Face Recognition Attendance System

Weiqi Xu

201769761

I. Statement of Ethical Compliance

The data and participant categories of this project are as follows:

> **Statement of Ethical Compliance**
>
> Data Category: E
>
> Participant Category: 0
>
> I confirm that I have read the ethical guidelines and will follow them during this project.

As a face recognition project, large databases of facial images need to be used for training model, so Data Category E is inevitable. **All data sets used in the course of this project have been confirmed in advance with the project supervisor and will be used for academic research purposes only**. The detailed explanation can be found in other parts of this report.

II. Project Description

The project aims to build a face recognition app specifically designed for students and public employees. It will take face recognition technology as the core model, providing a simple and effective way to conduct online attendance management, including registration, preserving personal information, face comparison, and recording of attendance time and attendance status.

Creating such an attendance management system based on face recognition technology deeply meet the increasing demand for online studying and working from home. Depending on this system, people get an opportunity to take attendance easily and efficiently on their personal computer anytime and anywhere. The use of face comparison greatly reduces the possibility of falsifying records, and this model is expected to guarantee high accuracy of face recognition in different light and background after training.

III. Aims and Requirements

3.1 Aims

 • **Achieve Convenient Attendance Record:**
With face recognition technology, users will be able to take attendance quickly and accurately and improve the authenticity and accuracy of the records compared with manual attendance.
 • **Improve Attendance Management Efficiency:**
The system backend can automatically record attendance time and user identity and

unified management of these data to facilitate follow-up queries, statistics and analysis work.

   • **Increase Environmental Adaptability of Face Recognition:**

To ensure that under different lighting conditions and complex backgrounds, the system can still maintain high accuracy of face recognition and meet the needs of diverse application scenarios.

   • **Data Security and Privacy:**

Keep the security and privacy of facial recognition information gathered from users, make it complied with relevant code of ethics and information security.

3.2 Requirements

   • **User Authentication:**

The system needs to include registration and login functions, and allow users to verify identity through student ID number or work number before taking attendance.

   • **Face Recognition:**

The system can capture human face through the computer's own camera without installing other hardware devices. Then identify the user and record attendance.

   • **Attendance Record Storage：**

The project should include a database and a data management system to implement real-time storage and update of the registration and attendance information.

   • **Simple User Interface:**

The user interface design should be clear and concise, to ensure that users without computer expertise can quickly understand and operate the attendance process.

   • **System Performance Optimization:**

When the number of users increases, the system needs to reduce delays and respond in a timely manner. Besides, it should maintain high recognition accuracy in different lighting conditions.

IV. Key Literature & Background Information

In recent years, with the continuous development and progress of computer vision and deep learning technology, face recognition technology has begun to be widely used in education, enterprise, medical, security and other fields (Kortli, 2020). At the same time, based on research conducted by Professor Kamil (2023), the impact of COVID-19 pandemic on a global scale and other public events makes online attendance an urgent and necessary initiative in reality.

For a long time, attendance has been a focus used by various of companies and universities to evaluate working and learning outcomes, but it is clear that traditional manual attendance marking is a tedious and time-consuming work (Khan, 2020). In contrast, Professor Gong's research (2020) proved that the face recognition attendance system achieved contactless automatic attendance by capturing and

analyzing the facial features of employees or students, which not only reduced the error caused by human operation, but also greatly improved management efficiency.

The current face recognition system mainly relies on convolutional neural network (CNN) and deep learning technology to extract and compare face features. The experiments show that some deep learning models have ability to achieve high recognition accuracy under different illumination levels, facial expressions and angle of swing (Thalluri, 2024). In addition, as Professor Shukla (2024) claimed that more efficient real-time face recognition algorithms could be developed by optimizing digital processing processes and adjusting data memory patterns. Therefore, it can obtain accurate recognition results within a extremely short response time.

In summary, face recognition attendance systems has shown great potential in modern attendance management nowadays. As the complexity of models increases and algorithms become more optimized, these systems will generate more efficient and accurate recognition result, enabling automated and intelligent attendance management in various types of organizations, providing a new direction for future management (Nijgal, 2023).

V. Development & Implementation Summary

5.1 Development Language and Environment

In order to finally develop an efficient and accurate face recognition attendance system, Python will be the most preferred programming language for this project. The main reason for choosing Python is because it offers rich image processing libraries and machine learning frameworks with a simple grammar structure and strong community support.

This attendance management system will be deployed primarily on Windows platform. That's because Windows system has advantages of wide range of hardware compatibility, rich development supporting tools and intuitive concise file management system. This not only conforms to the usage habits of most users, but also makes the system easier to maintain, expand and use.

5.2 Components of Project

• **Face Detection Model**
MTCNN can locate the face region in the captured image and detect key points for subsequent face alignment. It has strong detection accuracy and adaptability, and provide stable face detection result under different lighting conditions and angles. Then it is considerable to use KNN as an auxiliary module for face detection, quickly classifying potential face areas and filtering noise to improve overall detection speed.

- **Facial Recognition Model**

FaceNet is a good model using deep neural networks to embed facial features into a lower-dimensional space for comparison, then the distance of the characteristic vector is calculated to match the identity. As for OpenFace, it is suitable as a complementary recognition model to provide efficient and fast recognition effects under limited resources and achieve real-time face attendance.

- **Database Model**

MySQL can be used efficiently to store registration information and update personal detail, record attendance status and registration time. It provides reliable data management and query support for the system.

- **User Interface Model**

Use Flask or Django to build a Web-based interface, providing users with functions such as registration, management, query, attendance record view and so on. Through this interface the administrator can easily manage attendance data.

- **Attendance Record Model**

After the completion of identification, the attendance record is automatically generated and stored in the database to ensure the accuracy and integrity of the record.

Face detection model and face recognition model are the core part of the system, they provide the face area then recognize the identity according to those areas. Database model is responsible for storing and managing user information and attendance data, which is significant for the stable operation of the system. The user interface model provides a way to interact with the user, which makes the system more intuitive and easier to use. Attendance record model is the final function of the system, which will archive the identification results for subsequent inquiry.

5.3 Workflow

(1) Requirements Analysis and Software Environment Configuration:
Clear the system requirements, select the appropriate library, framework and development tools, configure the software environment, the establishment of code repositories.

(2) Development and Testing of Face Detection Model:
Using MTCNN / KNN to achieve face detection, test the recognition rate under different lighting and pose, and optimize the detection speed.

(3) Face Recognition Model Development:
Based on FaceNet to achieve high-precision face recognition, while integrating OpenFace to meet real-time needs.

(4) Database Design and Data Management:
the design of database table structure, the establishment of SQLite database, and the preparation of user data and attendance records access interface.

(5) Web Front-end Development:
Build user interface based on Flask or Django to register users and query data.

Connect face recognition results with attendance records via API.

(6) Integration of Attendance Record Module:

The identification module is integrated with the attendance record function to realize the automatic generation and data storage of attendance record.

(7) System Integration Test and Performance Optimization:

After the integration of each module, the system test is carried out to optimize the response speed and accuracy to ensure the stability in the actual environment.

VI. Data Sources

It needs to be emphasized again that as a face recognition project, using a large dataset of facial images to train the model is inevitable. **All data resources used in this project have been reviewed and discussed in advance with the project supervisor, and these data will be used only for academic research purposes.**
The following two publicly available face image datasets are widely used in face recognition projects. They can be accessed via attached links. After technically testing by many other professional academic teams majored in face recognition related projects, their reliability and privacy have be guaranteed.

- **Labeled Faces in the Wild (LFW)**

Access link: http://vis-www.cs.umass.edu/lfw/

The Labeled Faces in the Wild (LFW) dataset was released by the University of Massachusetts Amherst, primarily for face recognition research. It includes over 13,000 images of faces collected from the web, featuring 5,749 different individuals. This dataset has significant variation in lighting, angles, and resolution, making it diverse and challenging. And it is primarily used to train and evaluate face recognition algorithms, especially for face verification and matching tasks.

- **CelebA (CelebFaces Attributes) Dataset**

Access link: http://mmlab.ie.cuhk.edu.hk/projects/CelebA.html

The CelebA (CelebFaces Attributes) dataset was released by the Chinese University of Hong Kong, includes over 200,000 images of celebrity faces with extensive attribute annotations. These attributes cover 40 facial features, making it suitable for feature extraction and generation tasks. All photos included have a standard resolution of 178 x 218, and widely used for facial feature extraction, facial expression analysis, GAN training, and image editing tasks.

VII. Testing & Evaluation

7.1 Test Methodology

- **Unit test**: Test each module (such as face detection module, recognition module,

database module) independently to ensure that each module can achieve the expected function when running independently.

  • **Integration Testing**: Testing after integrating multiple modules to ensure smooth interaction between modules. After integrating the face detection and recognition module, test whether the system could achieve accurately identify.

  •**System Testing**: After the completion of the entire system integration, the system is tested as a whole to check whether all functions meet the requirements and ensure that the system operates stably under various operations.

  • **Performance Testing**: To test the performance of a system in highly concurrent, long-running, complex environments, and to evaluate the responsiveness, stability, and resource consumption of the system.

7.2 Test Type

  • **Function Test**: In the function test, it needs to prove that most of the functions of the platform can run normally. There may still be related problems, such as uploaded user photos that do not display properly, and repeated or erroneous attendance records. All of these issues can be tested and corrected by function test.

  • **Stress Test**: The main purpose of the stress test is to test whether changes in the number of users will negatively affect the normal operation of the system. Although the project is mainly used for small-scale online attendance, it is still possible to cause response delays for various reasons.

  • **Ease of Use Test**: In this section, it is a good choice to write a simple app configuration installation guide to guide users to connect the server to the local operating system on their personal device. Usability testing verifies that the system is fast and user-friendly.

  • **Security Test**: Security is a key consideration in software development. Specific to the project is the need to protect the user's photos and other personal privacy is not leaked or violated. This can be achieved through regular safety inspections and enhanced safety supervision.

7.3 Evaluation

Here are some simple criteria for evaluating the requirement mentioned above in the development section:

  • **Face recognition function test standard:**
test multiple recognition accuracy, reaching more than 90% accuracy

  • **Attendance record storage test standard:**
verify accurate storage and export of attendance data;

  • **Authentication accuracy test criteria:**
miscarriage rate controlled below 5%；

  • **Operation fluency test criteria:**
test the response time of the interface in different network environments, and ensure the response time is less than 1 sec;

- **Data security protection test standard:**
  through the encryption and access right security test;
- **Interface simplicity test**:
more than 85% of users can complete the first punch operation within 3 minutes.

VIII. Project Ethics & Human Participants

Considering that the personal facial recognition information involved in the face recognition process is sensitive, **there will be no other human participant in this project**. From requirements analysis to development to testing the whole process will be completed by myself independently.

Meanwhile, the two main datasets used to train the project model have already introduced in detail in the previous "VI. Data source" section. Face recognition projects can be seen as are a rare exception, even if applicable to Data Category E, but still meet the specific requirements of the Ethnic Guidance. To ensure that the project is 100% compliant with relevant ethical standards, a**ll data resources used in this project have been discussed in advance with the project supervisor, and it can be guaranteed that these data will only be used for academic research purposes.**

IX. BCS Project Criteria

An explanation of how this project meet the six BCS outcomes:
(1) An ability to apply practical and analytical skills gained during the degree programme.
In this project, the knowledge and skills of image processing, machine learning and deep learning which learned from previous courses will be used to implement face detection and recognition. Processing image data with deep learning models to optimize system performance by analyzing datasets and model outputs. In addition, the database design, the implementation of front-end communication, performance testing and other aspects will also apply programming, data analysis, system design and other knowledge to ensure the integrity of the entire project from technology to application.

(2) Innovation and/or creativity.
This project innovatively applies face recognition technology to attendance management, realizes attendance automation and optimizes the traditional attendance method. Provide accurate, real-time recognition by experimenting with different deep learning models, and design scalable modular system architectures. In order to enhance the user experience, I will develop a user-friendly interface to make the attendance system more intuitive and convenient. In addition, optimizing the system to adapt to the actual environment such as complex lighting conditions and

different backgrounds is also a creative application of face recognition technology.

(3) Synthesis of information, ideas and practices to provide a quality solution together with an evaluation of that solution.
In the project, I integrated technologies such as face detection, face recognition, database management, and web development into a complete solution. By choosing the right face detection and face recognition tools, the goal is to provide stable and accurate attendance functions. I will use many types of tests during the testing phase to fully evaluate the quality of the solution and ensure the accuracy and stability of the system. In addition, performance and user feedback will be analyzed upon completion of the project to further optimize the solution.

(4) That your project meets a real need in a wider context.
The face recognition attendance system solves the attendance problem in companies, schools and other scenarios, reduces the time-consuming and error possibilities caused by manual attendance, and improves the attendance efficiency. This kind of automated attendance system is particularly useful in the context of the epidemic, and can also be applied to a wider range of scenarios, such as meeting sign-in and event admission. The project is also designed to support further expansion, such as through access to a cloud database, multi-location synchronization time and attendance, to accommodate the needs of different organizations.

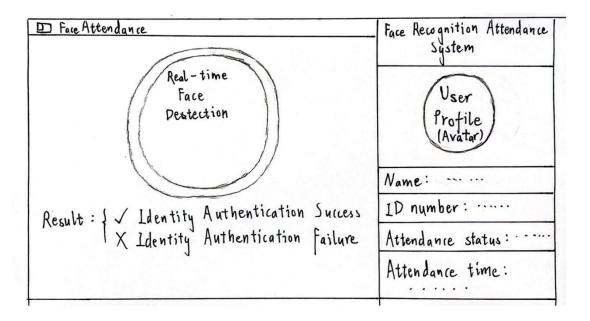**(5) An ability to self-manage a significant piece of work.**
The project uses an agile development process that divides work into multiple phases to effectively manage and track progress. I use project management tools to document tasks and set goals and timelines for each phase to ensure that each module is completed on time. In the development process, I will strictly abide by the project plan to develop a good schedule, regularly check the code quality and system performance, timely find and solve problems. This self-management approach helps to ensure the orderly progress of each phase of the project and ensures the final quality of the project.
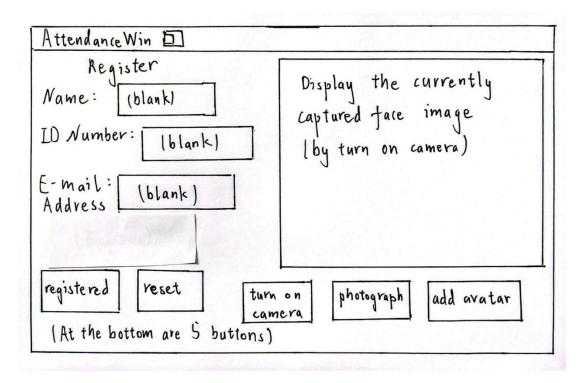
(6) Critical self-evaluation of the process.
During the course of the project, I will self-evaluate the progress of each development stage, especially for the key indicators such as the detection rate of the model, the recognition rate and the response time of the system. By reviewing and analyzing the test results, I will evaluate whether the system meets the expected accuracy and stability, and adjust the model parameters and optimize the code in a timely manner. At the end of the project, I conduct a review to analyze the strengths, weaknesses, and challenges encountered throughout the development process, so that I can continue to improve in future projects.

X. UI/UX Mockup

This section will use some hand-sketched images to visualize the user interface and basic interactions.
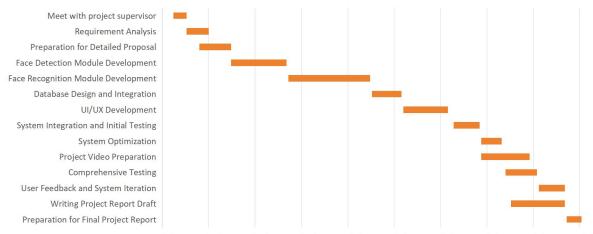
XI. Project Plan

This section includes a Gantt chart to represent a detailed project plan and duration.

Task	Start Time	Expected used days	End Time
Meet with project supervisor	2024/10/1	7	2024/10/7
Requirement Analysis	2024/10/8	12	2024/10/20
Preparation for Detailed Proposal	2024/10/15	17	2024/11/1
Face Detection Module Development	2024/11/1	30	2024/12/1
Face Recognition Module Development	2024/12/2	44	2025/1/15
Database Design and Integration	2025/1/16	16	2025/2/1
UI/UX Development	2025/2/2	24	2025/2/28
System Integration and Initial Testing	2025/3/1	14	2025/3/15
System Optimization	2025/3/16	11	2025/3/27
Project Video Preparation	2025/3/16	26	2025/3/28
Comprehensive Testing	2025/3/29	17	2025/4/15
Writing Project Report Draft	2025/4/1	29	2025/4/30
User Feedback and System Iteration	2025/4/16	14	2025/4/30
Preparation for Final Project Report	2025/5/1	8	2025/5/9

Face Recogniton Attendance System Project Plan

Start Time ■ Expected used days

XII. Risks & Contingency Plans

Common risks and countermeasures

Risks	Contingencies (Response measures)	Likelihood	Impact
Disks damage, hard drives failure and network outages (hardware failure)	Backup the website data in time, replace the ageing equipment	Low	Prolonged downtime and website data loss
Program bugs and code error (software failure)	Test and debug the website in advance	Medium	Inability to access the website
Slow progress or running out of time	Clear division of labor and priority tasks	High	Failure to integrate or lack of functionality
Programming difficulty problem	Choose the suitable language to balance efficiency and compatibility	Medium	Incompatible with different browsers or operating systems
Privacy violations and data breaches	Compliance strictly with Moral Consideration and BCS Project Standards	Medium	Damage reputation, cause legal problem
Other emergencies such as serious illness or loss of equipment	Be cautious	Low	Unable to complete tasks on time

Other detailed technical problems and their solutions

(1) **Lighting Variations and Environmental Interference**: Facial detection may fail under poor lighting or strong light. Solutions include using more robust models and adding image preprocessing steps (e.g., auto white balance).

(2) **Pose and Expression Variations**: Changes in facial poses or expressions may cause recognition failures. Training the model with multi-angle facial data can improve adaptability.

(3) **UI Lag and Responsiveness Issues**: Real-time facial recognition and processing can cause interface lag or delays. Optimizing code and using efficient algorithms can help maintain a smooth user experience.

(4) **Data Privacy and Security**: Protecting user privacy when storing and transmitting facial data is crucial to prevent data leaks. Encryption techniques can secure facial features and data transmission.

(5) **Hardware and Performance Requirements:** High-accuracy facial recognition models may require substantial computing resources. Lightweight models or GPU acceleration can be used to optimize performance.

Reference

Gong, Z., Li, X. and Ismail, M. (2020) 'Automatic time attendance system based on intelligent image processing technology', *Journal of Intelligent & Fuzzy Systems*, pp. 1–10. doi:10.3233/jifs-179971.

Kamil, M.H.M. *et al.* (2023) 'Online attendance system based on facial recognition with face mask detection', *Multimedia Tools and Applications: An International Journal*, 82(22), pp. 34437–34457. doi:10.1007/s11042-023-14842-y.

Khan, S., Akram, A. and Usman, N. (2020) 'Real Time Automatic Attendance System for Face Recognition Using Face API and OpenCV', *Wireless Personal Communications: An International Journal*, 113(1), pp. 469–480. doi:10.1007/s11277-020-07224-2.

Kortli, Y. *et al.* (2020) 'Face Recognition Systems: A Survey', *Sensors (14248220)*, 20(2), pp. 1–36. doi:10.3390/s20020342.

Nijgal, D.R., Subramanian, P. and George, S. (2023) 'Evaluating the Effectiveness of a Facial Recognition-Based Attendance Management System in a Real-World Setting', *2023 14th International Conference on Computing Communication and Networking Technologies, ICCCNT 2023* [Preprint]. doi:10.1109/ICCCNT56998.2023.10306966.

Shukla, A.K., Shukla, A. and Singh, R. (2024) 'Automatic attendance system based on CNN–LSTM and face recognition', *International Journal of Information Technology: An Official Journal of Bharati Vidyapeeth's Institute of Computer Applications and Management*, 16(3), pp. 1293–1301. doi:10.1007/s41870-023-01495-1.

Thalluri, L.N. *et al.* (2024) 'Automated face recognition system for smart attendance application using convolutional neural networks', *International Journal of Intelligent Robotics and Applications*, 8(1), pp. 162–178. doi:10.1007/s41315-023-00310-1.