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DEVELOPMENT OF AN ALGORITHM FOR MODELING PARAMETRIC MODELS OF TYPICAL CONSTRUCTION STRUCTURES USING VISUAL PROGRAMMING IN THE DYNAMO MODULE.

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Annotation. The article discusses the issues of optimizing the process of developing an information model of buildings and the introduction of BIM technology. The basic principles and principles of visual programming of building structures for the design of information models using BIM-technologies are considered. Dynamo has eveloped an algorithm to improve data modeling technology using visual programming. Based on the developed algorithm, the user or designer can take the necessary data from Revit and return it, as well as create new elements according to the desired parameters.

Key words: object; model; information model of structures; visual programming; programming environment; graphic diagrams; diagram nodes; computer-aided design systems.

Annotatsiya. Maqolada binolarning axborot modelini ishlab chiqish va BIM texnologiyasini joriy etish jarayonini optimallashtirish masalalari muhokama qilinadi. BIM-texnologiyalaridan foydalangan holda axborot modellarini loyihalash uchun bino tuzilmalarini vizual dasturlashning asosiy printsiplari va printsiplari ko'rib chiqilgan. Dynamoda vizual dasturlash yordamida ma'lumotni modellashtirish texnologiyasini takomillashtirish uchun algoritm ishlab chiqilgan. Ishlab chiqilgan algoritm asosida foydalanuvchi yoki dizayner Revit-dan kerakli ma'lumotlarni olishi va uni qaytarib

berishi, shuningdek kerakli parametrlarga muvofiq yangi elementlarni yaratishi mumkin.

Kalit so'zlar: ob'ekt; model; tuzilmalarning axborot modeli; vizual dasturlash; dasturlash muhiti; grafik diagrammalar; diagramma tugunlari; kompyuter yordamida loyihalash tizimlari.

Аннотация. В статье рассмотрены вопросы оптимизации процесса разработкии информационной модели зданий и внедрения BIM-технологии. Рассмотрены основные положения и принципы визуального программирования строительных конструкций для проектирования информационных моделей с использованием BIM-технологий. Разработан алгоритм совершенствования технологии информационного моделирования с использованием визуального программирования в Dynamo. На основе разработанного алгоритма пользователь или проектировщик могут получать необходимую информацию из Revit и передавать ее обратно, а также создавать новые элементы по необходимым параметрам.

Ключевые слова: объект; модель; информационная модель сооружений; визуальное программирование; среда программирования; графические диаграммы; узлы диаграммы; системы автоматизированного проектирования.

Introduction

Three-dimensional computer modeling (3D) is widely used in the design of a three-dimensional model of the installation and technological part of a project in construction. Obtaining design documentation and construction drawings from a three-dimensional model is the main part of BIM technologies.

Currently, the computer-aided design of metal structures is widely used in construction. In three-dimensional modeling, not only the geometry of the object is designed, but also parameters that exactly correspond to the real structure of the object; these include material, coating, standard, position number and shipping mark, with which objects the connection was made, the type of this connection. As a result of the design of the structure model, the data of the information model is processed and transferred to the draft drawings statements and specifications. Thus, a

generalized three-dimensional model of the project is obtained. Further, the system allows the unification of the work of departments into a single whole, collecting all the information in the documentation. When testing a three-dimensional model, intersections of metal structures with equipment and piping of the designed 3D models of structures are excluded.

The use of BIM design systems such as Autodesk Revit or Graphisoft ArchiCAD is widespread among users who are already adopting BIM technologies. One with BIM technology tools, can create detailed BIM models. With an increase in the number of such models and their level of complexity, the costs of their design increase, so the performance of the modeling process decreases sharply.

The development of BIM models requires more attention to the structure design process. In order for the final result of the project to correspond to what needs to be erected on site, it is necessary to use effective algorithms for the development of information models, for example, the design of masonry; the designer uses the algorithm for creating an information model to do his work. Since his actions are repetitive work called stone modulation, which mainly consists of the manual assembly of wall components, blocks, prefabricated structures, reinforcement, etc., an algorithm must be developed to use the BIM mechanism to effectively accomplish this task.

Therefore, to automate the design and obtain an optimal BIM model, it is necessary to use visual programming tools. The purpose of this article is to develop algorithms for designing BIM models using tools of visual programming languages, in particular, the visual programming language Dynamo. Dynamo is a platform that extends the standard functionality of Revit and allows one to perform any calculations using simple commands. Any user who designs residential buildings in Autodesk Revit knows that there are no ready-made solutions that would take into account all the subtleties of the process of calculating the parameters of a residential complex. Dynamo was created to extend the core functionality of Revit and save designers time to efficiently design BIM models.

Research methodology

VPL (Visual Programming Language) -based tools allow design algorithms to be programmed and then processed to create 3D models. Platforms such as Dynamo, Grasshopper, and Generative Components are examples of applications that use VPL. The research in this article is aimed at exploring the possibility of using tools based on visual programming languages, in particular the visual programming language Dynamo, for effective modeling in the design of BIM models.

The research in the article should be carried out in terms of the limitations, capabilities and usability of the Dynamo tool, using the example of developing BIM models for masonry [1].

Visual programming languages were developed in the 70s and arose as a result of combining work in the field of three-dimensional modeling, object-oriented programming languages and the spread of human-computer information technologies. The main idea of such a language is that a graphic model of an object is visually selected, filled with the necessary information describing the properties of objects, and actions that can be performed on a three-dimensional object are set.

In classical programming languages, it is necessary to study the syntax of the language, the rules for composing algorithms in order to write a program. In visual programming platforms using VPL, programs are built using graphical diagrams called graphs, which are made up of elements called nodes.

Each graphical diagram node contains nested structures used by the visual programming language Dynamo. When a developer creates a program graph for a 3D model, he creates a program for algorithms that describe actions at the nodes of the graph. Using the Grasshopper platform, based on this graph, you can create a graph, based on the graph data, and a three-dimensional model is projected, which is automatically generated from the processing program in its nodes.

VPL visual programming operators offer an advanced user interface and a complete set of commands for designing 3D models. With the help of these operators, you can develop models of complex architectural forms and save them in a digital model.

The joint use of tools for the development of VPL visual programming models and the information model of structures in BIM technologies is an effective method

that allows users to create modern projects, optimize development costs and minimize project creation time [2].

The main focus should be on training users of BIM modeling tools in higher education. Architects, designers and builders should study software development using visual programming systems in their courses because it will significantly increase their productivity.

Research results

Based on the above, an algorithm for designing programs in Dynamo has been developed. An example of using the algorithm to design stained glass is given in the following description

Algorithm in the Dynamo visual programming environment

1-block.

1. **Selection of objects.** In the column, select Revit-Selection-Categories. Put the Node on the field and select Curtain Wall Panels.
2. **Selection of objects.** Select the "All Elements of Category" node. We connect 2 nodes.
3. **Run the block algorithm.** Click Start and check the number of selected objects.
4. **Setting the parameters of the object.** Remove Watch. We put the SetParametrByName node. We connect Elements-Element. Put the "CodeBlock" node (double-click LMB). Enter the parameter name in quotes ("Color"). We connect the name of the parameter to the input "ParametrName".
5. **The choice of the material of the object.** To select a material, put the MaterialByName node and in front of it the Code Block with the text "Color1". Connect the Code Block to the name input, and the Material output to the Value input. We run the algorithm and see the appearance of a list of elements.

2-block.

1. **Counting elements.** Set the List. Count counter node from the Elements output. When the algorithm starts, we see the number of elements in the node.

2. Sampling the proportion of elements. We put the Code Block with the variable c multiplied by a fraction of 0.2.

3. Rounding off the number. We put the Round node and attach the input to the output of the variable c.

4. Sampling of the second share. In the same CodeBlock node, put the second line with * 0.2, and copy the rounding node and attach it to the second line. Copy - Ctrl + Move.

5. Shuffle the items in the list. Create a List.Shuffle node that distributes the selected items in a random order. We attach it to the output of the All Elements of Category node.

6. Selection of elements from the list. Create a List.TakeItems node that selects several items from the beginning of the list (in our case, from an already formed chaotic list). We connect the quantity from the rounded off values of the parts from the counter.

7. Selection of the remaining items in the list. Create List.DropItems, connect in the same way.

8. Sampling the second share. From the remaining elements, we make a selection with several elements, the number equal to the number of elements of the second part. Copy the List.TakeItems node, take the list and the List.DropItems node, and the quantity from the rounded second share.

9. Selecting the third part. We also select the remaining list items using the List.DropItems node with the same input as in section 8. As a result, we get three lists.

3-block

1. Creation of a group of nodes in the algorithm. Disconnect the Elements-Element bundle and select several nodes with the mouse. Create a group: Editing - Create a group. The group is intended for the convenience of simultaneous movement and copying of several nodes. Move the group to the right side of the working area. Copy it twice by moving it with the Ctrl key pressed. Assign different colors to three groups (right button - color selection).

2. Joining groups to the input. Rename the lines in the blocks with the names of the colors - Color1, Color2, Color3. We attach the outputs from the three lists of elements to the inputs of the Element. When the program is executed using the developed algorithm, the panels in the model change color randomly**.**

Conclusions and recommendations

Designers can use Dynamo at all stages of design: when creating conceptual forms; when developing structures according to the geometry of the structure specified by the architects; to develop specifications. The special significance of the developed visual programming algorithm is that the user or project developer can obtain the necessary information from the Revit information model and transfer it back to the model database. It is possible to create new elements of a three-dimensional object according to the specified parameters: build a wall according to a drawing, arrange objects with a given step. With the help of the Dynamo visual programming platform, you can quickly create all the necessary calculations, such as the calculation of the decoration of premises, the placement of lamps, connect engineering equipment, optimize the path of engineering networks, and calculate the supporting structures. In addition, designers can draw up the necessary documentation here, generate estimates, and so on. Dynamo can be easily customized and expanded to suit users' needs. This is a great opportunity to leverage BIM technology with Revit.

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