Software for the Study of Three-Dimensional Assemblies by Using Cellular Automata

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INTRODUCTION

In this paper, we consider the system of initial theoretical positions, which are the basis for research on the search for variants of cellular automata in the study of thermo-mechanical processes in 3D objects of SolidWorks. These studies are carried out by representing three-dimensional objects in the 2D von Neumann collations of the 1st order. Execution of this work also involves the creation of initial rules for changing the system, which are necessary for the direct use of cellular automata.

The main direction of the research of cellular automata is the algorithmic solving of individual problems, which in one way or another use a two-dimensional coordinate system.

The result of this work will be the development of the concept of the use of cellular automata for the study of three-dimensional objects, as well as the creation of appropriate software, which will allow the use of this concept in conducting various types of experiments.

THE MAIN TASKS OF THIS WORK

Initially, we have the assembly of 3D model of fixed-sized piles, which was created by using the early-developed software. [1], [2]

Next, we cut the existing assembly for a number of 3D cubes the same size. The number of this 3D cubes is limited and depends on the density of the cut parameters.

When we have some 3D cubes, it is necessary to make their transformation in order to represent them in the form of 2D squares. This step is very necessary and important, because with this transformation we will be able to use cellular automata.

In order to accomplish this task, we choose the 2D field of von Neumann in 1st order. According numbering of 3D cube facet and 2D neighborhood von Neumann in 1st order, we create a graphical relationship facet of 3D cubes, which are shown in Figure 1. [3]

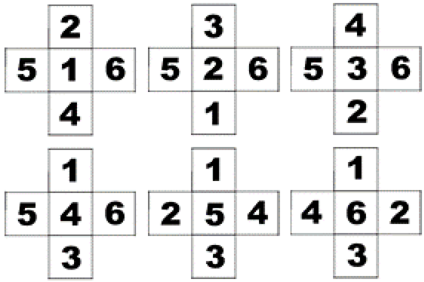

Fig.1 View relationship facet of 3D cubes by using 2D Von Neumann Fields

Therefore, we can see how one 3D cube facet can affect to another in the first figure. By using these relations was developed a general scheme for the external and internal facet of the created 3D cubes.

This schema is shown in Figure 2. The values of X [1-6] are the own facet of the selected 3D cube, and of course the value of Y [1-6] is the facet of the outer selected 3D cube that is adjacent to the selected one. It's clear that cells of one 3d cube can only interact with the cells of the adjacent 3d cube and not otherwise [4].

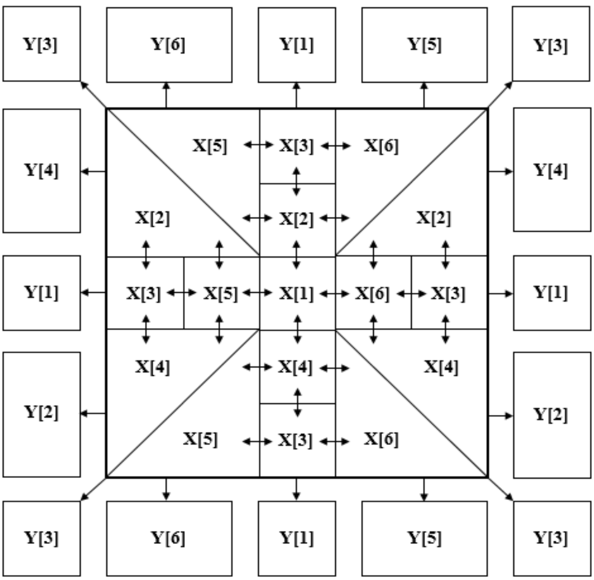

Fig.2 Scheme for the external and internal facet of the created 3D cubes

Visual representation of this scheme of relationship between the facets difference of 3D cubes, are shown in Figure 3.

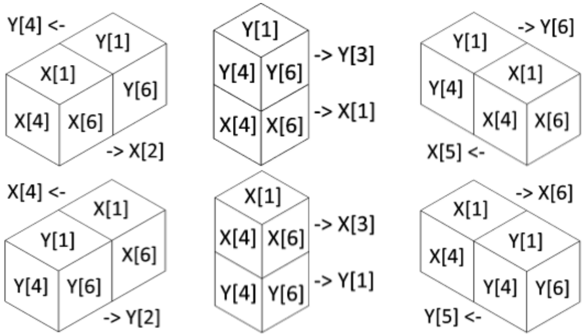

Fig.3 Visual representation the scheme of relationship between the faces of 3D cubes

CREATING INTERRELATION BETWEEN DEVELOPED CLASSES

To solve this task, it is necessary to develop several basic and secondary classes. With these classes, you can implement a scheme of interconnections between the faces of chosen 3D cubes. In Figure 4, you can see the graphical relationship between these developed classes.

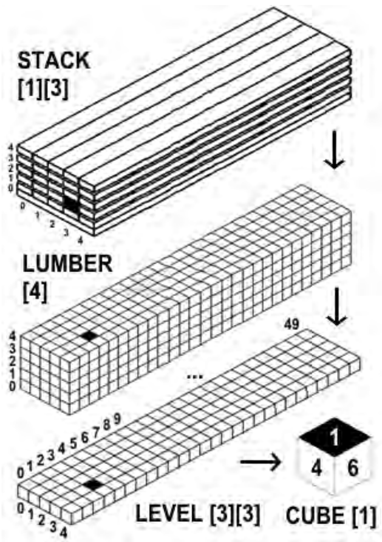

Fig.4 Graphic interrelation between developed classes

A class diagram of all developed classes you can see in Figure 5.

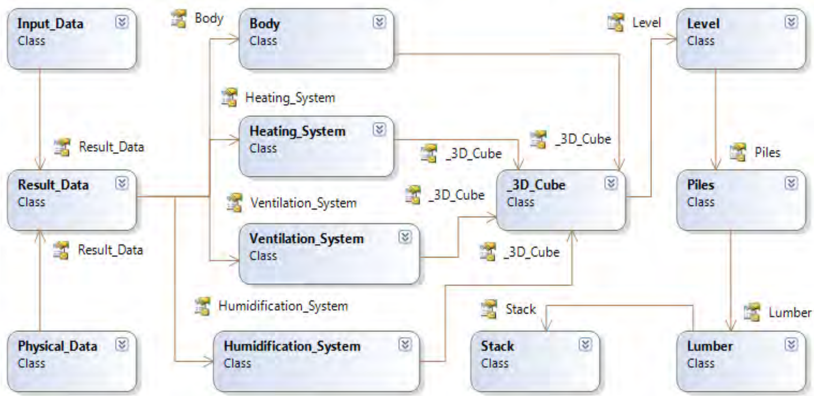

Fig.5 View the diagram of classes

GENERATION OF THE RESEARCHED SYSTEM BY USING DEVELOPED SOFTWARE

After creating and configuring all of the developed classes, was started the process of creating a graphical interface for generating the explored system. [5]

This graphical interface includes three blocks, each of which allows you to define various parameters of the generation of the studied system. The first block is called "Calculation the size and number of 3D cubes". It serves to provide the user with the following information: Length, height and width of one lumber; Number of lumber in one stack; Height of gaskets between lumber; Total number of stacks.

In addition, the first block has the button "Find", which allows you to determine the possible variants of the section density of the three-dimensional studied system. Based on the values of the selected density, 3D cubes were constructed. The height, width and thickness of these 3D cubes is equal to the value of the selected section, which can be multiple 0.25 mm. It is clear that the number generated 3D cubes will directly depend on the selected density cut. The process of creating 3D cubes is done by pressing a button, which is called "Begin creating".

The second block is called "Results of calculations". This block contains information about the number of created 3D cubes for the following parameters: One lumber; One stack of lumber; The whole researched system. Despite the large number of 3D cubes, the process of their creation does not take much time. However, a further process of calculation requires the availability of a PC that has good technical characteristics. In addition, this block has fields for entering the initial values of temperature and humidity of air and lumber [6].

When all the initial parameters are specified, it is necessary to complete the creation of the studied system by pressing the corresponding button. The last third block serves to verify the adequacy of the system.

This block becomes available immediately after creating the system under study. The verification process consists in choosing the coordinates of the required 3D cube. Next, you can get all the necessary parameters contained in the specified 3D cube.

The graphical interface of the software developed, besides text information, contains a visual representation of the above parameters, which in turn makes it more understandable and easier for the end user. The general view of the developed graphical interface is shown in Figure 6. [7]

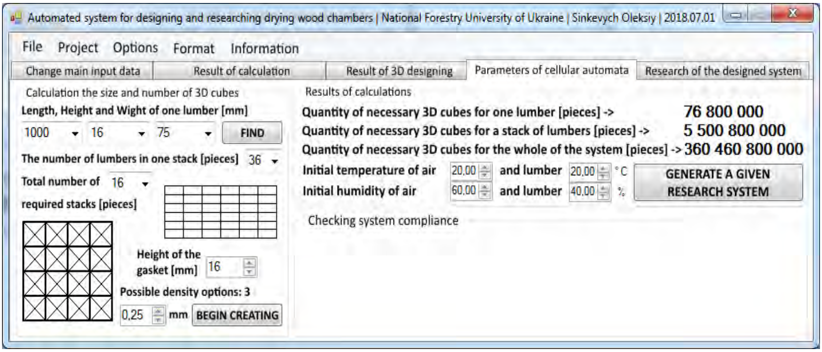

Fig.6 Graphical interface of the developed software

RESULTS

The result of this work is the creation the new software, which allows you to receive two-dimensional arrays of information that are necessary for using cellular automata. In addition, this software allows you to obtain arrays of information from the downloaded 3D models that are assembly in SolidWorks environment, by using early development application software. Also by using this software, was generate researched system, which can used cellular automata.

CONCLUSIONS

As a result of this work, was created a software with which you can download a 3D model of lumber piles and instantly calculate the number of possible variants of cutting each of the lumber into 3D cubes of the same size. The cutting process itself takes place using the SolidWorks API. The resulting 3D cubes were presented in the form of 2D neighborhood of von Neumann 1st order. With this view, a relationship scheme was created for the inner and outer sides of the created 3D cubes.

Also in this work, we developed the diagram of classes. In general, in this work, we examined the possibilities of using the theory of cellular automata in studying models presented in a three-dimensional coordinate system. Based on all these transformations, was generated a system, that would be investigated by using cellular automata. This software was developed by using programming language C#.

REFERENCES

[1] Y. Sokolovskyy. Software for Automatic Calculation and Construction of Chamber Drying Wood and its Components / Y. Sokolovskyy, O. Sinkevych // *Materials of the XII International Conference MEMSTECH 2016*, 20-24.04.2016, Lviv, Ukraine – Publisher Lviv Polytechnic, 2016. – pp. 209-213.

[2] Y. Sokolovskyy. Calculation of the Drying Agent in Drying Chambers / Y. Sokolovskyy, O. Sinkevych // *Materials of the XIV International Conference CADSM-2017*, 21-25.02.2017, Polyana, Ukraine – Publisher Lviv Polytechnic, 2017. – pp. 27-31.

[3] Toffoli T., Margolus N. A Cellular Automata Machine. – M.: WORLD, 1991. – 280 p.

[4] Wolfram S. A new kind of science. - Wolfram Media Inc., Champaign, Ill., USA.2002.

[5] Y. Sokolovskyy, O. Sinkevych Automated System for Modeling and Optimization Aerodynamic Processes in CAD of Drying Chambers / *Materials of the XXIV International Conference CADMD 2016*, 21-22.10.2016, Lviv, Ukraine - Lviv Polytechnic National University, 2016. - P. 31-38.

[6] O. V. Sinkevych, Software and algorithmic provided for work with cellular automates / O. V. Sinkevych, I. Ya. Sokolovskyy // *Scientific Bulletin of the National Forestry University of Ukraine: a collection of scientific and technical works*. - Lviv: NFU of Ukraine, 2018. Issue 28.3. - P. 137-141.

[7] Sokolovskyy J., Sinkevych O. Software and algorithmic support for representation of CAD models in 2D von Neumann neighborhood / *International conference "Advanced computer information technologies 2018"*; Cesce Budejovice, Czech Republic, June 1-4, 2018, p. 215-218.