Research on Campus Attendance System Based on Face Recognition and Trajectory Tracking

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Abstract. The traditional Morning jog attendance in colleges and universities is limited to manual supervision by swiping card attendance, which is prone to queuing and sign-in on behalf of others. In addition, the lack of quantitative records of exercise data makes supervision difficult. Location-based attendance systems represented by Dingding time attendance, or simple face recognition attendance systems cannot achieve accurate attendance. The campus happy running system based on face recognition and trajectory tracking innovatively combines face recognition and trajectory tracking, and students achieve accurate attendance certification within the designated "geo-fence". Practice shows that the system can meet the special needs of colleges and universities for Morning jog attendance and data recording, and it effectively improves the accuracy of identity verification.

1. Introduction
The traditional morning jog attendance in colleges and universities is limited to card machine swiping, manual supervision and other methods, which are prone to crowded queues and one person with multiple cards, and there is no track record of exercise data. While the location-based attendance system represented by Dingding time attendance, although the location is limited, there is still no way to avoid the problem of virtual positioning and multiple accounts per machine. Although some colleges and universities have introduced an attendance system for facial information authentication, they need to be equipped with additional attendance machines at designated locations and cannot locate and track movement trajectories[1-3]. At present, the popular sports apps, such as Keep, Happy Running Circle, Gudong, Xiaomi Sports, etc., can record exercise trajectories, but they cannot meet the requirements of the college's morning run attendance data statistical monitoring, and they lack effective identity information verification.

In order to meet the attendance needs of colleges and universities and the individual needs of students, campus happy running system is designed. It innovatively combines face recognition with trajectory tracking, and uses ArcSoft’s face recognition technology and Baidu’s LBS service to improve the accuracy of authentication. Before the students run, they must complete the living body detection and face recognition in the designated "geo-fence" to confirm the attendance success. During the running process, the client tracks real-time trajectory and draws trajectory graphs[4-7]. At the same time, the improved Douglas algorithm is used to thin out the latitude and longitude coordinate data and de-noise.
to ensure the smoothness of the trajectory drawing. Realize accurate attendance certification and real-
time tracking and recording of personal motion trajectory.

2. System Design
On the one hand, the system simplifies the school’s supervision and improves the management
efficiency of the Morning jog attendance, and provides important data basis for the college to analyze
the students’ Morning jog situation. On the other hand, from the perspective of meeting the individual
needs of students and stimulating their enthusiasm for sports, functions such as sports ranking, launching
of fun running activities, and personalized music recommendation are designed.

Before running, students use face recognition in the designated “geo-fence” to perform identity
authentication based on the LBS location service[8]; during the running, the client tracks real-time
trajectory, and visually draws the trajectory diagram on the map and displays it intuitively[5-8]. After
the sport, the exercise data is sent to the server, and the server compresses and stores the data. Students
can check their own exercise rankings and exercise statistics. At the same time, they can also initiate
activities or exchange experience with runners online. Managers can view attendance data, set exercise
areas, and check exercise data on the WEB side.

2.1. Overall structure
The Campus happy running system based on face recognition and trajectory tracking is a morning jog
attendance and recording system that integrates Baidu LBS (Location Based Services) service and
ArcSoft’s face recognition. The system includes a client APP and a server management system.

![The overall structure of the system.](image)

The client is an APP developed by Android Studio, with the help of the face recognition SDK of
ArcSoft’s technology and the Baidu Eagle Eye SDK provided by Baidu Maps to complete face
recognition and motion trajectory tracking. The server is deployed on Alibaba Cloud, and the Servlet
responds to the GET/POST request sent by the client, and the request is processed by the method
corresponding to the Servlet. The system structure diagram is shown in Figure 1.

2.2. Attendance
Attendance mainly completes identity and location authentication. The system specifies the student sign-
in movement area by setting up geographic electronic fences, and based on the live face recognition and
verification mechanism of ArcSoft, it effectively resists cheating methods such as photos, videos, and molds[1-3]. The precise positioning of the outdoor mobile terminal and face recognition work together to complete the dual authentication of identity and location to ensure the authenticity of the sign-in. The attendance process is shown in Figure 2.

![Attendance process diagram](image)

**Figure 2. Attendance process.**

After clicking the attendance function button, the system will automatically locate and check whether the user is in the specified geographic location. If the user is not in the designated area, remind the user to go to the designated area; if the user is in the designated area, turn on the face recognition function and compare it with the face data information obtained from the server. If it is within the threshold, pass. If the user uses this function for the first time, the user is reminded to register the face information data first.

2.3. **Draw the motion trajectory**

Capture the user's trajectory and draw the trajectory on the map, and use the intuitive chart data to display the data such as the mileage, duration and total number of exercises in real time. The user can see the detailed information and ranking of the exercise at a glance.

Click the "GO" button in the middle of the homepage to enter the motion track page, and the system will locate it in the background. The initial point affects the subsequent trajectory drawing, so a stricter screening mechanism is added to the module. The mechanism is as follows: among the recorded points of the motion track, the points with an accuracy greater than 50 meters will be directly discarded; at the same time, if the position of any two consecutive points is greater than 10 meters, the points are retaken; if the distance between 5 consecutive points is less than 10, it indicates that the GPS signal has been stabilized. After the signal is stable, the trajectory is drawn from the starting point, and the user's movement information is recorded in real time. After the user clicks the stop button, the exercise information is uploaded to the server. The Track synchronization process is shown in Figure 3.
3. Prototype System
The system uses Alibaba Cloud server, which is divided into two parts: Web server and Android client. The client's main development languages are Java, XML, etc., the server-side Servlet responds to the GET/POST requests sent by the client, and the environment is the windows 10 operating system.

3.1. Android client
The client structure is divided into three levels: view, class, and data. It mainly includes the following functions, the functional structure diagram is shown in Figure 4.

"Home page" module. Including sign-in, attendance, recording and uploading of motion trajectories, display of summary motion data, acquisition of satellite positioning signals, etc.

"Data Analysis" module. Including exercise mileage data analysis display, calorie consumption display in the past week, etc.

"message and activity management" module. Including push activity, participation, message exchange

"User Information Management" module. Including the registration and login of user information, the input of facial feature data, the query of historical trajectory, and the function of "Running with Music" with personalized music recommendation.

![Figure 3. Track synchronization process.](image)
3.2. *Servlet server*

The Servlet is developed under the built-in Java EE module. The Servlet receives/sends requests from the client and interacts with the corresponding methods of the server. The server mainly implements functions such as encryption and decryption, attendance information viewing, sports fence setting, trajectory processing, sports data analysis and display, and running music recommendation. The specific description is as follows.

"Encryption and decryption" module, after the system starts, apply for the latest encryption public key from the server. Through the asymmetric encryption algorithm, the privacy of users is effectively protected and hijacking is prevented. At the same time, MD5 algorithm is used to generate Token (user token) to determine the user's unique identity information and to ensure the security of the server interface.

"Trajectory processing" module, in order to solve the problem of mobile phone latitude and longitude "drift" during the movement, the Douglas Spock algorithm is introduced to thin out the data, denoise, and compress the movement trajectory. And redesigned the trajectory tracking adaptive algorithm, combined with the speed and direction obtained by the mobile phone from the GPS when the user is running, calculates and compares the predicted user's next location with the actual point obtained, discards the point with a large deviation, and reacquires the new point.

The "Running with Music" module realizes the music recommendation function of the sports, combining the training models in the three recommendation algorithms of BaselineOnly, KNNBasic, and KNNBaseline to obtain the prediction set, and finally generate a personalized recommendation list.

4. Testing and Application

4.1. *Description*

Mobile terminal: 7Plus, 8.1 Android system.

Network environment: wireless network or 4G, the client accesses the Tomcat server through the public IP.
When the APP is started for the first time, the system dynamically requests all kinds of permissions required by the user. During the startup process, the home page and related data load faster. As the Android system has different long-connection service differences in message push, there is generally a delay of 10 seconds to three minutes depending on the difference of mobile terminal brands. The final motion trajectory during the running process, the default accuracy is 30 meters, and it takes about 10 seconds for the GPS position to stabilize. After the GPS signal is stable, there is almost no delay in drawing the trajectory.

4.2. Main test cases
The main function test examples are shown in Table 1. In addition, unified tests were conducted on the system interface, controls, database access, prompt information and data accuracy. In the testing process, the code standardization and database functions were also optimized accordingly. The test results show that all the functions of the system can be operated as required and have good scalability.

| Test items              | Prerequisites                                                                 | Test steps                                                                                      | Predicted results                                                                 | Test results          |
|------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------|
| Attendance             | The page is displayed normally, the network connection is normal, the front camera is normal, the positioning is on and the person is within the specified range | Click the attendance button, the system compares the location and face information detection and return the result | Attendance success at the specified location                                      | Attendance success    |
| Motion tracking        | The page is displayed normally, the network signal is normal, and the GPS signal is normal | After signing in, click the "GO" button to start running. Observe the changes in the movement track while moving | Correctly display the changes in the movement trajectory                            | Correct display of movement trajectory |
| Push activities        | The interface access is normal, the network connection is normal, and the APP is running normally | Click the "Create Activity" button, fill in the data, click "Create" button, check whether the activity list is successfully created, and another user clicks to participate in the activity. The creator deletes the activity. | The activity is created successfully, the activity list exists, the data is displayed normally | Create, participate, and delete operations all run correctly |
| Personalized music     | The page is displayed normally, and the network signal is normal              | Switch between different registered users, enter the Music Running Companion Listening module, and observe the changes in the personalized music list obtained | Different users recommend different music lists.                                    | Display recommended music list correctly |

5. Conclusion
In order to meet the needs of Morning jog attendance in colleges and universities and the individual needs of students, Campus happy running system is designed. It innovatively combines face recognition and trajectory tracking to achieve accurate attendance certification within the designated "geo-fence".
At the same time, the improved Douglas algorithm is used to thin out the latitude and longitude coordinate data and de-noise, to ensure the smoothness of the motion trajectory drawing, and to record the personal motion trajectory in real time. Other functions such as sports music recommendation, sports ranking, and initiation of fun running activities fully meet the individual needs of users. Practice shows that the system can provide an important basis for the college to record and analyze the student's exercise situation while motivating students to exercise, effectively improving the management efficiency of the Morning jog attendance.

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