A systematic approach to derive navigation model from data model in web information systems

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RÉSUMÉ. Les méthodologies de conception de systèmes d'information web présentent le modèle de navigation comme étant un élément très critique dans le processus de développement. Ce dernier est un moyen efficace permettant de représenter la structure et le chemin selon lesquels les données sont présentées à l'utilisateur. Cependant, ces méthodologies ne traitent pas l'aspect comportemental lors de la modélisation de la navigation, où les services et l'interaction avec l'utilisateur ne sont pas présentés. Dans cet article, nous proposons une approche alternative de nature à élaborer un modèle de navigation plus complet et mieux structuré. Il est basé sur l'utilisation de la notion de cas d'utilisation atomique et la combinaison entre le modèle conceptuel de données et le modèle de cas d'utilisation. Ce faisant, notre approche fournit une vue unifiée des aspects structurels et de comportement d'une application Web.

ABSTRACT. The design methodologies of web information systems present the navigation model as a very critical element in the development process. It is considered as an efficient means to represent the structure and the path according to which data is shown to the user. However, such methodologies do not deal with the behavior aspect in the navigation modeling, and services and interaction with the user are not represented. In this paper, we present an alternative approach to build a more complete and better structured navigation model. It is based on the use of the atomic use case concept and the combination between the conceptual data model and the use case model. In doing so, our approach provides a unified view of the structural and behavior aspects of a web application.

MOTS-CLÉS: Système d'information web, modèle de navigation, UWE, Ingénierie du Web.

KEYWORDS: Web Information Systems, Navigation Model, UWE, Web Engineering.

1. Introduction

Nowadays, web information systems are increasingly adopted due to the ubiquity of the client and also because user experience is becoming each time more interactive [1, 2]. The most notable methods for web application design [4, 5, 8, 9, 10, 11, 12] support the design of Web applications building conceptual, navigation and presentation models. Conceptual modeling of Web applications does not differ from conceptual modeling of other applications.

One of the possible debatable concepts used in the web community is the concept of navigation. Navigation is an important aspect widely studied by a lot of researchers, such as comparison between requirements of the methods in [12], comparison business process development in [13], comparison between UWE, WebML and OOH in [14], Requirements Engineering In current web engineering methodologies [12], and comparison study describe advantages and disadvantages of some selected methods [15].

Navigation design is a critical step in the design of web applications, and the navigation model is one of the important models in the process of the developing web applications [7]. However, a navigation model based on a domain model is relatively rigid when faced to new, often unpredictable, use contexts. The reason is that the OO paradigm is specially suited to encapsulate data concerns into classes, but it is not so well suited to represent other concern types, such as business-related or functional.

Usually, navigation model is considered as a means to structure the information to show to the user, without any reference to the user-view behaviour. The navigation model is much more than this because it should integrate the system user-view services the web application should provide to the user.

In this paper, we propose an alternative approach to build a more complete, but also, better structured navigation model. It is based on the use of the atomic use case concept and the combination between the conceptual data model and the use case model. In doing so, our approach provide a unified view of the structural and behavior aspects of a web application.

The paper is structured as follows: Section 2 explains the background work for typical information system web engineering processes, especially the derivation process of the navigation model. Section 3 describes our approach throughout the presentation of underlying concepts and the method. Finally, Section 4 presents some concluding remarks and an overview of future work.

2. Navigation modeling

In the past few years, some web engineering methods have suggested an operation to the development of Web Applications. The significance of the navigation between the application nodes is the meaning of the navigational model which is one of the fields [13].

Both in the UML-based Web Engineering (UWE) [4] and the OO-H [5] methods the navigation model is derived in part from the content or conceptual model respectively. UWE is an approach that allows the modeling of the architecture, the navigation space and the interfaces of web systems using UML with some extensions [4]. It defines a UML profile including stereotypes which denote new modeling elements. The modeling process proposed by UWE is composed by four steps:

- Requirement Analysis with Use Cases.
- Conceptual Model.
- Navigation Model.
- Presentation Model

Based on the standard UML, the UWE methodology [4] is an object-oriented approach, where the notation and diagrams are restricted to those provided by UML. UWE presents a new approach for improving the navigation model. In the navigation space model, a stereotyped class diagram is used,

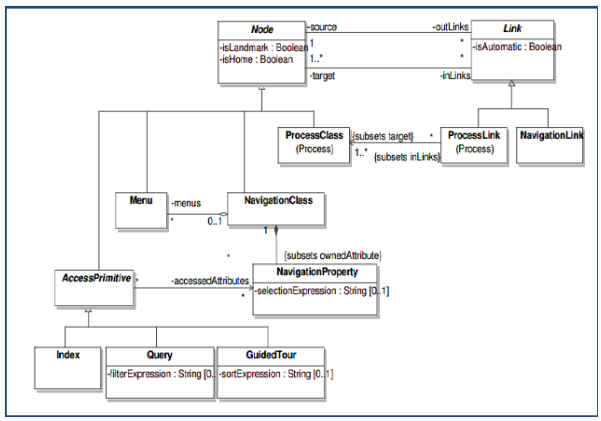

Fig. 1. UWE navigation package [3].

including the classes of those objects, which can be visited during navigation. The <<navigation class>> and the <<navigation link>> stereotypes are used to model nodes and links.

As a refinement of the navigation space model, the navigation structure model includes stereotypes such as: <<menu>>, <<query>>, <<index>> and <<guided tour>>. Modeled in UWE by a composite object, index means direct access to instances of a navigation class. Each index item is in turn an object, which has a name that identifies the instance and owns a link to an instance of a navigation class.

3. The proposed approach

Usually, the most notable current approaches to model hypermedia depart from any kind of domain model to define the navigation design model of the system under

development. Our approach, on the contrary, is different. It builds the navigation model from both the conceptual data model and the use case model (Fig. 2).

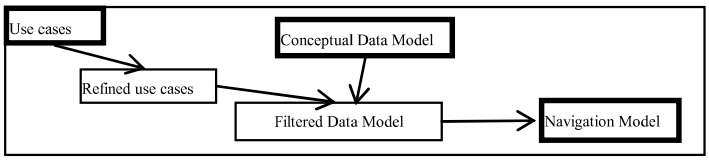

Fig. 2 The flow model of our approach.

We is illustrate our approach by taking the case study of a conference management Web system, which hosts multiple users and conferences, allowing the creation of new users and conferences at any time. Any user can apply for a new conference. After approval from the Supervisor, the applicant becomes a conference chair. He can add new chairs and new PC members. An author can list the conferences awaiting submissions. He can submit a paper, upload new versions, or indicate other users as co-authors thereby granting them reading and editing rights. PC members are allowed to view the submitted papers. PC Chair can assign papers to PC members for reviewing either manually or automatically based on some rules. Reviewers can download papers they are concerned with and upload their reviews. The authors can read the reviews and the accept/reject decision made by the PC chair.

A. The use case model

Use case modeling is widely used in modern software development methods as an approach for describing a system's software requirements [4]. A use case represents how a system interacts with its environment and who are the actors involved in such interactions.

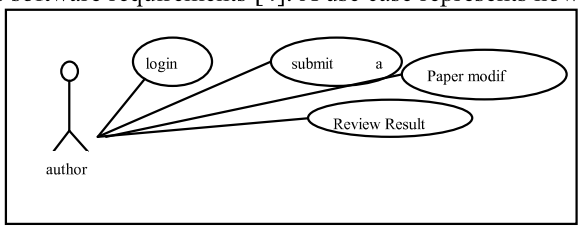

Fig.3 A use case model.

However, to deal with web pages and navigation, we need to break use cases into more reusable units.

Breaking use case down into their smallest size allows breaking them into their most reusable, most common elements. From there, structuring, planning, and designing become much more predictable.

To this end, we use the concept of atomic use cases [16]. An atomic use case is used to decompose a use case in order to identify units of functional behaviour a system should offer to the user. Such units of functional behaviour will be transformed into navigation structures.

Atomic use case is defined as an atomic functionality that the system offers to the user. For instance, the use case “buying a book” may be broken down into the atomic use cases: “viewing a book catalogue”, “register as a new customer”, deleting an item from the shopping cart.

We identify two types of atomic use cases: *structural atomic use case* and *functional atomic use case*. An atomic use case can be structural, when it provides a data view (i.e. viewing a catalogue, viewing the customer’s data, etc.).

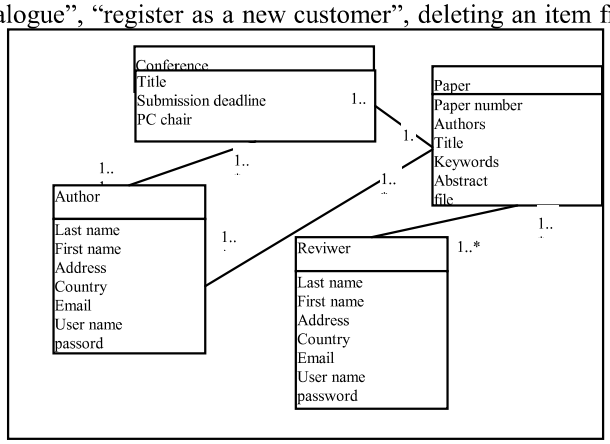

Fig.4 An excerpt of a conceptual data model of a conference management system.

A functional *atomic use case* implies some interaction with the user, generally requiring some input data (i.e. searching a book, adding a product to the shopping cart, etc.).

B. The conceptual data model

The conceptual data model of the Web application is built with UML classes models. This model is the input artifact to the derivation process of navigation and presentation models. Fig4 depicts an excerpt of a conceptual data model for a conference management web system.

C. Refining the use case model

To identify meaningful interaction units we refine the use case model using the atomic use case concept as defined above.

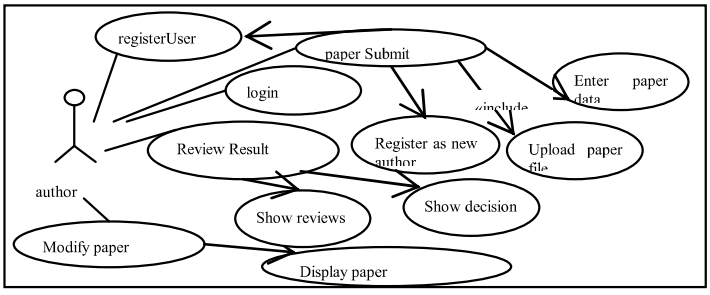

Fig.5 A refined use case model..

Refining the use case model consists of decomposition each use case into atomic use cases and hierarchically structure theme using the conceptual data model. For example in the use case "login", we identify two atomic use cases: *successful login* and *forgot password*.

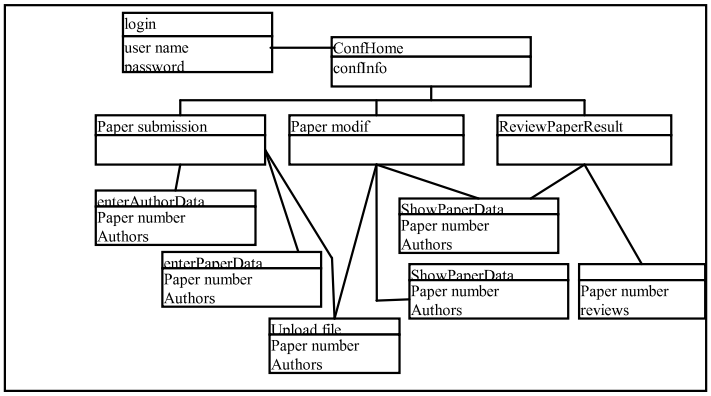

Fig.6 the refined conceptual data model

The use case "submit a paper" is decomposed into the following atomic use cases: *register new author data, register new paper data, and upload the paper*. Figure 5 depicts the refined use cases model.

D. Deriving the navigation model

In most current web engineering approaches, navigation model is created from navigation classes, a set of guided tours, indexes, queries and links. Also the navigation classes and links are parts of conceptual classes.

To build the navigation model, we use as input to our approach both the refined use case model (Fig.5) and the conceptual data model (Fig.4). Using the refined use case model, we filter the conceptual data model where only data elements and links that are relevant to the refined use case model remains.

In a use case, an atomic use case may be organized using include and extend relationships defined by UML. "Include" and "extend" relationships have the same semantics that in the use case model: An include relationship specifies the location in a flow of events in which the base use case includes the behavior of another one that the behavior of the base use case may be optionally extended by the behavior of another use case [20g]. UML defines two stereotypes to mark these relationships: the <<include>>,<<extend>>.

Taking into account the definition of structural atomic use cases, we refine the conceptual data model in order to represent data and links invoked by such atomic use cases. In addition, we enrich the obtained conceptual model by adding corresponding classes invoked by the functional atomic use cases. We start by adding a home class to represent common data.

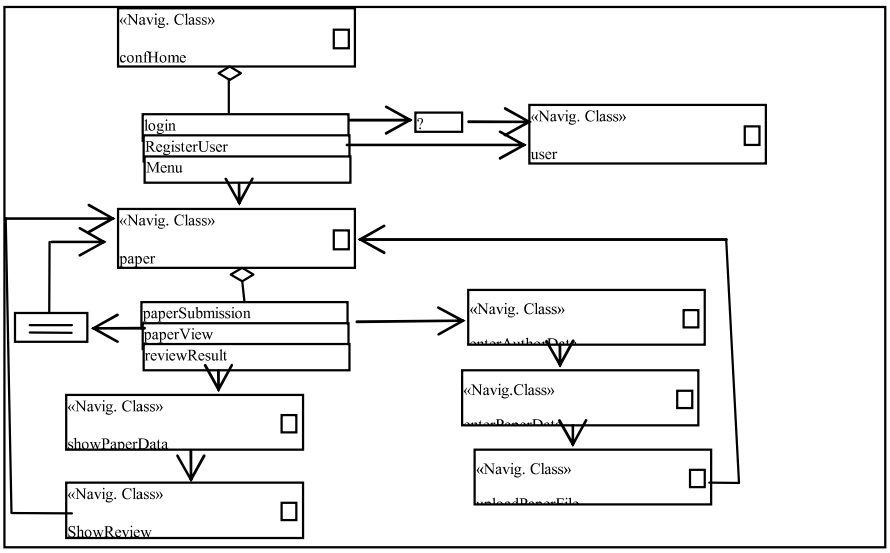

Fig.7 the navigation model..

For an atomic use case we define a class that contains invoked data in the initial conceptual data model. Figure 6 depicts. A navigation model will be derived from the two above-mentioned models, while adding the navigational structures such as menus, indexes, queries, guided tours, etc. Thus, we apply the mapping rules of UWE to derive the navigation model from our refined conceptual data model. Our navigation model includes not only navigation between data nodes and behavioral nodes (Fig. 7.).

4. Conclusion

In web engineering, navigation model is defined as an important model in all the hypermedia design. In this paper we have presented an approach to systematic derivation of the navigation model from use cases and the conceptual data model. Use cases are refined and restructured based on the concept of atomic use case. Then, the conceptual data model is refined with regard the refined use case model. In doing so, we have facilitated the derivation process of the navigation model, which incorporates not only, data and their links but also the user-view related behavioral units. Our approach allows systematizing the derivation of the navigation model, throughout the definition of the process, the modeling techniques and the mapping rules. As a future work, we plan to investigate other case studies to measure the usability of our approach, and also to integrate it into model-driven design environment.

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