UDC 004.8 **doi:** https://doi.org/10.20998/2522-9052.2022.1.18

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PROCESS OF 3D PRINTING IN ONLINE EDUCATION

Abstract. **The subject of the** review is methodology of the subsystem verification and printing 3 D -model online learning system mixed type. To do this, a review of analogues, technologies, stages of printing were identified. Due to the development of technology, the educational process is being transformed. Education uses blended learning, part of which is distance learning. **The object of research** is use of additive technologies, which can make the learning process more motivating. Thus, if in distance education there is an opportunity to develop a 3D model online, check it for fidelity, send the model to print, it optimizes the learning process. **The aim is to design** with IP topics that uses the additive technologies in the educational process. **Methods used**: IDEF- diagram describing the function of the system; authentication rules, verification of 3 D models, sending the model to print, selecting a device online, and basic screen forms. **Conclusions**. The development of innovative thinking in higher education students should become a priority of modern higher education, and the introduction of new elements in modern education is inevitable. And given the development of 3D printing technologies, additive technologies are the most promising for the use of visualization in online and mixed teaching.

Keywords: additive technologies; blended learning 3d-model; 3d-printing; rules database; database.

Introduction

Industry 4.0 is emerging more and more clearly. It is clear that enterprises are able to provide a fundamentally new level of productivity and competitiveness, and this is a powerful boost. What will be possible thanks to digital technologies that can process huge data sets and comprehensively manage production - from design and manufacture to logistics and technical support of the product.

Main part

New requirements for learning appear due to the development of technology, and the educational process is transformed. Education uses blended learning, part of which is distance learning. The use of additive technologies allows to make the modeling process more meaningful and progressive. Thus, if in distance education there is an opportunity to develop a 3D model online, check it for fidelity, send a model to print, it optimizes the learning process.

In the analysis of the subject area was identified a structural diagram of the relationship of objects: a teacher, a student, a moderator, an administrator.

The teacher has the opportunity to create distance learning courses, provide knowledge and skills and control this process.

The student has the opportunity to study courses and send reports and 3D models for testing.

In the distance system, which uses additive technologies, it is possible to perform the functions of checking 3D models and sending to print under the supervision of a moderator and a teacher.

There is also an administrator who manages the entire system.

This approach will allow the use of modern devices in distance learning. It will be possible to send models to print and check for basic errors.

Based on the analysis of the subject area, the stages of 3D printing were highlighted. These are creating a digital model, exporting a 3D model in STL format, generating a G-code, preparing a 3D printer for work, printing a 3D model and finishing the object.

In general, the system model can be represented by IDEF0 notation, in which the input data is a formalized task, the mechanism is an analyst, control mechanisms are 3D modeling technologies and printing standards. And the output is a printed model (Fig. 1).

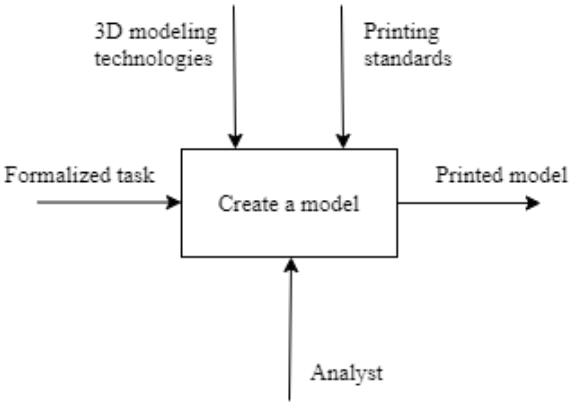

Fig. 1. The first level

The first two levels covered by the system are performed in the modeling tools and send to the system for verification. Validation of the 3D model involves the division into stages, for which the input data can be a developed model.

Thanks to modeling technologies, a digital model is created. Such a model must also meet printing standards. Then the model is sent for printing.

The formalized model is exported to a digital format model. Then this model is exported to STL format using 3D modeling technologies. Then the G-code is generated using a slicer. Next, the criteria are checked to ensure that the model meets the printing standards, and sent to the queue for printing.

There are four categories of users in the system: a student, a teacher, a moderator, an administrator. Certain rights were allocated within the system for each category according to the subject area review scheme.

Opportunities for user actions in the system:

a student: loading models, view download history, receiving messages;

– a teacher: loading models, view download history, receiving messages, view student downloads, granting permission to print;

– a moderator: all that the teacher, print start control, check the operation of devices;

– an administrator: all that the moderator, adding and editing users, making changes to system settings.

The simulated system uses a knowledge based on the production model. Types and subtypes of rules are identified for the correct operation of the system. For each type of rule, there is a subtype that defines the rules that are involved at a particular stage and they are needed for verification. Rules are built with the help of an expert: to add or edit a rule in the database, the user just need to add the required term to the database. Therefore, the method of training with an expert is used.

Rule types: for users; compliance of the 3D model with the requirements; to select a printing device.

Subtypes of inspections: authentication; 3D model checking; sending the model for printing; select a device on the network.

The database stores information of registered users. Login and password are provided to authorize users. Then there is a check in the database whether the user exists or not, and the rights are determined. If the check is successful, the user enters the system itself. If the check is not successful, it is possible to register or re-enter the login and password.

The test scheme is shown in the Fig. 2.

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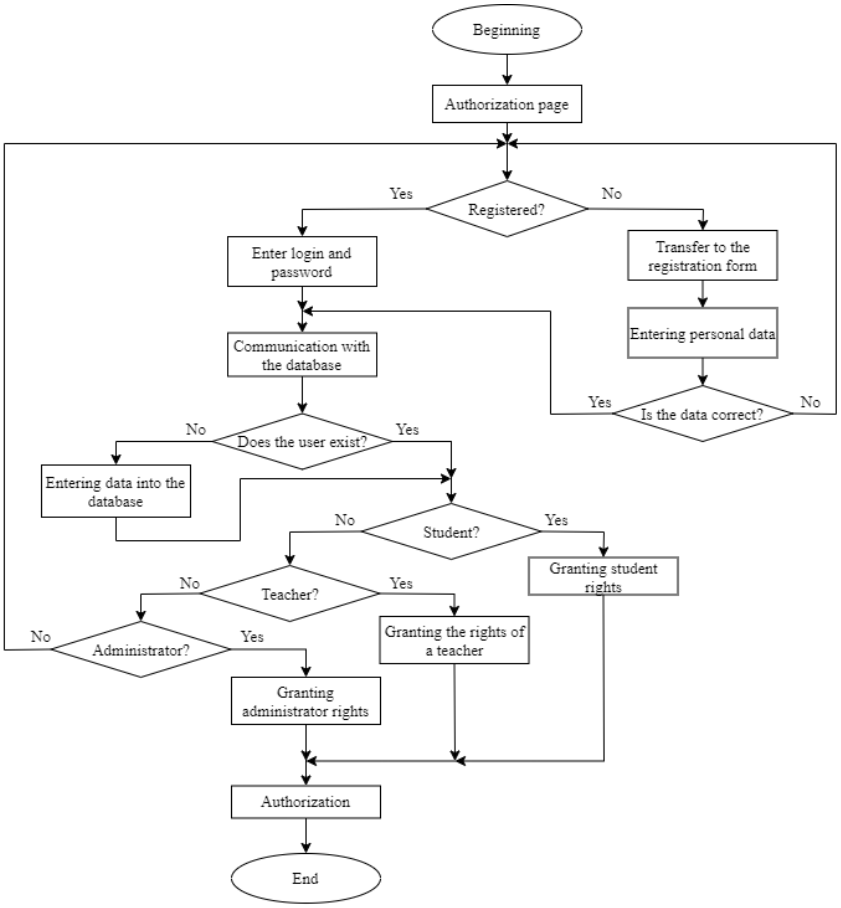

Fig. 2. The scheme of user authorization

Rules:

1) if the user has the identifier Student, then he is granted student rights, otherwise the next check is performed;

2) if the user has the identifier Teacher, then he is granted the rights of a teacher, otherwise the next check is performed;

3) if the user has the identifier Administrator, then he is granted the rights of the administrator, otherwise the user has no rights.

Verification of compliance of the model with the requirements is due to the parse code (Fig. 3).

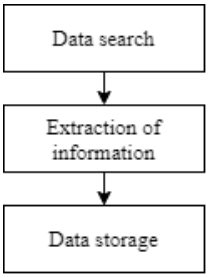

Fig. 3. Stages of syntactical analysis

During the first stage of "Data Search" the source code of the model is loaded. A script starts working with the model. It breaks down all the content, highlighting the necessary information.

During the second stage of "Extraction of information" data search is due to a certain set of characters that describe the purpose of the search.

During the third stage of "Saving Data" information is entered into the database. The result of the parsing is written to the table of identifiers for further processing.

A file with the 3D model is fed to the input model in the unit to check the compliance of the additive model.

The rules in the rule base are used for verification. Since it is not possible to write a parser for a complete analysis of the file, there are the rules that are checked by the analyzer and the rules that are provided for testing to the teacher in the form of a web page.

If the model does not meet the requirements as a result of checking 3D model validation rules, the process exits and the user is sent an error message.

The model unit, which has already been pre-tested for 3D model requirements, is fed into the input device selection check unit.

After the user selected the desired device, system checks whether the selected device meets the requirements for 3D printing or not.

If it is right than the model is sent for printing, if it is false than printing is not allowed and the corresponding message is sent to the user.

The model of the device selection type rule base is shown in Fig. 4.

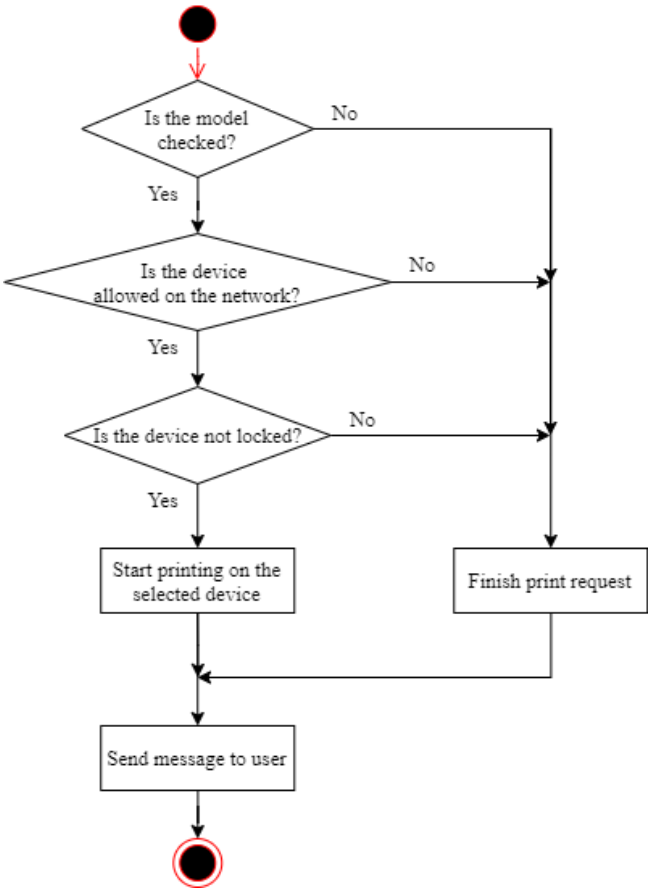

Fig. 4. Model of the base of the rules of the type "device selection in the network"

Requirements:

– the model is tested;

– the device belongs to the permitted network devices;

– the device is not locked.

Conclusions

The development of innovative thinking in higher education students should become a priority of modern higher education, and the introduction of new elements in modern education is inevitable. And given the development of 3D printing technologies, additive technologies are the most promising for the use of visualization in online and mixed teaching.

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Received (Надійшла) 05.01.2022
Accepted for publication (Прийнята до друку) 02.02.2022

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Процес 3D друку в онлайн-освіти

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Анотація. **Предметом** огляду є методологія побудови підсистеми друку 3D-моделі системи онлайн-навчання змішаного типу. Для цього було визначено огляд аналогів, технологій, етапів друку. Завдяки розвитку технологій навчальний процес трансформується. В освіті використовується змішане навчання, частиною якого є дистанційне навчання. **Об'єктом дослідження** є використання адитивних технологій, які можуть зробити процес навчання більш мотивованим. Таким чином, якщо в дистанційній освіті є можливість розробити 3D-модель онлайн, перевірити її на вірність, відправити модель на друк, це оптимізує процес навчання. **Метою** є розробка з IP-тем, що використовує адитивні технології в навчальному процесі. **Використані методи:** IDEF- діаграма, що описує функцію системи; правила аутентифікації, перевірка 3D-моделей, відправка моделі на друк, вибір пристрою в режимі онлайн та основні екранні форми. **Висновки.** Розвиток інноваційного мислення у студентів вищих навчальних закладів має стати пріоритетом сучасної вищої освіти, а впровадження нових елементів у сучасну освіту є неминучим. А враховуючи розвиток технологій 3D-друку, адитивні технології є найбільш перспективними для використання візуалізації в онлайн- та змішаному навчанні.

Ключові слова: адитивні технології; змішане навчання; 3d-модель; 3d-друк; база даних правил; база даних.

Процесс 3D печати в онлайн-образовании

Н. К. Гайдар, А. Э. Заволодько, П. Е. Пустовойтов

Аннотация. Предметом обзора является методология построения подсистемы печати 3D модели системы онлайн-обучения смешанного типа. Для этого был определен обзор аналогов, технологий, этапов печати. Благодаря развитию технологий, учебный процесс трансформируется. В образовании используется смешанное обучение, частью которого является дистанционное обучение. **Объектом исследования** является использование аддитивных технологий, которые могут сделать процесс обучения более мотивированным. Таким образом, если в дистанционном образовании есть возможность разработать 3D модель онлайн, проверить ее на верность, отправить модель на печать, это оптимизирует процесс обучения. **Целью** является разработка с IP-тем, использующим аддитивные технологии в учебном процессе. **Использованные методы:** IDEF-диаграмма, описывающая функцию системы; правила аутентификации, проверка 3D-моделей, отправка модели на печать, выбор устройства в режиме онлайн и основные экранные формы. **Выводы.** Развитие инновационного мышления у студентов высших учебных заведений должно стать приоритетом современного высшего образования, а внедрение новых элементов в современное образование неизбежно. А учитывая развитие технологий 3D-печати, аддитивные технологии наиболее перспективны для использования визуализации в онлайн- и смешанном обучении.

Ключевые слова: аддитивные технологии; смешанное обучение; 3d-модель; 3d-печать; база данных правил; база данных.