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3D visualization in learning systems

The article considers the possibility and necessity of using 3D graphics in learning systems. Using the example of an interactive maze that is built in the Unity 3D system, visualization capabilities of mines are shown. Using the example of an interactive maze that is built in the Unity 3D system, visualization capabilities of mines are shown. This technology allows us to simulate situations in real time using the built-in toolkit of the development environment.

The learning and training of operators of complex industrial technical systems on real installations and in real conditions is very dangerous and expensive, and often can not be realized. An alternative is computer simulation complexes that simulate as much as possible real installations, generate virtual objects and allow you to train to acquire correct and sustainable skills. Management of complex technical systems (industrial plants, nuclear power plants, assembly workshops, etc.) is a complex process that requires long training and appropriate training. The training of operators of such systems includes both a theoretical part (the study of the corresponding mathematical models, the theory of games, differential systems, reliability criteria, etc.), as well as practical, without which it is impossible to obtain sustainable management skills.

Particularly significant in the development and production of professional training systems with elements of 3D visualization is a realistic of video and possibility of modelling of situations [1]. With the advent of the first training complexes, it became the basis of the educational process.

However, in systems used in the past, the number of situations was small, in addition, the relationship between them and the actions of students was absent, the information displayed on the screen did not depend on its decisions, and this was a great disadvantage of the training.

The realism of the video that a person sees through instrument glasses or windshield is today one of the main indicators of the quality of the training complexes. The higher the adequacy of the situation, the easier it is to relate the simulator to reality, the easier it is to get used to controlling complex systems.

The main problem for developers is interactivity, since it is very difficult to prepare and anticipate all the necessary angles in advance, directions of movements, landscapes and landscapes of considered situations. The computer system synthesizes a virtual environment, that is, creates, based on the information contained in the database, the image that the user to be seen must see from the point where he is based on the movement in his space of himself and his colleagues in the classroom.

Objectives of the research:

1) develop a unified model of 3D objects for use in the learning systems;

2) to develop and modify existing 3D visualization methods in the learning systems;

3) to develop methods of 3D visualization of educational materials in the learning systems.

To represent the 3D world in learning systems, two main tasks need to be solved: the preservation of information about the objects themselves and the rules for their interaction. Similar to the work [2], the interactive 3D visualization model in the learning system is described by describing existing 3D objects (physical and functional) and the environment:

- object parameters: physical parameters of 3D objects (object type, coordinates in space, form, composition, color, material, etc.) and functional parameters (passage of object, parameters of physical interaction between objects, functional dependencies between the state of the objects, etc.);

- parameters of the environment (illumination, gravity, weather conditions).

$I3DV = \{OP\{PP, EP\}, EP\},$ (1)

where OP – множина параметрів об'єкту;

 $PP = \{pp_1, pp_2, ..., pp_k\} - a$ subset of physical parameters;

 $FP = \{fp_1, fp_2, ..., fp_l\} - a$ subset of functional parameters;

 $EP = \{ep_1, ep_2, ..., ep_m\} - a$ set of environmental parameters.

The physical parameters of objects should be considered as parameters of the first (lowest) level, which can be influenced by functional parameters (second level) and environmental parameters (third level).

The functional parameters are divided into dependent (describing the parameters of the object in interaction with other objects (the direction of the movement of objects within the radius of the explosion)) and independent (patency of the object, the possibility of moving in space). In fig. 1 independent functional parameters have indexes from 1 to e, the independent functional parameters have indexes from e + 1 to l.

Parameters of the environment can affect the physical and functional parameters of objects (of all objects and objects on a selected basis).

For the presentation of a model of coal mines for interactive learning methods to eliminate the consequences of possible accidents, can be used only physical parameters (Fig. 2).

The mine is divided into a group of blocks with the same structure. The presented model is implemented in the Unity3D and consisting of two types of objects (tunnels and crossroads), each of the objects has its own properties (Fig. 3).

The use of xml simplified the formation of a 3D object map and allowed the development of multiple software complexes with the ability to exchange data with internal and external systems

<ring id="ring77"> <position x="3.7953" y="2" z="67.97712"></position> <rotation rotUp="0" rotLeft="92.25482"></rotation> <scale radius="0.2" length="10"></scale> </ring>





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Fig. 2. Introduction of a model of the mine

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Fig. 3. Physical parameters of objects

All environment parameters are taken in the model system with the default settings of the Unity3D system. Also, in this system implemented methods of

control cameras (Fig. 4). But a separate task was the task of finding a path between the points on the map.



Рис. 4. Реалізація візуалізації шахт

Path-finding algorithms in 3D learning systems

There are four main methods of Path-finding:

- algorithm A*;

- navigation graph;
- the method of combining heuristics in three-dimensional space;
- method of navigation grids (navigation mesh).

Algorithm A^* [3] implies splitting the space into identical cells, for each of which is set, passable cell or not. The object to search for the path occupies one cell. According to the obtained possibility matrix, the wave algorithm or one of its modifications is the path from one cell to another.

The method of the navigation graph [4] assumes a search for a path on a graph, where its vertices are three-dimensional points, edges, and the segments connecting these points with a price equal to the length of the segment. All edges of the graph are passable (the character can walk along them without having encountered an obstacle). The task of finding a path is to find the nearest vertices to the initial and end points, and then to search the path on the graph between these vertices using the criterion of the minimum weight of the common path

The method is well suited for 3D space, however, one can take into account the following drawbacks of the method of the navigation graph [5]:

- the large laboriousness of the task of the graph, since in some cases it is required to specify an over-number of vertices of a graph;

- moving objects through the search of paths pass empty space along an unnatural trajectory, since follow the specified edges of the graph. The manifestation of the problem can be mitigated if you increase the number of vertices of the graph, which will aggravate the previous disadvantage;

- in a situation where the dynamic object is on the edge of the navigation graph, there is no correct way to construct the path through this edge;

- the navigation graph is badly suited for finding paths for moving objects of different sizes, since when placing the vertices of the graph, you have to focus only on one specific character size.

The method of combining heuristics in 3D space [6] involves the use of a special algorithm for solving a problem situation for a small number of common cases of the need to circumvent the obstacle. A possible example is an attempt to collide with the obstacle to find a ray with a minimum deviation from the viewer's vector of a character that does not intersect with the 3D world polygons. In the case of finding such a ray, the character moves along it, and then tries to follow the end point on the straight path.

The navigation mesh method [7] assumes the assignment of a polygon 3D space model. Then there is a rule that there is a path between any two vertices of a convex polygon located inside this polygon. Using this method, it is difficult to consider dynamic objects, since this requires large computing power.

Conclusions

Our model allows to unify the rules for representation of 3D objects in learning systems. This method modulates algorithms for finding a path in 3D space and gives the ability to exchange patterns between systems of different developers.

Further directions in the research are the analysis of the sufficiency of a set of model parameters for solving various problems of representation of interactive objects in teaching systems.

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