EasyChair Preprint

№ 15210

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Bin Wang, Hongjie Hu, Xinwen Guo, Yilin Xie and Yumeng Fang

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October 8, 2024

Design and Implementation of University Emergency Management System Based on QR Code Scanning and Mobile Terminal

Wang Bin, Hu Hongjie, Guo Xinwen,Xie Yilin and Fang Yumeng
Chongqing University of Posts and Telecommunications
Chongqing, China
Email: binwang@cqupt.edu.cn, 571763457@qq.com,guoxw@cqupt.edu.cn, 2512429627@qq.com, 2778269858@qq.com

***Abstract*—Students in universities have the characteristics of high aggregation and large range of personnel activities. This paper designs and implements a set of campus emergency management system based on QR code scanning and mobile terminal, which is mainly used for the emergency management needs of universities in special circumstances such as epidemics and floods. Through GPS positioning and QR code scanning on the mobile terminal, emergency management of college students is realized. The university emergency management system designed in this paper has been developed and put into use in a certain university. The mobile terminal applet has been updated 34 times, a total of more than 100,000 basic data of students have been collected, a total of more than 22,000 students have been reported by scanning the code, more than 2.85 million health check-in data have been collected, and the total number of visits has reached more than 8.31 million times.**

Keywords—QR code scanning, mobile terminal, emergency management

I. INTRODUCTION

Students in universities have the characteristics of high aggregation and large range of personnel activities. In special circumstances such as epidemics, floods, and major festivals, there is a strong demand for emergency management to ensure the safety of students and the safe and stable operation of the campus. Emergency management work is complex and changeable, and the use of manual methods has brought huge work pressure to university staff. It is very necessary to research and develop a "student emergency management system" that can meet the needs of high stability, high concurrency and dynamic management.

II. ARCHITECTURAL FUNCTION DESIGN

Architectural Function Design refers to the process of designing the functions and capabilities of a system or application's architecture. It involves identifying the requirements and objectives of the system, and then designing the architecture to meet those requirements. This includes defining the components, interfaces, and interactions of the system, as well as specifying the functionality and behavior of each component. The goal of architectural function design is to create a system that is efficient, scalable, and maintainable, while also meeting the needs of the users and stakeholders.

A. The overall framework of the project

The "Student Emergency Management System" is divided into two parts: the "Student Data Collection" mini-program and the "Emergency Management Background". Among them, the "Student Data Collection" mini-program includes functions such as "daily check-in", "information submission", "return trip", "scan code registration", "departure approval", etc. The "Emergency Management Background" includes a series of functions such as "search statistics", "data analysis and anomaly detection", "student health records", "student health anomaly reminder", "return scan code data large screen", etc. The specific details are shown in Figure 1.

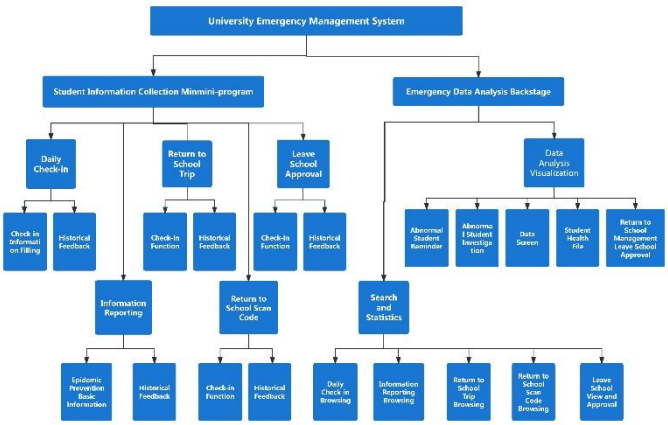

Fig. 1. The overall architecture of the student epidemic platform.

B. Specific functional design

- The "daily check-in" function

  The "daily check-in" function includes three functions such as "check-in function", "check-in history", and "feedback function".

- The "information filling" function

  The "information filling" function is used to collect basic information of students, and it includes three sub-functions, namely "view filling history", "new filling" and "feedback function". Among them, the "new filling" function contains 16 fields, of which 4 fields are generated by the system, 10 fields are selected, and 2 fields are filled in. In order to facilitate students to check in, data pre-filling is carried out by using system automatic filling, mobile phone cache and other methods to minimize the repetitive operations and filling burden of students. At the same time, in the check-in process, a confirmation process is added to reduce the false reporting rate of students.

- "Return to School Trip" Function Design

The "Return to School Trip" function is mainly used for students to report their return trip to school. In view of the situation that students may take multiple means of transportation, the return trip can include multiple sections. After clicking "Add a Section of Trip", fill in the departure place, departure time, arrival place, arrival time and other information of the four means of transportation of "aircraft", "railway", "passenger transportation" and "private car". The saved itinerary can be modified according to the actual situation, and the update is completed by clicking "Upload Itinerary". Before filling in the "Return to School Trip", students need to read the "Return to School Commitment" and confirm it. There are a total of 66 fields to fill in the return trip. "Scan Code for Check-in" Function Design

The "Scan Code for Check-in" function provides students with the function of scanning the code to return to school at the school gate. This function is mainly for the campus prevention and control management needs of the security department. Determine whether the student is within the scope of the batch of returning to school according to the student list provided by the relevant department, and divide the students into 4 types according to different situations: green code (can return to school), red code for repeated registration (repeated registration is not allowed to return to school), red code for prohibited return to school (prohibited from returning to school), and yellow code (non-**first batch of returning to school students from** Hubei are prohibited from returning to school). As shown in Table Ⅰ, it is the design of the database table for returning to school and scanning the code.

TABLE I. "RETURN TO SCHOOL AND SCAN CODE" DATABASE TABLE DESIGN

"Return to School and Scan Code" Database Table Design

Serial Number	*Field Name*	*Filling Method*	*Remarks*
1	Student ID	Automatically Generated	
2	Name	Automatically Generated	
3	College	Automatically Generated	
4	Scan Code Time	System Generated	
5	Scan Code Location	System Generated	Fill in step by step to the district (county) level
6	Repeat Times	Generated in the Background	

- "Leaving School Approval" Function Design

The "Leaving School Approval" function process includes the following processes: waiting for the counselor's approval, waiting for the approval of the person in charge, waiting to leave the school, waiting to enter the school, ending, the counselor's approval not passed, and the person in charge's approval not passed. Click the "Declaration Entrance" to fill in the leaving school process. After submitting the application, after the counselor and the person in charge approve it, you can use the functions of scanning the code to leave the school and scanning the code to enter the school in sequence (students must leave and return to school within the leave time filled in by themselves. The specific time calculation rules are as follows: the allowed time to leave the school is after the "Outgoing Time" filled in when asking for leave, and before the "Expected Time to Return to School"; the allowed time to return to school is before the "Expected Time to Return to School + 15 minutes" filled in when asking for leave, accurate to the minute; if the return time exceeds the "Expected Time to Return to School + 15 minutes", it will prompt "Not returning to school on time", and the scan code result will be a red code). As shown in Table Ⅱ, it is the design of the data field for leaving school approval.

TABLE II. LEAVING SCHOOL APPROVAL DATA FIELD

Leaving School Approval Data Field

Serial Number	*Column Name*	*Method*	*Remarks*
1	Log_id	Auto-increment	
2	Student ID	Automatically generated	
3	Name	Automatically generated	
4	College	Automatically generated	
5	Grade	Automatically generated	
6	Leaving scan time		2020-01-20 04:30
7	Leaving scan location		Chongwenmen
8	Departure time	Select date and minute	
9	Expected return time	Select date and minute	
...	...	...	...
17	Vice-chairperson approval number		Vice-chairperson's number
18	Vice-chairperson's opinion		
19	Process status		Pending counselor approval, ..., pending entering the school, end
20	Process status code		
21	Outgoing location (province, city, district)	Fill in (later changed to select place name)	Outgoing location (province, city, district)
22	Detailed outgoing location	Fill in	Detailed outgoing location

- "Search statistics" function design

  "Search statistics" function: This function provides basic browsing and query functions for the collected data such as "daily check-in browsing", "information submission browsing", "student return information", "scan code registration query", and "leave approval query". The roles and permissions in the "Student Data Collection and Analysis System" system are shown in the following Table Ⅲ.

TABLE III. SYSTEM ROLE PERMISSION DESIGN

System Role Permission Design

Serial Number	*Role Name*	*Available Functions*	*Permission Scope*	*Remarks*
1	Undergraduate student	Mini Program End		20,480 people
2	Postgraduate student	Mini Program End		4,213 people
3	Undergraduate counselor	Epidemic Situation Backstage	Students under one's charge	86 people
4	Vice secretary in charge of the undergraduate college	Epidemic Situation Backstage	Students in the college where one works	14 people
5	Postgraduate counselor	Epidemic Situation Backstage	Students under one's charge	21 people
6	Vice secretary in charge of the postgraduate college	Epidemic Situation Backstage	Students in the college where one works	13 people
7	Student management personnel	Epidemic Situation Backstage	Students throughout the school	5 people

- "Data Analysis and Data Visualization" Function Design

  The "Data Analysis and Data Visualization" includes functions such as "Health Abnormal Student Alert", "Abnormal Student Screening", "Data Dashboard", "Student Health File", and "Return to School Management - Departure and Return Approval": "Health Abnormal Student Alert" can automatically judge abnormalities based on the information filled in by students, and display the list of abnormal students, which is convenient for counselors, student management personnel and other roles to further understand the situation of students; The "Abnormal Student Screening" function mainly studies GPS information processing technology, uses GPS longitude and latitude data to generate student geographic location information, and automatically compares the longitude and latitude information of student punches with the information filled in by students when screening abnormal students to support the abnormal student screening work; The "Data Dashboard" function uses data visualization to visually display the background data of the epidemic, and the "Student Health File" function is based on the daily punch-in data of students, uses data processing technology to handle the repetition, missing items, ambiguity, etc. in the data, and extracts the residence history, contact history, and health history of students to form a student health file, so as to achieve full control of the situation, full coverage of personnel, and full accuracy of information; The "Return to School Management - Departure and Return Approval" mainly provides counselors, vice-chairmen of the college, and student management personnel with functions such as approving students' applications for leaving school and searching and viewing students' departure status.

C. Technical Implementation

The front-end technology stack uses lightweight WeChat applet and web system. The back-end technology stack uses high-performance nginx server and PHP scripting language. In this solution, Redis is used as a cache solution to increase the speed of data reading and reduce the load on the database. The database uses the mainstream mysql.

III. USING THE TEMPLATE

The project's rapid research and development work is carried out using a full-cycle, high-frequency demand feedback and rapid iterative rapid research and development approach. First, through high-frequency demand feedback, we continuously collect the dynamic management needs, data analysis needs and usage feedback of the business department, and continuously conduct user demand analysis. Second, through rapid rapid research and development iterations, we continuously update technologies and fix problems, and develop and launch functions that meet new needs.

A. High-frequency demand feedback

We have carried out intensive dynamic management demand communication, new functional demand research, and problem feedback with the Student Affairs Office and the Graduate School. As shown in Table Ⅳ, it is a partial list of opinions for communicating with the Graduate College.

TABLE IV. THE NEEDS AND OPINIONS OF THE GRADUATE COLLEGE

No.	*Function Module*	*Requirements and Feedback*
1	Daily Check-in	Students fail to submit data for clocking in. After investigation, it may be due to improper operation by students or server problems.
2		Verify the authenticity of the list of students returning to Chongqing from Hubei. Based on the first batch of student lists provided by the Graduate School.
3		Propose suggestions for screening problem students (based on the clock-in location, whether the temperature is normal, etc.)
4		Modify the health file to not display the clock-in situation of all students in the past 14 days, but to screen out problem students based on travel history, contact history, and physical health status.
…		…

14	Return to School Itinerary	The bug that the expected arrival time cannot be modified.
15	Leaving School	According to the situation of counselors, propose the need to adjust student counselors (such as maternity leave, job transfer, etc.)
16	Approval	Feedback that counselors cannot view the student's submitted leave application.

B. *Rapid research and development iteration*

The project team continuously carried out technological updates and problem fixes through rapid research and development iterations, and developed and launched functions to meet new requirements. From initially addressing the dynamic management needs of constantly changing clock-in fields, to addressing the stability and concurrency requirements of the program in the mid-term, and to continuously adding a series of functions to support the return of students to school in the later stage, as shown in Table Ⅴ, the iterative situation of the "Epidemic Information Collection" mini-program, a total of 34 iterations were completed.

TABLE V. ITERATIVE SITUATION OF THE "EPIDEMIC INFORMATION COLLECTION" MINI-PROGRAM

Serial Number	***Version Number***	***Function Module***	***Changes***
1	V2.1.1	Daily check-in	Initial "student number", "name", "location", "whether there is respiratory infection" four fields
2	V2.1.2	Daily check-in	Join the collection of geographic longitude and latitude
3	V2.1.4	Information submission	Solve the logical problem of whether to go out (select "not going out" and fill in the "destination of going out" at the same time)
…	…	…	…
32	V2.5.1	Leave school approval	Embed the scan code out of school and enter the school function in the student leave school approval process
33	V2.5.2	Leave school approval	Optimize the daily check-in for students during the summer vacation
34	V2.5.3	Daily check-in	Make field changes for students' summer vacation health check-in

IV. PRACTICAL APPLICATION RESULTS

This project is developed using a fast iteration model. A special working mechanism and work group are established to collect feedback from students and teachers, conduct regular feedback discussions and development work arrangements, and meet frequently changing needs through dynamic adjustments.

The results of this project have been applied to the epidemic prevention and control work of students in a certain university. The WeChat mini-program has accumulated more than 100,000 pieces of basic student data, more than 2.85 million pieces of health check-in data, and a total of more than 8.31 million visits. The specific visit volume is shown in Table Ⅵ. The "Emergency Management Data Backend" has been accessed more than 286,000 times. It has effectively reduced the pressure on information collection and processing of users such as counselors, and supported the emergency management work of the school.

Fig. 2. University students scan the code.

TABLE VI. DATA SITUATION OF THE "EPIDEMIC INFORMATION COLLECTION" MINI-PROGRAM

Data situation of the "Epidemic Information Collection" mini-program			
No.	***Function module***	***Data situation***	***Access times***
1	Daily health check-in	A total of more than 2.85 million daily health check-in data were collected.	2,412,819
2	Basic epidemic prevention and control data information submission	A total of more than 106,000 basic epidemic prevention and control data were collected.	447,466
3	Return trip	A total of more than 30,000 return trip sub-routes were collected.	277,896
4	Scan code to report	More than 7,400 students in the second batch and more than 15,000 students in the third batch scanned the code for reporting.	99,035
5	Departure and leave request	A total of more than 30,000 departure approval processes were initiated by students.	960,309
6	Total		8,315,848

V. COMPARISON WITH EXISTING SYSTEMS

A. *Swift, Accurate, Efficient*

Comparison with existing systems, the current approach incorporates the use of QR codes and GPS technology to expedite the collection of student information. This enhancement ensures the prompt acquisition of data, thereby facilitating a more rapid and efficient response to emergencies. The integration of these technologies not only streamlines the information gathering process but also enhances the overall effectiveness of the emergency management system by

providing real-time data that is crucial for decision-making and resource allocation.

B. Scalable and Agile

High-frequency demand feedback and rapid R&D iteration synergistically enhance each other, circumventing the inflexibility often encountered in emergency systems that struggle to scale or adapt to the evolving demands of emergency scenarios. This dynamic approach significantly bolsters system efficiency and enriches the user experience.

VI. FURTHER WORK

There are three difficulties in emergency management in universities. First is to accurately obtain the status information of students. This paper solves this problem through scanning codes, mobile phone GPS, and other methods. The second problem is the dynamic emergency management demand. The next step is to study the construction of a general data base through a multi-source heterogeneous data center, integrating various data such as student basic information and GPS information, to provide a unified data basis for various intelligent applications of emergency management and realize emergency management in universities.The last question is the sustainability and portability of the system.By building the system using a modular framework, each functional element was designed to be independently updateable and replaceable. This modularity facilitates ease of maintenance and allows for seamless upgrades, ensuring the system remains robust and relevant over time.

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