INFORMATION SYSTEM DESIGN AND PROTOTYPING USING FORM TYPES

Jelena Pavićević
Faculty of Mathematics and Computer Science, University of Montenegro, Cetinjski put bb, 81000 Podgorica, Serbia and Montenegro
jelenap@cg.yu

Ivan Luković
Faculty of Technical Science, University of Novi Sad, Trg D. Obradovića 6, 21000 Novi Sad, Serbia and Montenegro
ivan@uns.ns.ac.yu

Pavle Mogin
Victoria University of Wellington P.O. Box 600, Wellington New Zealand
pmogin@mcs.vuw.ac.nz

Miro Govedarica
Faculty of Technical Science, University of Novi Sad, Trg D. Obradovića 6, 21000 Novi Sad, Serbia and Montenegro
miro@uns.ns.ac.yu

Keywords: Form Type, Prototype, Information System Design, Relational Database Schema, CASE tool, XML, IIS*Case.

Abstract: The paper presents the form type concept that generalizes screen forms that users utilize to communicate with an information system. The concept is semantically rich enough to enable specifying such an initial set of constraints, which makes it possible to generate application prototypes together with related implementation database schema. IIS*Case is a CASE tool based on the form type concept that supports conceptual modelling of an information system and its database schema. The paper outlines a way how this tool can generate XML specifications of application prototypes of an information system. The aim is to improve IIS*Case through implementation of a generator which can produce an executable prototype of an information system, automatically.

1 INTRODUCTION

A development of CASE tools that support information system (IS) and database (db) design may be based on the form type concept, which enables formulating a methodological approach that allowes a designer to specify screen forms of transaction programs and, indirectly, define an initial set of attributes, constraints, business rules and procedures. During the automated process of the design, the set of form types will be transformed into an implementation db schema. As a result, formal design specifications of an IS may be generated. Basic concepts and formalisms, this approach relies on, have been founding from late 80's. Meanwhile, we have established and constantly improved a theoretical model, which is based on a method of developing ISs and db schemas by gradual integration of designed subsystems (Luković, 2002; Luković, 2003; Mogin, 1995). The whole idea is implemented in IIS*Case. IIS*Case is a CASE tool designed to support modelling IS software, db schemas, and generating the appropriate formal specifications. Our aim is to improve IIS*Case through the implementation of a generator which can produce an executable prototype of an IS, automatically. At the time being, functionalities of IIS*Case are extending with a generator able to produce such prototypes in the Java programming environment. The paper presents the form type concept and outlines a way how IIS*Case can generate software prototypes of an IS, by using form type specifications.

2 THE FORM TYPE

The form type concept is introduced in (Mogin, 2004; Pavićević, 2005). It generalizes document types, i.e. screen forms that users utilize to communicate with an IS. Using this concept, a designer specifies screen forms of transaction programs and, indirectly, creates an initial set of attributes and constraints that will be embedded in generated db schema and design specification of the IS.

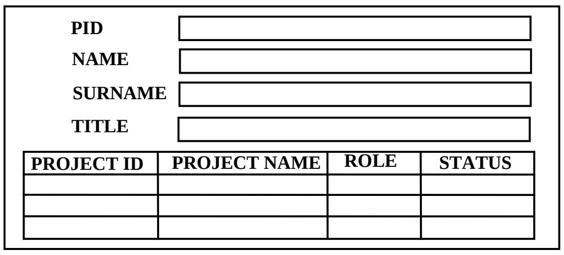
A form type is a named tree structure, whose nodes are called component types. Each component type is identified by its name in the scope of the form type, and has nonempty sets of attributes with associated domains, and constraints. The set of constraints is a union of sets of keys, unique constraints, and tuple constraints. Sets of unique constraints and tuple constraints may be empty.

Example 1. Figure 2 shows the structure of a form type F, which generalizes the screen form in Figure 1. The form type consists of two component types: EMPLOYEE and PROJECT, which are graphically represented by rectangles. Sets of attributes of component types are shown in rectangles. Attributes underlined with solid lines indicate component type keys, whereas attributes of unique constraints are underlined with dashed lines.

At the abstraction level of instances, each form type has its instances. Each form type instance represents a particular document that user creates, modifies, or uses to communicate with the IS. In our approach, a form type instance is a tree structure over the instances of component types. Each instance of the root component type is, at the same time, the instance of a form type itself. It is identified by a value of any of the root component type keys. If a component type N_i is directly superordinated to the component type N_j, then each (child) instance of N_j is identifiably associated with exactly one (parent) instance of N_i and each instance of N_i may be related to more than one instance of N_j. Each instance of N_j is identified by a value of any key of N_j, in the scope of its parent instance.

A possible number of instances of the component type within its parent instance is specified by choosing one of the two options: 0-N, or 1-N. The option 0-N means that the set of instances of the component type may be empty, while 1-N specifies that there always exists at least one instance of the component type, within its parent instance. The maximal number of child instances is always unbounded.

Example 2. Figure 3 shows an instance of the form type from the Figure 2. Each instance of the component type EMPLOYEE from Figure 2 represents a particular screen form aimed at browsing and editing records about employee's engagement in different projects. Each EMPLOYEE record is identified by a value of key *PID*. *Name*+*Surname* is a unique constraint. It means that every non null value of two-tuple *Name*+*Surname* must be unique among all EMPLOYEE records. Each instance of the component type PROJECT represents one of projects in which the employee is engaged. Each employee may participate in several projects. Each record about employee's engagement in the project is identified by values of keys *ProjID* and *ProjectName*, but only in the scope of the appropriate, exact value of the parent component type key *PID*. For each project, an employee may have a role associated with her/him in the project team, defined by a value of the attribute *Role*. *Role* is a unique constraint of the component type PROJECT, which means that each non null value of *Role* must be unique among all PROJECT records of an employee identified by a value of *PID*. □



PID	
NAME	
SURNAME	
TITLE	

PROJECT ID	**PROJECT NAME**	**ROLE**	**STATUS**

Figure 1: A screen form

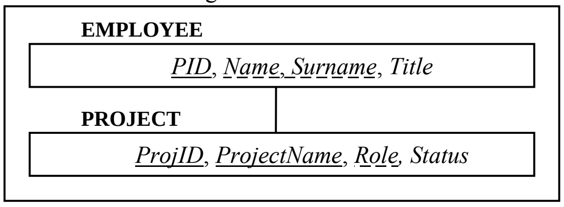


Figure 2: The form type for the form in Figure 1

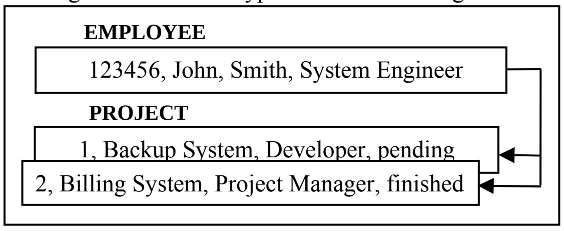

EMPLOYEE
123456, John, Smith, System Engineer
PROJECT
1, Backup System, Developer, pending
2, Billing System, Project Manager, finished

Figure 3: An instance of the form type in Figure 2

3 IIS*CASE AND THE FORM TYPE

Figure 4 shows the main screen form of IIS*Case (Integrated Information Systems*Case, V.6.0), a CASE tool based on the form type concept. IIS*Case is designed to provide complete support for developing db schemas, which are complex with regard to the number of concepts used and to generate design specification of ISs. Having an advanced knowledge of IS and db design is not explicitly needed for using IIS*Case. IIS*Case gives an intelligent support during the design process. IIS*Case supports:

- Conceptual modelling of a db schema,
- Automated design of relational db subschemas in the 3rd normal form,
- Automated integration of relational db subschemas, and
- Generating XML specifications of the information system.

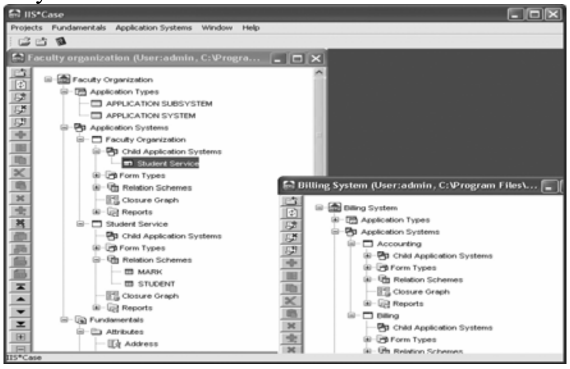
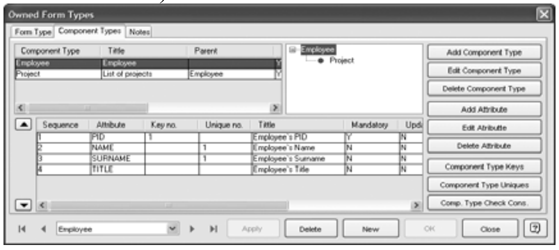


Figure 4: IIS*Case – Main Screen Form

All the concepts and methods that IIS*Case uses, and full specifications of implemented algorithms, are described in (Luković, 2003; Mogin, 1995; Mogin 2004, Pavićević 2005). Design of a complex IS in IIS*Case is organized by its decomposition onto application systems. Application system is a specification of a subsystem of the future IS that contains a set of form types and may include one or more child application systems (Govedarica, 2004, Pavićević 2005).



Component Type	Title	Parent
Employee	Employee	
Project	List of projects	Employee

Sequence	Attribute	Key no.	Unique no.	Title	Mandatory	Upd
1	PID	1		Employee's PID	Y	N
2	NAME		1	Employee's Name	N	N
3	SURNAME		1	Employee's Surname	N	N
4	TITLE			Employee's Title	N	N

Figure 5: IIS*Case – Screen Form for specifying form types

IIS*Case imposes strict structuring rules for form types. Using the screen forms, one of which is shown in Figure 5, designers are able to specify form types of various structures. They may define component types, their sets of attributes and the constraints: key, unique, and check constraints. A form type is organized as a tree structure of component types.

4 APPLICATION PROTOTYPING

In (Govedarica, 2004), a method for design application prototypes based on XML is presented. The method proposes generating platform independent XML specifications of an IS. Further XSL transformations, applied on those XML specifications, produce an executable prototype of the IS in the Java programming environment.

The model represented in (Govedarica, 2004) is based on User Interface Markup Language (UIML). Application prototypes are specified by means of XML, and after that, they are automatically transformed into UIML specifications. XML specifications of the prototypes are platform independent, while the resulting UIML specifications are platform dependent. The prototypes may be interpreted by a Java Render. Java Render by Harmonia Incorporation® is chosen programming and run-time environment. Implementation of this method in IIS*Case will provide the automated generation of fully functional application prototypes.

5 XML SPECIFICATION OF THE FORM TYPE

IIS*Case generates valid XML documents containing design specifications of the form types, and generated db schemas. Such documents, together with XML specifications of application systems, are integrated into an initial XML specification of the information system. XML specifications are independent of any run-time environment and the repository structure of any CASE tool.

The process of generating prototypes is based on using XSL transformations and Java programming environment. The next research step is to create an XSL transformation that will be able to transform the initial XML specifications into final UIML documents. IIS*Case will be able not only to generate, but also to interpret final XML (UIML) specifications of IS as fully functional prototypes.

6 CONCLUSION

The form type concept is semantically rich enough to enable specifying such an initial set of constraints, which makes it possible to generate application prototypes and underlying implementation db schema, automatically.

From the designer's point of view, IIS*Case offers a simple and natural way for defining the initial set of attributes and constraints of various kinds. By the knowledge of the authors, it is an original approach, which cannot be found in the same form in similar tools. It simplifies defining the rules, constraints, and procedures, particularly if the designed software and db schema of an IS are complex with regard to the number of concepts spanned. By the experience of the authors, these design activities usually require a large intellectual effort and an advanced knowledge in the IS and db area, but real designers do not always posses those skills. We believe that IIS*Case may significantly help them in overcoming IS and db schema complexity.

Implementation of the *application prototyping generator* in IIS*Case will enable generating fully functional and highly standardized application prototypes, by supporting a design method and the design activities that are almost completely automated. A possibility to use such application prototypes to communicate to end users is very important in order to identify all the requirements, business rules and constraints, early and precisely.

7 FURTHER RESEARCH

At the time being, IIS*Case V.6.0 can generate XML specifications of designed db schemas and form types. It also has an SQL generator that supports full implementation of db schemas under different DBMSs. Further research and development efforts are oriented towards extending functionality of IIS*Case to support complete development the software of an IS. Accordingly, we are working on:

- Implementing the *application prototype generator*,
- Implementing a *design template tool* for formal specifying common models of user interface (UI), and
- Implementing a *form type visual editor*.

A method for formalizing and generating specifications of IS software applications based on XML technology is discussed in (Govedarica, 2004). This method is to be improved and implemented in IIS*Case to enable automatic transforming XML specifications into executable application prototypes.

The *design template tool* will be implemented in order to support standardization of application prototype UI. Designers would be able to apply one of the predefined UI templates, or create and apply their own ones to preserve a consistent look and fill of all the generated prototypes. One of the necessary tasks to reach that goal is to provide visual design and specification of form types by means of the *form type visual editor*.

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