Creating 3D Model of Buildings and Utility Networks of a Technical University Using ArcGIS 9.1

M.B. Guzairov
Department of Computer Science and Robotics
Ufa State Aviation Technical University
Ufa, Russia
e-mail: guzairov@rb.ru

S.V. Pavlov
Department of Computer Science and Robotics
Ufa State Aviation Technical University
Ufa, Russia
e-mail: psvgis@mail.ru

O.I. Khristodulo
Department of Computer Science and Robotics
Ufa State Aviation Technical University
Ufa, Russia
e-mail: hristodulo@mail.ru

S.A. Abramov
Department of Computer Science and Robotics
Ufa State Aviation Technical University
Ufa, Russia
e-mail: s.abramov@gmail.com

O.M. Babin
Department of Computer Science and Robotics
Ufa State Aviation Technical University
Ufa, Russia
e-mail: babin.om@gmail.com

Abstract[1]

This paper contains information on implementation of 3D-model of a technical university using ArcGIS software and its special module 3D Analyst.

1. Introduction

Geoinformation systems (GIS) in its development use the progress in many other fields. One of the fast-upcoming fields is 3D visualization of Earth surface and contemporary GIS as tools for data manipulation. These tools provide wide abilities for creation, visualization and analysis of spatial 3D data.

3D modeling is quite a new ability of geoinformation systems. It provides not only graphical representation of information but gives unique possibilities for solving a set of tasks connected to analysis and processing of spatial data.

The necessity of realistic representation of our world increases the importance of 3D modeling. 3D models make it easy to plan, control and make decisions in many fields.

Three-dimensional photorealistic visualization of a territory using computer graphics and GIS is able to change a technology of a technical university management in Ufa State Aviation Technical University (USATU).

The interaction of the three-dimensional model with other GIS tasks provides abilities of its appliance in many activities, e.g., service of engineer communications, sewers, gas pipelines, heating networks, electricity, land surveying, roads and buildings planning, security activities and others.

The urgency of the development is in the point that changing from 2D-modeling to 3D-modeling makes it easy for a man to interpret the information provided. Its especially useful when complex objects like buildings and communications with big amount of heterogeneous and intersecting data are being modeled. 3D-modeling solves the problem of data analysis, path finding, visibility zones calculation and others. [1]

2. State of Art

Goals of system implementation:

- 3D-visualization of buildings, constructions and communications of USATU;

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- Development of a "virtual tour" through the university.

To implement the system for 3D-modeling included in USATU GIS we a supposed to do the following:

- carry out system analysis of USATU GIS and study its functionality;
- develop models and schemes of data organization in the 3D-modeling subsystem;
- develop algorithms and software implementing additional functions of the system.

3. Implementation of the 3D-Modeling System

As a bottom layer we used a part of Ufa map with the university yard and some neighbor blocks. The data on buildings, constructions and communications is stored in USATU GIS database (DB) as shape files. This approach made it possible level-by-level modeling of the university buildings. Gaining of attributive information on objects in 3D-scene is still available.

Data in USATU GIS DB is stored in 2D. Special functions and instruments of ArcGIS 3D Analyst were used to switch from 2D to 3D.

For point features:

- usage of models in VRML, 3DS and SKP format;
- setting the starting heights of points;
- usage of special symbols.

For linear objects:

- setting of a horizontal and vertical stretch;
- line to pipe transformation;
- setting the starting heights for lines;
- setting the transparency;
- using special symbols;

For polygonal objects:

- setting the starting heights of polygons;
- setting the transparency;
- setting the gradient fill of a polygon;
- using textures.

The implemented system has been integrated into USATU GIS by creating "3D-modeling subsystem" button (section "tasks" of USATU GIS main menu). Choosing the special point of menu leads to loading of ArcScene with the following opening of the project (fig. 1), [2].

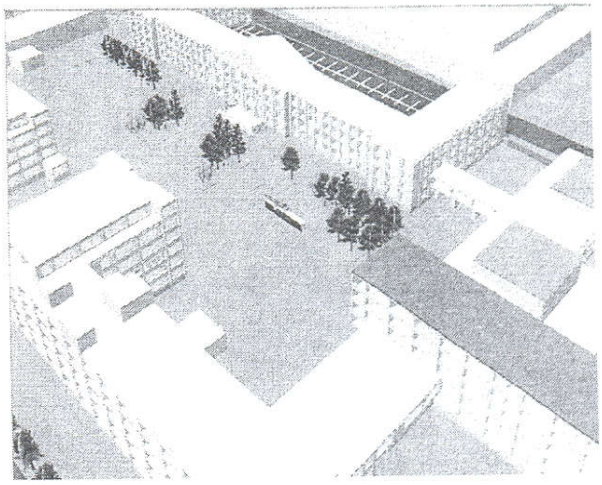

Figure 1. Loaded Project of 3D-Modeling Subsystem

The important points in modelling are base height and its stretching. Base height is separating the floors and objects.

There are several methods of setting the base height and stretching:

- set the constant of height and stretching for all objects in a layer;
- add the attributive table with values of height and stretching, then set these data as a source of heights;
- use coverage files with the preset values of heights.

We used the second method as a best for this case. For its realization special utility has been implemented. It set the values according to floor numbers and file names to the corresponding fields.

For windows modelling "Transparency" property has been used. The 75%-transparency set to the "Windows" layer allow to see objects from the inside of the building if they are in the visibility zone. As a result the model of a building has been obtained.

The constructions are different objects like service buildings, pedestals, cabins and others situated in USATU territory. For that constructions the texturing have been used. As an outline the layer of buildings and constructions of USATU has been used. Textures were applied to the surface of constructions. In case of lack of coincidence between texture and contour the last was edited in Adobe PhotoShop.

Textures were made of digital photos (350 total have been made, selected were used in texturing).

Communications in buildings were separated floor-by-floor by different height and views.

Underground communications like gas pipeline, water supply, heating network, sewers, etc. were hidden under ground using different heights with the negative values.

As a result we have a view of communications that are not placed one by the other with intersections (fig. 2).

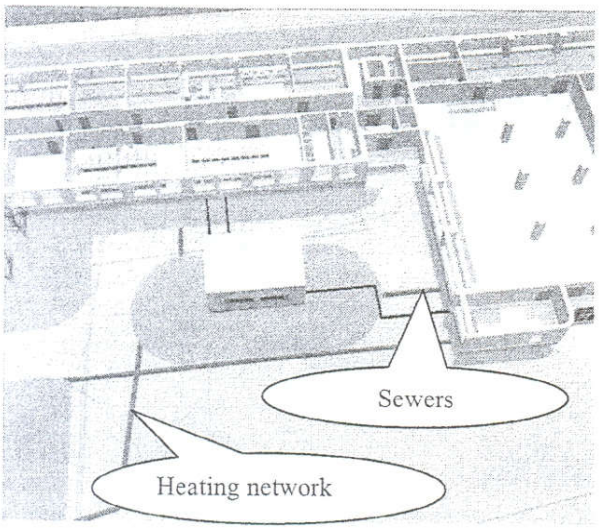

Figure 2. Communications of USATU University Yard

The model contains some objects that not related to USATU. They are the buildings of neighbour blocks, trees, cars, bus stops, etc, that were used to make the model more "realistic". Neighbour buildings have been taken from a city map. Trees, cars, bus stops, etc. are point features so that we can replace them with other 3D-models from 3D Analyst models library. But base set of models is quite enough for modelling. For creation the objects that haven't been found in the library Autodesk 3D Max has been used.

"Virtual tour" module allows making virtual journeys through USATU buildings, territory and surrounding area. The module is managed by a form made in VBA.

Form contains the following components:

- starting point of the way;
- end point of the way;
- "include building passages" option (when turned on, it allows to take into account the inside passages between buildings);
- make the plane as a start point (when turned on, it makes the plane as a start point of all way, because the plane in the university yard of USATU is a good reference point).

After choosing the start and the end point of a way and pressing "Show" button camera will be controlled by the module showing the way from start to the end point.

4. Conclusion

Implemented subsystem of 3D-modeling of buildings, constructions and communications of USATU was integrated in USATU GIS. This allows solving the following problems:

- 3D-view of an objects is more obvious for user, designer or builder;
- availability of the third dimension as a coordinate expands the set of tasks that can be solved;
- the information has better precision that allows to represent some small elements haven't been in the model earlier;
- "virtual tour" module makes it possible to take virtual journeys through USATU, its territory and buildings. This can be of a great assistance in getting information on university for entrants, students, professors and guest of USATU.

In future it is planned to make 3D-models of other departments and objects of USATU. The work on communication modeling will be continued.

References

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