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3D-MODELING OF THE INTERIOR OF THE ROOMS BY CLOUD TECHNOLOGIES

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Abstract. The work considers the possibility of using 3D-modeling technology for interior design of restaurant premises; criteria were determined and on-line applications designed for 3D interior design were compared, their advantages and disadvantages are defined. The example of one of the on-line services describes how to design an interior project for a pop art youth café.

Keywords: cloud technologies, 3D-modeling, room interior, design, visualization.

Introduction

In the research of current conditions of economic development of Ukraine, an important place given to small and medium-sized businesses, which play a significant role in the formation of enterprise. Foreign experience of doing business shows that it is the medium and small business sector that is the most widespread, flexible and dynamic form of business [10, 15]. However, despite the fact that the effective activity of small and medium-sized enterprises has a significant impact on the economic growth of the country, provides employment and directly improves living standards, Ukrainian entrepreneurship faces a number of problems the hinder its development.

Along with such problems as the general state of the Ukrainian economy monopolization of business, imperfection of the tax system, instability of business conditions, etc. – there is a problem of lack of sufficient starting capital, own financial resources, raw materials, premises and equipment for starting a business [10, 15]. To solve this problem, entrepreneurs usually try to save money on attracting specialists of a certain profile – independently search for professional information, personally perform job responsibilities in several positions, and even perform the selection of premises and develop their design.

Small and medium-sized service businesses are owners of small cafes, coffee shops, bars, and the like. Designing a room is one of the main expense items in organizing their business. An important factor that will save on this article is the current state of information technology development, and especially – the emergence of professional cloud services in the field of room design. Architects and designers have long been using paper, ruler and pencil to make plans. This process has become easier and more productive with the help of computer software for interior design.

The purpose of the work is software modeling of the interior of the youth café and its elements in the style of pop art, as well as visualization of the developed model.

Therefore, as a *research object* in our work, we will choose the process of 3D modeling of the interior of the premises.

The subject of the research is the possibilities of on-line programs for the development of 3D project of the room design.

The objectives of the research will be:

1. Exploring the features of 3D interior modeling technology.

2. Comparison of on-line applications designed for 3D interior design, identifying their advantages and disadvantages.

3. Design of the project of the youth café hall with the help of on-line program for 3D modeling of the interior of the premises.

The methods of research will be literature study, analysis, comparison and modeling.

1 Analytical review of literature

In the 21st century, the development of modern information technology is gaining momentum – no field of activity can do without information technology, and architecture is no exception. Interior designers, as representatives of this field, usually use serious software to create their projects, which uses sophisticates graphical data analysis algorithms and requires powerful computers with advanced input and output devices.

A review of contemporary literature on 3D interior design shows that AutoCAD and Autodesk 3D-MAX are the most sought after in the industry. These software products provide a complete cycle of designing buildings – from the drawing of the foundation, the floors, walls and engineering communications to the furnishing of premises and their filling with design elements. In the works of S. R. Dundyak [11], I. N. Egorova, A. V. Gaidamashchuk [12], I. O. Kuznetsova [13] and other scientists who research the possibilities of architectural CAD for interior design of premises, there is a clear argument that working with these packages requires a high level of user training. However, the use of high-grade CAD is not always justified – in cases where architectural tasks are not systematic or there are no computers with the necessary power or equipment – there is no need to spend money on the purchase of CAD systems, their installation and maintenance. A research of three-dimensional interior and exterior modeling environments using the Lee J. research [4] shows that there are many on-line services that do not need to be downloaded in today's Internet environment and storage of gigabytes of data. According to RBC-Ukraine, in 2017, almost half of Ukrainian companies used cloud technologies [1], and Forbes estimates that almost 83% of companies worldwide will use clouds in 2020 anyway [14]. The current state of development of cloud services gives the business powerful enough opportunities to modernize its work. First, the use of cloud technology can significantly reduce the operating costs of equipment and software, and secondly – if you have access to the Internet access to work information from anywhere in the world [1; 14].

2 Comparative features of on-line services for modeling interiors of rooms

To analyze the services that allow you to model the interior of the premises on-line, the following programs have been selected:

– *Roomstyler* is a free-of-charge on-line interior design service that allows you to choose your modeling accessories (furniture, flooring, walls, décor, etc.) without limitation. In addition, you can add to the benefits that the program can not only design and style a room, but also look for inspiration, because Roomstyler also functions as a book viewer with tens of thousands of designed rooms already on the net. The application's interface is easy to use and allows you to view both plan and 3D images. To

get started, you need to sign up; you can do this with a Facebook account, because the program is closely link with social networks [8];

− *Planer 5D* is a free web application designed for the design of premises. The design can be show in 2D and 3D. Now the user has the opportunity to erect walls from scratch and fill the premises as they wish, or edit the finished works, which can be select from the existing gallery. Planner 5D has a Russian-language interface and is very easy to use. A significant drawback of the program is that not all furniture is free. Most furniture is pay, so choice of filling for the room is very limited for the average user [6];

− *Sweet Home 3D* is a freeware computer program designed to simulate and visualize different purpose spaces. The program interface has a large number of languages, including Russian. It is quite easy to work in the program, in the main window there are several fields: the current project in the form of a plan, 3D visualization and elements for interior design [9];

− *Homestyler* – a free room modeling software. You need to sign up before you go to work. From this resource, you can be acquainted with the works of other users and professional designers, thus finding inspiration for your own project. The program has an English interface; it is quite easy to use. With Homestyler you can easily create a floor plan of the project and fill the room with any furniture and décor, because in addition to the material offered by the program, users have the opportunity to download their own textures and furniture [2];

− *Roomle* – an on-line service for the design of premises. The program has an English interface, but in is easy to use, so there should be no difficulty with translation. A large number of "icons" guide users in the process of creating their own project. The disadvantage of the service is the low quality of 3D rendering [7];

− *Floorplanner* – a freeware application for designing floor plans for a future building. The program has an English interface. First, the user should replace the measurement system with a metric using the option at the bottom of the screen. With the program, you can design any room, save or print the project, having previously passed a free registration. The major disadvantages of the program are the ability to consider only the first floor, not the frame structure and the ability to create only a general scheme of the house, and for the drawings of the frame building need to use other programs [3];

− *Plan Your Room* – a free application for on-line design of the room. The interface is English and easy to use. User registration is only required if you want to save the project. The major disadvantages of the program are that the choice of furniture is limited and the tools of the program can be difficult to use. Plan Your Room is quite poor in function: it is impossible to change the style of the floor in the design, there is no choice of color for the objects, and there is no "cancel" button [5].

The following were the main criteria against which the functionality of the software was compared:

− basic requirements for the hardware of the computer on which the simulation will take place;

− equipment for modeling;

− possibility to download external textures;

− possibility to download external models (furniture, décor, etc.);

− the presence of built-in visualization tools (rendering);

- format conversion (import and export files from other applications);
- access from mobile devices;
- trial version and its limitations;
- availability of training materials (tutorials);
- providing feedback, technical and service support to users.

A detailed analysis and results of an on-line services study of the 3D interior design of the room are present in Table 1.

The analysis found that the most convenient and advanced on-line services for interior design is a cloud environment Homestyler. Its complete range of modeling tools is the most comprehensive and versatile: unlike other services that allow only floor and wall modeling, Homestyler has designed tools for designing arches, ledges, niches, and more. Window and door model kits are consistent in style and color.

The design of the rooms is done through wallpaper libraries, ceramic tiles, wood elements, painting elements and friezes. The library of furniture and decor is sufficiently extensive and logically structured – there are separate directories for the design of the kitchen, bedroom, living room, office and other premises. A library of decor and art materials has been develop separately, with a large number of design elements (window accessories, paintings, photo frames, statuettes, houseplants, etc.). The collection of lamps, sconces and floor lamps is quite harmonious and at the same time diverse.

The great advantage of this program is the ability to download and save in the library user external (developed in other applications or downloaded from the Internet) textures and 3D models (furniture, decor, etc.).

Built-in rendering tools allow you to create high-quality renderings and a virtual 3D tour of the developed project (in HD format with a resolution of up to 2560x1440 pixels).

Table 1 – Comparative characteristics of cloud services for 3D interior design

Criteria	Programs						
	Planner5D	Roomstyler	Sweet Home 3D	HomeStyler	Roomle	Floorplanner	Plan Your Room
1	2	3	4	5	6	7	8
Access to the program (links)	https://planner5d.com/ru/	https://roomstyler.com/3dplanner	http://www.sweethome3d.com/	https://www.homestyler.com	https://www.roomle.com/	https://floorplanner.com/	http://www.planyourroom.com/
Developer	Planner 5D LLC, Russia	Floorplanner, Netherlands	eTeks, France	EasyHome, China	Austria	Floorplanner, Netherlands	No information available
Interface language	Russian	English	Russian	English	English	English	English
Trial version and its limitations	+ Limited selection of equipment for modeling, it is impossible to make a project renderer	-	-	+	-	+ The inability to make multiple floors in one project, the choice of equipment is not wide enough, the lack of 3D-tour, the image quality is not high	-
Basic requirements for the hardware of the computer	RAM is at least 2GB (better than 4GB), processor not less than 2 GHz, video card availability						
Tariff packages	269,14 – 1346,77 UAH/month	-	No information available	-	-	606,06 UAH/month	-
Format conversion (import and export files from other applications)	There is no export in the free version	Export: 2D image (jpg)	No information available	Export: DWG project, floor plan	Export: 2D image (png)	Export: 2D image (jpg, png)	No export
Access from mobile devices	+	-	-	+	+	+	-
Availability of training materials (tutorials)	+	+	+	+	+	+	-
Providing feedback, technical and service support to users	+	+	+	+	+	+	+

1	2	3	4	5	6	7	8
Equipment for modeling:							
floors of rooms	+	+	+	+	+	+	+
walls of rooms	+	+	+	+	+	+	+
arches, speeches, niches, etc.	+	+	No information available	+	+	-	-
interior of the premises with the help of furniture	In the free version, not all furniture is free	+	+	+	+	+	+
interior with decor	In the free version, not all décor items are free	+	+	+	+	+	-
Possibility to download external textures	+	-	No information available	+	+	-	-
Possibility to download external models (furniture, décor, etc.)	-	-	No information available	+	-	-	-
The presence of built-in visualization tools:							
rendering	In the free version its missing	+	+	+	+	+	-
creating a 3D-tour	In the free version its missing	-	-	+	+	In the free version its missing	-

3 Interior development of youth café in pop-art style at homestyler

The design environment is download at https://www.homestyler.com. The environment requires authorization for the development of the project; the authorization is not required to familiarize with the gallery of works and video instruction on working with the environment.

The working field is an unlimited plane, which for convenience has a virtual dimensional grid (Pic. 1). The toolbar contains commands for working with project files (download, save, customize, etc.), to build walls of future premises, to export and import a project, to render and view it.
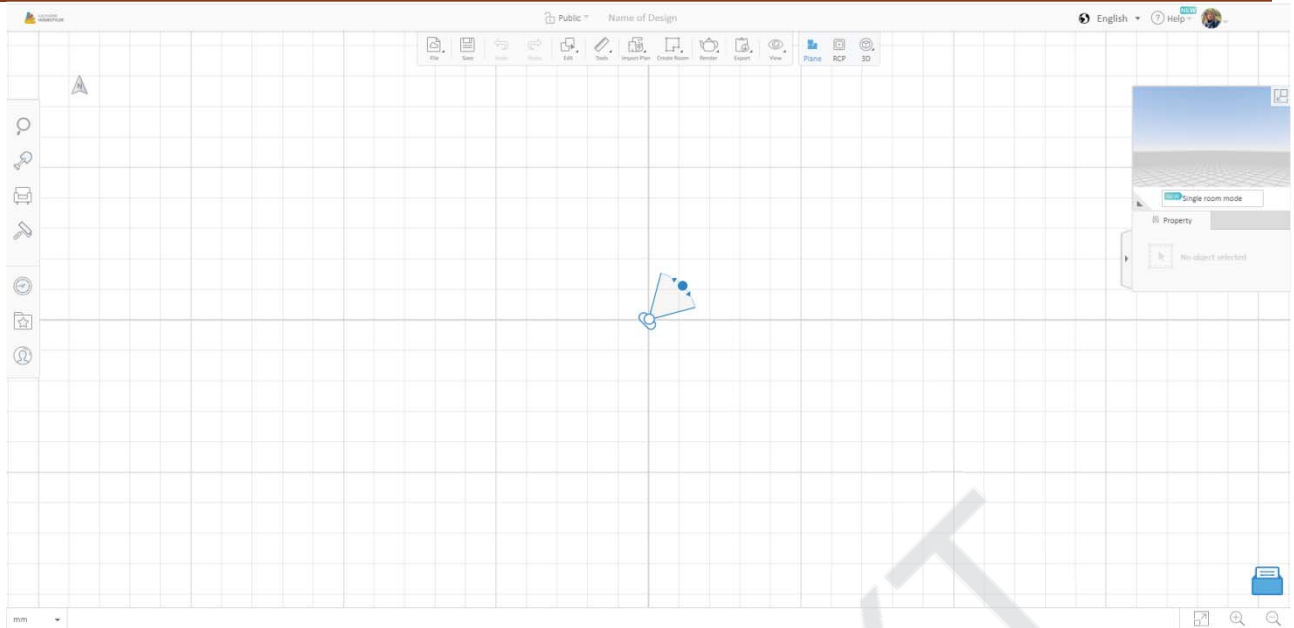
Pic. 1 – Homestyler workspace

In the center of the worksheet is a visualization tool (in the form of a camera) that allows you to see the simulation results in 3D at once. It is enough to move the camera along the lines of the project with the mouse (the corresponding window is located in the upper right corner of the worksheet). The button ⬚ is switch between the display modes of the room layout and its 3D model.

The library (catalog) of models of building elements (doors, windows, arches, etc.), furniture and style design of the room is located on the left edge of the worksheet (Pic. 2). This library also has a directory where the user can store external textures and elements.
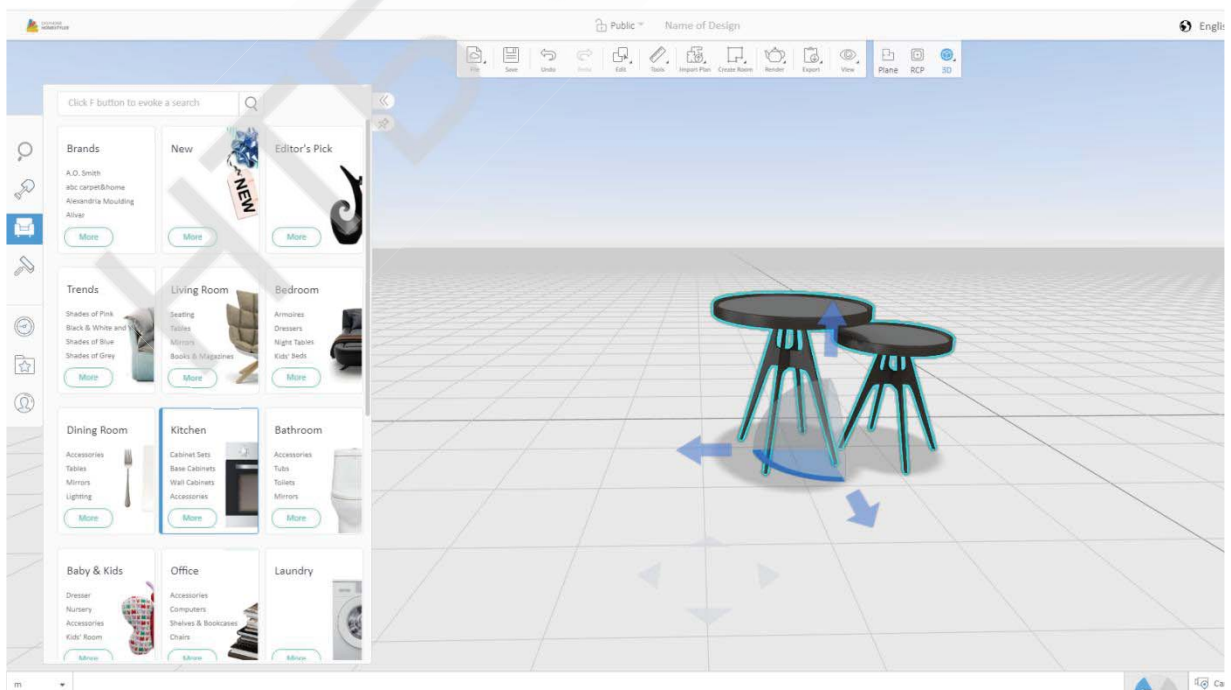
Pic. 2 – Catalog of Homestyler built-in models

Each built-in model has properties that can be change at the user's request (Pic. 3).
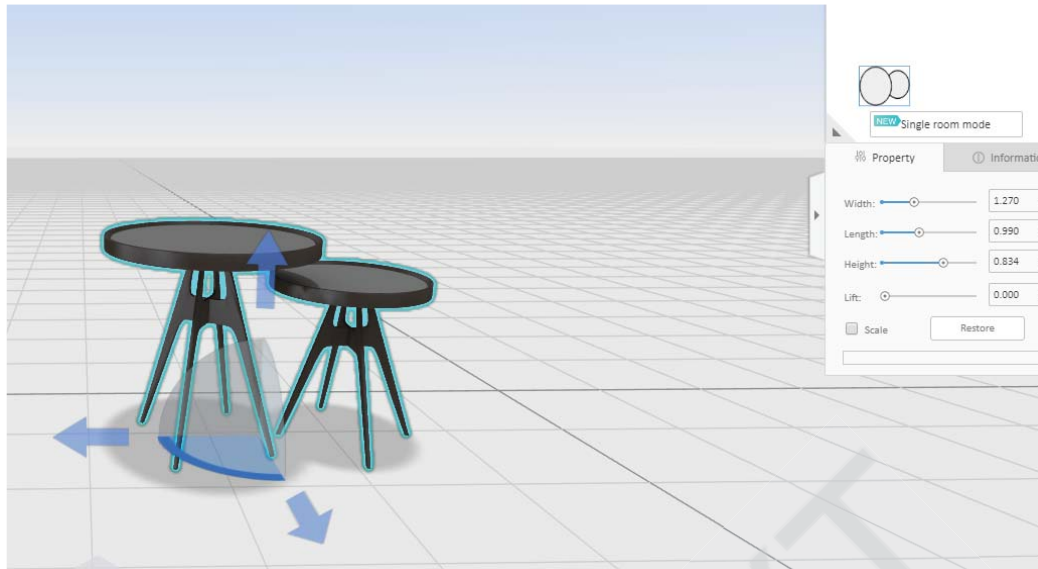
Pic. 3 – Setting element properties

The modeling of a youth café room begins with the establishment of its properties (ceiling height, wall thickness) with the *File → Preferences* tool. The next step is to build the exterior and install the interior walls. Doors and windows of the future room are select from the *Building →Doors* and *Building → Windows* directory respectively. Their properties (width, height. Level relative to the floor), the direction of opening are set using the appropriate menu.

The next stage of modeling is the choice of wall, ceiling and floor coverings. A set of matching textures is located in the *Style* directory. Unfortunately, for pop-art design, the embedded textures were not enough. Therefore, the necessary textures were downloaded with the help of the *My contents → Upload image* (Pic. 4).
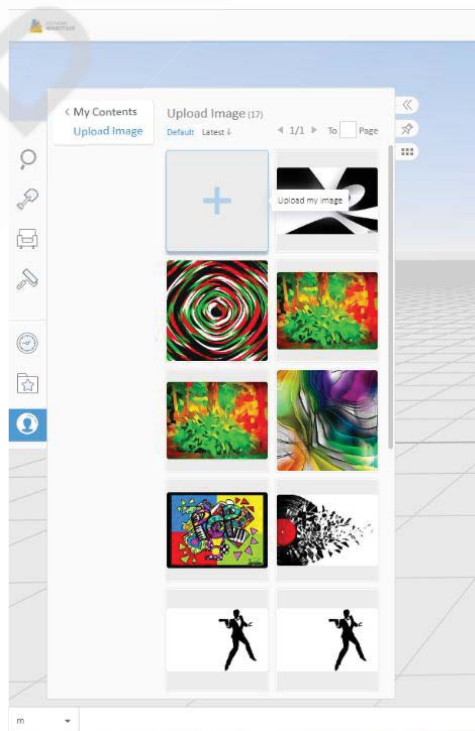

Pic. 4 – Loading external textures

The selection and installation of furniture and accessories, as well as the construction of the composition of the future room is done using the tools (commands) of the *Catalog* menu. This is a painstaking, time-consuming job, so the user must periodically save the project (*File → Save…*). The result of planning and furnishing a 2D room is show in pic. 5.
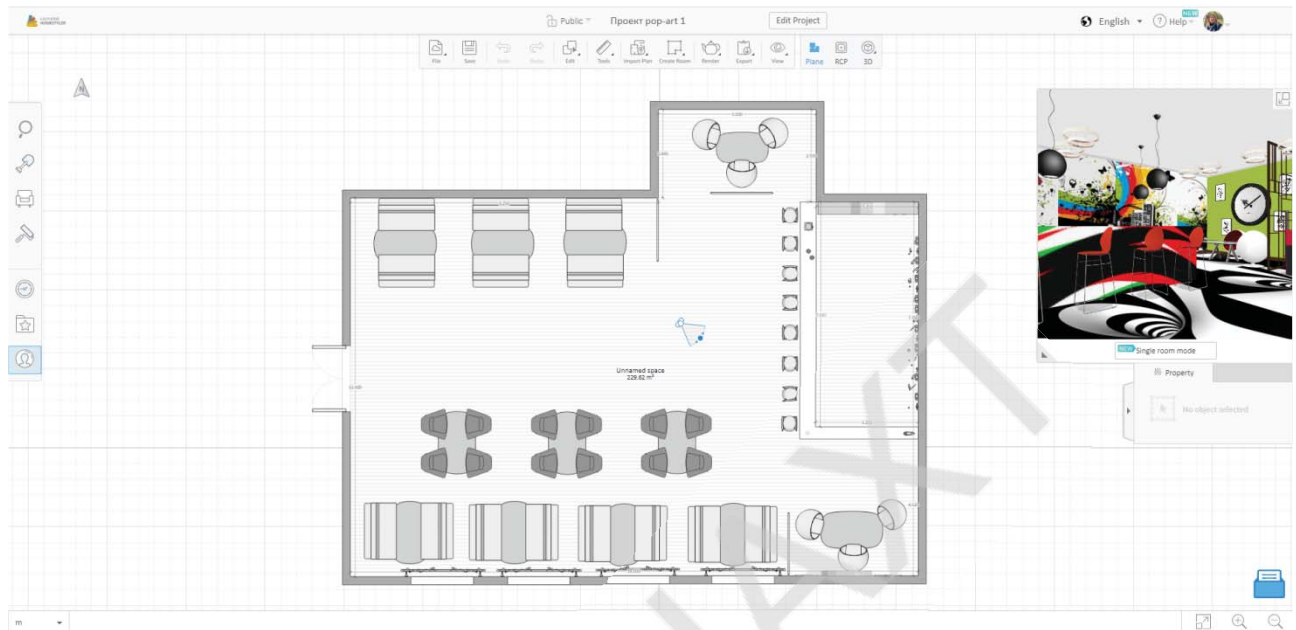
Pic. 5 – General view of the project (in 2D mode)

For ease of adjustment of the room lighting parameters, it is necessary to translate the project worksheet into RCP mode (Pic. 6) – in this mode, it is possible to place light fixtures with appropriate precision and scaling.
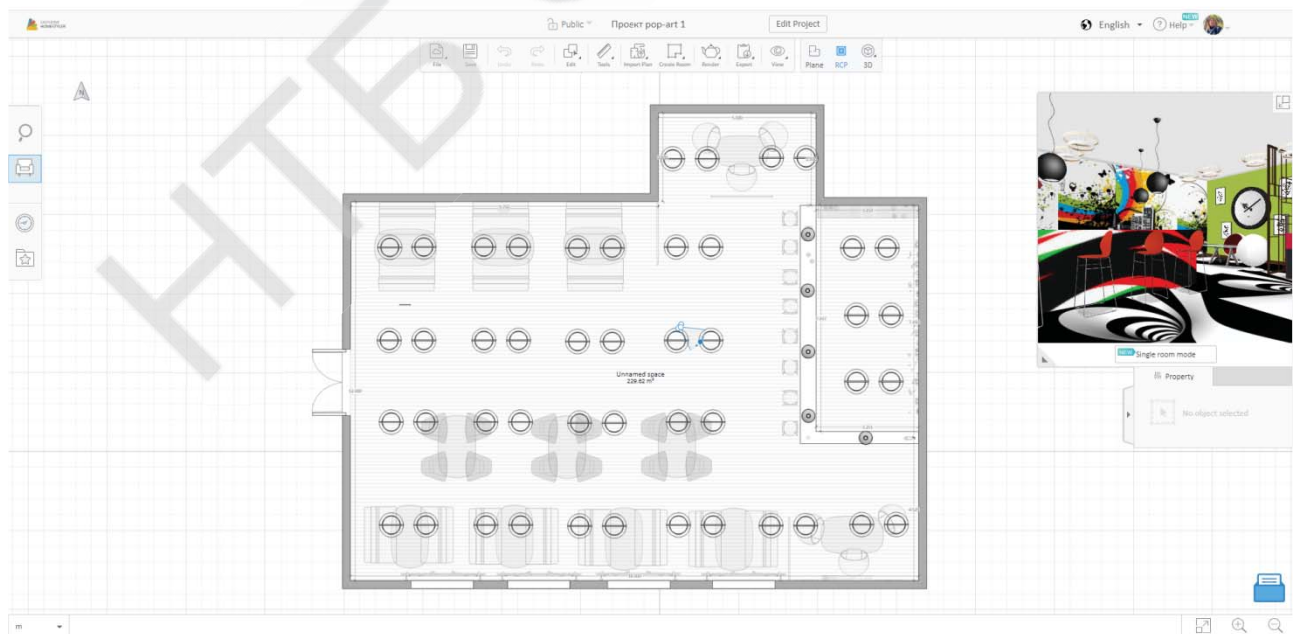
Pic. 6 – RCP mode to adjust the room lighting

3D project rendering is done using built-in rendering tools. To provide quality visualization, the user can choose from four modes of image quality (800x600… 2650x1440), one of six Interior Lighting (Nature… Customized) modes and one of five Environment (Green Grass… Dusk Field) modes. In addition, due to the flexible settings

of the camera (change of height, angle of view, radius of coverage of the room), it is possible to realize the highest quality of visualization (Pic. 7 and Pic. 8).
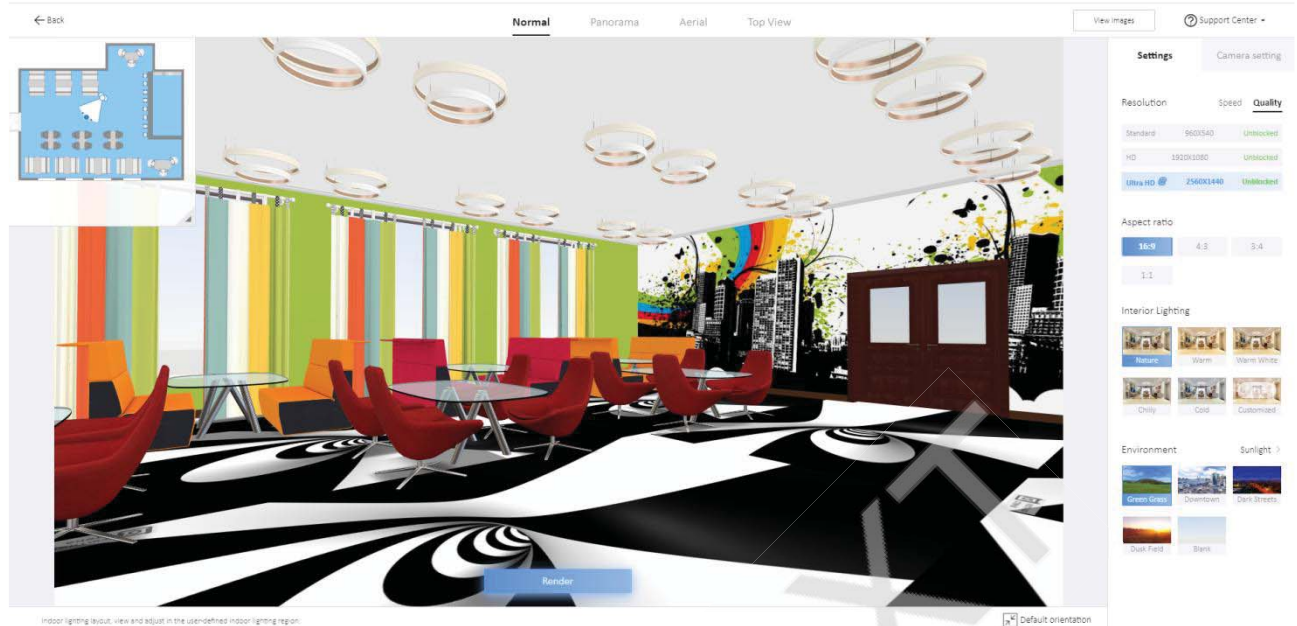
Pic. 7 – Visualization tools configuration menu

Pic. 8 – Camera settings panel

The result of rendering a 3D model of a room is stored in the user's personal account on-line and can be download from it to any media in .png format.

The development of a virtual 3D tour of the project takes place in two stages – first, it is necessary to form panoramic images, which will later become the basis for the 3D tour. To create panoramic images, you must place the camera where it will rotate and take steps to adjust the image quality. Panoramic images are combine into a 3D tour using the *Render → Create 720° Virtual Tour* command.

The result of modeling a pop-art hall in a youth café is show in Pic. 9 and at the link: https://www.homestyler.com/floorplan/?assetId=2709272b-bb15-414a-bf83-5c9c809d85d3

Pic. 9 – The result of the interior design of a pop-art youth café

Conclusions

In the general term, 3D modeling is the process of converting any surface of a 3D object from drawings, drawings, photographs, or imaginations into digital electronic representation through mathematical operations. The ultimate goal of interior design is to develop a virtual three-dimensional model that can be view from all sides to have a realistic picture of the future object, to predict the quality of the changes made (reconstruction) to the future design, to select furniture and design, and so on. Modern information technologies allow you to perform 3D modeling of the interior of the premises without the involvement of expensive resources.

To this end, approaches to building 3D models of premises have been consider during the work, features of 3D interior modeling technology have been studied, and applications have been selected to enable this task to be accomplished through a cloud-based online environment.

As a result of a comparative analysis of selected on-line programs designed for 3D modeling of the interior of the premises, exploring their advantages and disadvantages, it was determined that the most modern, sophisticated, convenient and containing the largest model libraries for interior design, as well as meeting modern 3D modeling requirements, is the https://www.homestyler.com, software product developed by China's EasyNome campaign. Homestyler.com tools have implemented a pop art interior design for a youth cafe.

Today, architectural visualization is an emerging area of 3D modeling. Creating a photorealistic image of a project is a time requirement that must ensure a modern level of presentation of the design results, and to which reasonably high criteria are applied. Therefore, the software environment used in this field should ensure the effectiveness of the developer's actions by being able to draw attention to many of the smallest details.

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