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Alisher Shomurodovich Fazilov
Tashkent Institute of Architecture and Civil Engineering
Candidate of Technical Sciences, Associate Professor,
Tashkent, Uzbekistan

Maruf Kuchimovich Kuchimov
Tashkent Institute of Architecture and CivilEngineering
Senior Lecturer

DEVELOPMENT OF A VISUAL PROGRAMMING ALGORITHM FOR BIM-MODELS USING MODULE OF STRUCTURES BY DYNAMO MODULE

Abstract: *The article discusses the issues of optimizing the process of developing an information model of buildings and introducing BIM technology. An algorithm has been developed to improve information modeling technology using visual programming in Dynamo.*

Key words: *Algorithm, computer modeling, information model of structures, three-dimensional visual programming.*

Language: *English*

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Introduction

Three-dimensional computer modeling (3D) in the design and development of a 3D model of the installation and technological part of the project, as well as the release of 3D documentation from the 3D model of the project documentation and drawings are an integral part of BIM technologies.

In construction, a modern system of computer-aided design of metal structures in three-dimensional space, adapted to modern standards, is actively used. When modeling, an object is laid not only its geometry, but also the parameters corresponding to the real design, such as material, coating, standard, position number and shipping mark, with which objects the connection was made, the type of connection and so on.

After the model of the structure is built, all these data are processed and automatically reflected on the drawings, statements and specifications. This allows you to create a common project model in three-dimensional space and combine the work of departments into a single whole, ensuring a consistent release of documentation. When checking the model, collisions (intersections) of structures with equipment and piping of the designed structures are eliminated.

Using BIM authorization tools such as Autodesk Revit® or Graphisoft ArchiCAD®, It has become common practice for users who have already made contact with BIM. Using these tools, you can create detailed BIM models. However, when the level of development of these models increases, the productivity of the modeling process begins to decline.

The development of BIM models requires more attention to the design rules of the simulated building system, so that the final result matches what needs to be done on site. For example, in masonry design, the designer uses a set of rules to do your work. Some of these rules are associated with a recurring task called stone modulation.

This task mainly consists in the manual assembly of wall components (blocks, prefabricated structures, fittings, etc.). Simulation performance in this case is

affected if the BIM tool used does not have the functions to effectively complete this task.

Materials and Methods

The same goes for the formwork design. This type of design also uses a set of rules and has repetitive tasks that can affect performance if performed manually.

Therefore, it is advisable to use visual programming tools to automate the design and obtain the optimal BIM model. The purpose of this article is to develop BIM-model design algorithms using visual programming language tools, in particular, Dynamo visual programming language. Dynamo is a platform that extends the standard Revit functionality and allows you to perform any calculations with the click of a button. Any engineer who designs residential buildings in Autodesk Revit knows that there are no turnkey solutions that 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.

Tools based on VPL (Visual Programming Language) allow you to encode design rules and then process them to create 3D models. Tools such as Dynamo®, Grasshopper®, and Generative Components® are examples of applications that use this type of language.

This study aims to explore the possibility of using VPL-based tools to reduce simulation time in the production of LoD 400 BIM models. To achieve this, Autodesk Revit® and Dynamo® applications were selected.

The research was conducted in terms of limitations, capabilities and ease of use of the Dynamo® tool with an emphasis on the development of BIM LoD 400 masonry models.

Visual programming languages were developed in the 70 s and arose as a result of combining work in the field of computer graphics, programming languages and human-computer interaction

The main idea of such a language is easier to use and learn through the use of graphic artifacts, rather than a text programming language.

In text-based programming languages, users need to learn the language syntax before they can code programs. In VPL tools, logic programs are constructed using diagrams called graphs, which consist of elements called nodes.

Nodes contain encapsulated structures used by the visual programming language. When a user creates a program graph indirectly, he creates program codes that are hidden in the nodes of the graph. Using the Grasshopper® module, a graph is created on the basis of this graph, when this graph is working, three-dimensional geometry is generated from the built-in processing code in its nodes. VPL tools offer a more user-friendly interface between humans and computers, making it easier to learn and use a programming language. VPL tools have been used in the BIM context for several years, particularly in the study of complex architectural forms and to support digital production. Sharing VPL and BIM model development tools is an interesting strategy that users should use. The three VPL tools mentioned above enable integrated work with BIM model authorization tools. Dynamo® is integrated with Autodesk Revit®, Graphisoft ArchiCAD integrates with Rhinoceros 3D and Grasshopper®. The fact that VPL is relatively easy to learn than textual programming languages is related to who will use this type of language.

The focus is on users of BIM model development tools. However, architects, engineers, and technicians do not have software development classes at their graduate courses, because this, of course, is not the subject of their release.

Based on the foregoing, a program design algorithm was developed in Dynamo. An example of using the algorithm to develop a stained-glass window is given below.

Results

BUILDING AN ALGORITHM IN DYNAMO*: *Stage-1.

1. Panel selection. *In the tree, select Revit-Selection-Categories. We put Node on the field and select "Stained Glass Panels" (CurtainWallPanels).*

2. The selection of panels. *Select the node "All Elements of Category". Connect 2 Nodes.*

3. View selected. *Put the "Watch" node, connect.*

4. Run the algorithm. *Click Launch and check the number of selected panels.*

5. Installation parameters. *Delete Watch. We put the SetParametrByName node. Connect the Elements-Element. We put the Code Block node (double-click LMB). Enter the parameter name in quotation marks ("Color"). We connect the parameter name to the input "ParametrName".*

6. Material selection. *To select a material, put the MaterialByName node and in front of it a Code Block with the text "Color1". We connect the Code Block to the input name, and the output Material to the input value. We start the algorithm and see the appearance of a list of elements.*

Stage- 2.

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

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

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

*4. **Sample of the second share.** In the same Code Block 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 items in a list.** Create a List.Shuffle node that distributes the selected elements in a chaotic manner. Attach it to the output of the All Elements of Category node.*

*6. **Fetching items from a list.** We create a List.TakeItems node that selects several elements from the top of the list (in our case, from an already formed chaotic list). We connect the quantity from the rounded values of the fractions from the counter.*

*7. **Selecting the remaining items in the list.** Create List.DropItems, connect in the same way.*

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

*9. **Sample third share.** The remaining list items are also selected using the List.DropItems node with the same input as in section 8. As a result, we get three lists.*

Stage-3.

*10. **Creating 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 designed for the convenience of simultaneously moving and copying multiple nodes. Move the group to the right side of the working field. We duplicate it twice by moving it with the pressed Ctrl key. Assign three colors to three groups (right button - color selection).*

***Joining groups to input.** Rename the lines in the blocks with the names of the colors - Color1, Color2, Color3. We connect the outputs from three lists of elements to the inputs of Element. We start the algorithm. The panels in the model change randomly.*

Conclusion

Designers can use Dynamo at all stages of design: when creating conceptual forms; when developing structures according to the geometry of the building specified by the architects; to form specifications. An important advantage of the developed algorithm is that the user or designer can get the necessary information from Revit and transfer it back. There is an opportunity to create new elements according to the necessary parameters: build a wall along given lines, arrange columns with a given step. Using Dynamo, you can quickly create a heat engineering calculation, calculation of interior decoration, arrangement of fixtures, connect engineering equipment, optimize the path of utility networks, calculate load-bearing structures. In addition, engineers can draw up the necessary documentation here, and form estimates. Dynamo can easily be modified to fit your needs. This is a great opportunity to leverage Revit and BIM technology.

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