Knowledge Training System of Urban Pest Control Based on Big Data Analysis

Xin Zhang(B) and Ming-fei Qu

Beijing Polytechnic, College of Mechatronic Engineering, Beijing 100176, China
Jameszlx@163.com

Abstract. Urban insects are a large group of arthropods closely related to urban economic construction and people’s life. If they are not effectively controlled, they will bring harm and loss to urban economic construction and people’s life. In this context, in order to help the relevant urban management departments to better complete the work of urban pest control, the design of urban pest control knowledge training system based on big data analysis is studied. The research includes the overall design and detailed design of the system. The overall system discusses the overall system architecture, system function architecture, system architecture, system topology and other macro or surface theories. The technical points of the whole training information management system are in the detailed design stage, which is divided into system login configuration module, training demand management module, resource management module, teaching management module, performance management module, system management module and other modules. Finally, the system test and performance analysis are carried out for the system. The results show that the training system can support 500 users to use simultaneously and meet the needs of users’ learning and training.

Keywords: Big data analysis · Urban pests · Knowledge of killing and prevention · Training system

1 Introduction

With the development of the city, the ecological environment of the city, including climate, hydrology, animal and plant communities, has changed. With the increase of houses, warehouses, processing plants and restaurants, more shelters have been provided for cockroaches, beetles, longicorn and other pests. The domestic garbage and waste are not cleaned up in time, and the number of pets has expanded, providing a rich source of food for flies, mosquitoes, fleas and other pests. At the same time, with the global warming and the widespread use of indoor air conditioning, the weather in the city tends to be rainy and humid, which provides rich food and suitable living place for ants, cockroaches and other pests. The possibility of large-scale insect disaster in the city is greatly enhanced, and the cockroaches, known as “rich and valuable insects”, have replaced bedbugs and lice to become the first of the new four pests [1]. Urban
pests are closely related to people’s production and life, which cause great harm and loss to people’s health, food, architecture, furniture and storage. Therefore, more and more attention has been paid to them, and people’s desire for urban pest management is becoming stronger and stronger. Killing and controlling urban pests is not only effective by individuals, but also requires the collective efforts of relevant urban management departments. However, the reality is that people’s knowledge of urban pest killing and control is relatively weak, especially the use of some insecticides is more vague, once used incorrectly, the consequences will be unimaginable [2]. Therefore, it is not necessary to train the relevant staff on the knowledge of urban pest control. At present, the training of urban pest control knowledge mainly relies on human propaganda and collective activities. However, the training effect of these methods is very small, which not only limits the scope, but also wastes a lot of human and material resources. Therefore, it is of great practical significance to study a training system of urban pest control knowledge, which not only breaks the limitation of training time and space, the content of the training is more standardized and comprehensive, playing the effect of joint participation [3]. However, the traditional urban pest control knowledge training system can not support more users to use together, and can not meet the needs of user learning and training.

Aiming at the problems of the traditional system, this paper designs a knowledge training system of urban pest control based on big data analysis. Based on big data analysis, the overall design and detailed design of urban pest killing and control knowledge training system are two levels. The system overall discusses the system architecture design, overall structure design and system function module design. The detailed design of the system discusses the six functional modules of the whole training system. At last, we find a way to test the whole training information management system, and test the concurrent performance of the system. The results show that the training system can support 500 users to use simultaneously and meet the needs of users’ learning and training.

2 Design of Knowledge Training System for Urban Pest Control

Urban pests, in a narrow sense, refer to insects that live in urban environment and cause harm or inconvenience to human production, life and health, such as mosquitoes, flies and termites; in a broad sense, urban pests refer to those that live in urban environment and cause danger to human production, life and health Harmful or inconvenient animals, such as insects such as mosquitoes, flies and termites, as well as ticks, mites, scorpions, spiders, centipedes, mice and other mammals and arthropods [4].

The development of the city will inevitably lead to the reduction of the land for agriculture and forestry and the destruction of a large number of natural vegetation, while the land for agriculture and forestry has become a part of the urban division and the reduction of natural vegetation around the city, which in turn affects the non biological factors (soil, climate, etc.) in the city; in addition, the complexity of urban construction makes the urban environment complex and changeable. On the one hand, these changes bring environmental pressure to the survival of urban pests, which makes their living environment severely disturbed; on the other hand, they provide abundant habitat resources for the survival of urban pests, which makes the species of pests more
abundant. The richness of pest community in urban environment is high, and it has significant heterogeneity, which is related to the complex diversity of urban environment. For example, the pests in urban areas are different from those in suburban areas. Due to frequent commercial activities, high concentration of people and objects, strong mobility, pests in urban areas are generally more than those in suburban areas; buildings in urban areas are highly concentrated, and there are less vegetation such as water surface and pond, and pests such as mosquitoes and flies are generally less than those in suburban areas. In the face of the above situation, urban pest control is imminent.

2.1 System Overall Design

Considering the research and system requirements of the system, the basic requirements of online training learning in the design process are shown in Table 1 below.

| Basic requirements | Explain |
|--------------------|---------|
| Stability          | The system should not go down as much as possible, and it can have high reliability on the premise of meeting the concurrent needs of users |
| Foresight          | The training system developed has some advanced nature to ensure that it will be in the lead level in the next two to three years |
| Applicability      | It has universal applicability to all relevant staff while achieving the expected effect of training for relevant staff |
| Extensibility      | The system must be able to upgrade conveniently according to the business development and users’ needs. The architecture design and development platform of the system should have good scalability and portability |

2.1.1 System Architecture Design

The system architecture design is divided into five layers: infrastructure layer, data resource layer, application support layer, business implementation layer and web client access layer. The specific architecture is shown in Fig. 1 [5].

(1) Infrastructure layer
   It mainly involves system infrastructure, including hardware server, network facilities, operating system, database system, software, etc., as well as relevant standards and specifications to ensure the stable and efficient operation of the system.

(2) Data resource layer
   All kinds of data files related to system operation, such as external files, business data, logical data, etc., are stored in different database servers.

(3) Application support layer
   Technical support of system application, including workflow engine, form designer and web service.
2.1.2 System Function Architecture Design

The training system of urban pest killing and control knowledge has six functions: system login configuration, training demand management, resource management, teaching management, performance management and system management. The main functional framework of the urban pest killing and prevention knowledge training system is shown in Fig. 2 [6].

2.1.3 System Architecture Design

Because the structure of B/S belongs to the progress and innovation of architecture, the web-based mode is the response of application service to client’s request service. Through the browser interface, the client can access and handle the business, and the business logic is processed on the web server. At present, the B/S structure is a more popular solution of the system architecture. The web server is located in the business logic layer in the B/S structure. It can process the requests submitted by users, and access
the data in the data layer. According to different requirements, it needs to update the database [7]. The design mode of the urban pest killing and control knowledge training system is shown in Fig. 3.
The overall architecture of the staff training management system includes data layer, business logic layer and presentation layer. Each layer of the architecture is interrelated. The three-layer architecture is independent and interrelated in each function. In the framework of employee training management system, application server and database server need to be configured. The application server processes business logic after responding to the client’s request. During the process, data call is required to the database server. After the application server processes business logic, the server displays the results to the web of client browser. The system that generates the results from the application program, displays the designed interface and unified standard B/S mode, does not need to consider the physical location of the system database, and all the complex work in the system is uniformly handled by the application server [8].

2.1.4 System Topology Design

The training system is based on the B/S mode, and the system architecture adopts the three-tier architecture of database server, application server and browser. The application server is used to deploy the training program of urban pest killing and prevention knowledge. In this paper, the application server adopts redundant design. When one server fails or has problems, the other can take over completely. If both servers operate normally, the load balance can be realized. The database server runs the database management system of this paper, and the storage device is used for storage System data information. Because the training system is in the Internet environment, and needs to provide 7 × 24 h of operation support, so the network design and deployment needs higher requirements. The important hardware facilities in the network (such as core switch, core server) need to introduce redundancy scheme in the network design, and can be directly replaced in case of failure.

The network topology design of online training and learning system is based on eliminating single point fault as much as possible, and the important equipment has redundancy scheme. For example, in the network of this paper, we deploy two cross switches for information exchange and transmission. The application server and database server adopt the form of two computers, which can not only realize standby, but also realize the load balance of resources when the system is under great pressure. For example, the application server adopts redundancy design, two devices are installed with application programs, one as standby. When one application server has problems, it can be directly switched to another standby server for use, so as to improve the availability and reliability of the system. RAC load balancing is adopted for database server. Under normal circumstances, any server can process data. Once one server has sudden accident or failure, the other server can operate independently without affecting the normal operation of the system.

2.2 System Software Design

From the functional structure of the system in the previous chapter, we can clearly see that the system mainly includes six functional modules. In this chapter, each functional module will be designed and described in detail.
(1) System login configuration module design
For this module, we need to define the relevant initial data, so that the whole configuration of the system can be initialized. This work is generally carried out by the system administrator. One of its core functions is to make a preliminary plan for permissions, plan roles, set related passwords, and set parameters for related system column menus [9].

(2) Training demand management module design
Training demand management function business mainly refers to the definition and acquisition of training demand, as well as the filling and review of demand. Training demand management includes the functions of demand survey definition, Department demand filling, Department demand review, employee demand filling, employee demand review, training demand query, etc., mainly covering the operations of adding, deleting, modifying, checking, filling, submitting, reviewing, printing, etc. for various functional businesses. The functional architecture of the training demand management module is shown in Fig. 4.

(3) Design of resource management module
The main function of this function module is to prepare for the next training and learning around the relevant resources of training and learning, including the upload and update of learning materials such as courseware materials, documents, courseware videos, etc. Before the training, the training master data information must be entered and managed. The existence of training resources is an important information resource to ensure online training and learning. It is the basis to ensure that the system training can meet the expectations of the trainees. According to the description in the system requirements specification, we design the training resource

Fig. 4. Functional architecture of training demand management module
management module as the following parts. The functional structure design is as follows: Fig. 5 shows [10].

![Diagram of Resource Management Module](image)

**Fig. 5.** Functional architecture of resource management module

(4) Teaching management module design

Teaching management includes six sub modules: course management, online homework, online learning, online examination, score query and teaching evaluation, and its functional framework is shown in Fig. 6.

(5) Test management module design

In this module, the main content is to test the learning effect of users, and use the results to carry out subsequent evaluation and course improvement. According to the test paper corresponding to the user training course, when the user completes the training, submit the test paper automatically matched with the background setting to take part in the exam and answer questions. According to the set answer time in the answer, the user can submit the test paper manually within the corresponding time, or the system will automatically submit the test paper when the answer time is too long. And according to the test results to generate test scores. The functional architecture of the exam management module is shown in Fig. 7.

(6) System management module design

System management business function refers to the management and maintenance function of system basic information such as system parameters, training categories, training reports, etc., mainly including the statistical analysis of training situation of relevant staff, as well as the management of query sets defined and assigned permissions in the engine. The functional architecture of system management is shown in Fig. 8.
Fig. 6. Functional framework of teaching management module

Fig. 7. Functional architecture of examination management module
3 System Implementation and Test

After analyzing the requirements of the system and designing the system, the next step is to realize the system. This chapter introduces the implementation of the system.

3.1 System Development Environment

The system configuration of hardware and software environment of employee training management system is as follows:

1) System hardware environment
   The hardware environment of the system adopts Intel Core i5 CPU, 500 g hard disk and 4G memory.

2) System software environment
   Using Windows 7 operating system as the system design and client test platform, this paper uses MyEclipse 5.1 development kit, Tomcat 6.0 server, SQL Server 2005 database, JDK 1.5

3.2 Test Tools

In the whole test process of the urban pest killing and prevention knowledge training system based on big data analysis, the function test is mainly manual test, and the performance test is mainly test tools. The test tools we used include:

1) LoadRunner: a commercial stress testing tool. It simulates virtual users to perform concurrent operation of the system, and records the operation of all aspects of the system. Testers can also monitor the system load in real time.

2) HP QuickTest professional: auxiliary system function test tool. With QTP tool, testers can record scripts, edit scripts, and run test scripts.

3) Bugzilla: it is an open-source free error or defect tracking system, which can help testers manage the whole process of software development, including defect submission, defect repair, defect closure, etc.
3.3 Performance Testing

One of the biggest problems in the design of this system is how to meet the needs of a large number of users logging in at the same time to complete online learning and training. Therefore, the performance test of this system is the concurrent performance test of the system.

First of all, through the establishment of a large number of test users, in the Load-Runner tool, by setting to load a user every 3 s, until all users are loaded, all users concurrently perform system business operations, and the performance test report of urban pest killing and prevention knowledge training system based on big data analysis is shown in Table 2.

| Number of concurrent users | System average response time (s) | Application service CPU usage (%) | CPU usage of database server (%) | Number of business errors |
|----------------------------|----------------------------------|----------------------------------|---------------------------------|--------------------------|
| 100                        | 0.006                            | 2.1                              | 1.3                             | 0                        |
| 200                        | 0.014                            | 2.2                              | 1.3                             | 0                        |
| 300                        | 0.019                            | 2.3                              | 1.6                             | 0                        |
| 400                        | 0.04                             | 4.6                              | 2.1                             | 0                        |
| 500                        | 0.07                             | 5.3                              | 2.7                             | 0                        |
| 600                        | 0.32                             | 6.3                              | 3.6                             | 0                        |

It can be seen from Table 2 that the response of concurrent users performing business operations between 100 and 600 is 0.006–0.4 s, the CPU utilization rate of application server is 2%–7%, and that of database server is 1%–4%. When the number of concurrent users in the system reaches 500 peak, the CPU utilization rate of application server and database is 0.006–0.4 s The utilization rate is in the normal range. At the same time, we also conduct real-time monitoring on the important performance indicators of the database and application server, such as disk read-write and memory usage, as shown in Figs. 9 and 10.
According to Figs. 9 and 10, the resource utilization rate of both is within a reasonable range. Through the test, it can be concluded that the training system can support 500 users to use simultaneously.

4 Concluding Remarks

In conclusion, the rise of urban entomology in China has become a necessity due to the acceleration of urbanization. With the rise of Urban Entomology and the further modernization of the city, the problem of urban pest management will be put on the agenda. Therefore, this paper studies the knowledge training system of urban pest control based on big data analysis. The system has been tested to meet the needs of a large number
of users, but there are many deficiencies in the design and development process of the system. In the future research, in order to make the relevant staff training system play its auxiliary role in urban pest control, we need to optimize the system designed in this paper in the following aspects, such as how to establish a reasonable curriculum system, how to arrange the relationship between training programs, how to realize the quantitative assessment of online test results, how to avoid the score test One sidedness in evaluation and singleness in personnel training.

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