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APPROACHES TO IMPLEMENTING VIDEO DATA MANAGEMENT SERVICE WITH THE CONTEXT-AWARE RECOMMENDATION

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***Abstract*: The work aims to develop video data management service with a context-aware recommendation. It consists of the user interface which is presented as a website with the mobile application and the server. This paper describes the approaches to implementing video data management service. The decomposition of the task of video data management service development, the use case diagram, the generalized class diagram, the technologies and the services used in the development process have been considered. The developed structure of the video data management service has been presented. Features of designing the user interface of the video data management service have been considered. The issue of testing the developed video data management service has been considered.**

***Index Terms:* video data management service, client-server architecture, Java, JavaScript, Hibernate.**

I. INTRODUCTION

Nowadays, it has been possible to take an incredible step towards automation of different aspects of human life: simply search for information using the Internet, structure data on your computer or perform complex calculations, etc. It is a fact that creation, storage and viewing of digital video were always one of the most important areas of information technology and, consequentially, the amount of video data is growing rapidly. That is why there is a need for different means of storing and viewing video data. Examples of the use of video data management services include: creating and maintaining personal or shared video archives, storing and viewing entertainment content, saving video data from video surveillance systems and video recording systems, saving educational video data sets for machine learning systems, etc.

Context-aware computing [1] is becoming an increasingly popular research area with the further prospect of developing context-aware recommender systems, which are used to filter out a large number of videos to find out some that might be interesting for the user.

Java [2] is a high-level, class-based, object-oriented programming language that is designed to have as few implementation dependencies as possible. It is a general-purpose programming language intended to let programmers write once, run anywhere, meaning that compiled Java code can run on all platforms that support Java without the need to recompile.

Extensible Markup Language (XML) [3] is a markup language and file format for storing, transmitting, and reconstructing arbitrary data. It defines a set of rules for encoding documents in a human-readable and machine-readable format.

The Hibernate Framework [4-5] is an open-source object-relational mapping (ORM) tool that provides the ability to map object-oriented domain models to relational databases for web applications. Object-relational mapping is based on the containerization of objects and the abstraction that provides that capacity.

The issue tree [6] is used to break down problems into their component parts. As a result, it helps to focus efforts on more manageable smaller problems that can be tackled one by one. Ultimately, the solutions for each smaller piece lead to solving the larger whole.

The popular modeling language UML (Unified Modeling Language) [7] is used to develop the use case diagram. This standard uses graphic notations to create an abstract model of the system, which gives us the optimization of the development process of video data management service and increases the efficiency of its implementation.

A class diagram [8] is an illustration of the relationships and source code dependencies among classes in the Unified Modeling Language (UML). In this context, a class defines the methods and variables in an object, which is a specific entity in a program or the unit of code representing that entity.

Black-box testing [9] is a method of software testing that examines the functionality of an application without peering into its internal structures or workings. This method of test can be applied virtually to every level of software testing: unit, integration, system and acceptance. It is sometimes referred to as specification-based testing.

The Apache JMeter Tool [10] is designed to load test functional behavior and measure performance of web

application or a variety of services, in our case, the video management data service.

II. PURPOSE OF THE WORK

The purpose of the work is to develop a video data management service with context-aware recommendation. The main functions of the service are the following:

1) video data management on the platform server;

2) viewing video data in the mode of video stream transmission from the server;

3) creation of a new channel, within which its owner can add new videos;

4) rating and commenting on the video, the ability to subscribe to the channel;

5) context-aware content-based recommendation of videos;

6) the possibility to edit the user profile;

7) the possibility to distribute videos on social networks.

The video data management service is multitenant and can be configured to run from any device with internet access. The client side of the online platform is implemented as a web application using the Java programming language, XML and the Hibernate framework. The server side of the online platform is implemented using MySQL Server.

The resulting program should include all the above functions and correspond to the principles of the client-server architecture as well as include the context-aware recommendation to stand out among other products using a unique sorting algorithm.

The generalized class diagram of the video data management service is given in Fig.1.

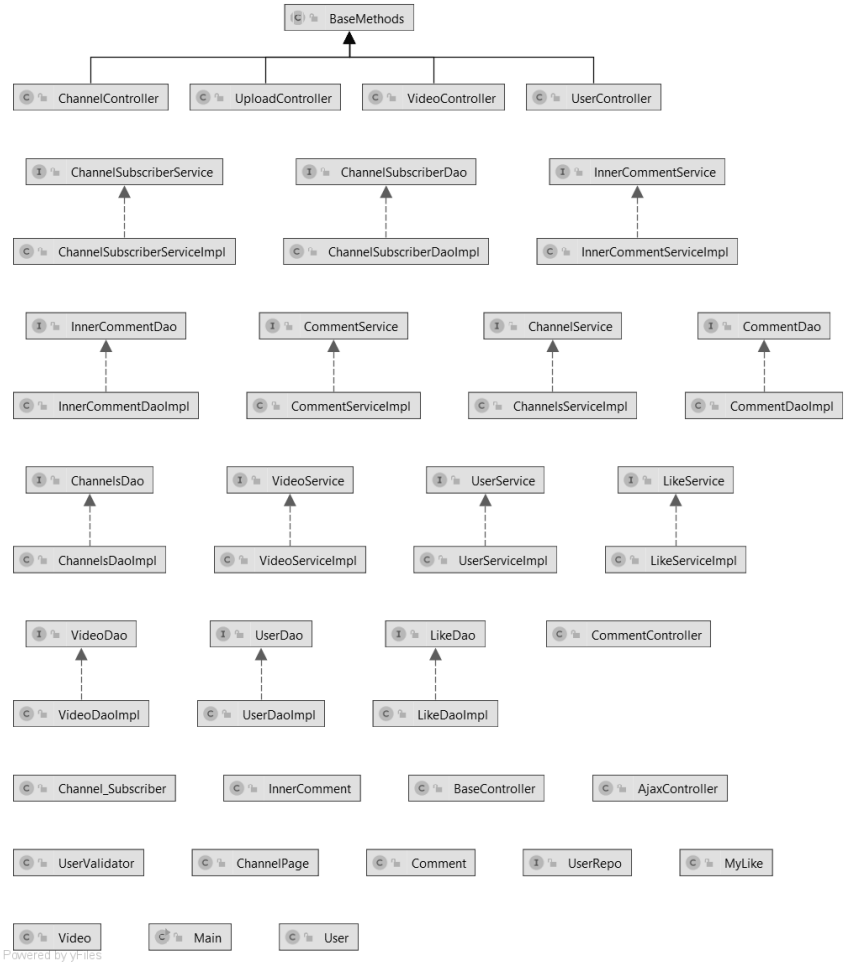

Fig. 1. The generalized class diagram of the video data management service with the context-aware recommendation.

III. THE DECOMPOSITION OF THE TASK OF THE VIDEO DATA MANAGEMENT SERVICE DEVELOPMENT

During the development of the video data management service, one of the first stages was the consideration of the subject area and the prediction of possible problems in the implementation of the product on which we focused. The issue tree was formed for the most optimal analysis of the development (Fig.2).

One of the most important stages of the development is the creation of decomposition: that is the parallelization of the problem into several main parts, which became the reason for building the issue tree as the most optimal solution; The formed tree as a base contains a vertex, which is divided into three conditional groups with individual subsections, which fully describes the decomposition process.

The first branch (1, Fig.2) of the issue tree is forming the main goal of the development of the video data management service. It describes the implementation approaches to cover almost all the needs of modern users when they are using such products (1.1, Fig.2).

The second sub-branch (1.2, Fig.2) of the first branch, which should be taken into account, is the functionality conditions of the video data management service. Since it is designed for a large volume of users, it must meet the following conditions: we should consider the fact that at the moment there are already quite a large number of analogs, and our product must absorb all the advantages of similar services and also offer something unique to become a great alternative with a lot of benefits; Beside this, the video data management service should, first of all, have a simple and intuitive user interface, which will not contain anything complicated for the average computer user. In addition, high functionality speed and a sufficient level of security should be ensured.

The third sub-branch (1.3, Fig.2) of the first branch should contain various options for achieving the given development goal while preserving all the functionality despite any conditions. Also, it should be taken into account how best to present information to the user, which graphic design will work best, etc., and choose the most optimal option.

After we switch to the second branch (2, Fig.2) and consider the first sub-branch (2.1, Fig.2), we must analyze the functionality of our system. That means taking into account all the duties assigned to our product and all aspects that may arise during the execution of the system:

- quality content;
- instructions for using the software product;
- help in case of technical failures or difficulties;
- definition of criteria for quality control of the finished system;
- assessment for the value of each of the criteria;
- system testing;
- analysis of the obtained results;

The second sub-branch (2.2, Fig.2) of the second branch should be responsible for resource support for development, namely the selection of both free and paid libraries and frameworks, the main criteria of which should be: reliability, good support from their developers, etc.

The third sub-branch (2.3, Fig.2) is responsible for the mechanism of managing the functionality of the video data management service, i.e.: process accounting; strategic planning; system control and, of course, its analysis. The most important point in the formation of functionality is the planning itself, since it must be ensured at a high level. It should be noted that accounting process includes the formation and application of the most optimal functions to ensure the performance of tasks formed during planning.

The first sub-branch (3.1, Fig.2) of the third branch should characterize various methods and methods for organizing the system development process: structuring relations between management and those who are subordinate to it. If we consider the concept of organizational structures, we mean a set of management links that are at the same level in a certain place in the role hierarchy.

The second sub-branch (3.2, Fig.2) of the third branch organizes the process of functioning of the given system: to choose the right choice to significantly speed up the work process in the video data management service by simplifying user interaction.

The third sub-branch (3.3, Fig.2) ensures the process of interaction between the video data management service and other unrelated systems.

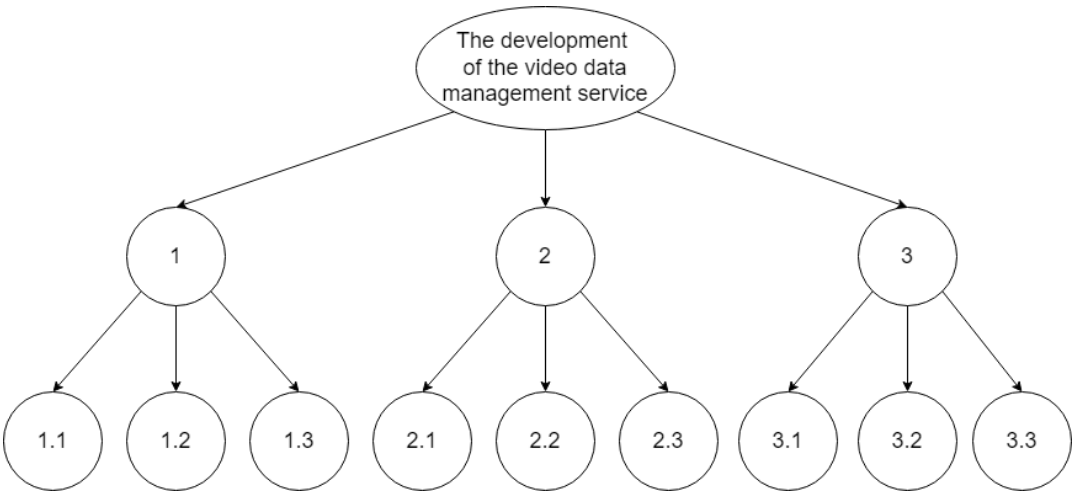

Fig. 2. The issue tree of video data management service with the context-aware recommendation.

IV. THE DEVELOPMENT OF THE USE CASE DIAGRAM OF THE VIDEO DATA MANAGEMENT SERVICE

A use case diagram represents the user's interaction with the system and shows the relationship between the user and the various use cases in which the user takes or can take part.

The development of a software system must begin with the creation of a diagram of precedents. The first step is to think through the operation and interaction of the system with users. The UML language represents several types of relationships between entities and precedents, such as:

- association;
- extension;
- inclusion;
- generalization;

The user authorizes or registers in the system, then is allowed to create a channel or view an existing one, after which the following options are available to the user: adding a video; adding preferences; subscribing to the channel or adding comments/sub-comments;

A diagram of precedents was developed based on the well-thought-out operation of the model and the interaction of the video data management service with the user (Fig.3).

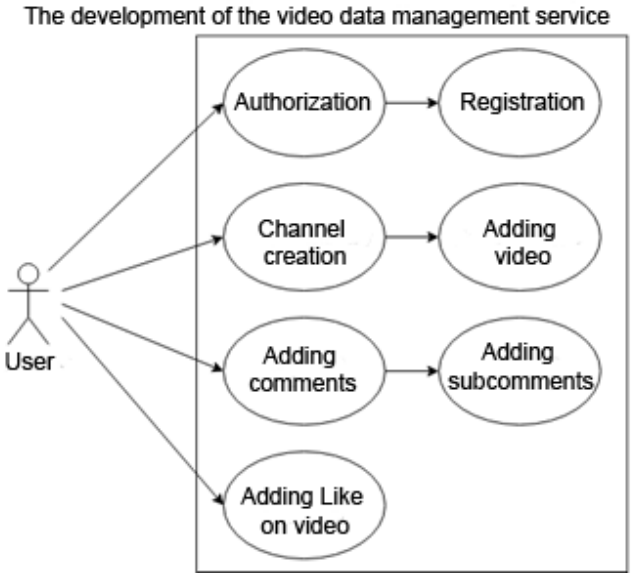

Fig. 3. The use case diagram of the video data management service with the context-aware recommendation.

V. DEVELOPMENT OF THE SERVER SIDE OF THE VIDEO DATA MANAGEMENT SERVICE

In the development of the server part, the Hibernate framework was used, which provides the possibility of establishing a connection with a remote database server.

The Hibernate framework has one very useful feature, namely EntityManager - a utility designed for working with database objects (tables). In other words, it is the use of a programming technique that links the database with the concepts of object-oriented programming languages.

It greatly simplifies the work of the developer with the creation of tables and fields in the database, since this process can be fully automated using the appropriate classes that must be added to the EntityManager and will be executed during the first connection to the database.

Decorators (@OneToMany, @Column) were used on the fields to indicate the purpose of the field when creating the table in the database.

Web hosting is a service of providing cloud disk space, network connection, and other resources for hosting physical information on a server that is permanently on the network (for example, on the Internet).

After reviewing all the available choices the Heroku - a product of the Salesforce company was chosen.

Heroku is a cloud platform that supports several programming languages and is designed to host developed web applications for public distribution.

VI. DEVELOPMENT OF THE CLIENT SIDE OF THE VIDEO DATA MANAGEMENT SERVICE

The client component of the software service of video data management is implemented in the form of a web application and mobile app. Accordingly, the user interface looks like a multi-page website. Java and JavaScript programming languages were used in the development of the user interface, which implements two independent sections: an administrator and a default user. The default user interface contains a window for user authorization, the main working window, a window for watching videos, a window for downloading videos, a window for creating a channel, a window for viewing created channels, a window for viewing user profile information with the possibility to edit it and others. The platform administrator interface provides basic functions for managing the platform, user data and service data.

Fig. 4. Example of the client interface: user profile.

VII.TESTING THE CLIENT SIDE OF THE VIDEO DATA MANAGEMENT SERVICE

The main goal during testing is to identify errors that may occur during the use of the program by end users: it helps to improve the algorithms and improve the project's functions; In addition, you need to understand that just one small mistake can have big consequences, which can bring about the failure of the whole program. During the testing of the video data management service, two methods were used: black and transparent boxes.

The black box method is quite simple and clear, but it can significantly improve the quality level of the final code. The main principle of its operation consists in testing the functions of the software product by checking the inconsistencies that may arise when comparing the expected reaction of the software product to certain actions and the actual reaction.

Testing is modular, so it can be divided into the following stages:

Testing the authorization module:

- launch the authorization page;
- fill in the fields;
- click on the "Login" button;
- check the correspondence of the data in the database with the data entered;
- close the page;

Conclusion: the module works correctly.

Testing the registration module:

- launch the registration window;
- fill in all the necessary fields (login, password and personal information);
- check for hints about incorrectly filled fields and correct filling errors, if any;
- check the availability of the login;
- add data to the database;
- check the validity of the entered information;
- close the Internet service page;

Conclusion: the module works correctly.

Other modules were tested in a similar way provided above.

VIII.TESTING THE SERVER SIDE OF THE VIDEO DATA MANAGEMENT SERVICE

The server side of the video data management was tested in the aspect of correctness and efficiency, in other words, load testing.

The maximum trouble-free server load was determined (Fig. 5) using the Apache JMeter tool with the following thread group parameters: 5,000 unique users, that are sending requests not in a determined amount of iterations, but in an infinite loop to find out if after some time server will shut down.

As we can see from the graph results (Fig. 6), the server-side is capable of ensuring up to 5,000 simultaneous unique requests with a response time no longer than 200 ms. Average parameter describes the average value of server response time, in other words, the objective load graph. The Median describes the appropriate median value. The Deviation describes the appropriate standard deviation and the Throughput (green line) describes the throughput of executed requests. In fact, Average and Throughput values are enough to calculate the maximum trouble-free server load.

In conclusion, the testing confirmed the absence of critical errors in the operation of the software service of video data management.

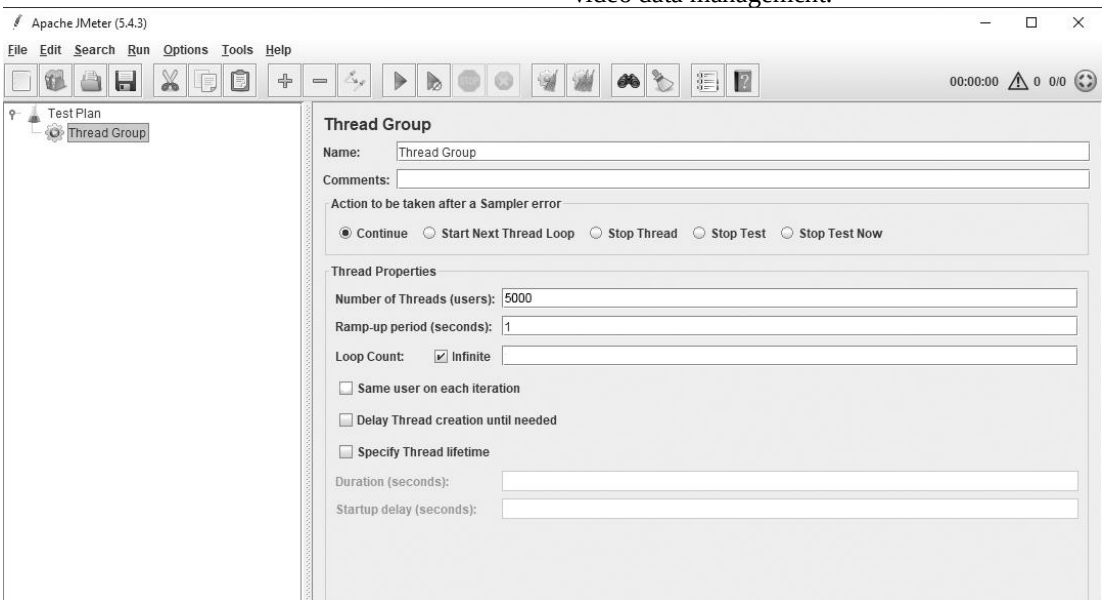

Fig. 5. The thread group settings of the server-side testing of the video data management service.

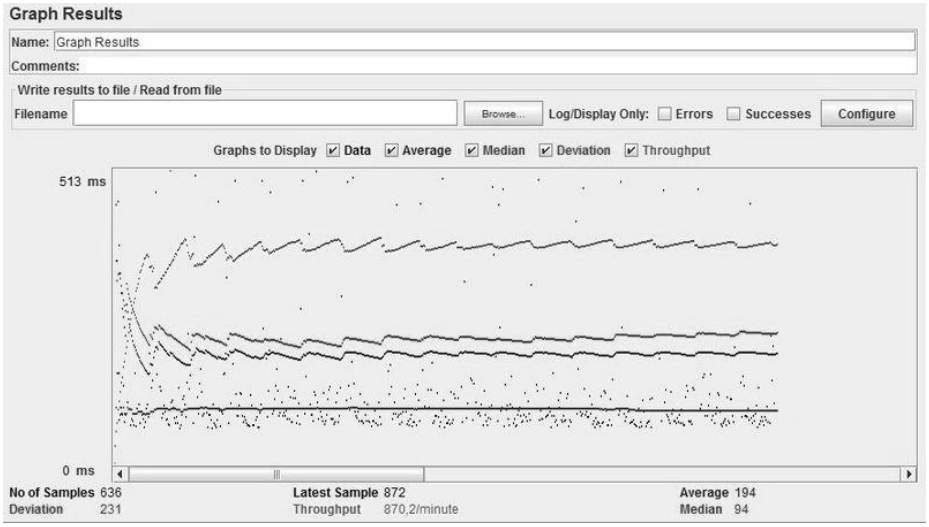

Fig. 6. The results of load testing of the server side of the video data management service.

IX. CONCLUSION

The approaches to developing video data management services were considered.

The developed structure of the software service of video data management was presented. The algorithm of its work was considered. The structure of the software service of the video data management database was proposed. Features of designing the responsive user interface of the video data management service were considered. The issue of testing the developed video data management service was considered.

The client-side testing of the video data management service confirmed the absence of critical errors in the operation of the video data management service.

During the server-side testing, it was found that the developed video data management service can ensure error-free operation when receiving up to 5,000 simultaneous requests from unique users. However, even if more than 5,000 simultaneous unique requests are received, the server will not shut down due to critical loading, which was proved with load testing, because a response time longer than 200 ms is acceptable in case of a bad Internet connection, etc. Therefore, this received simultaneous request number can be higher, if we change the server-side environment to more productive, but for our developing approach, it is a great result.

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