have been fully defined from the earlier stage – i.e. information requirement and modeling. The main objective of the navigation design process is to define navigation hyperspace by specifying how information in the application domain is presented as navigation objects and inter-connected with hyperlinks. Navigation objects can be clearly defined by navigation access elements. It is also important to describe what access elements are supposed to be modeled in this stage, and how they are interconnected. In general, navigation design processes can be performed in two different sub-design efforts, namely navigation class scheme and navigation
context scheme [4]. In the former, navigation classes are defined to present navigation nodes that are reachable by web users. These nodes are linked depending on the user navigation preferences. On the other hand, the navigation context scheme is aimed to equip the navigation nodes with access elements. This will define “how” those navigation nodes are reached by web users. The second design stage in web interaction process is user interface design. The user interface model is constructed to present abstract user interface design – presented through logical views of web page layout, incorporating visual characteristics of the information being presented on each navigation node. Page components or user interface elements should be defined through graphical notations before designers can deploy them as user interface objects on particular page layouts [15]. The idea is to locate page components on page layout according to the storyboard. At the end of the process, user interface models are constructed to present the screen layout including page components and their positions.

3 NAVIGATIONAL OBJECTS

The Navigation design process should present the structure of the navigational hyperspace, including its navigational nodes, interaction classes, and access elements reachable through hyperlinks. All of these can be described as navigational objects or information. They should describe what information and hyperlinks offered to the web users, and how they can be made reachable. In short, this stage shows the overall aspect of the application navigation structure. Figure 2 illustrates the relationship of navigation objects in an application domain.

In Figure 2, navigation nodes are represented using the big circles interconnected with other nodes through hyperlinks. It is a conceptual class of the domain that contains and delivers information to the users. Each navigation node may have its own interaction node, which acts as a node that might provide some interactive features for users in order to access information; such as filling a form or other operational/functional inputs. The interaction node is represented using small shaded circles. They are subset nodes of any navigation node (each interaction node cannot stand on its own). On the other hand, users may travel from one navigation node to another through hyperlinks (dotted arrow) equipped with navigation access elements. Hyperlinks can be unidirectional or bidirectional, depending on the navigational preferences. Finally, navigation access elements (dotted square box) act as the navigation mechanism that explains to users how navigation nodes can be reached through different navigation facilities. They are selected according to the best suitable navigation approach. The following are some of the common navigation access elements used in websites.

**Menu:** Menu provide composite objects (homogeneous) of menu items which have fixed name (frozen) and have a specific link to navigation target node, interaction node, or other access elements.

**Trail Menu:** This is an alternative to menu access elements if the menu contains several sub-items. The sub-items can be expanded and collapsed when web users click on the menu item in order to provide a more dynamic view and faster access time to menu items.

**Index:** The index access element is a basic type of navigation facility provided in most web information systems nowadays, and has been offered in most current web design methods. In general, an index contains a number of arbitrary listed name items with a link to a target navigation node. Every item has its own unique name and
owns a link (target) to any instance of a navigation or interaction nodes.

**Tree**: Tree provides a hierarchical structure view of a complex index structure. It is best used for nested indices or any navigation node that provide generalization for its objects or instances. It consists of subject names, which can be expanded or collapsed (for orientation purposes), and sub-item names for providing access to navigation targets.

**Text Query**: A text query is an interactive text input provided through an input field for web users to search information. Users need to provide a keyword as input to allow the application to search for the desired item. If the search result returns nothing, an error – item not found is displayed. If search results are returned, they are presented via an index structure or directly brought to the navigation target class. This access element is best used for expert users as they know the keyword to be keyed-in.

**Selectable List**: Selectable list provides an easy-to-go navigation facility which is similar to the text query access element. The difference is that several frozen (cannot be changed) listed input items can be provided where web users are required to select only the desired items (which might be presented as drop down list) in order to acquire the results or navigation class. Search results can be displayed using a tree or index structure. Selectable list gives more guidance for web users as a search mechanism (no need to enter keyword) and it is suitably used for beginners as compared to text query.

**Guided Tours**: A guided tour provides web users with ordered sequential access to a number of navigation nodes (more specifically, navigation instances). The sequences are predefined by the application and are best used for presentation type and manual guidelines that enforce a sequence of navigation class presentation.

**Page**: Page provides direct access to a group of instances in a navigation node (it is an alternative to guided tours). The page items are grouped and named (or numbered) and each of them has its own link to a target instance location. Pages are suitable if a navigation node consists of several numbers of page instances.

![Diagram of Navigational Objects]

Figure 3. Collaboration of Navigational Objects

Figure 3 summarizes the collaborations between navigational objects in the context of their interconnectivities. Users can navigate from one navigation or interaction node to another through hyperlinks and specific access elements (including menu and trail menu). During the design lifecycle, designers have to play a vital role in choosing the best and most appropriate access elements in the navigation hyperspace. These should provide a suitable selection of access elements to ensure users are able to achieve their navigational objectives and information needs in a specific time window. We will describe how navigational objects can be translated into an abstract logical layout of user interface presentation in the next section.

4 MAPPING RULES: OUR APPROACH

The navigational objects described in the previous section are presented through a navigation model to view how navigation hyperspace should look like. It gives some idea on how users will navigates and browse information on the website. Once navigation objects have been clearly defined, the user interface design process is undertaken in order to present the abstract logical layout of each web page. In general, the objective of user interface design is to provide graphical guidance of presentation model that
represents user interface elements on every single web page. During this design process, designers only focus their efforts on structural organization (logical abstract of user interface elements); and not on the physical characteristics of page layouts such as color, font types, image size, etc. In order to translate navigational objects into user interface elements, we propose mapping rules which provide ideas on how to deal with each navigation object. The following table shows the mapping rules between navigation objects and user interface elements.

**Table 1: Mapping Rules for creating User Interface Elements**

<table>
<thead>
<tr>
<th>Navigation Objects</th>
<th>Map to – User Interface Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>«navigation node»</td>
<td>«UIPage» → «framePage» → «UIElement»</td>
</tr>
<tr>
<td>«interaction node»</td>
<td>«UIInteraction» → «framePage»</td>
</tr>
<tr>
<td>«hyperlink»</td>
<td>«accessElement»</td>
</tr>
<tr>
<td>«access element»</td>
<td>«UIElement» → «accessElement»</td>
</tr>
</tbody>
</table>

We divide our user interface elements into different categories, namely «UIPage» – to present a web page, «UIInteraction» – to present interactive features in a web page, «UIElement» – a group of user interface elements that can be categorized into «accessElement», «multimediaElement», and «formElement», «framePage» – to partition web page layout, «UILogin» – specific interface element to start interaction process, and «UISession» – to describe interaction session. Table 2 provides the details of each user interface element.

**Table 2: Details of User Interface Elements**

<table>
<thead>
<tr>
<th>UI Element</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>«UIPage» User Interface Page</td>
<td>Models the presentation of a navigation node. It should acts as a page (window) showing information, hyperlinks, and access elements. It can be partitioned, in order to locate or separate specific information for easy and understandable viewing purposes by web users.</td>
</tr>
</tbody>
</table>
The final result of User Interface model describes (in a web page) how many interface elements are involved, where they are located on the page layout, which frame they belong to, and what will happen if interaction took place between web users and web application. To clearly demonstrate how navigational objects are translated into the user interface elements presentation through our proposed mapping rules, we will explain them in the following section. For the sake of explanation, we provide an example using a common web information system as a case study.

4.1 Case Study

In this section, we will clearly elaborate about how navigation and user interface designs are performed based on the website http://fsktm.upm.edu.my. The main idea is to show how the navigation model can be implemented to a user interface model so that all the information of navigation objects are easily translated to user interface elements. Figure 4 shows part of the Navigation Model about two navigation nodes, called; homepage’s node and research group’s node.

According to Figure 4, a menu element is provided as the main navigation facility on the homepage’s node. Once a user clicks on one of the menu items, a hyperlink brings the user to an index element view. A list of research groups should be displayed as indices so that a user can make a selection. Once a selection is made, a hyperlink will direct the user to the respective research group’s navigation node. The processes of the navigation are then implemented as shown in Figure 5.

4.1.1 How the Mapping Rules Work?

Based on Table 1, we can map four navigation objects into the user interface elements namely navigation node, interaction node, hyperlink, and access elements. We demonstrate how homepage’s navigation node can be mapped as a web page logical presentation layout. As refer to Table 1, the rules that needed to be applied are by mapping navigation node into three stages, namely UIPage, framePage, and UIElement. This is described as the following figure:

![Figure 6: Mapping Navigation Objects to User Interface Model through Mapping Rules](image)

The web page is basically partitioned into three separate frames through «framePage» stereotype. All partitions comprises of their own user interface elements («UIElement»). The first and second frames store user interface elements type «accessElement», while the third frame stores user interface elements type «multimediaElement». The user interface model in Figure 6 acts as the
main storyboard of the actual web page, where it describes some ideas about the logical presentation of the web page layout.

Designers provide some information about how the web page will look like during the implementation stage. All information is stated as logical presentation layout, not physical presentation layout. This is because all decorations such as theme colors, frame sizes, animation contents, and text appearances are decided by the web developers according to their web development skills. This is shown by Figure 7. All elements defined in the user interface model (i.e. Figure 6) are directly mapped into the actual implementation of the web page. Additional information with regards to decoration is up to the web developer to decide.

5 CONCLUSION AND FUTURE WORKS

This paper presents our proposed approach for web interaction design in the context of navigational objects and user interface elements. The approach relies on the several categories of defined navigational objects such as navigation node, interaction node, hyperlink, and access elements by translating them into user interface elements according to the proposed mapping rules. The main objective is to design and produce navigation and user interface models as high level design model so that the application domain of Web Information System (WIS) can be seen as a higher abstract structure domain view. The domain can be simplified, easy to understand, and systematic in terms of the whole architectural view of WIS. The main contribution of the proposed approach is that it applies a web design approach, – which is part of the web engineering methodologies. It provides systematic guidelines for designers to design models for the user centric approach according to standard or extended graphical notations such as Unified Modeling Language (UML). Moreover, we also emphasize on the way to adopt suitable design objects or elements based on the case study examples given. Although more elements can be used in current WIS, we hope that our approach could provide useful design tips in the whole WIS design lifecycle. Therefore, we are strongly believe that the traditional way of web designs, including ad-hoc approach, are no longer relevant and not suitable for the current demands of web-time product development cycles.

Our future works will be devoted to increase and improve our design approach to cover more complex and complicated web application design categories such as personalized web semantic, e-Cloud applications, e-commerce applications, and others. The design techniques might be different, but more case studies are necessary to separate some common design features for such web applications. More design elements (navigational objects and user interface elements) are expected in the future works by supporting them through the use of specific graphical notations for more systematic design and development lifecycles.

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7 REFERENCES


