КОМП'ЮТЕРНІ НАУКИ, ІНФОРМАЦІЙНІ ТЕХНОЛОГІ, СИСТЕМНИЙ АНАЛІЗ ТА КІБЕРБЕЗПЕКА

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INFORMATION TECHNOLOGY OF MAKING CONTROLLED CRITICALLY SAFE DECISIONS WHEN VIEWING POINT CLOUDS "WEB POINT CLOUD VIEWER"

The developed software product performs the following functions: work with cloud storage, work with camera, work with stage, work with model measurement, work with models and work with point clouds. The application of such a system is designed to automate and improve the end user's work with point clouds, namely their storage in the Autodesk cloud storage, display and manipulation. Interaction with such a system does not require high system requirements of hardware and software. From the obtained results it is possible to draw a constructive conclusion that the functional direction of the complex algorithmic model fully meets the requirements of the task.

Keywords: point clouds, visualization systems, laser scanner, photogrammetry, 3D coordinate systems, Autodesk, Autodesk ReCap.

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ІНФОРМАЦІЙНА ТЕХНОЛОГІЯ ОПТИМІЗАЦІЇ КОНТРОЛЬОВАНИХ ЛЮДИНОЮ КРИТИЧНО-БЕЗПЕКОВИХ РІШЕНЬ ПРИ ПЕРЕГЛЯДІ ХМАР ТОЧОК "WEB POINT CLOUD VIEWER"

Розроблений програмний продукт виконує такі функції: робота з хмарним сховищем, робота з камерою, робота зі сценою, робота з вимірюванням моделей, робота з моделями та робота з хмарами точок. Застосування такої системи призначене для автоматизації та покращення роботи кінцевого користувача з хмарами точок, а саме їх зберігання у хмарному сховищі, відображенні та маніпулюванні Autodesk. Взаємодія з такою системою не вимагає високих системних вимог до апаратного та програмного забезпечення. З отриманих результатів можна зробити конструктивний висновок, що функціональний напрямок складної алгоритмічної моделі повністю відповідає вимогам завдання.

Ключові слова: точкові хмари, системи візуалізації, лазерний сканер, фотограмметрія, 3D системи координат, Autodesk, Autodesk ReCap.

FORMULATION OF THE PROBLEM

The cloud of points obtained as a result of laser scanning is the primary result that requires high-quality processing. Further work consists in solving two main and sometimes mutually exclusive problems - increasing the accuracy of surface reproduction, which is solved by increasing the points in the cloud, and providing the necessary speed, with a diametrically opposite solution.

The development and implementation of appropriate efficient information technologies using appropriate modern development tools allow the implementation of systems that simultaneously provide high scanning accuracy combined with acceptable speed, allow you to operate large clouds of points with acceptable lead times.

ANALYSIS OF RECENT RESEARCH

Currently, there are quite a few desktop applications for working with point clouds, first of all, it's Autodesk ReCap (Figure 1). This application allows you to create 3D models from photos or laser scanning with excellent accuracy and efficiency, as well as accurately create 3D clouds or grids for further design in Autodesk tools [2], such as Revit, Civil 3D, AutoCAD, Navisworks and more. Recap provides an opportunity before indexing the project and its completion in a single cloud of points, to apply various settings using a set of filters.

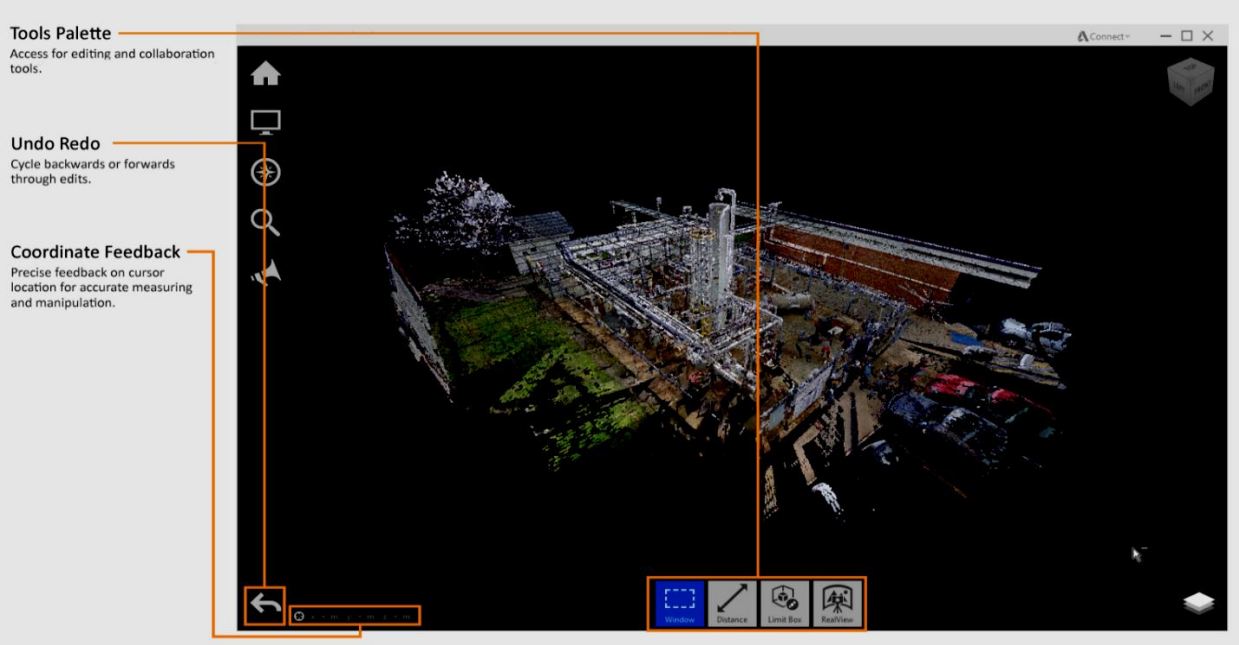

Figure 1. Autodesk ReCap

ReCap determines how to exclude aggressively rejected points from an imported scan file, that is, points that do not belong directly to the object. The ReCap toolkit allows you to measure, mark point clouds and share them with collaborators.

In addition, because points are generated by your own Autodesk product, points can be imported into all other Autodesk products. You can use the ReCap dot file to clean up a scan of an existing building and then import it into Revit to start the exact 3D BIM design [3]. You can also import a cleaned ReCap cloud in Civil 3D [4].

The main disadvantage of ReCap is its desktop and paid implementation.

The current global trend in the development of modern information technology is their Internet orientation, which consists in the implementation of software in the form of web applications with obvious conveniences and benefits.

The Potree web application [4] is a free open source cloud point rendering created at the Institute of Computer Graphics and Algorithms, TU Wien [6] (Figure 2).

This technology is easily integrated into the mechanical engineering and manufacturing industries. It is possible to capture the reality of any existing part, such as a pipe flange, to which you want to connect, but has no design parameters. With this technology, you can impose a new part according to the size, placement of holes in the bolts with tolerances.

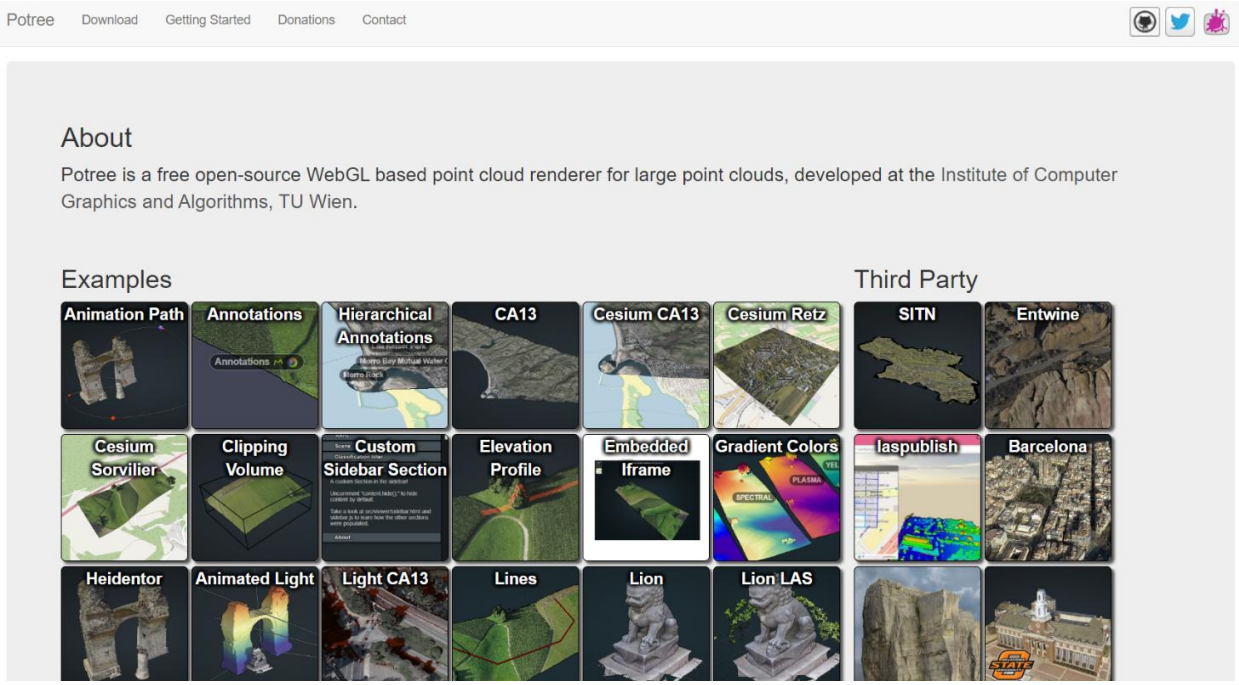

Figure 2. Potree

This web application provides opportunities directly for point cloud rendering, as well as additional features for measuring geometric parameters.

The main advantage of this web application is its open source.

Another example of specialized sites for viewing point clouds is the site Online LIDAR point cloud viewer [7] (Figure 3). This site also provides the ability to render a cloud of points with a set of additional features.

The main disadvantage of this site is the support of only two data formats LAS 1.2 [8] and XYZ [9].

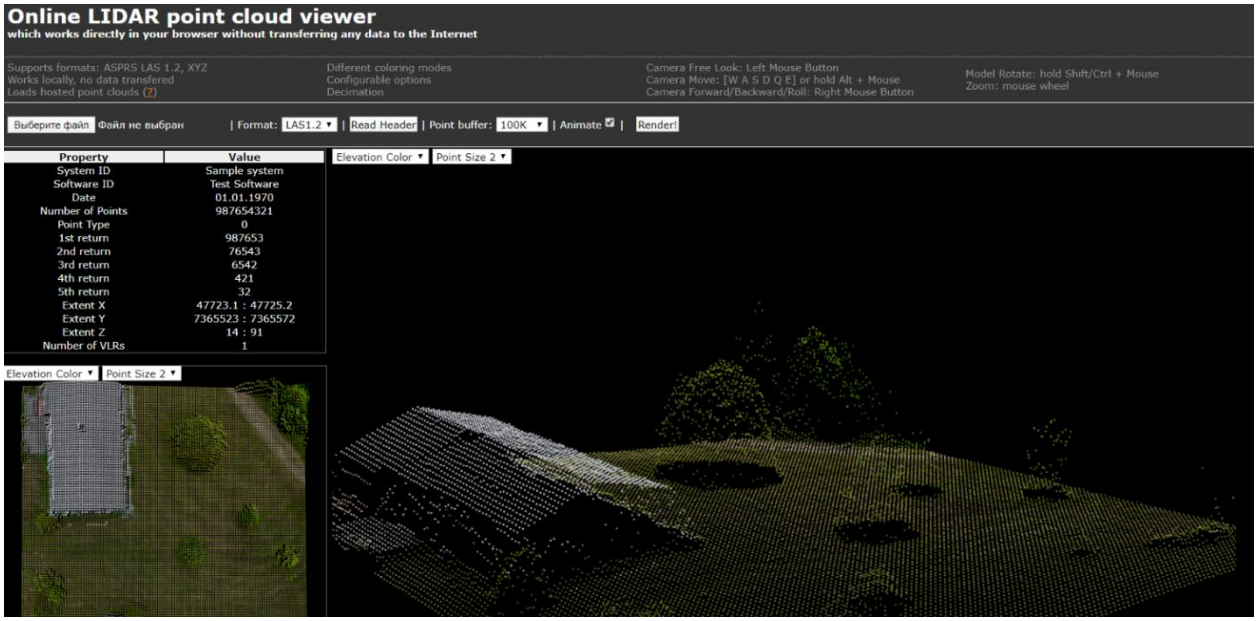

Figure 3. Online Lidar point cloud viewer

The analysis of literature sources shows a significant and growing need for means of identification of remote users. This is due to the rapid development and widespread introduction of information technology in various spheres of human life. The process of informatization and digitalization of society creates opportunities for raising the standard of living of people to a qualitatively new level, and creates a whole range of challenges and threats associated with various types of misuse of data. A prerequisite for abuses in the information sphere is the acquisition of unauthorized access by attackers, which determines the issue of identification of remote users as a priority.

In modern systems, various access control systems are implemented from hardware, hardware-software, software-hardware to purely software that implement various technical solutions and software algorithms.

In the case of information systems and information technologies, the basic tools of these issues are the use of appropriate algorithms for identifying remote users. These algorithms should provide reliable protection against malicious intrusion, and on the other - to provide comfortable access to appropriate users. One of the most effective are technologies that implement the concept of "zero knowledge". However, the application of this technology requires a solution to the question of the level of computing power.

The purpose of the research: as a result of the analysis of existing approaches the following tasks of research which purpose is realization of the viewer of clouds of points "Web Point Cloud Viewer" with a sufficient level of accuracy and speed of computing ability and availability are formulated:

1. To analyze the existing methods, technologies and solutions of methods of information system of visualization of objects as clouds of points;
2. Improving existing methods of visualization of objects as a cloud of points in the direction of improving accuracy and speed;
3. To develop information system for visualization of objects as a cloud of user identification points using the obtained models and methods;
4. Perform an experimental test of the information system for visualization of objects as a cloud of points.

PRESENTATION OF THE MAIN MATERIAL

In modern production, the wide expansion contains models that are stored in the form of a cloud point. A point cloud is a set of data about points in a real coordinate system [10].

In a three-dimensional coordinate system, points define the coordinates X, Y, and Z, and are most often defined to represent the outer zone of an object.

The point cloud can be created by a 3D scanner [11]. Such devices form a large number of points in the objects with the subsequent presentation of information about the cloud of points in the data files.

Capturing individual unrelated points is the key to using a cloud point. Recovered point clouds are easy to edit, display and filter. The computer should not worry about the scale or ask for points, limit the position and capabilities, color. This makes them a convenient way to store large amounts of detailed data.

Although point clouds can be used for rendering and validation, they do not need to be supplemented for

use in the context of 3D applications. Therefore, they are usually retold in models with a polygonal or triangular grid, in the NURBS model or CAD model through the process of so-called system reconstruction. It is not uncommon for a scan of a single area, such as a city block or airfield, to contain billions of data points.

There are many methods of converting a cloud of points into a 3D surface. In particular, in [12] a comparative table with 35 methods of converting information from a cloud of points is given. Some approximations, such as the Delaunay triangulation, the Alpha form, and the rotary crop method, will construct a triangular or polygonal grid for already existing vertices of the point cloud, while other approximations will construct long-range volumetric tables or reconstruct uncertain confidentiality using a cropping algorithm.

One of the industries where point clouds are used is industrial metrology and quality control using industrial computed tomography. The cloud of points obtained as a result of three-dimensional scanning of the finished industrial production is compared with the corresponding CAD-model of this production or other (reference) chromatography, which provides a difference between the projects and the actual parameters. These differences can be reflected in the form of color maps, in those places and areas that deviate between the actual surface and the formal model can be automatically highlighted by certain indicators. Geometric dimensions and additional dimensions can also be used using a point cloud.

Dot clouds can be used to represent and visualize volumetric data, for example, in the field of medical imaging. Due to the use of cloud points in such tasks, data animation and stimulation are achieved.

In geographic information systems, point clouds are one of the sources used to create a digital terrain model. Point clouds are also used to create digital models of urban areas.

To design the structure of the web application "Web Point Cloud Viewer" provides analysis and automation of information flow processing. Specialized software is developed for users of the system; its functionality must meet all the necessary conditions for processing account data. Business processes in the work of the user of the system can be divided into the following groups:

1. Business process "Using cloud storage" (Figure 4):
- creating a new user;
- user login;
- user logout;
- creation of new folders;
- loading point clouds into the storage;
- loading point clouds from storage.

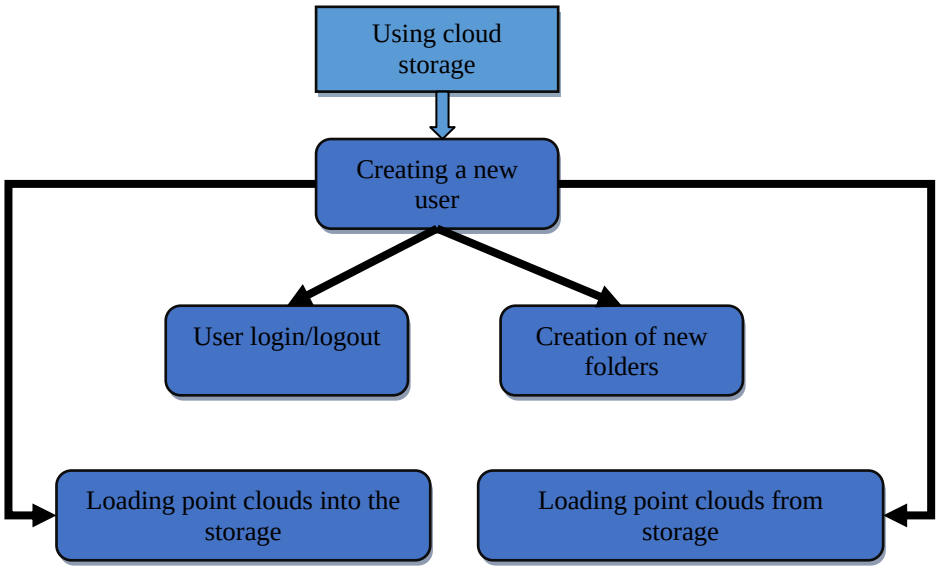

Figure 4. Business process for working with cloud storage

2. Business process "Working with the camera" (Figure 5):
- change of the camera inspection sector;
- change the type of camera;
- change the position of the camera;
- return the camera to its original position.

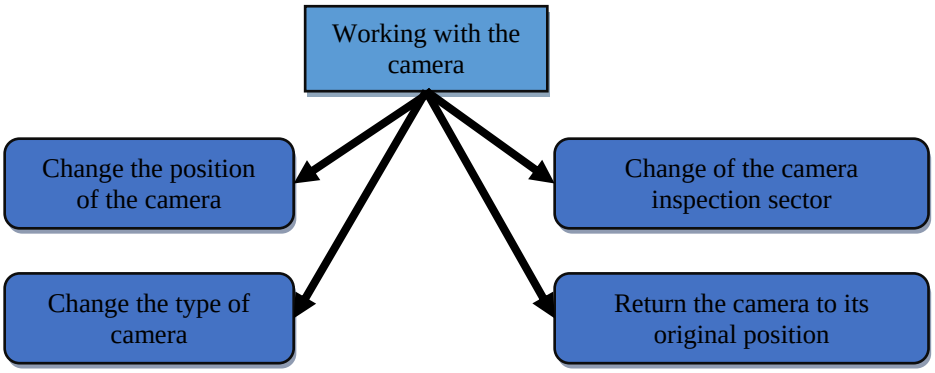

Figure 5. Business process for working with the camera

3. Business process "Working with the scene" (Figure 6):
- showing the model from different angles;
- taking a picture of the scene;
- change the color background of the scene;
- support for the list of keyboard shortcuts;
- display of the global coordinate system of the model.

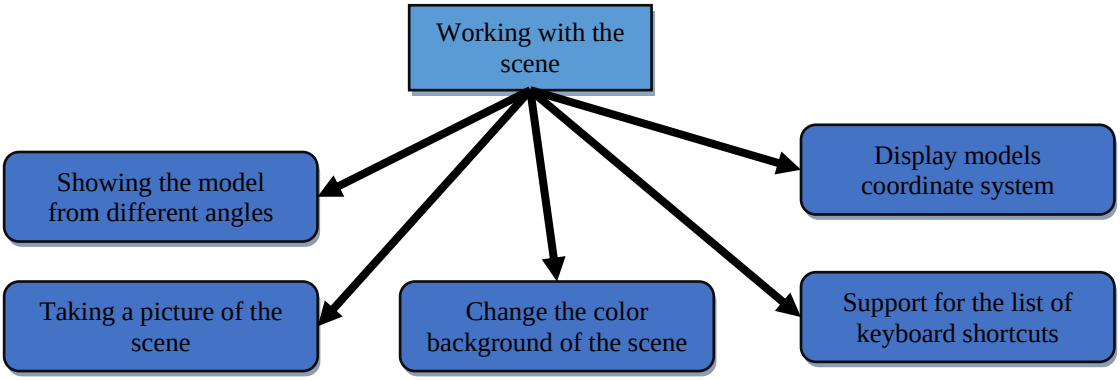

Figure 6. Business process for working with the scene

4. Business process "Working with the model" (Figure 7):
- modification of the size of points;
- color change of model points;
- return to the original color.

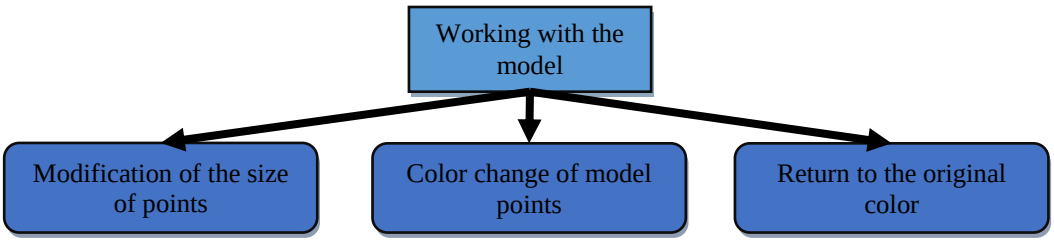

Figure 7. Business process for working with the model

5. Business process "Working with model measurement" (Figure 8):
- measuring the position of the point;
- measuring the distance between two points;
- measuring the distance between many points;
- measuring the angle between points;
- area measurement.

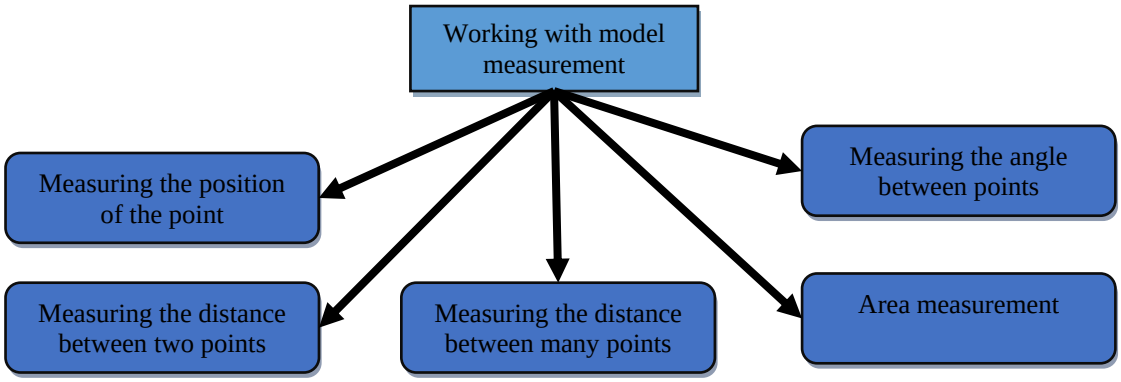

Figure 8. Business process for working with model measurement

6. Business process "Working with point clouds" (Figure 9):
- file extension recognition;
- processing and reading binary files;
- processing and reading files in ASCII format;
- model preview.

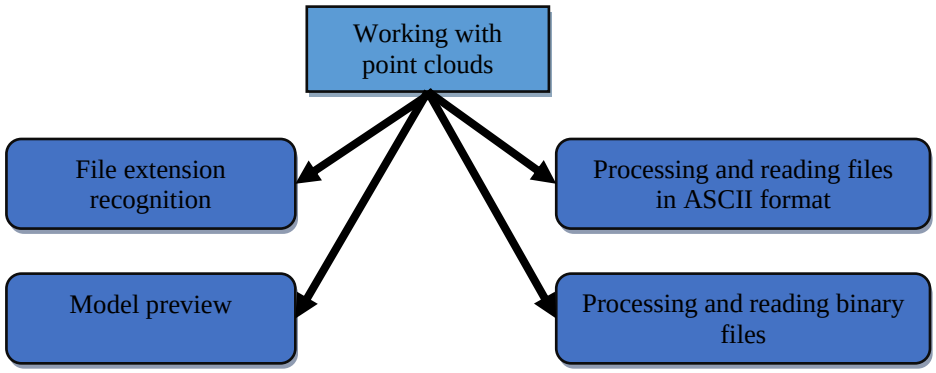

Figure 9. Business process for working with point clouds

Business process for user work with cloud storage. This business process provides the user with the ability to create an account, log in to an account, log out of a personal account, upload point clouds to the repository, and upload point clouds to a local computer.

Business process for working with the camera. This business process provides the user of the IP with the ability to change the viewing sector of the camera, change the position of the camera, change the type of camera (perspective orthogonal) and return the camera to its original position.

Business process for the user's work with the scene. This business process allows the user of the IP to change the side from which the model is displayed, take and load a scene image, change the background color of the scene, dynamically show the direction of the model using a global coordinate system. In addition, this business process provides the ability to support the execution of commands using hotkeys, as well as displays a list of them.

Business process for user work with the model. This business process allows the user of the IP to modify the colors and sizes of the model points and return the sizes and colors of the points to the default state.

Business process for user work with model measurement. This business process allows the user of the IP to determine the position of the point, measure the distance and angle between the points, as well as measure the area.

Business process for user work with point clouds. This business process provides the user of the IP the ability to process and retrieve data from binary files as well as files in ASCII format. This business process also determines the file extension and allows you to view a preview of the model.

In order for a web application user to be able to work with personal account data, he must perform the required set of operations for authorization.

To start working with the connected cloud storage, the user must log in to the personal account of Autodesk. If an error message was received while trying to log in to your account, it means that the IP user entered incorrect data. If the login and password were entered correctly, the software application will have to grant permission to access user data from Autodesk servers.

On its account page, the user deals with the following functionality: working with the cloud storage (creating a new user, user login, user login, creating new folders, loading point clouds into the repository, loading point clouds from the repository), working with the camera, change camera view, change camera position, return camera to starting position), work with scene (show model from different sides, create scene snapshot, change scene background color, display global model coordinate system, work with hot keys), work with model (modification of point size, coloring of model points, return of original color), work with model measurement (measuring point

position, measuring distance between two points, measuring distance between many points, measuring angle between points, measuring area) and working directly with point cloud (file extension recognition, processing and reading binaries and files in for mother ASCII, model preview).

Thus, after analyzing the processing of information flows, for the web application "Web Point Cloud Viewer" was defined a complete list of business processes that are subject to automation algorithms. With an organized functional diagram of the end user and object-oriented feature groups, you can develop an information system structure that will be designed to view, manipulate, and modify point clouds, as well as to store documents from an Autodesk account.

CONCLUSION

The developed software product performs the following functions: work with cloud storage, work with camera, work with stage, work with model measurement, work with models and work with point clouds.

The application of such a system is designed to automate and improve the end user's work with point clouds, namely their storage in the Autodesk cloud storage, display and manipulation. Interaction with such a system does not require high system requirements of hardware and software.

From the obtained results it is possible to draw a constructive conclusion that the functional direction of the complex algorithmic model fully meets the requirements of the task.

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