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Library Seat Detection System based on Image Recognition and Deep Learning

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Abstract

Every exam week, university libraries will be in short supply and maliciously occupy seats. In order to solve this situation, we designed the library as the detection system based on image recognition and deep learning. The detection system includes three parts: video intelligent processing end, server back-end data storage section and wechat applet display end. At the video intelligent processing end, we realize the recognition of seat usage in the image based on OpenCV image processing and deep learning vgg16 algorithm; At the back-end data storage end of the server, on the one hand, it can return to the wechat applet to show the usage of each seat, on the other hand, it can update the content of the database according to the data transmitted from the video processing end; On the wechat applet display side, we showed users the use of Library seats. The library seat detection system can not only make full use of the library seat resources to a certain extent, but also reduce the working pressure of the library staff.

Keywords

Library Occupancy; Image Recognition; Deep Learning Vgg16 Algorithm; Database.

1. Introduction

Every exam week, there will be a shortage of seats and malicious occupancy in university libraries. In order to solve this problem, we design a library seat detection system based on image recognition and deep learning, which can not only make full and efficient use of Library seat resources, but also reduce the working pressure of library staff.

2. Overall Design of the System

The system mainly has three main modules: video intelligent processing terminal, server back-end data storage terminal and wechat applet display terminal.

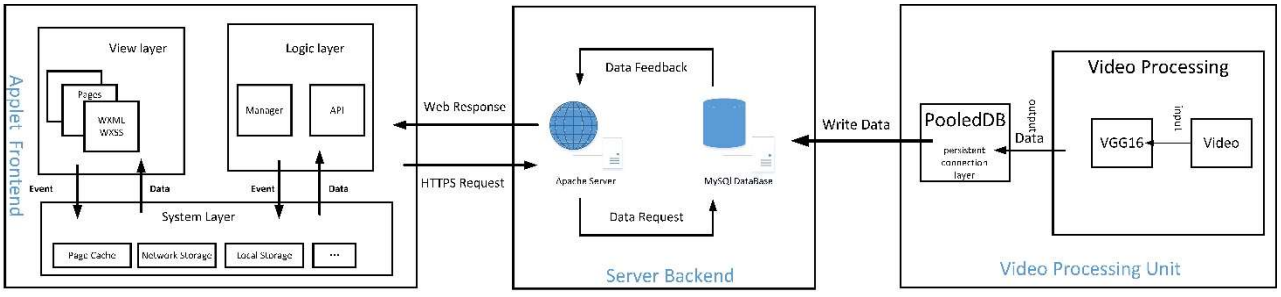

Fig. 1 Overall system structure

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2.1 Sub-section Headings

In the video intelligent processing terminal, we will judge the usage of each seat and upload the usage of this seat to the database.

First of all, we will obtain the video, based on the OpenCV library VideoCapture class, according to a certain number of frames segmented into a number of pictures.

Then, we divided the processed picture into several small pictures with a seat as the unit. For each small picture, we divided the empty position and the non-empty position, and set the training set and test set.

Finally, we use VGG16 algorithm to train the model. After the model training is completed, input the small picture to be detected, and then judge the current usage of the picture as shown in this small picture. After obtaining the usage status code, it is stored into the array of all seats on the whole picture, and then the array is directly written into the server database.

2.2 Server Back-end Data Store

The back-end data storage section of the server mainly has two functions: on the one hand, it handles the data request of wechat mini program, queries the content in the database and returns the data of the usage of each seat. On the other hand, it receives data from the video processing end and updates the content in the database.

2.3 Wechat Small Program Display Terminal

The main function of the front end of wechat mini program is to show users the use of library seats.

The applet mainly includes seat reservation, seat preview, lost and found in the library, announcement and other related functions. Among them, seat preview is the core function of this applet. The back-end support of seat preview is image processing and deep learning algorithm, which can intelligently identify the use of each seat, including normal use, invalid seat, malicious seat occupation and available use. The front and rear ends are separated to achieve relevant effects. The system structure is shown in the figure:

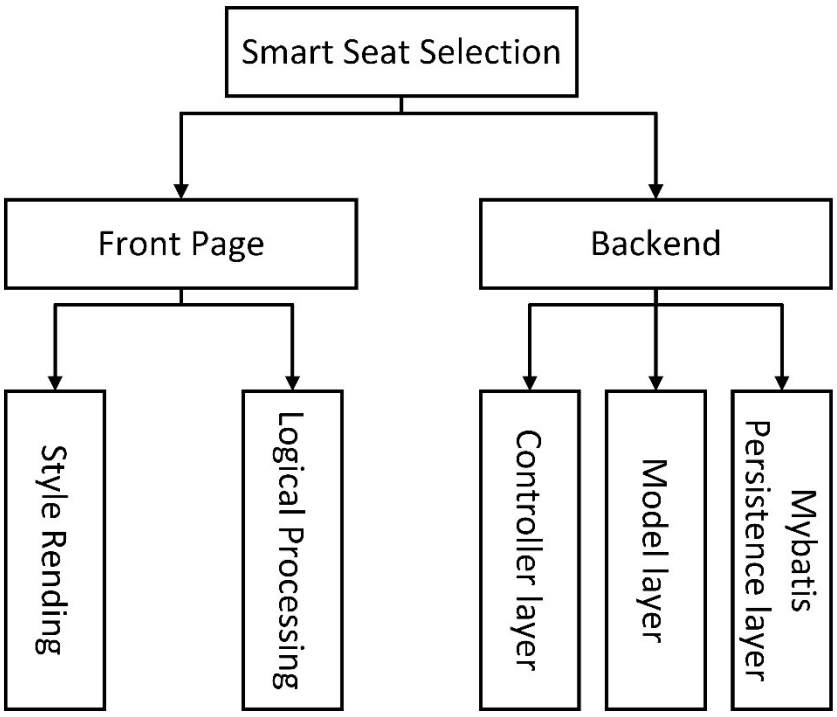

Fig. 2 Front and rear end system structure diagram

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3. Video Intelligent Processing Terminal

At the video intelligent processing end, we will judge the usage of each seat and upload the usage of the seat to the database.

In order to judge the usage of each seat, we established an image recognition model based on OpenCV image processing and deep learning vgg16 algorithm. The specific process is as follows:

(1) Obtain original image data

We process the video to obtain the original image data. Considering the amount of image data, we take the operation of intercepting the video once every 30 seconds.

(2) Image processing using OpenCV

We use OpenCV to process the image, and set up the training set and test set.

Firstly, we perform binarization and edge detection on each image to detect the area with the most information in the video.

Fig. 3 Binary image processing

Fig. 4 Edge processing image

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Then, mask the image according to the detection results to eliminate the useless areas.

Fig. 5 Regional test results

Then, in order to detect the edge of each table in the library, we carry out Hough transform on the image, select a larger threshold, and detect the vertical lines in the image.

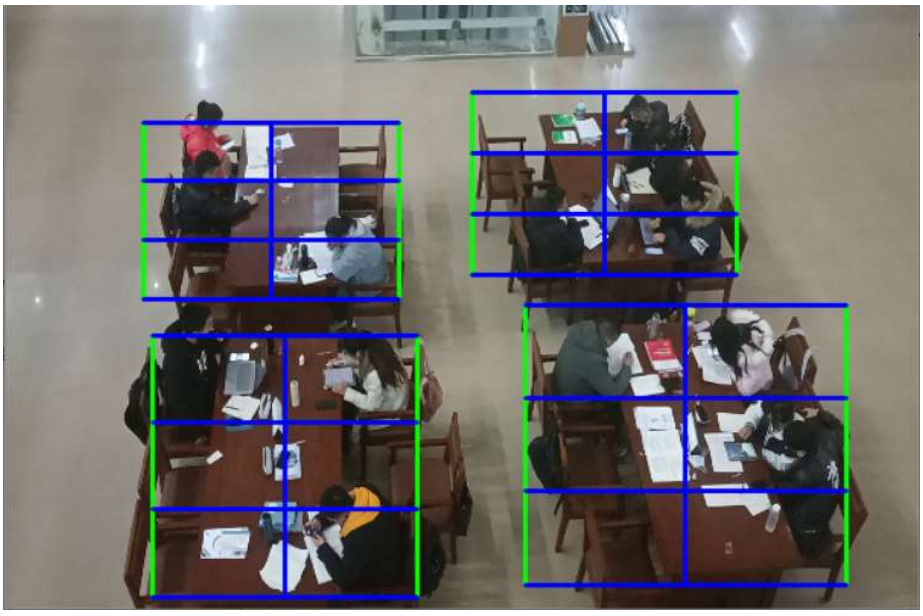

Fig. 6 Hough transform result

Finally, according to the result of Hough detection division, we cut the image to get the image of each seat.

Finally, after image processing, 1776 images are obtained, which are divided into training set and test set according to the ratio of 7:3, and each item is divided into empty position and non empty position.

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After dividing the data set, the vgg16 algorithm is used to train the model. The framework of the network model is shown in the table below. After the model is trained, the image of each position is taken as the input. After entering the trained model, the position information of each image is obtained.

Table 1. Vgg16 algorithm network model framework

Layer (type)	Output Shape	Param #
input_7 (InputLayer)	[(None, 76, 168, 3)]	0
block1_conv1 (Conv2D)	(None, 76, 168, 64)	1792
block1_conv2 (Conv2D)	(None, 76, 168, 64)	36928
block1_pool (MaxPooling2D)	(None, 38, 84, 64)	0
block2_conv1 (Conv2D)	(None, 38, 84, 128)	73856
block2_conv2 (Conv2D)	(None, 38, 84, 128	147584
block2_pool (MaxPooling2D	(None, 19, 42, 128)	0
block3_conv1 (Conv2D)	(None, 19, 42, 256)	295168
block3_conv2 (Conv2D)	(None, 19, 42, 256)	590080
block3_conv3 (Conv2D)	(None, 19, 42, 256)	590080
block3_pool (MaxPooling2D)	(None, 9, 21, 256)	0
block4_conv1 (Conv2D)	(None, 9, 21, 512)	1180160
block4_conv2 (Conv2D)	(None, 9, 21, 512)	2359808
block4_conv3 (Conv2D)	(None, 9, 21, 512)	2359808
block4_pool (MaxPooling2D	(None, 4, 10, 512)	0
block5_conv1 (Conv2D)	(None, 4, 10, 512)	2359808
block5_conv2 (Conv2D)	(None, 4, 10, 512)	2359808
block5_conv3 (Conv2D)	(None, 4, 10, 512)	2359808
block5_pool (MaxPooling2D	(None, 2, 5, 512)	0
flatten_4 (Flatten)	(None, 5120)	0
dense_4 (Dense)	(None, 2)	10242
Total params: 14,724,930 Trainable params: 12,989,442 Non-trainable params: 1,735,488		

4. Server Backend Data Storage

4.1 Database Design

(1) Seat information, including: seat number, seat usage code, this transfer status code, last status code, maintenance times, and whether it is reserved.

(2) User information: the data items include: user number, user nickname, telephone number, grade, user category, email, etc.

(3) Announcement information, including data items: Announcement number, published user number, announcement title, announcement content, etc.

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(4) Lost and found information, including data items: number, name of lost items, contact information, additional information, etc.

4.2 Design Details

(1) The server uses Java, the mainstream language of network programming.

(2) At the control level, the interaction with wechat applet uses HTTP protocol, Tomcat as the web server container and inherits the httpservlet class to respond to the request of the applet.

(3) At the persistence level, using the current mainstream mybatis persistence layer framework saves the tedious configuration work. Compared with JDBC, it eliminates the work of setting parameters and obtaining result sets.

(4) In terms of tool classes, Maven is used to build tools, which greatly simplifies the management of jar packages. At the same time, GIT development tool is used to make collaborative development more convenient.

5. Wechat Applet Display Terminal

The front end of the system is realized by wechat applet. Wechat applet is a new way to connect users and services. It can be easily obtained and disseminated in wechat without downloading and installing like traditional mobile applications. At the same time, it has an excellent use experience.

The implementation of the front-end of the system adopts the native framework of wechat applet, supplemented by vant web app mobile components, and carries out data interaction with the server through the native API. The requested data is displayed in the view layer after being processed by the logic of the applet.

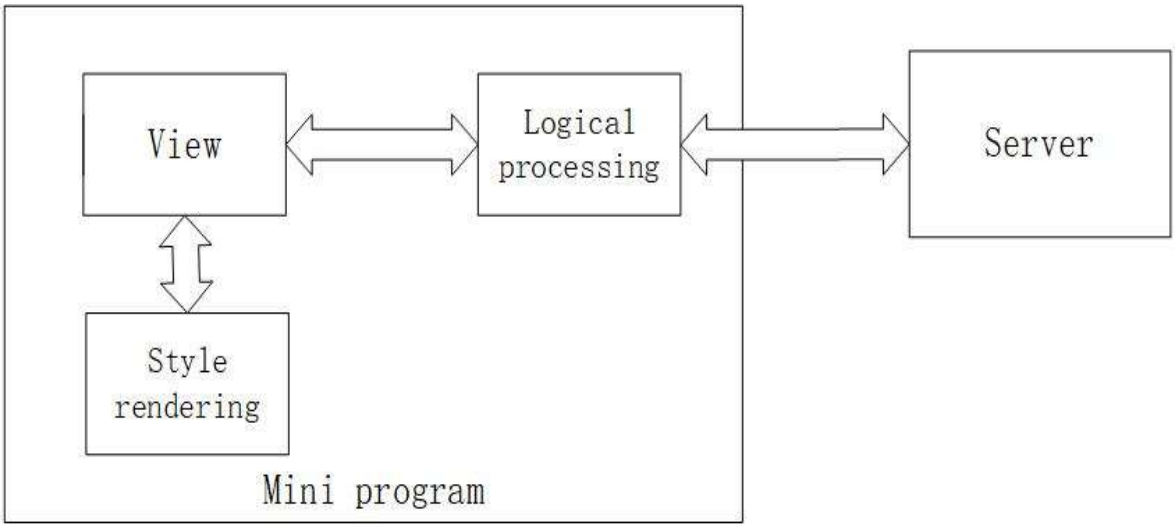

Fig. 7 System front end structure diagram

The view layer is designed and built through the unique wxml of wechat applet, and the rendering of the view layer is to render each view container through wxss. The logical interaction part uses the native framework and API of wechat applet, which can do the best in compatibility.

The main functions are as follows:

Function 1:

The design of the home page shows most of the functions of the system, including selected books, lost and found, behavior report, collection release, seat situation, announcement release and notice display. The notice display content needs to be uploaded to the background server after being

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published in the "announcement release" module, and then requested by the applet. After returning the data, it will be displayed on the home page.

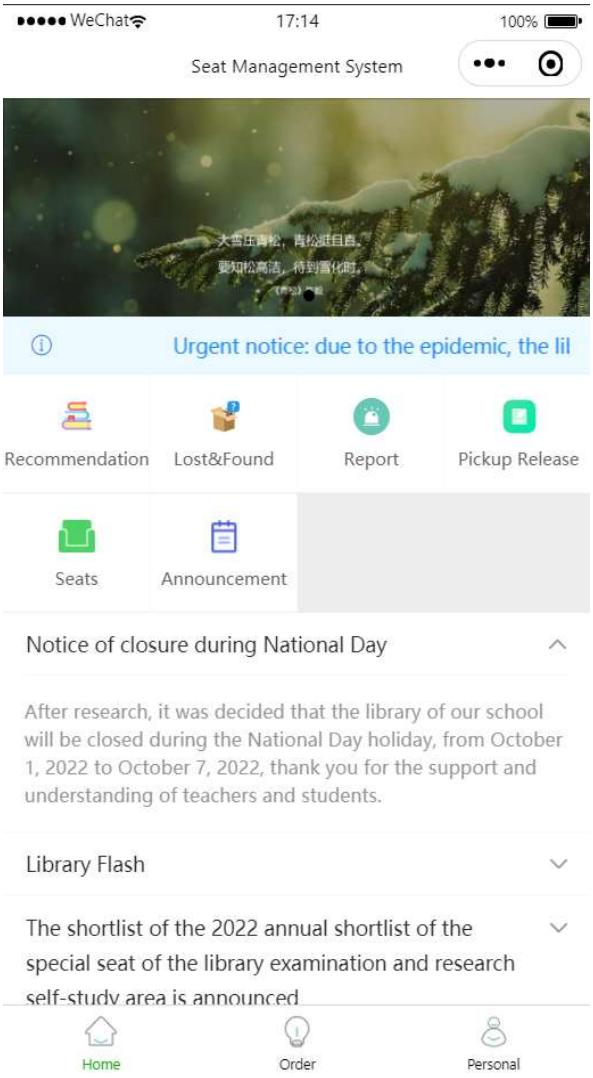

Fig. 8 Homepage

Fig. 9 Announcement

Function 2:

The main function of the system is to feed back the seat situation identified in the background. "Seat situation" is the feedback of seat information and its current situation. The page is mainly divided into two parts. The left side is the floor navigation bar, which is used to distinguish different floors of the library, and the right side is the seat display area. By requesting the background server, the corresponding data is returned and transformed into visual data through logical processing. Different colors of seats represent different states of seats:

Colorless: invalid seat;

Green: normal and unoccupied;

Dark blue: normal and someone is using it;

Red: problem seat (including malicious seat occupation, no one for a long time, etc.).

Clicking seat grouping will display more detailed seat information, improve the friendliness of the interface and help first-time users understand.

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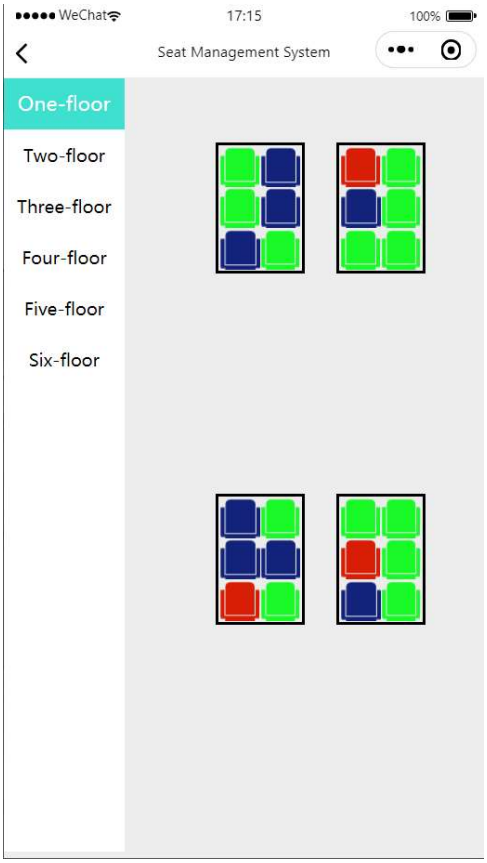

Fig. 10 Seating information page

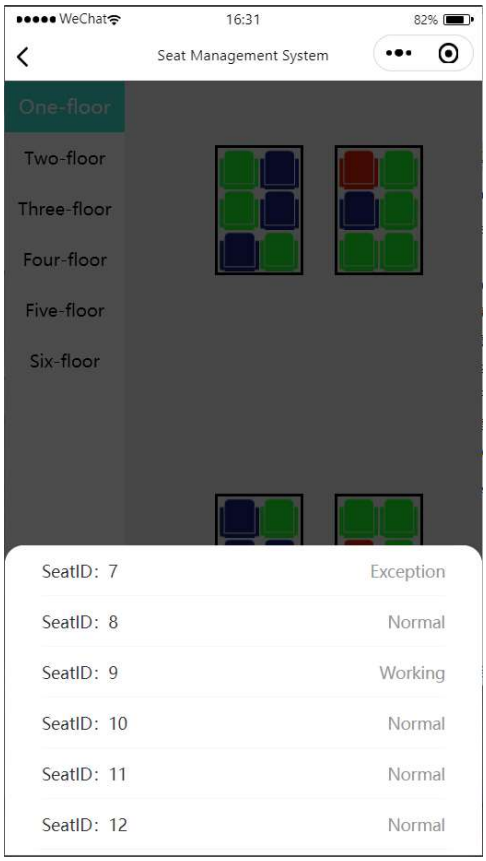

Fig. 11 Seat details

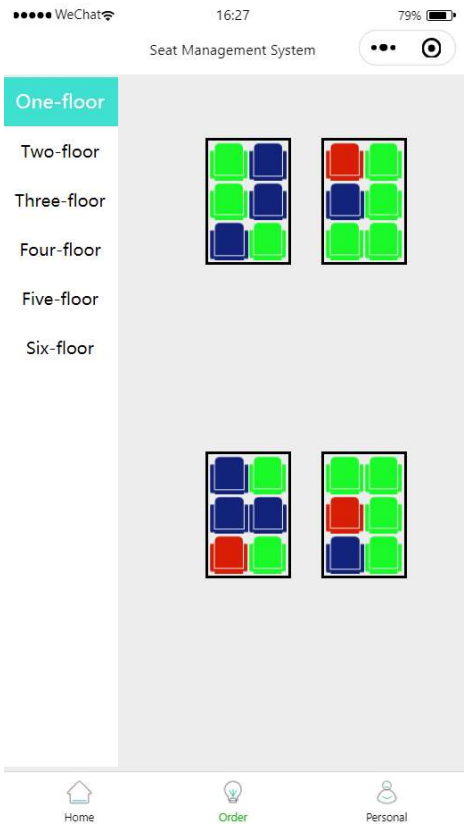

Fig. 12 Reservation interface

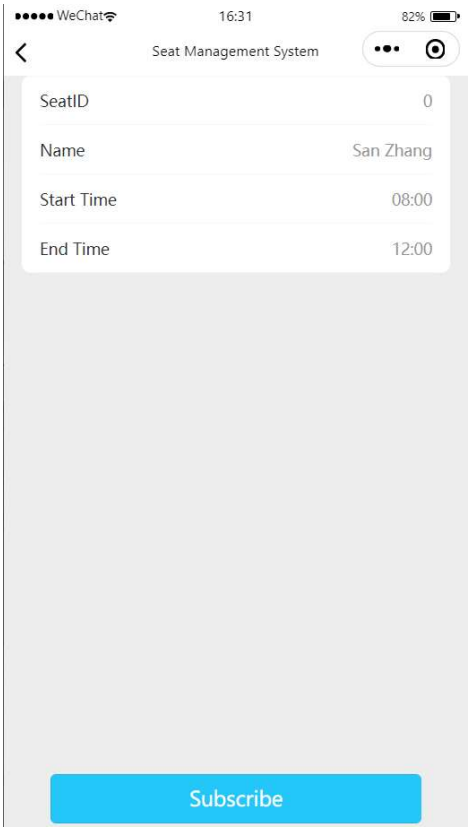

Fig. 13 Appointment details page

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Function 3:

Seat reservation function is another main function of the system. Through the identification of seats in the background, the seats that can be reserved normally are automatically displayed. Click the seat to enter the information filling interface and select the reserved seat number, time and other information. Click Submit appointment. Whether the seat can be reserved is determined by the background data, which will be reflected to the user after the front-end processing and rendering for the user to choose.

Function 4:

When using the system, you need to log in. When logging in, you need to fill in the corresponding user information as the basis for distinguishing different users.

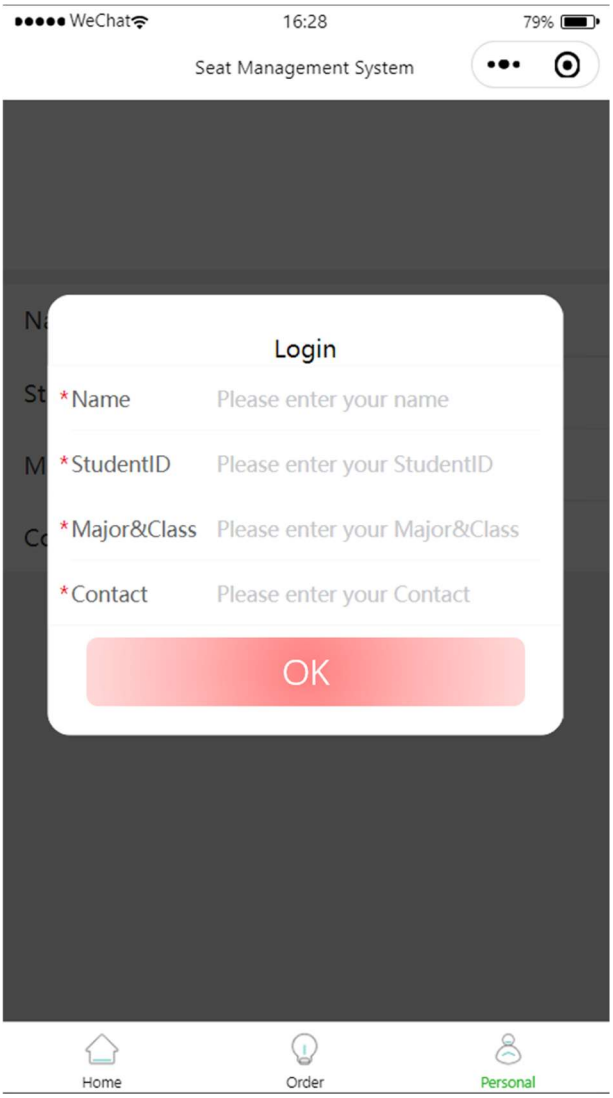

Fig. 14 Login page

Function 5:

The "lost and found" module and the "picked up and announced" module are auxiliary functions. After picking up items, users fill in the description information of the items and leave their contact information before publishing them on the system. The owner browses and searches in the "lost and found" module.

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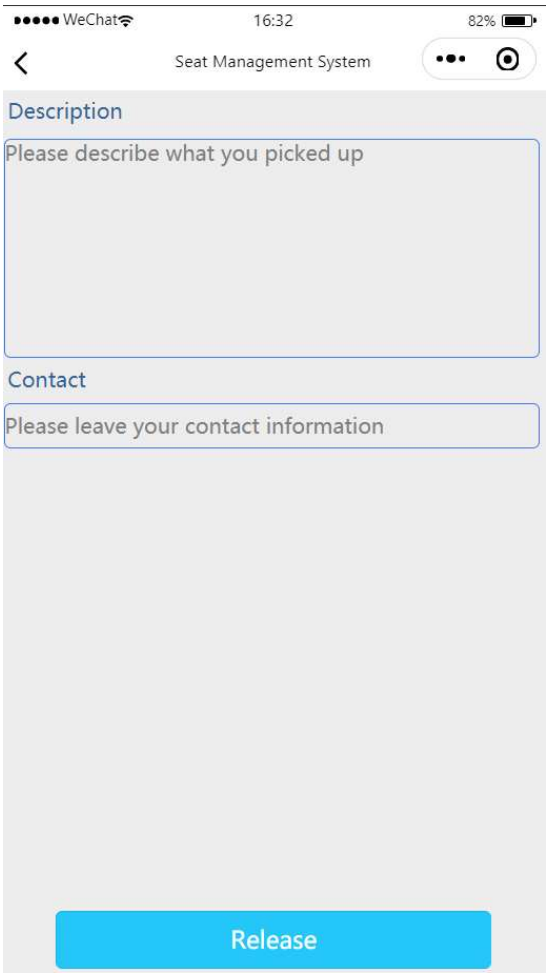

Fig. 15 Pickup release

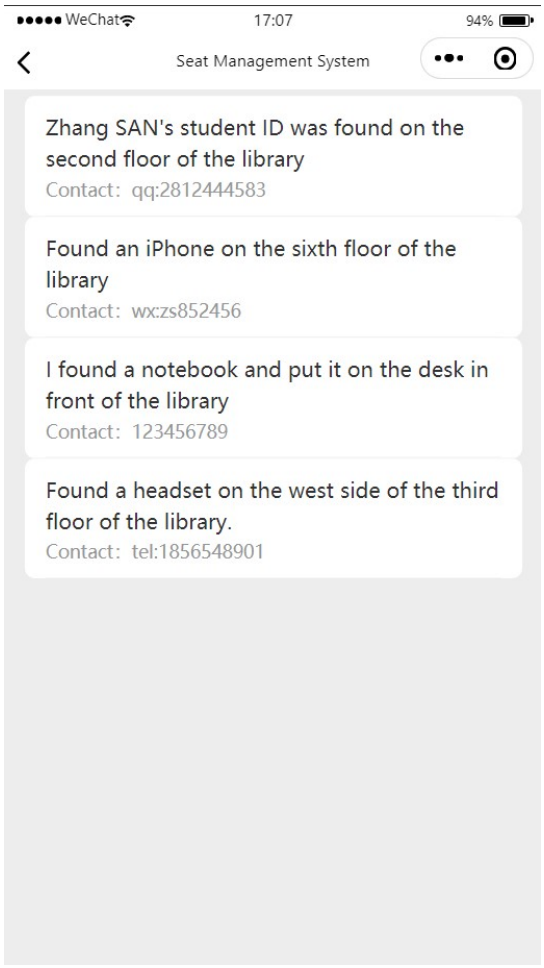

Fig. 16 Lost and Found

Acknowledgments

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