Overall structure design of model management and data protection system based on STL

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Abstract. This paper realizes the development of STL model management and data protection system for 3D printing cloud platform. Firstly, the 3D printing cloud platform is briefly introduced, and the system requirements analysis, system technical architecture construction, system flow and system database design are completed. Then, based on ASP.NET, database and other technologies, combined with C# language, Web development is carried out. Finally, from the perspective of tourist users, registered users and background administrators, the functions of their respective modules are realized.

1. Introduction
Since its advent, 3D printing technology has been gradually applied in many fields of society, such as aerospace, ship, automobile and medical treatment. With its unique processing method, this technology has become an indispensable means of large-scale customization [1]. However, many small-sized 3D printing devices and some industrial-grade 3D printing devices are independent and scattered in various social fields, and some of them are even idle. Most of the devices already in use are also used for prototype manufacturing in the process of new product development. If these 3D printing devices can be added to the supply chain of products, the production level of manufacturing industry will be improved rapidly. Based on this situation, some high-tech enterprises use the Internet to create a 3D printing sharing platform that can quickly install customized ideas into actual products, and gradually upgrade and update it, eventually becoming the current 3D printing cloud platform [2]. Cloud print service is one of the core services of 3D printing cloud platform, which includes the main functions of users submitting orders to the platform, platform distributing orders to production service providers, printing and delivery by production service providers, and user evaluation feedback.

1.1. Introduction of 3D printing cloud platform
The 3D printing cloud platform is a service platform that can meet the personalized customization needs of different users, and it is also a comprehensive embodiment of various high technologies such as 3D printing and Internet. The 3D printing cloud platform is an industrial ecological network, which includes general users, design engineers, service providers and other member groups. General users can search 3D models published in the platform, design product models online by using remote software provided by the platform, and express requirements to design engineers in the platform and obtain product design services. Design engineers can make their own design ideas public, and ordinary users can communicate with engineers if they need them. Engineers can combine the needs of users to turn ideas into products and sell them to users, thus earning design fees. Service providers can use the digital model of 3D
printing equipment to materialize and then forward it to users, thus earning service fees. Figure 1 shows the specific process of 3D printing customization.

![Figure 1. 3D printing cloud platform personalized custom flow chart.](image)

1.2. Basic functions of 3D printing cloud platform

The 3D printing cloud platform should at least have the following functions:

1. User management

The 3D printing cloud platform should be able to maintain and manage the information of various users. At the same time, all users in the platform have a unified service access portal, which only need a single authentication and login. In this process, users' information security must also be guaranteed.

2. Cloud print service

The core function of 3D printing cloud platform is cloud print service. The steps of cloud print service are as follows. The user uploads the model designed by himself or selected from the platform, and then sets specific printing parameters, such as material, colour, quantity and post-processing. After the user submits the information, the system automatically generates an order, and the user confirms the order information and pays relevant fees. According to the user's order information, the platform forwards the order to the corresponding 3D printing service provider in the platform. The 3D printing service provider receives the order, processes the product, and sends it directly to the user after the processing is completed. The user evaluates the service provided by the platform after confirming the receipt of goods, and the whole cloud print service process ends.

3. Release of creative demand

When users can't design their own products, they can publish the product requirements. The platform matches the appropriate designers according to the user's needs, and then the designers complete the creative design of the products. Design requirements issued by users will be made public after approval.

4. Registration and release of resources

After the platform integrates the equipment resources, design service resources and design software resources of 3D printing and publishes them, users can select these virtual resources.
2. System requirements analysis

After in-depth communication with printing customers on the current 3D printing platform, the problems in the management of model files on the current 3D printing cloud platform are summarized. The customer's requirements are analyzed in detail, and the functional requirements of the system are analyzed by use case analysis. By constructing a use case diagram composed of participants, use cases and connections, the functional requirements of the system are obtained. Participants in STL model management and data protection system for 3D printing cloud platform have three roles, which are tourists, registered users and background administrators. The following use cases are analyzed for these three users.

2.1. Tourist use case analysis

Tourists in this system refer to the vast number of 3D printing demanders and enthusiasts, who are more concerned about the model information and 3D printing works provided by the system. When visitors visit the system, they can enter the public communication area of the system and objectively understand other users' feelings about 3D printing experience and processing effect. This kind of information communication can help users to know the feedback of users in time. Visitors learn about the development and application of 3D printing cloud platform and the advantages of the system in the introduction of the system. They can also observe the internal structure of each model by 3D browsing in the public STL model library. Use case diagram of tourist is shown in Figure 2.

![Tourist use case diagram](image)

Figure 2. Tourist use case diagram.

2.2. Registered user use case analysis

Registered users refer to users who have completed user registration and successfully logged into the system. They have more rights than guest users. Registered users can not only browse all models in the STL 3D model library in 3D, but also download them locally. Registered users can set up their own file management space in the system for personal model file management in the future. If the user wants to create a privately named 3D model library in his homepage and manage it, he can upload the STL format three-dimensional model named by individuals in the personal three-dimensional model library and manage it. If you find that you have made mistakes during your operation, you can leave a message to the back-office manager by contacting us. In order to protect the copyright of digital works of 3D printing designers, users need to embed and extract watermarks from STL models. Use case diagram of registered user is shown in Figure 3.
2.3. Background administrator use case analysis

Background administrators refer to the staff who manage and maintain websites. In order for registered users to use the system safely and effectively, the background administrators must manage the information of registered users on time, delete the violators and pull them into the blacklist, and they are not allowed to register again. There are a large number of STL models in the public STL model inventory. If it is not managed on time, redundant website garbage will affect the stable and normal operation of the system, so the background administrator must be able to manage the public STL model library and the STL models in it. Back-office managers should be able to handle the data protection information of STL model of registered users, and handle the message information left by registered users at the front desk, and give feedback to users in time. In order to ensure the information security of system users, the administrator can also change the login password regularly. Use case diagram of background administrator is shown in Figure 4.
3. System technical architecture
The STL model management and data protection system is based on the typical ASP.NET three-tier architecture technology, which is specifically divided into representation, business logic and data access layers. ASP.NET's three-tier architecture is clear, easy to debug and extensible. It can provide the same object-oriented programming environment for the developed applications [3]. It can not only build portal websites, but also realize complex Web systems and e-mail delivery systems [4]. Many programming languages, such as C#, VB, C++, can run on the same Microsoft operating system, and these programming languages can access the components generated by each other through the .NET framework [5]. The system technical architecture diagram is shown in Figure 5.

![System technology architecture](image)

Figure 5. System technology architecture.

The presentation layer (WEB) is located at the top of the system architecture, which is mainly used to store display pages interacting with users, such as ASPX pages and HTML pages [6]. Business logic layer (BLL) is located in the middle layer, which is mainly used to store the code for logically processing data according to specific problems. Data Access Layer (DAL) is mainly used to store the codes for operating the original data, which encapsulates all the operations interacting with the database and provides data services for the business logic layer [7].

The development environment of the system is shown in Table 1.

| Operating system | Window7 |
|------------------|---------|
| Development tools| Microsoft Visual Studio 2012 |
| UML modeling tool| Rational Rose |
| Database design tool| PowerDesigner 12 |
| Database environment| Microsoft SQL Server 2008 Express |

4. Overall system flow
Combining STL 3D model management with data protection system's daily actual business process and system requirement analysis, since tourists can become registered users after registration, the two processes are merged, and only the registered users and background administrators are analyzed for system process.

4.1. Operation process analysis of registered user
When visitors enter the STL 3D model management and data protection system, they can communicate with other users in the public communication area, or browse the STL models in the public STL 3D model library in 3D, but they cannot download them. Then, visitors become members after they register.
their accounts and login the system, at which time they can download any STL model in the STL 3D model library. Registered users can also protect their own STL models, embed watermarks into their own STL models, or extract watermarks from the models for 3D printing. Registered users can access my homepage, manage their personal information, and change their account number or password. Or the user establishes his own 3D model library here, modifies the name of the model library, uploads his own STL model in the library, and modifies its information. At this time, the STL model uploaded by the user automatically enters the STL public 3D model library, and other users can browse or download it. At this time, the user ends the operation of the system. Figure 6 is a flow chart of register user operation.

4.2. Operation process analysis of background administrators
The background administrators enter the administrator login interface and login the account number. The administrators can view the user information, and decide whether to delete the user account information and pull it into the blacklist according to whether there is any illegal operation. Then administrators can change their passwords, reply to messages from system users, and change the background of the front desk homepage. The background administrators can also enter the public STL model library management module, modify the information of the model library, view the public STL model, and manage it. Or the background administrators can enter the data protection module to manage

![Flow Chart](image_url)
the watermark information and carrier. Figure 7 is the operation flow chart of the background administrator.

![Operation Flow Chart](image)

Figure 7. Background administrator operation flow chart.

5. System function module design

The system function module is mainly designed for tourists, registered users and background administrators.

1. Visitor function module. 3D printing enthusiasts can learn about the 3D printing cloud platform in the system introduction, communicate with each other in the public communication area, and directly browse the STL model in 3D.

2. Registered user function module. Registered users can download STL models and modify their personal information on the basis of realizing all functions of guest users. They can set up personal STL model library, upload STL models and manage them, and also feedback problems to the background administrators in contacting us. Finally, they can embed and extract the watermark of STL models.

3. Background administrator module. Background administrators can manage registered user information, public STL model library and STL models in the library. The background administrators should be able to handle the watermark information and carrier information of STL model of registered users, and handle the message information left by registered users at the foreground, and change the background of the front page of the foreground. Administrators should also be able to change the login password.

Figure 8 is the design drawing of system function module.
6. System database design
The STL model management and data protection system management system relies on SQL Server 2008 to create and manage the database. A database can be regarded as an electronic filing cabinet, where electronic files are stored. Users can add, query, intercept, update and delete data in files [8]. SQL Server is a relational database management system [9]. This section mainly analyzes the database of the system. The purpose of database analysis is to get the storage mode of the internal data of the system, and then get all the entities of the system database [10], and build the entity-contact model.

According to analysis, the system database should contain five data tables, which are user registration information table (TB_User), model library information table (TB_DemoFile), model information table (TB_Demo), exchange information table (TB_AboutUs) and background picture information table (TB_Banner).

(1) User registration information table (TB_User), which is used to store the registration information of users in the system, and its specific attribute information is shown in Table 2.

| Field name   | Data type | Length | Empty allowed | Primary key |
|--------------|-----------|--------|---------------|-------------|
| Id           | int       | 10     | no            | Yes         |
| Account      | varchar   | 50     | no            | no          |

Figure 8. System function module design.
(2) Model library information table (TB_DemoFile), which is used to store model library information created by system users, and its specific attribute information is shown in Table 3.

Table 3. Model library information table (TB_DemoFile).

| Field name | Data type | Length | Empty allowed | Primary key |
|------------|-----------|--------|---------------|-------------|
| Id         | int       | 10     | no            | Yes         |
| Name       | varchar   | 50     | no            | no          |
| UserId     | int       | 50     | Yes           | no          |
| Times      | datetime  | 50     | Yes           | no          |
| Des        | text      | 50     | Yes           | no          |

(3) Model information table (TB_Demo), which is used to store the model information uploaded by registered users of the system, and its specific attribute information is shown in Table 4.

Table 4. Model information table (TB_Demo).

| Field name | Data type | Length | Empty allowed | Primary key |
|------------|-----------|--------|---------------|-------------|
| Id         | int       | 10     | no            | Yes         |
| Name       | varchar   | 50     | no            | no          |
| FileId     | int       | 10     | Yes           | no          |
| Urls       | varchar   | 50     | Yes           | no          |
| DDDFileUrls| varchar   | 50     | Yes           | no          |

(4) Exchange information table (TB_AboutUs), which is used to store the exchange information between registered users of the system and background administrators, and its specific attribute information is shown in Table 5.

Table 5. Exchange information table (TB_AboutUs).

| Field name | Data type | Length | Empty allowed | Primary key |
|------------|-----------|--------|---------------|-------------|
| Id         | int       | 10     | no            | Yes         |
| Name       | varchar   | 50     | no            | no          |
| Tel        | varchar   | 50     | Yes           | no          |
| Email      | varchar   | 50     | Yes           | no          |
| Contents   | text      | 200    | Yes           | no          |

(5) Background picture information table (TB_Banner), which is used to store the information of the background picture changed by the system background administrators. The specific attribute information is shown in Table 6.

Table 6. Background picture information table (TB_Banner).

| Field name | Data type | Length | Empty allowed | Primary key |
|------------|-----------|--------|---------------|-------------|
| Id         | int       | 10     | no            | Yes         |
| Urls       | varchar   | 50     | Yes           | no          |

7. Conclusion
This paper mainly introduces the overall structure of the STL model management and digital watermarking system for 3D printing cloud platform. First of all, based on the actual demands of
customers, the demand analysis of the system is completed. Then, the advantages and construction methods of the ASP.NET three-tier architecture used in the system are briefly introduced, and the three-tier architecture of the system is built by hand. Then, the realization of visitor user function, registered user function and background administrator function is completed, and the system flow is analyzed from the registered user role and background administrator role, and then the functional module design of the system is completed. It mainly includes registered users’ download STL model function, personal information management function, personal STL model library and STL model management function, background administrator's registered user information management function, public STL model library and STL model management function in library. At the same time, registered users can feedback problems to the background administrators when contacting us, and can embed and extract the watermark of STL model. The background administrators can deal with the watermark information and carrier information of STL model of registered users, and deal with the message information left by registered users at the front desk, and complete the functions of changing the background of the front page of the front desk and modifying the login password. Finally, according to the data to be stored in the system, the database of the system is designed.

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