Conference Paper

Application of Hexagonal Conceptual Model for Solving Problem of Synchronization By Visual Designing of Complex Systems

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Abstract

In this article, solutions in the field of synchronous technology of the computer-aided design of complex systems on the example of the integral structure are discussed. The main attention is paid to the methods of conceptual and functional and logical design using the tools of visual presentation. The data transfer problem between the levels of design models have been analyzed. To synchronize design models at the system level, a hexagonal conceptual model is proposed for the visual presentation of information about the integrated structures and the VI-XML language – for the implementation of the synchronous modeling environment.

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1. Introduction

The relevance of the synthesis of the aggregate-based, replicable and system methods and means of visual description of the conceptual, structural and functional, and logical views of the integral structure are due to the fact that the synthesis of the project is necessary to formalize the functional-logical properties of the structure created at the earliest possible stages of the design. The task of the formal description of functional-logical properties of the designed product at the stage of generating ideas is an urgent task. It can solve by means of various design methods [1]. Creating a project is based on analysis of prototypes, which contain IP blocks of functional-logical description. Such blocks can be implemented in the languages of [2]: UML, XML, ASM, C, SystemC, SystemVerilog, HDL (VHDL, Verilog), libraries of physical entities, etc.

When conducting the research, we shall proceed from the assumption that a comprehensive solution of the design of the integrated structure is aimed at the creating and merging into a single representation at different levels of model abstraction (UML, ESL - Electronic System-Level; TLM - Transaction-Level Modeling; RTL - Register Transfer Level), and are presented in different languages to describe: UML, SystemC, VHDL, Verilog, etc. [3]. It determines the need for the use of mechanisms of formalization and manipulation of knowledge about the projected functional and logical structure in a single semantic interdisciplinary and inter-species hierarchy, which provides a unified and fully integrated parametric description of the functional, integral structure.

The purpose of this article is to solve the problem of the formalization and synchronous processing of heterogeneous information about the functional-logical properties of the integral structure of the early (conceptual) design stages with the ability of migration of data and knowledge of various project presentation levels.

The objectives of research in this article are the tools of visual description of the integral structure as a complex element of the system, methods, and tools of their formal implementation, storage and integration into existing CAD systems. In general, the methods and means of developing an integrated system to describe the structure of the project should be on the level of an intuitive visual language to provide the concept of functional modeling and subsequent translation to a lower level of the project.

2. Materials and Methods

Generalized route of formalization of the initial presentation of the project by means of simultaneous visual modeling include. Under visual simulation is meant a set of methods that use visualization metaphors that offer to represent an object from different points of view and can be used for the development and evolution of object modeling [1, 4, 5]. Visualization metaphors of this juxtaposition of abstract or real objects visually perceived images. Visual modeling languages, in turn, are formed from a fixed set of metaphors and the rules of the construction of these visual models.

Visual modeling tools should be able, firstly, to provide information about the integral structures, which are understood as the set of elements with different physical properties and forms that are in certain spatial, mechanical, thermal, electromagnetic and energetic interconnections. This relationship is determined by the system engineering, circuit design, design and technological information and ensures the specified functions with required accuracy and reliability under the impact of various factors. In the design of integrated structures are identified the following basic design levels: the system level, the RTL level, the physical level (Figure 1) [6–8].

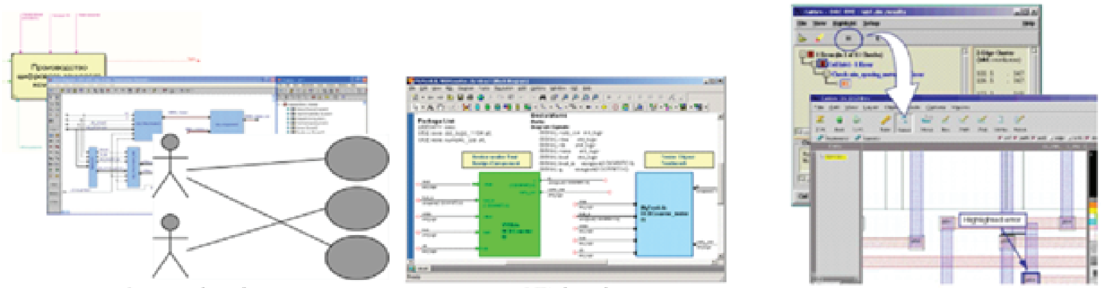

Figure 1: Baseline levels of designing integrated structures.

Overall functional and logical view of the projected integral structure is laid at the system level. This representation can be implemented in the general case of the conceptual-abstract, structural-functional component and object methods [4, 7, 9, 10]. Synchronization of parametric and structural composition of interconnected objects of different levels of design is one of the main tasks of complex visual methods. With such an approach, the used visual modeling environment should provide synchronous tools with a complete description of functions, components, element base of the system integrated into a single project database.

The modern character of the design of complex systems characterized by increasing complexity and difficulty of building integrated models for formal, through description, storage, and processing of knowledge within a single CAD system. Search data solutions to problems at the moment are built around the use of visual modeling and design as the main tool of generation, storage, and processing of knowledge, especially in the early stages of development.

By visualizing the design of complex systems is understood the phenomenon of formal description of the system design process and the finished project as a universal calligrapher with decomposition and modeling options [1, 4, 10]. To do this is created a set of methods (notations) that use graphical models (graphical notation) and methods of formal description text (text notation), in conjunction with the means of man-machine interactive interaction. This provides a clear and detailed view of the characteristics of objects in the design process, expert analysis, and rapid decision-making.

The term 'visual design' refers to the use of visual expressions (graphs, drawings, icons, tables), which are elements of the graphical language, in the design process [1, 4]. Visual language is defined as a language based on visual primitives to describe their main components in textual and graphical notations [4].

With the use of visual methods, description involves certain problems. First, we should highlight the problems of convergence and encapsulation.

The problem of convergence (from the English convergence – convergence at one point) due to the complexity of the interpenetration of technologies (conceptual, structural and functional, logical and physical levels of the model), when the boundaries between the individual levels are cleared, and many interesting solutions are found at the junction of the levels of visual models.

The problem is due to encapsulation at this stage of fragmented visual analysis and isolation when it is used at different levels of the project.

The solution of these problems is aimed at creating visual tools formalized description of complex systems.

This decision is based on the model of related concepts and judgments, which is the basis for the meta-language constructions and representations of circuit design and technological information. In [11], a language VI-XML (Visual Intelligence XML – XML subset). Modern means of visual modeling combine graphical notation (library elements of visual language, editing the repository browser model, etc.) and text notation associated with the components of visual language, which describes the components of the data attributes. The combination of graphical and textual notation should provide a synthesis of full-text documents on the developed models.

Providing a clear relationship and unity of the interpretation of the concepts of one of the most important problems to be solved in the early conceptual stages of a project. The concepts inherent to the same level of detail describing one often correlate with the concepts of the other, or vice versa, the concepts with the same name in different contexts have different signs. Considering the generally pyramid of decision (subject area examination processes and objects) to consider the level of generalization, characteristic of a certain level of 'expertise' (interpretation) of the domain. In the initial (conceptual) level determined by the basic properties of the system, worked out at the structural framework and the parameters for the object is held detailing the class and object model. It is necessary to provide a link levels and elements of the model with each other. For these purposes the proposed multi-level cellular hexagonal structure (upper lattice plane – conceptual, lower – structure, inner – object). This approach provides communication concepts different level of generalization [10, 11]. What I should know the head does not have to know a worker in a particular workplace and vice versa. However, visual models, which describe each of the levels, should have a clear and unambiguous interpretation in not depending on the level of decision-making.

This approach is the basis for the implementation of the language to describe models VI-XML.

Conceptual analysis is defined as the technique of construction and verification of the conceptual framework [12]. To solve the problem interaction migration elements of different levels of presentation models, you can use the method of calculating concepts schemes. It implements the following recursive procedure: A simple diagram of the concept consists of the name of this concept. Driving concepts resulting generalizations, it is the intersection of schemes differentiable concepts. Driving concepts resulting from the aggregation of signs and associations is the unification of schemes integrable concepts.

Conceptual analysis is a generalization of the object [13] and, therefore, a true statement about the possibility of conversion of the synthesis mechanism conceptual model into an object while maintaining completeness and consistency.

In the early stages of synthesis of modern integrated circuits, which are characterized by complex internal logical structure, variety of output interfaces and complex assembly solutions, most commonly used conceptual and ontological or structural-functional approach to describe the functional logic of the system – object analysis [14, 15]. To talk about the creation of a universal design methodology that considers all the aspects necessary to assess the extent of the relationship of conceptual and object representations.

Graphically link the components of the conceptual and object model can be represented in the form of a hexagonal close-packed lattice (Figure 2), which defines the principles of functioning models of transformation mechanisms. The figure shows only one lattice segment, in general terms, it is synthesized for each subspace conceptual field. Horizontal communication defines the connection between the individual components of the model object of the subspace, and vertical communication form is summarizing all the components of the subject area as a whole.

As a result, it can be argued that for a complete description of the subject area is sufficient to use the conceptual model (and its partial implementation, structural and functional, object models, etc.). Conceptual structure and syntax of concepts will describe the declared meta-language, and the description of semantics and perform tasks on a special object language defined in the conceptual model [12].

Formed description of the system-level design languages of visual modeling suggests further encapsulation with a logical presentation and subsequent modeling, as well as broadcast to a lower level of performance of the project. In general, the synthesis route system-level design tools is represented by the following [6, 16–19]: means

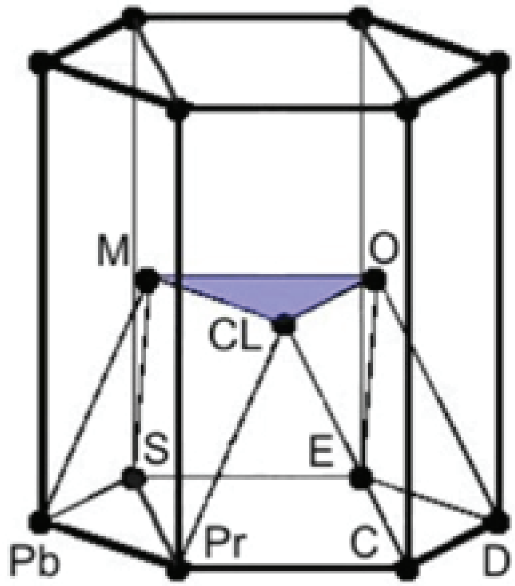

Figure 2: Presentation of conceptual relationships and object domain analysis in the form of a hexagonal close-packed lattice (shown in one segment of the lattice). (O – Object, M – Method, CL – Class, Pb – Problematic, S – Semantic, Pr – Pragmatic, C – Concept, D – Design, E – Entity, *i, k* – level domains.)

the conceptual and abstract, structural-functional, object and component descriptions of the system-level design to visual modeling languages, tools descriptions at different levels of abstraction: ESL – Electronic System-Level; TLM – Transaction-Level Modeling; RTL – Register Transfer Level and in different languages: SystemC, VHDL, Verilog, a set of tools for debugging on the SystemC language projects, a means of optimizing the architecture, debugging, verification and control requirements models. System-Level visual modeling tools should provide a high-level algorithmic synthesis of a functional description of the algorithm in C or C ++, followed by synthesis of the RTL-description of the project (VHDL or Verilog). Effective interaction migration design information between the levels and design tools determines the efficiency of the synthesis solution as a whole.

3. Results

3.1. Synchronous technology formalization of design and technological information based on Vi-XML language

Language formalized description of synchronous visual models VI-the XML discussed in details in [11], it is based on a unified graph structure, in which the vertices of VI-model presented in the form of concepts describing the objects and their parameters, and the edges of the graph in the form of judgments, describing the relationship objects. The visual model is described in the XML meta-language, the elements of which are the concepts and judgments. Visually VI-XML document is presented in a tree structure. Using the language of VI-XML, the simulated system can be represented as a set of objects (concepts) and links (judgments groups).

This description language design models as the basis for a universal visual modeling environment that provides a single interface for creating and editing visual models using common and new graphical notations [11]. The proposed approach defines the ability to connect all levels of visual modeling in a single closed hierarchy of components and processes in the description of complex systems.

4. Discussion

The proposed approach to implementing an integrated visual design provides a single tool to create and modify design models on the base of visual languages. Application VI-XML language provides synchronization of project procedures and allows to overcome the fragmentation and isolation of complex visual analysis in the initial levels of modeling complex systems.

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