Software Engineering Lab

Background:

The education sector is witnessing a rapid evolution in adopting technology to streamline various processes. One such area is attendance management. Traditional methods, such as manual attendance taking, are time-consuming and prone to errors. Leveraging facial recognition technology can offer a more efficient and accurate solution. The project aims to implement a facial recognition-based attendance system using camera sensors to automate the attendance tracking process in educational settings.

Problem Definition:

The traditional methods of taking attendance in classrooms involve calling out names or passing around an attendance sheet, both of which can be cumbersome and inefficient. Additionally, they may not be foolproof, as students can mark attendance on behalf of absent classmates. To address these issues, the project seeks to introduce a reliable and automated attendance system based on facial recognition technology.

Objectives (Functionalities)

Five functionalities of Face Recognition Software are:

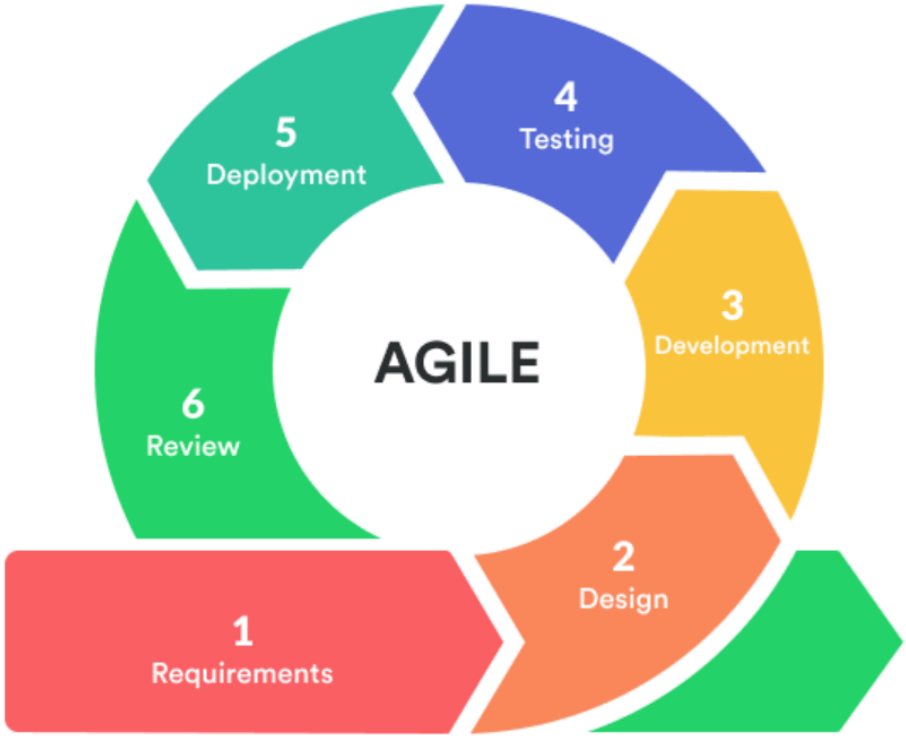
1. Registration:
    a. Registering students for a facial recognition-based attendance system involves capturing their facial features during an enrollment process.
    b. During the enrollment session, direct students to individually position themselves in front of the camera. Utilize the facial recognition software to capture a series of images, incorporating various angles. This process aims to generate a comprehensive set of facial data for the creation of a detailed and robust facial template.
    c. The collected student information and their corresponding facial templates are stored into the database. The database will be used for matching during attendance sessions.
2. Cameras or image sensors are used to capture images during the attendance sessions. The images will be stored in a database for future use.
3. Facial Landmark Detection:
   Utilize facial landmark detection algorithms to identify key points on the face, such as eyes, nose, and mouth. These landmarks serve as reference points for subsequent feature extraction.
4. In the scenario where an image exhibits blurriness for diverse reasons, a preliminary deblurring procedure is conducted using the 'cv2.filter2D' function from the OpenCV library. Subsequent to the deblurring process, the reconstruction of facial features ensues

through the application of facial recognition algorithms. This entails the identification of facial landmarks, extraction of pertinent features, and the generation of a facial template for each distinct individual.

5. During attendance, the system looks at the unique facial features of a person's face and compares them to the facial features it has stored in its memory. It uses methods like measuring the distance between points or checking how similar they are to decide if the person matches someone in the system. This helps determine if the person is present or not.
6. If the similarity between the real-time facial template and the stored templates surpasses the set threshold, the individual is marked as present, and their attendance is recorded. If no match is found, the individual is considered absent.If the similarity between the real-time facial template and the stored templates surpasses the set threshold, the individual is marked as present, and their attendance is recorded. If no match is found, the individual is considered absent.
7. The database system keeps track of who attended, noting their ID, the time they were there, and other important details. It stores this information in a safe place called a database. To make sure no one unauthorized can access or change this information, the system uses special codes and security measures, like locking it with a key. This way, the attendance records are kept private and secure.

Process Model.

For a face recognition-based attendance capturing project, the Agile process model is generally more suitable than other Software Engineering Models.



The reasons for choosing Agile Software Model are:

Dynamic Nature of Requirements:

Face recognition technology is rapidly evolving, and project requirements may change as new insights, algorithms, or features become available. Agile allows for flexibility and accommodates changing requirements more effectively than the more rigid Iterative Waterfall model.

Frequent Stakeholder Involvement:

Agile emphasizes continuous collaboration with stakeholders, including end-users. In a face recognition attendance project, regular feedback from users is crucial to refining algorithms, improving accuracy, and enhancing the overall user experience. Agile methodologies, such as Scrum, facilitate this ongoing interaction.

Iterative Development for Continuous Improvement:

Face recognition projects often benefit from an iterative development approach, where the software is built incrementally, tested, and improved in successive iterations. Agile supports this by delivering functional increments in short time frames, allowing for continuous improvement based on real-world usage and feedback.

Adaptability to Technological Advancements:

Agile methodologies are well-suited for projects involving emerging technologies. In the field of face recognition, where advancements occur frequently, Agile allows teams to adapt to new insights, technologies, or algorithmic improvements during the development process.

Risk Mitigation and Early Issue Identification:

Agile facilitates early identification and mitigation of risks. In face recognition projects, where the accuracy and reliability of the system are critical, addressing potential issues promptly through iterative development is essential to ensure a robust final product.

Customer-Centric Approach:

Agile places a strong emphasis on delivering value to customers regularly. Face recognition attendance software should provide tangible benefits to users, and Agile ensures that users receive incremental improvements and features in a timely manner.

Collaborative Cross-Functional Teams:

Agile promotes the collaboration of cross-functional teams, including AI specialists, software developers, and domain experts. In a face recognition attendance project, where multiple skill sets are required, this collaborative approach is valuable for effective problem-solving and innovation.

Transparency and Visibility:

Agile methodologies provide transparency and visibility into the project's progress. Regular meetings, such as sprint reviews and daily stand-ups, keep all stakeholders informed about the status of the project, fostering better communication and alignment of expectations.

While the Iterative Waterfall model allows for some flexibility within its structured phases, it might not provide the same level of responsiveness to changing requirements and continuous user feedback as Agile methodologies do. Therefore, for a face recognition-based attendance capturing project, where adaptability, customer involvement, and continuous improvement are crucial, Agile, and specifically Scrum, is generally a more appropriate choice.

Tools and Technologies(software and hardware)

To implement a facial recognition project with the specified functionalities, we would need a combination of hardware and software tools:

HARDWARE:

- Multiple camera setup: Utilize webcams or mobile device cameras at different angles to capture full facial data.
- Camera Sensors: High-resolution cameras capable of capturing images from various angles. Preferably, we can use cameras with good low-light performance for better results in different lighting conditions.
- Computer: Mid-range desktop or laptop with a decent processor (Intel Core i5/AMD Ryzen 5 or higher), sufficient RAM (8GB or more), and an available USB port for the camera.
- Storage: Enough HDD or SSD space to store captured images and trained models
- Internet connection: Required for online resources, libraries, and potential cloud-based processing. We can always start with a basic setup and gradually upgrade hardware as our project evolves and needs change.
- Enclosures and Mounting Hardware: Depending on the deployment scenario, enclosures and mounting hardware may be needed to protect the cameras and computing devices and ensure optimal positioning for capturing facial images.
- Power Supply: Ensure a stable and uninterrupted power supply for all hardware components. Consider backup power solutions, such as uninterruptible power supply (UPS) systems, to prevent data loss or system downtime in case of power outages.

SOFTWARE:

- Face detection: OpenCV, Dlib libraries for detecting faces in captured images.
- Registration Module: A web-based or desktop application for registering students.
- Interface for capturing facial images and storing relevant information.
- Real-Time Notification System: A backend system to handle real-time updates and notifications.
- Use messaging services like Firebase Cloud Messaging or WebSocket for instant notifications.
- Attendance Analytics: we can use data visualization tools like Matplotlib or Plotly for generating attendance reports.
- Database: PostgreSQL, MySQL, MongoDB for storing user data, facial encodings, and other relevant information.
- APIs: Cloudinary, Imgix for handling image uploads and processing.

- Image processing libraries: OpenCV, scikit-image for pre-processing and analyzing retinal images.