Design of an integrated monitoring system based on object-oriented

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Abstract—The integrated monitoring system is a security system that integrates information, storage, transfer and transportation management. This paper takes the security and defense integrated monitoring system of a certain military warehouse area as the background. Aiming at its complexity and diversity, in order to enhance the security and robustness of the integrated monitoring system, this paper adopts object-oriented software development technology. Taking the Rational Unified Process (RUP) as the software development method, the Unified Modeling Language (UML) as the main analysis and design description language, and the requirements analysis and system design of the integrated monitoring system are carried out. This system is based on the C/S structure model to realize the development and deployment of the integrated monitoring system, uses the database design tool PowerDesign to design the database, and uses the ASP.NET development tool realizes the functional modules. In order to achieve a clear security system framework, traditional use case diagrams, data flow diagrams, ER diagrams and other description tools are used as a supplement to system requirements analysis and design.

1. INTRODUCTION
Technology has changed the world. There has been a huge increase in technology in almost every area of technology. The pace of progress and diversity is very rapid. As a result, new technologies have emerged and have been put into use as needed [1]. In the network era, the security level of the warehouse is also constantly being tested. Therefore, it is particularly important to establish a reliable and stable security system.

Object-oriented technology is a software engineering technology that has been widely used since 1990s, the basic idea is to divide the problem space naturally and establish the problem domain model in a way more similar to human thinking. So that the designed software describe the real world as much as possible, and construct reusable and maintainable software [2]. There are few literatures on the integrated monitoring of object-oriented technology, and most of the existing literatures are based on the Internet of Things technology as an entry point for research [3-5], and there are few literatures about developing object-oriented integrated monitoring system with high-level language. This article uses the object-oriented program design method mainly because it can make the program structure clear and simple, improve the reusability of the code, effectively reduce the amount of program maintenance, and improve the efficiency of software development [6-7].
A common security measure in daily life is to use traditional door locks, the safety of the door lock cannot be guaranteed. Therefore, the door lock has to be replaced, which increased the cost. Moreover, the lock is easy to be damaged maliciously, and the key is easy to be lost and copied. Another common security measure is to use RFID card to unlock the warehouse door. With the continuous advancement of social needs, there are more and more requirements for intelligent access control system, which also provides a broad space for radio frequency communication technology. The establishment of Internet of things access control system has become a trend. Its advantages are that the personnel in and out are strictly controlled, but some people will crack the encryption algorithm or steal RFID card, so that there are hidden dangers in the reservoir area. Aiming at this problem, a relatively safe security measure has emerged, that is, to recognize the user's identity through face or fingerprint, so as to achieve the purpose of strictly controlling the entry and exit personnel without the help of external devices. Our current biometric technology has some shortage, especially in the area of authentication, because some data transmission between the server and the client is based on wireless communication.

In view of the above problems, in order to improve the reliability and robustness of the integrated security system, this paper proposes a security system which integrates RFID, face and fingerprint dual authorization authentication, infrared recognition and video encryption, GPS positioning and other technologies.

2. ANALYSIS OF INTEGRATED MONITORING SYSTEM

2.1 Maintaining the Integrity of the Specifications

The integrated monitoring system needs to meet the following three requirements.

Material transportation: when driving through the gate of the reservoir area, the relevant staff need to carry out the double authorization authentication of face and fingerprint and license plate number. In case of double authorization authentication operation, select one person from Party A and Party B for double authorization operation, if two persons of Party A or two persons of Party B conduct authorization operation at the same time, it will be illegal authorization and prompt authorization failure. Party A and Party B must input fingerprints and faces in turn, and the time interval should not exceed 3 seconds. Otherwise, the authentication fails and needs to be reauthenticated. After both parties have successfully authenticated, the corresponding authorization operation will be carried out and the authentication process will be completed. After the field transfer verification, if there is no special situation, the materials only need to be put on the robot storage platform, and the machine line patrol car stores the materials according to the specified route. When an alarm occurs in the warehouse, the relevant staff should wear RFID wristwatch and swipe the card through the warehouse entrance guard, pass the double-layer detection of infrared grating and radiation probe, and verify the identity of the relevant personnel in the background of the system, then they can obtain full permission to enter the security gate, and shall not take off the RFID positioning monitoring wrist watch to locate and detect the position of relevant personnel in real time. At the same time, the material storage environment and perimeter in the warehouse will also be monitored in real time, and there will be encrypted video real-time monitoring around the warehouse to prevent accidents. When the relevant staff leave, they need to leave from the warehouse entrance guard for security inspection.

Material transfer: when materials need to be transferred, relevant staff need to verify their identity in the background and obtain the corresponding authority. After obtaining the corresponding authority, two staff members will open the truck door after double authorization authentication of face and fingerprint, then transfer the materials to the truck, drive through the warehouse gate to verify the identity and leave the warehouse after confirmation. Or through the same verification method, move goods from a truck to a warehouse. The simulation storage diagram is shown in Figure. 1.

Material transportation: real time encrypted video monitoring, GPS real-time positioning monitoring and temperature and humidity monitoring in the carriage will also be carried out during the transportation of materials.
2.2 System function analysis
The overall functions of the system include inbound and outbound management, transfer management, and transportation management.

Inbound and outbound management: the system administrators carry out information (warehouse information, material information), positioning mode, statistical analysis, users, double authorization authentication, material environmental parameter detection, fingerprint and face double authorization authentication, machine line patrol car access goods, etc.

Transition management: Double fingerprint authentication and face recognition authentication management.

Transportation management: GPS positioning module management (vehicle trajectory, vehicle coordinates), material detection (material state detection, material environmental parameter detection).

Data entry, query, modification, and deletion management: Administrators can input, query, modify, and delete warehouse information, material information, fingerprint information, face information, etc.

3. Modeling of integrated monitoring system
In this paper, the object-oriented design method is used to establish the model of integrated monitoring system. The system use case diagram, data flow diagram, class diagram and E-R diagram are mainly designed.

3.1 Design of system use case diagram
Use case diagram mainly describes the relationship between actors and system use cases, which is composed of three parts: actor, system and relationship. Participants and systems are connected by relationship, while use case diagram is completed by developers and users after many group meetings. Other parts of software modeling start from use case diagram. Different from the traditional process oriented “input-processing-output” way of describing requirements, use case modeling is an object-oriented thinking method to organize requirements through use cases. Use case modeling abstracts function into system use case, and builds appropriate use case model for target system. The use case model is composed of actors and use cases, and its main purpose is to explain how the actors as external users interact with the target system [11].

After the analysis and investigation, the business process of the integrated monitoring system can be divided into the following six use cases: materials into the warehouse, materials out of the warehouse, goods transfer, goods transportation, input data information, query data information. In this paper, UML modeling language is used to design the use case diagram of transition management, transportation management and warehouse manager, which are shown in Figure 1. It mainly includes the operations of the administrator when the materials are in and out of the warehouse, the certification that the administrator needs to carry out during the transition, and the realtime positioning and tracking that the administrator needs during the transportation.

![Diagram of use case](image-url)
3.2 Design of system data flow diagram.

Data flow diagram: abbreviation DFD, from the perspective of data transmission and processing, expresses the logical function of the system, the logical flow direction and the logical transformation process of data in the system in a graphical way. The data flow chart describes the logical relationship of data flow, storage and processing. It can not only express the logical flow direction of data in the system, but also express the logical function and logical transformation of data. The drawing of data flow chart is based on the business flow chart of each business. There are many methods of drawing data flow graph [12].

In this paper, the UML modeling language is used to design the data flow diagram of the integrated monitoring system, as shown in Figure 6, which clearly expresses the logical function of the integrated monitoring system.

![DFD diagram of integrated monitoring system](image)

**Figure 2.** DFD diagram of integrated monitoring system

3.3 Design of system class diagram

UML class diagram describes the static structure of classes in a system. It not only defines the relationship between classes in the system, such as association, dependency, aggregation, etc., but also includes the internal structure of classes (properties and operations of classes). Class diagram describes a static relationship, which is effective in the whole life cycle of the system [13]. Different objects in a class can have the same properties and methods, and a class can represent a common property of objects.

The classes that can be abstracted from the integrated monitoring system include: material information class, warehouse information class, material type information class, material location class, face information class, fingerprint information class, G-PS information class, monitoring information class, etc. In this paper, UML modeling language is used to design the integrated monitoring system class diagram, as shown in Figure 3.
Figure 3. Class diagram of warehouse management module

3.4 Design of system E-R diagram
E-R diagram, also known as entity relation graph, provides a method to represent entity types, attributes and relationships. It is a conceptual model that can describe the real world, an effective method to describe the conceptual model of real world relations, and a way to represent conceptual relationship models.

The integrated monitoring system is mainly around the warehouse in and out, transfer and transportation tasks. E-R diagram can directly reflect the relationship between entity types and attributes. And this paper uses UML modeling language to design the integrated monitoring E-R diagram, as shown in Figure 4.

Figure 4. ER diagram of warehouse material management

4. SYSTEM DATABASE DESIGN
After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar.

4.1 System database design
The database name of this system is IMS (integrated monitoring system). This paper introduces two main tables, namely base station information table and material location table. The two tables are introduced below.
(1) Base station information table: the base station information table mainly includes five fields: station number, RFID location card number, time, received signal strength and heart rate, as shown in Table 1.

| Field    | Field name          | Types  | Is empty | Remarks              |
|----------|---------------------|--------|----------|----------------------|
| station  | Site number         | int    | no       | Primary key, identity column |
| rfidLc   | RFID positioning card number | int    | no       |                      |
| time     | time                | datetime | no       |                      |
| rssi     | Received signal strength | int    | no       |                      |
| heartRate| Heart rate          | int    | no       |                      |

5. DESIGN OF INTEGRATED MONITORING SYSTEM

The main interface of the integrated monitoring system includes information management, location mode selection, real-time query, statistical analysis, user management, system maintenance, double authorization authentication, material inspection, personnel positioning, etc. taking an integrated monitoring system as an example, the main interface of the system is designed by using object-oriented technology, as shown in Figure 5.

![Figure 5. main interface of integrated monitoring system](image)

In order to ensure the identity of the entry and exit personnel, the system designs face recognition and fingerprint recognition dual authorization authentication. Within one minute after the face recognition is completed, fingerprint authentication must be carried out. Otherwise, it is impossible to enter the warehouse and record the entry time and exit time. Face recognition includes input and retrieval. Input: first retrieve and connect the device, and then input the face and ID at the same time. Retrieval: check the input face number with the background database. If the input face matches the background database, the recognition is successful.

6. CONCLUSION

Through the above discussion and analysis, we can see that in the design and implementation of the integrated monitoring system based on object-oriented technology, many factors need to be considered. The whole design process is very rigorous. The ultimate purpose of the software is to serve users, while our integrated monitoring system based on object-oriented technology is to provide convenience for administrators. Compared with other integrated monitoring systems, our system has higher security. At the same time, it can improve the development efficiency of the integrated monitoring system. In addition to the system administrator and special circumstances, the system basically realizes the unmanned management, which greatly reduces the manpower and the investment of the later human and financial resources. With the development of science and technology, object-oriented technology, a new software technology, has a great development space in the future.
ACKNOWLEDGMENT
Here, I would like to thank Networking and Information Technology for providing the platform, my student Su Yue for cooperating with me to complete the system design and development, and the School of Computer Science and Technology for supporting this project.

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