Design of Intelligent Warehouse Management System Based on MVC

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Abstract—**Aiming at the problems of single function, low service level and difficult to meet customers' demand for warehousing business in warehouse management system, a collaborative filtering recommendation algorithm is proposed. The algorithm calculates the similarity between items by analyzing user's consumption behavior records, finds similar items to 'target user's favorite items, recommends similar items to 'target user', and designs commodity recommendation function for customer preferences, so as to improve user satisfaction and commodity sales efficiency. In order to provide users with better service experience and make the system operators easy to use, it is proposed to use B / S architecture and MVC framework model to design four modules : user management, allocation management, warehouse information management and report management, and to establish the corresponding database for unified management. Finally, the intelligent warehouse management system with high user experience satisfaction and convenient background management operation is obtained.**

Keywords-Intelligent Warehousing; Collaborative Filtering Recommendation; MVC; Commodity Recommendation; Warehouse Management System

I. INTRODUCTION

From the current point of view, many domestic enterprises' warehousing management information systems are faced with problems such as simple structure, fewer functions, and the mismatch between the service level of the system and the needs of customers. Although some large-scale warehousing companies abroad have reduced the investment of manpower to a large extent through information construction, they still cannot fully realize the automation and intelligent management of the warehousing system [1]. He Jiabo and Gu Xinjian of Zhejiang University proposed Internet-based shared storage [2] and analyzed the economic effects brought by warehouse management, but did not propose specific system design and implementation. This intelligent warehouse management system uses B/S The architecture uses the MVC framework pattern to separate the system control, user view, and warehouse data to further improve the maintainability of the system. Li Qingshan of Xidian University and others, in order to improve the efficiency of warehousing and reduce transportation costs, proposed a coordinated optimization algorithm for cargo location and AGV path [3]. The system adds a product recommendation function to the warehouse management, and proposes a collaborative filtering recommendation algorithm for products based on user preferences. This paper designs and develops an intelligent warehouse management system based on MVC. Its application can make warehouse management more convenient, save

manpower and material resources, and improve the economic benefits of the enterprise.

II. RELEVANT WORK OF INTELLIGENT WAREHOUSE MANAGEMENT SYSTEM

A. MVC Pattern

MVC is a software design model that uses a method of separating business logic, data and interface display to organize code, integrates business logic into a component, does not need to rewrite business logic, and improves personalized customized interface and user interaction. MVC is a unique development method that maps traditional input, processing and output functions to the structure of a logical graphical user interface. The purpose of the MVC mode is to achieve a dynamic program design, simplify subsequent modification and expansion of the program, and make it possible to reuse a certain part of the program. In addition, the MVC mode makes the structure of the program more intuitive by simplifying the complexity. MVC has the advantages of low coupling, high reusability, low life cycle cost, fast deployment, strong maintainability, and conducive to software engineering management. Therefore, the design of this system is based on MVC pattern [4].

MVC application is divided into three core components: model, view and controller. Each component processes its own tasks, making large projects simpler and more logical [5]. As shown in Figure 1.
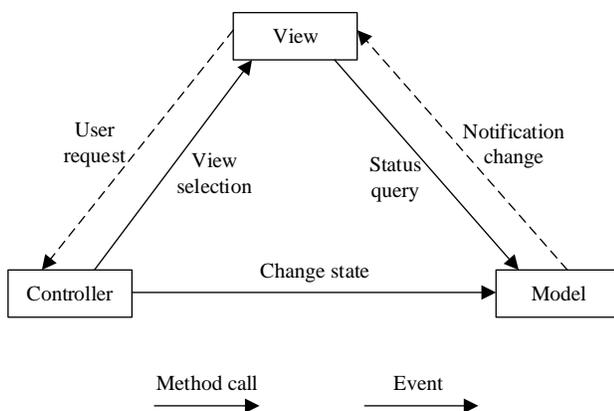

Figure 1.   MVC development framework pattern.

B. Recommendation Algorithm Based on Collaborative Filtering

Nowadays, there is a flood of information on the Internet, and it takes a high cost to find a piece of information that suits you, so there is a recommendation system. For users, the recommendation system can save their time; for merchants, the recommendation system can better sell their products.

Neighborhood-based recommendation algorithm is the most basic algorithm in the recommendation system, which is divided into two categories: user-based collaborative filtering algorithm (UserCF) and item-based collaborative filtering algorithm (ItemCF). The user-based collaborative filtering algorithm is to find users who are similar to the 'target user', and then recommend what he likes to the 'target user'. The item-based collaborative filtering algorithm is to find items that are similar to the items liked by the 'target user', and then recommend the similar items to the 'target user'[6]. Item-based collaborative filtering algorithms are used more in the industry, because user-based collaborative filtering algorithms have two main disadvantages: as the number of users on the website increases, it will be more and more difficult to calculate the similarity of the number of users. The time complexity and space complexity of its operation are basically squared with the number of users' growth; user-based collaborative filtering algorithms are difficult to explain the recommendation results [7], so this system uses item-based collaborative filtering algorithms.

C. Commodity Recommendation Function Strategy

The item-based collaborative filtering algorithm (ItemCF) recommends items that are similar to the items they previously liked. However, the ItemCF algorithm does not use the content attributes of the items to calculate the similarity between the items. It mainly calculates the similarity between the items by analyzing the user's behavior records. The algorithm believes that the reason why item A and item B have great similarity is because most users who like item A also like item B.

The item-based collaborative filtering algorithm is mainly divided into two steps:

1) *Calculate the similarity between items:*

|N(i)| is the number of users who like item i, |N(j)| is the number of users who like item j, |N(i) ∩ N(j)| is the number of users who like item i and item j at the same time . Then the similarity between item i and item j is:

$$w_{ij}=\frac{|N(i)\cap N(j)|}{|N(i)|} \qquad (1)$$

The similarity of two items in collaborative filtering is because they are liked by many users. The higher the similarity of the two items, it means that the two items are liked by many people together [8].

Improvement of item similarity calculation formula: The above formula has a problem. When item j is a very popular commodity and many people like it, then it will be very close to 1. Therefore, the above formula makes many items have a great similarity with popular products, which is obviously not a good feature of a recommendation system [9]. To avoid recommending hot items, the following formula can be used:

$$w_{ij}=\frac{|N(i)\cap N(j)|}{\sqrt{|N(i)||N(j)|}} \qquad (2)$$

This formula reduces the weight of item j, thus reducing the likelihood that popular items are similar to many items.

2) *Generate a recommendation list for users based on the similarity of items and the user's historical behavior:*

Calculate user u's interest in an item j by the following formula:

$$P(u,j)=\sum_{i\in S(j,k)\cap N(u)}W(j,i)\times r(u,i) \qquad (3)$$

Among them, P(u,j) represents user u's interest in item j, N(u) represents the set of items that user u likes (i is a certain item the user likes), and S(j,k) represents and item j The most similar set of K items (j is an item in this set), W(j,i) represents the similarity between item j and item i, and r(u,i) represents user u's interest in item i (Here simplified r(u,i) is equal to 1).

The meaning of this formula is: the more similar an item is to the item of interest in the user's history, the more likely it is to get a higher ranking in the user's recommendation list. Then, according to the degree of interest from high to low, the N items recommended to the user u are determined.

D. *Related Technology Introduction*

1) *System front-end technolog*

Layui follows the HTML/CSS/JS writing and organization form, and uses its own standard front-end framework. For back-end developers, it has a low threshold, is ready to use, and has a simple appearance, complete content, and rich components. Every detail from the core code to the application programming interface has been carefully crafted, which is very suitable for the rapid development of the interface. Echart is a Javascript chart library that can run smoothly on computers and mobile devices, and is perfectly compatible with most current mainstream browsers. In the front page, it can bring users more intuitive and vivid data charts. This technology has an important role in the system, it can count the inventory information of goods and warehouse order information. JQuery is an efficient, streamlined and powerful JavaScript tool library. jQuery greatly simplifies JavaScript programming. JQuery has a unique chain syntax and a short and clear multi-functional interface; it has an efficient and flexible CSS selector that can extend the CSS selector; it has a convenient plug-in extension mechanism and a wealth of plug-ins, and JQuery is compatible with various mainstream browsers.

2) *System back-end technology*

The main back-end technologies of the system include Springboot, Spring, Shiro, Thymeleaf, Druid, and Mysql.

Springboot provides a large number of third-party libraries, which makes it very easy to create

a spring project, without even needing to configure some cumbersome XML configuration files. Springboot creates a separate spring project, no longer needs to deploy Tomcat, simplifies the Maven configuration, automatically configures spring applications as much as possible, provides production indicators, robust checks and externalized configurations. Spring solves many common problems encountered by developers in J2EE development by providing powerful functions. Spring can be used in combination with many web frameworks or desktop applications. It is an application framework that solves enterprise programming. And the complexity of development supports agile development. Shiro is a powerful Java security framework that can implement security operations such as identity verification, permission verification, session management, and data encryption. Thymeleaf can be used as a template engine for web applications and can be easily integrated with Web frameworks such as Spring MVC. Thymeleaf can be opened directly in the browser without starting the entire web program. Compared with other template engines, Thymeleaf has a better advantage. The Druid database connection pool is relatively more efficient and more scalable. It can monitor

database access performance, database password encryption, and monitor database access. MySQL is an open architecture that allows users to make a high degree of choice. With the gradual maturity of technology, MySQL supports more and more features, performance has been improved, and more and more platforms are supported, with stable functions and excellent performance [10].

III.   DESIGN AND IMPLEMENTATION OF INTELLIGENT WAREHOUSE MANAGEMENT SYSTEM

A.   *Use Case Diagram of Intelligent Warehouse Management System*

Constructing a use case model is a consensus reached by developers and customers or end users in defining the basic functions of the system and providing a basis for future work in the requirements specification [11]. The use case diagram includes three models: participants, use cases, and systems. Through the use case diagram, you can clearly see the connections between the various components in the system, which makes it easier to understand the composition of the system.

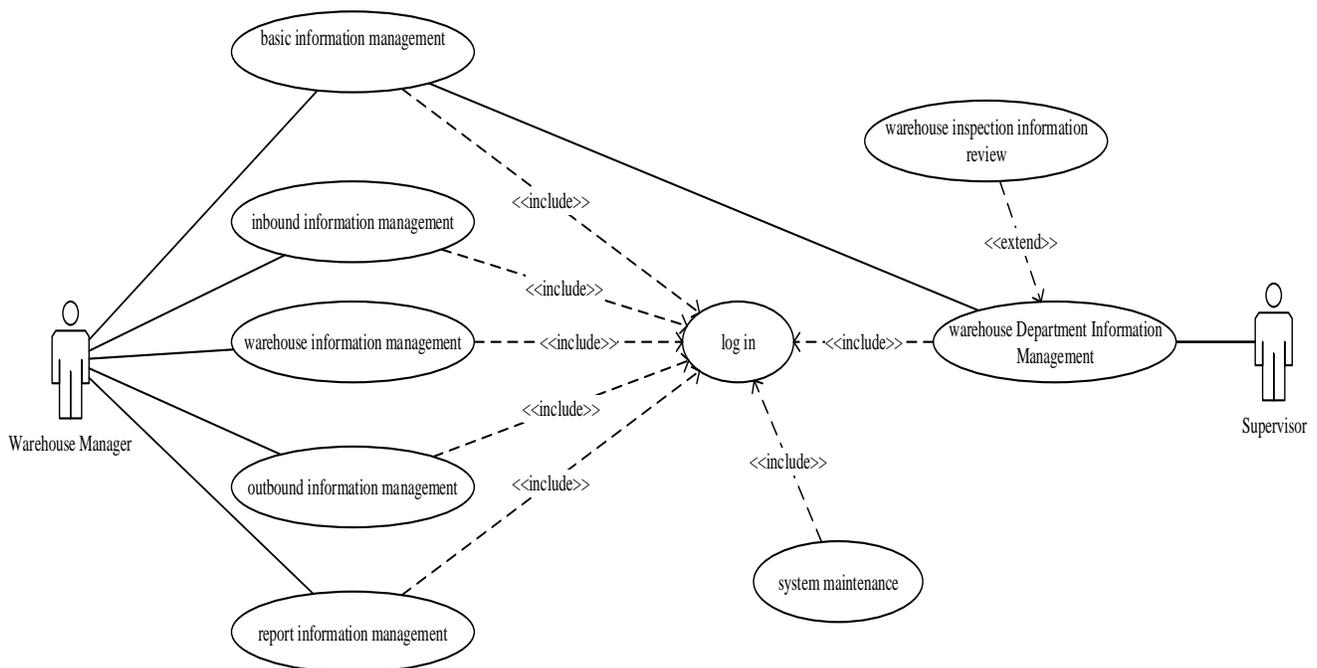The use case diagram of this system is shown in Figure 2.

Figure 2.   Use case diagram of intelligent warehouse management system.

B. Composition of Intelligent Warehouse Management System

The design of intelligent warehouse management system is mainly divided into user management and warehouse management. Among them, user management has designed user information table, role information table, organization information table, system menu table and role authority table. Paying attention to the design of computer software database can not only reduce the maintenance of the software in the later stage, and achieve the purpose of saving manpower and material resources, but also help the efficient display of system functions.

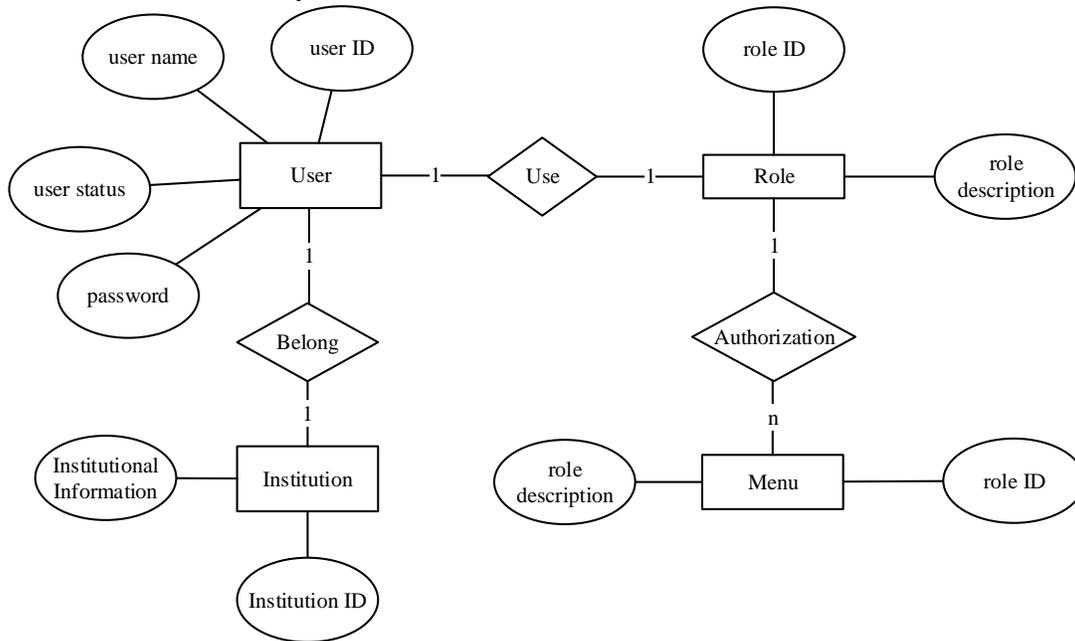The E-R diagram of this system is shown in Figure 3.

Figure 3.   System E-R diagram.

System design generally consists of two parts, namely database design and system function design. These two parts are indispensable for building a complete system and require close cooperation. In these two parts, the database design is the basis of the entire system design. The database design is related to the realization of system functions, stability, scalability and other aspects [12].

In this intelligent warehouse management system, the database tables are composed of user information tables, institutional information tables, system menu tables, role information tables, role permission tables, commodity inventory tables, commodity catalog tables, commodity type maintenance tables, warehouse information registration tables, Outbound warehousing pre-review form, commodity order flow sheet, system parameter table, and business parameter table.

The list of database tables is shown in Table 1 below.

TABLE I.   LIST OF DATABASE TABLES

Name	Database table name
user message table	table_user
Institutional information table	table_organization
System menu table	table_menu
Role Information Table	table_role
Role permissions table	table_rolepower
Commodity inventory table	table_inventory
Product catalog table	table_categories
Commodity Type Maintenance Table	table_assert
Position information registration form	table_register
Outbound and Inbound Pre-audit Form	table_check
Commodity order flow table	table_order
system parameter table	table_parameter
Business Parameter Table	table_BizParam

C. *Intelligent Warehouse Management System Architecture*

This system adopts the B/S architecture and uses the MVC framework pattern to separate system control, user view, and warehouse data to improve system maintainability [13]. The database uses MySQL as the implementation of the above model. The system architecture diagram is shown in Figure 4.
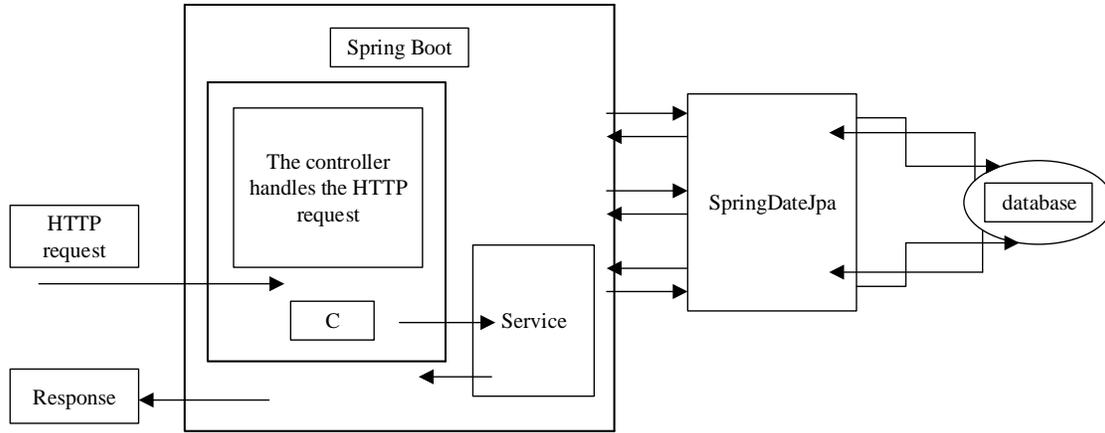
Figure 4.   System architecture diagram.

D. *Function Modules of Intelligent Warehouse Management System*

The entire intelligent warehouse management system is divided into four modules: user management, allocation management, warehouse information management, and report management [14]. The detailed functional module division is shown in Figure 5.
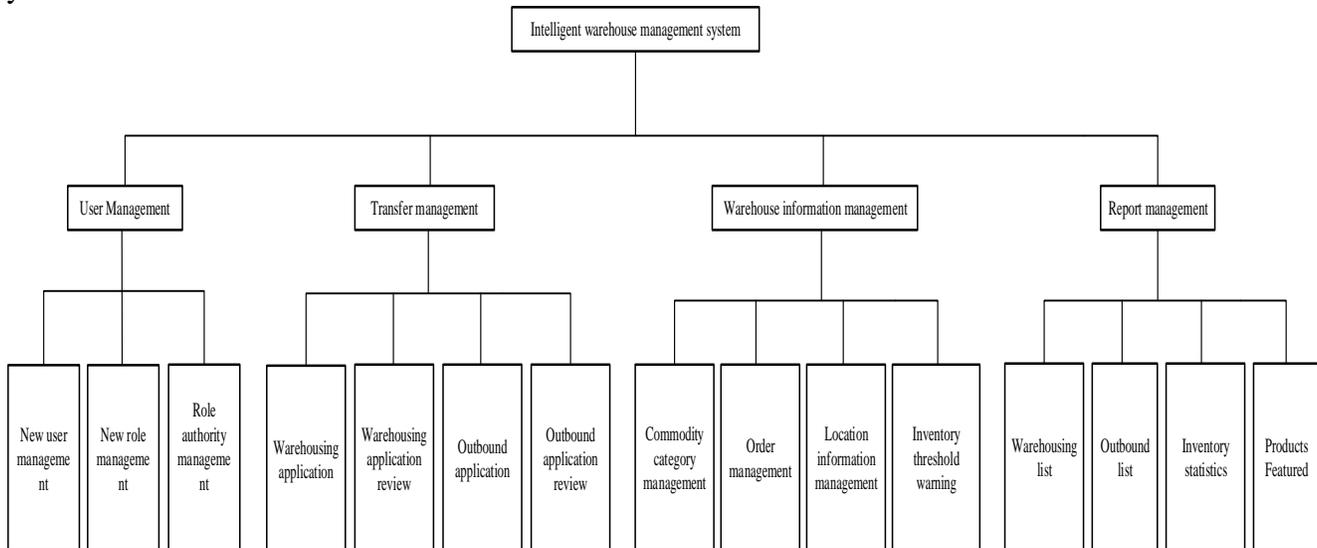
Figure 5.   System function module diagram.

The functions of each module are as follows:

1) *User management*

New user management: Manage basic user information, including adding, deleting, modifying, querying, and modifying user passwords.

2) *Allocation managemen*

Warehousing application: Manage warehousing application information, including adding, deleting, modifying, and querying commodity warehousing applications. Summarize warehousing applications.

Warehousing application review: Manage warehousing review information, including modification of the approval status of the warehousing application, and modify inventory information.

Outbound application: Manage outbound application information, including adding, deleting, modifying, and querying commodity outbound applications. Summarize warehousing applications.

Outbound application review: Manage the outbound review information, including the modification of the approval confirmation status of the outbound application, and modify the inventory information.

3) Warehouse information management

Commodity category management: Manage the basic information of commodities in the warehouse. This functional module includes adding, deleting, modifying, and querying commodity categories. This function relates to goods or manages the category of information.

Storage information management: mainly manage the detailed information of the goods, including the new, delete, modify, and query functions of the goods. For product introduction and inventory management.

Order management: Manage the order information of the warehouse. This function manages the goods out of the warehouse information and sales orders. This function manages the inventory value of the location information.

4) Report management

Warehousing list: Export the warehousing list according to time and other filtering conditions in excel.

Outbound list: Export the outbound list in excel according to the filtering conditions such as time.

Inventory statistics function: filter the current product inventory according to conditions such as time or category, and export it in excel.

Commodity recommendation function: Recommend according to sales volume based on customer's hobbies.

E. Implementation Platform of Intelligent Warehouse Management System

The realization of this system is to separate system control, user view, and warehouse data by using B/S architecture and MVC design mode. The web provides functional modules such as furniture allocation management, warehouse management, and report management. Users of different roles can perform business transfer through the authority menu given by the system.

The B/S architecture adopts the working mode of browser request and server response. Users can access various information generated by Web servers on the Internet through a browser, and each Web server can connect to the database server in various ways, and a large amount of data is actually stored in the database server [15]. This mode unifies the client, concentrates the core part of the system's function realization on the server, and simplifies the development, maintenance and use of the system. You only need to install a browser on the client, and install SQL Server, Oracle, MySql and other databases on the server. The browser interacts with the database through the Web Server. This greatly simplifies the client computer load, reduces the cost and workload of system maintenance and upgrades, and reduces the overall cost of users.

IV. APPLICATION ANALYSIS OF INTELLIGENT WAREHOUSE MANAGEMENT SYSTEM

A. System Application Process

When the intelligent warehouse management system is applied, the user needs to log in first, and the operation successfully enters the functional interface of the system. After entering the interface, enter the main page of the system. There are mainly six functional module menus in the system. When the user operates the menu, the system judges whether the operation is successful or not. If the operation fails, it returns to the operation error page, and then judges whether it has operation authority. If it succeeds, it will return to the insufficient authority page. If it has authority, it will complete the specified operation. The flow chart of the system is shown in Figure 6.
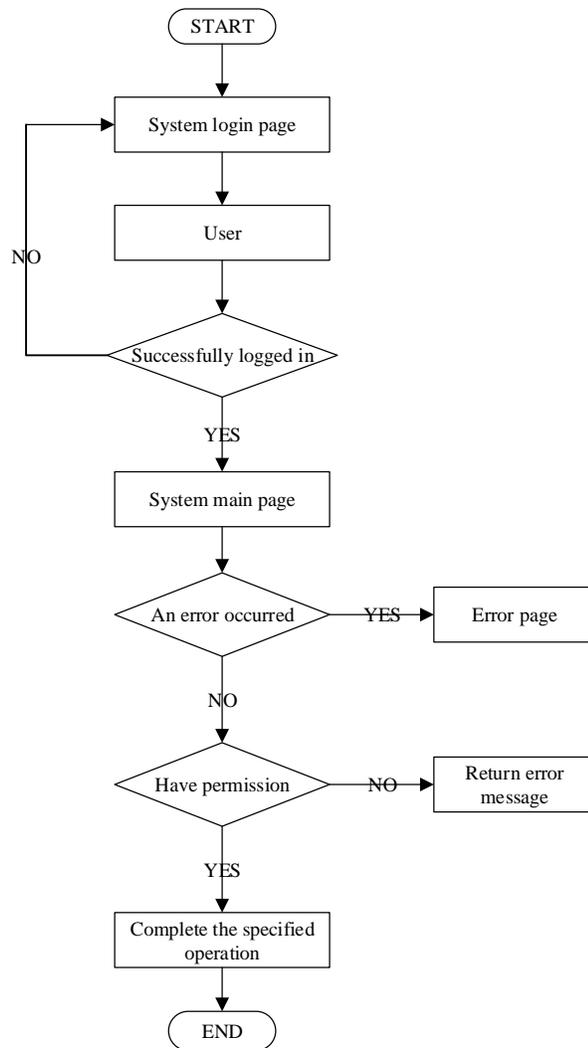
Figure 6.   System function flow chart.

B. System Feasibility Analysis

Mainly introduced from three aspects: economic, technical, and operational analysis.

The relevant information required by this system can be investigated and collected through existing similar systems, and the required software conditions are also easy to obtain. This greatly reduces development costs. This intelligent warehouse management system is very practical, and after using this system, the management level of the warehouse system can be improved, the efficiency of the entire warehouse's merchandise sales can be improved, and the merchandise sales can be increased. Therefore, it is feasible to analyze this system from an economic point of view.

Technically, this system uses the MVC framework model and the Java development language. These development technologies are relatively mature now. With the progress of the times and the development of computer technology, the PC hardware configuration is very high, which can fully meet the development requirements. Therefore, from a technical perspective, this system is completely feasible.

Only the operator can use the system proficiently, the system can bring more convenience and benefits to the warehouse. In today's society, computer technology is becoming more and more popular, and computers have become quite common, and all types of users have a certain level of computer operation. Therefore, the operational feasibility is completely feasible for this system.

In summary, this system is completely feasible.

V.   CONCLUSIONS

The MVC-based development model can adapt well to the characteristics of the warehouse management system, and it is more convenient to query and browse, and the operation interface is simple and friendly, which can greatly enhance the reusability, maintainability and ease of use of the system. To adapt to the actual needs of the enterprise's warehouse management system. The item-based collaborative filtering algorithm saves users time, helps merchants sell their products better, enhances customer satisfaction and improves sales efficiency.

This article includes a detailed introduction to the meaning of development and current status at home and abroad, related technologies developed, and the design of system functions. The intelligent warehouse management system based on MVC will give customers a better experience, and also make warehouse management more efficient and convenient.

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