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Data Sharing based on Facial Recognition Clusters

[1]Rajkumar Rajasekaran, [2]Narayanamoorthi M, [3]Rashi Solanki, [4]Veer Sanghavi, [5]Prashna Thapa, [6]Jolly Masih
[1]School of Computer Science and Engineering
Vellore Institute of Technology
Tamil Nadu, India
vitrajkumar@gmail.com
[2]School of Computer Science and Engineering
Vellore Institute of Technology
Tamil Nadu, India
mnarayanamoorthy@vit.ac.in
[3]School of Computer Science and Engineering
Vellore Institute of Technology
Tamil Nadu, India
rashisolanki2002@gmail.com
[4]School of Computer Science and Engineering
Vellore Institute of Technology
Tamil Nadu, India
veersanghavi8@gmail.com
[5]School of Computer Science and Engineering
Vellore Institute of Technology
Tamil Nadu, India
prashnathapa7@gmail.com
[6]School of Management
BML Munjal University
Gurugram, Haryana, India
jolly.iabm@gmail.com

Abstract— The evolution of computer vision technologies has led to the emergence of novel applications across various sectors, with face detection and recognition systems taking center stage. In this research paper, we present a comprehensive examination and implementation of a face detection project that harnesses the cutting-edge face recognition model. Our primary aim is to create a reliable and effective system that can be seamlessly integrated into functions allowing users to input their image to capture their facial features, subsequently retrieving all images linked to their identity from a database. Our strategy capitalizes on the dlib library and its face recognition model, which com- bines advanced deep learning methods with traditional computer vision techniques to attain highly accurate face detection and recognition. The essential elements of our system encompass face detection, face recognition, and image retrieval. Initially, we employ the face recognition model to detect and pinpoint faces within the captured image. Following that, we employ facial landmarks and feature embeddings to recognize and match the detected face with entries in a database. Finally, we retrieve and present all images connected to the recognized individual. To validate the effectiveness of our system, we conducted extensive experiments on a diverse dataset that encompasses various lighting conditions, poses, and facial expressions. Our findings demonstrate exceptional accuracy and efficiency in both face detection and recognition, rendering our approach suitable for real-world applications. We envision a broad spectrum of potential applications for our system, including access control, event management, and personal media organization.

Keywords- Face Clustering; face recognition; Dlib

I. Introduction

In an era defined by rapid technological advancement, the field of computer vision has witnessed remarkable strides, paving the way for transformative applications across diverse sectors. At the forefront of these innovations lie face detection and recognition systems, which have assumed pivotal roles in enhancing security, streamlining access control, and personalizing user experiences. Within this ever-evolving landscape, the integration of deep learning with traditional computer vision techniques has yielded breakthroughs in the accuracy and efficiency of facial analysis. In the pursuit of harnessing these capabilities to their fullest potential, this research paper embarks on a comprehensive exploration and practical implementation of a face detection project, anchored by the state-of-the-art face recognition model. The core mission of this endeavor is to create a robust and user-friendly system, designed to seamlessly interlace with various functionalities, thereby empowering users to employ QR codes for the effort- less capture of their facial images. Subsequently, the system will retrieve and present all images associated with their identity from a centralized database. Such a system promises to revolutionize the way we engage with facial recognition technology, with far-reaching implications for access management, event organization, and personal media curation. Our project endeavors to provide a comprehensive exploration of our approach, revealing the technical intricacies that form the foundation of its development and implementation. Beyond the technical aspects, our goal is to highlight the potential transformative influence of our system on real-world applications, emphasizing its adaptability and reliability as an innovative solution within the continually evolving field of facial recognition technology.

II. LITERATURE SURVEY

Sanchez, Linsangan, and Angelia [1] introduced an innovative triangular feature-based approach to facial recognition. Their research demonstrated promising results, achieving a 92% accuracy in machine learning models. However, they highlighted constraints related to the distance of the camera from the face, shedding light on the practical challenges faced in real-world deployments of facial recognition systems. In the realm of real-time face detection, Zhang et al. [2] tackled the challenge of deploying face detection on mobile devices, achieving a delicate balance between speed and accuracy. Their work is particularly valuable in the context of applications running on resource-constrained devices, such as smartphones, where real-time face detection is a critical component. Kumar, Kaur, and Kumar [3] provided an extensive review of the wide array of face detection techniques, offering valuable insights into standard databases used for evaluation and the practical applications of these techniques in the ever-evolving field of computer vision. Their work serves as a foundational reference for researchers and practitioners, summarizing the state of the art and highlighting the challenges and future directions in face detection research.

Meshkinfamfard, Gorban, and Tyukin [4] addressed the crucial issue of reducing false positives in face recognition. Their work was particularly relevant in the context of real-time identity surveillance systems, where the occurrence of false positives can have significant consequences. Additionally, Ranjan et al. [5] developed a fast and accurate system for face detection and identification using deep learning techniques. Their work achieved state-of-the-art performance across benchmark datasets and showcased the capabilities of deep neural networks in the domain of face recognition. Dodge and Karam [6] conducted a compelling study comparing human and deep learning recognition performance under various visual distortions. This research highlighted the pressing need for more robust recognition models, especially in scenarios where images may be subjected to noise, blur, or other distortions. The findings underscore the complex interplay between human visual perception and deep neural networks, opening avenues for future investigations. Suryavanshi, Dubey, and Sharma [7] explored facial component detection with a modified version of the Viola- Jones algorithm. Their approach addressed the challenges posed by varying lighting conditions and its impact on recognition accuracy, highlighting the need for robust solutions that can perform consistently across different environmental settings.

Chen et al. [8] contributed “YOLO-face,” a real-time face detector that significantly improved detection speed without compromising accuracy. Their work is instrumental in addressing the increasing demand for real- time face detection in various applications, including video surveillance and human-computer interaction. The landscape of facial recognition and face detection research is rich and multifaceted, with various studies contributing significantly to the enhancement of accuracy and efficiency in these crucial domains. Fan et al. [9] presented a face detection system based on OpenCV, emphasizing the importance of precise facial feature localization. Their work sheds light on the significance of accurate localization in applications such as face recognition, where understanding the specific locations of facial landmarks plays a pivotal role. Liu et al. [10] delved into the intricate task of facial landmark localization, emphasizing the importance of accurately capturing the positions of facial landmarks. Their work is particularly significant as precise facial landmark localization is a critical step in applications like face recognition, facial pose estimation, and facial image synthesis.

Collectively, these studies offer diverse insights, challenges, and techniques, collectively contributing to the advancement of face detection and recognition. The convergence of fast and accurate real-time detection, robustness under visual distortions, and improvements in facial landmark localization underscores the interdisciplinary nature of this research domain, highlighting the importance of continual innovation and exploration in the quest for more reliable and efficient.

III. DATA DESCRIPTION

The dataset comprises images of eight different individuals, each identified by a unique label or identifier. These individuals could represent a diverse set of people, such as employees, students, or social network users. To ensure the model’s accuracy, each individual is represented by a minimum of six pictures. This abundance of images for each person enhances the model’s capacity to distinguish between individuals effectively. The dataset includes images captured in a range of settings, providing the model with exposure to different environments, lighting conditions, and contexts. mages captured within various indoor locations like offices, homes, and public buildings. This will account for differences in lighting and background settings. Images taken in diverse outdoor settings, including parks, streets, and recreational areas. This introduces the model to the challenges posed by natural lighting and outdoor backgrounds. Images from both casual, everyday situations and formal events, providing a wide range of attire and appearances. By encompassing images from these diverse settings, the dataset aims to train a robust face detection and clustering model capable of accurately identifying and grouping individuals in real-world scenarios.

TABLE I. DATA DESCRIPTION

Total Images	50
Total Faces	8

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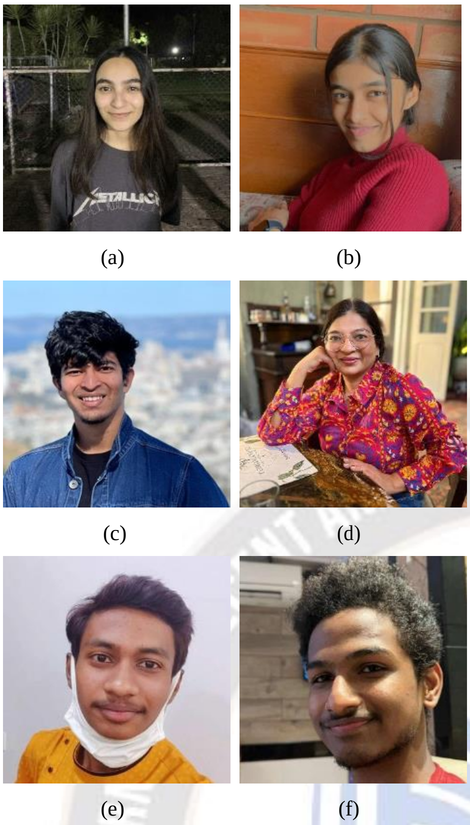

Figure 1. Example pictures of few individuals in the dataset

IV. Methodology

A. Data Collection

Begin by assembling a comprehensive dataset of facial images, ensuring diversity in lighting conditions, poses, and facial expressions.

B. Face Recognition and Clustering

Utilize the face recognition algorithm to detect and locate faces within each image in the dataset. Extract facial landmarks and feature embeddings for each detected face. Apply clustering techniques to group similar faces into clusters based on their feature embeddings. This step forms the basis for classifying individuals within the dataset. Make a folder consisting of all the clusters with respect to the number of faces that have been detected.

C. Testing and Evaluation

Assess the system's performance by testing it on a diverse range of individuals, monitoring accuracy, and response times. Conduct experiments to evaluate the system's ability to handle different lighting conditions, angles, and facial expressions.

D. User Input/Real Time Scanning and Delivery

- Image Classification: Input an image and use our model to recognize its corresponding cluster.
- Real Time Scanning: With the help of a webcam the algorithm will capture the face and retrieve the respective cluster.
- Zip File Creation: Create a compressed zip file containing all the images within the recognized cluster.
- Email Delivery: Send the generated zip file to the email address provided by the user.

E. Iterative Improvement

Continuously improve the system by fine-tuning the clustering and face recognition, optimizing parameters, and expanding the dataset with new images to enhance recognition accuracy. Address any real-time performance issues, such as latency, by optimizing code and system resources.

By following this methodology, the project aims to develop a robust and efficient system capable of recognizing and classifying faces based on clusters established during the training phase. This approach integrates data collection, preprocessing, clustering implementation to create a versatile facial recognition system with practical applications in various domains.

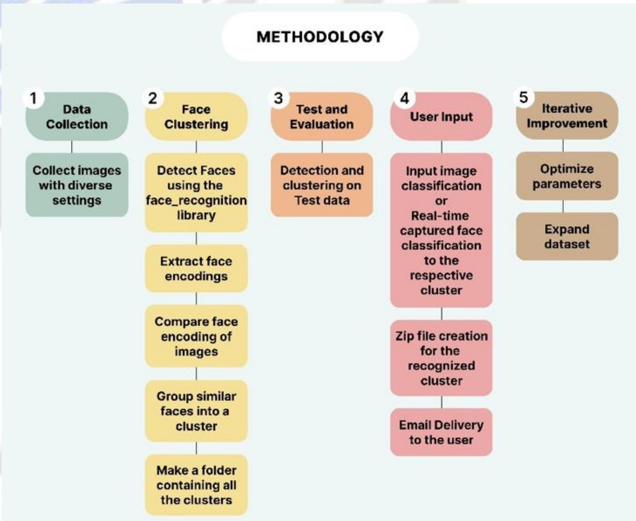

Figure 2. Methodology

V. High Level Solution Flow

A. Initialization and Setup

- The code begins by importing necessary libraries, such as 'face recognition', 'os', 'pathlib', 'shutil', 'cv2', 'numpy', 'smtplib', and 'tkinter'.
- The 'encodings' dictionary is initialized to store face encodings of different clusters.
- The code defines the SMTP email configuration for sending emails using Gmail.
- It sets up directory paths for the 'dataset' and

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'results' to organize the input data and store processed results.

B. Modeling and Clustering the Dataset

- The code processes each image in the 'dataset' directory using face recognition techniques.
- For each image, it calculates the face encoding using 'face recognition' library.
- It then compares the encoding with existing clusters (if any) and assigns the image to an existing cluster if a matching face is found.
- If no matching cluster is found, a new cluster is created.
- The processed images are copied to their respective cluster directories in the 'results' directory.
- The code keeps track of encodings for each cluster.

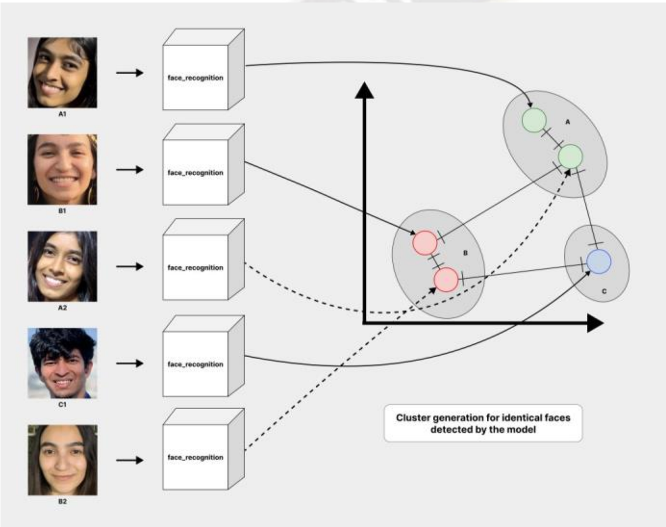

Figure 3. Cluster Generation

C. Detailed explanation about the face recognition algorithm

The 'face recognition' library is built on top of the popular face recognition framework dlib and provides a user-friendly interface for face recognition tasks. It uses a pre-trained deep learning model to detect and recognize faces in images. The algorithm behind 'face recognition' is based on deep neural networks and face embeddings. Here's a high-level explanation of the algorithm and some mathematical background:

1) Face detection: Face detection is the process of locating where in an image (or frame) the faces are. The 'face recognition' library uses a Histogram of Oriented Gradients (HOG) feature-based object detector in dlib to perform face detection. HOG is a technique that extracts local patterns of pixel intensities and uses them to identify objects in an image. The detector scans the image for regions with high HOG feature similarity to a pre-trained face model.

Figure 4. Face Detection

2) Face Landmark Detection: Once face is detected, the library can also perform facial landmark detection to identify the position of key points on the face (e.g., eyes, nose, mouth, chin). The shape predictor model in dlib is used for facial landmark detection.

TABLE II. FACIAL LANDMARK POINTS RANGE

Feature	Point Range
Left jaw line	1-8
Chin	9
Right jaw line	10-17
Left eyebrow	18-22
Right eyebrow	23-27
Bridge of nose	28-31
Bottom of nose	32-36
Left eye	37-42
Right eye	43-48
Outer edge of lips	49-60
Inner edge of lips	61-68

Figure 5. Facial Landmark Points

3) Face Encoding: Face recognition is not based on the raw image of the face but on a compact representation called a face encoding. A face encoding is a numerical

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vector that captures unique characteristics of a person's face. The 'face recognition' library uses a pre-trained Convolutional Neural Network (CNN) model to compute these face encodings. The neural network model is trained on a large dataset of labeled face images. It learns to map a face image to a fixed-size vector, which represents the face identity.

4) Face Comparison: To recognize faces, the library compares the face encodings of the detected faces. It computes a numerical similarity score between two face encodings using a distance metric such as Euclidean distance or L2 distance. A lower distance indicates a higher similarity between two face encodings, which suggests that the faces likely belong to the same person.

5) Mathematical Explanation: Let's denote the face encoding of two detected faces as 'F1' and 'F2'. The distance between these two face encodings can be calculated as the Euclidean distance (L2 distance) between them: distance = sqrt (sum ((F1 - F2)$\hat{2}$)) If the distance is below a certain threshold (e.g., 0.6), the two face encodings are considered to belong to the same person. If the distance is above the threshold, the faces are considered to belong to different individuals.

The pre-trained model used by 'face recognition' has been trained on a large dataset with diverse faces, making it capable of recognizing a wide range of individuals. The algorithm is highly accurate for face recognition and is widely used in various applications, including security systems, access control, and photo tagging.

D. User Input

- The code creates a Tkinter file dialog to allow the user to select an input image file.
- The user is prompted to input their email address for future communication.

E. Archiving and Email Preparation

- If a matching cluster is found for the input image, the code creates a ZIP archive of the cluster directory.
- It constructs an email with a subject and body, preparing to send the ZIP archive to the user.

F. Sending the ZIP Archive

- The code uses the 'smtplib' library to send the email.
- It connects to the Gmail SMTP server, logs in with provided credentials, and sends the email to the inputted email address.
- If there are any errors during the email sending process, it handles them gracefully.

VI. Benefits

- **Enhanced User Convenience:** The system's utilization of QR codes simplifies the user experience, allowing individuals to effortlessly retrieve their pictures from a database by simply scanning a code, thereby reducing the time and effort required for manual searches.
- **Efficient Face Matching:** The model's ability to create clusters of faces from the database demonstrates its efficiency in organizing and categorizing images. This not only speeds up the retrieval process but also reduces false positives and negatives in face recognition.
- **Scalability:** The system is scalable and can handle a large volume of user data. As more users upload their pictures, the system can efficiently manage and retrieve images, making it suitable for both individual and enterprise-level applications.
- **Personalization:** By identifying the user's cluster and retrieving all their pictures, the system provides a highly personalized experience. This personalization is valuable for users who want to access their own pictures quickly and conveniently.
- **Reduced Search Time:** Traditional image retrieval systems require users to manually search for their images. In contrast, this system significantly reduces search time, as users only need to upload a single image to access all their pictures.
- **Potential for Commercial Use:** Beyond personal use, this system has potential applications in commercial settings, such as event photography, where attendees can quickly access their event photos using QR codes and facial recognition.
- **User Engagement:** The system's ease of use and personalized image retrieval can enhance user engagement and satisfaction. Users are more likely to use and recommend a system that offers a seamless experience.
- **Technological Advancement:** This research paper con- tributes to the advancement of facial recognition and image retrieval technology, demonstrating practical ap- plications that can benefit a wide range of industries.

VII. Limitations

- **Privacy Concerns:** While the system enhances security, it also raises privacy concerns. Collecting and storing user images and contact details could potentially lead to data breaches or misuse if not adequately protected.
- **Accuracy Limitations:** Facial recognition technology may still have accuracy limitations, especially in cases of low-quality images or varying lighting conditions. False positives or negatives could lead to users not being able to access their pictures.

- **User Reluctance:** Some users may be reluctant to provide contact details and upload their pictures due to concerns about privacy or data security, which could limit the system's adoption.
- **Dependency on QR Codes:** The system relies heavily on QR codes for user interaction. If users are not familiar with or do not have access to QR code scanning technology, it could hinder the usability of the system.
- **Legal and Ethical Issues:** The use of facial recognition technology is subject to legal and ethical considerations. Different regions and countries may have varying regulations, and compliance can be challenging.
- **User Training:** Users may require some level of training or guidance on how to use the system effectively, particularly if they are not tech-savvy, which could be a barrier to entry.

VIII. Results

In this section, we'll discuss our project's findings, how they connect to the original business problem, and compare the clusters we identified with those from real-time face scanning.

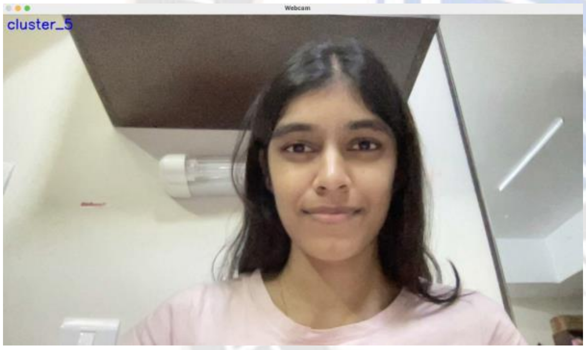

Figure 6. Cluster Recognition

Figure 7. Cluster Generated

TABLE III. Evaluation Metrics

Metric	Value
Total Images	50
Total Faces Detected	8
Correctly Recognized	8 (100%)
Incorrectly Recognized	0 (0%)
Precision	100%
Recall (Sensitivity)	100%
F1-Score	100%
Specificity	N/A (No False Positives)

IX. Comprehensive Case Study: Automated Attendance System With Face Recognition

A. Introduction

In the realm of education, managing attendance is a critical task, especially for large class sizes. Traditional methods of manual attendance taking are laborious, prone to errors, and can be manipulated by students. This case study delves into the development and implementation of an Automated Attendance System that employs face recognition technology, leveraging OpenCV. This system aims to revolutionize attendance management for educational institutions.

B. Problem Statement

The prevalent issues with traditional attendance management in educational institutions include inefficiency, inaccuracies, and the potential for proxy attendance. Our objective is to create an automated attendance system capable of:

1) Rapid and precise facial recognition.
2) Matching recognized faces with a predefined database of student photos.
3) Marking students as 'Present' or 'Absent' based on recognition outcomes.
4) Electronically storing attendance records for easy access and management.

C. Solution

1) *System Architecture:* Our automated attendance system encompasses the following components:

- Face Detection and Recognition Model: OpenCV is employed for face detection and recognition. The model is trained on a dataset of student photos, clustering them into folders, each corresponding to an individual student.

Figure 8. Classroom

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- Camera Setup: Faculty members utilize a camera linked to a computer or a mobile device to capture classroom images.
- Attendance Management Portal: Faculty interact with a web-based portal where they initiate attendance sessions and examine the results.
- Database: A pre-populated student database with photos and relevant information for each student.
- Attendance Log: The system maintains an electronic attendance log, marking each student as ’Present’ or ’Absent’ for each session.

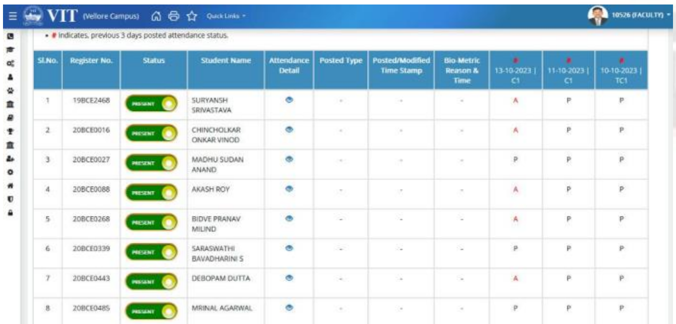

Figure 9. Attendance Log

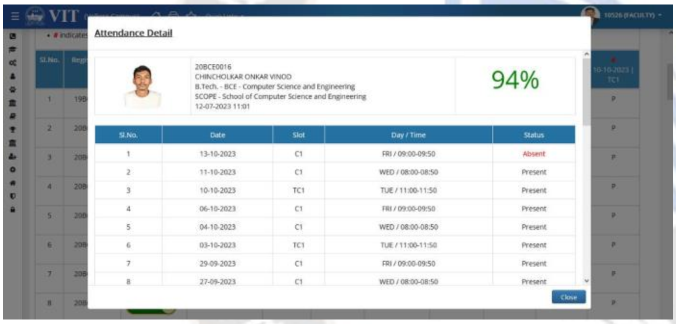

Figure 10. Sample Student Attendance Profile

2) *Workflow:* The system workflow is as follows:

- Data Collection: The faculty captures a classroom photo, including all students present.
- Face Detection: OpenCV is used to detect faces in the image.
- Face Recognition: Detected faces are compared with the student database. If a match is found, the system identifies the student.
- Attendance Marking: The system records recognized stu- dents as ’Present’ and undetected faces as ’Absent’ in the attendance log.
- Attendance Management: Faculty review the results on the attendance portal, make corrections as needed, and save the attendance record.

3) *Key Features:*

- Real-time Recognition: The system can process class- room photos in real-time, suitable for large classes.
- Accuracy: The OpenCV-based recognition model has been trained extensively, enhancing accuracy.
- Flexibility: The system adapts to diverse classroom set- tings and lighting conditions.

Electronic Records: Attendance records are electronically stored, accessible for future reference and analysis.

D. Implementation

1) *Data Collection and Training:* To build the recognition model, an extensive dataset of student photos was collected and labeled. OpenCV was employed for face detection and recognition, and the model was fine-tuned for optimal accuracy.

2) *Hardware and Software:* The system was implemented on a computer with a camera, and a web-based attendance portal was developed using modern web technologies. OpenCV was integrated into the portal for real-time face recognition.

3) *User Training:* Faculty members received training on system usage, including operating the camera, accessing the portal, and interpreting attendance reports.

E. Benefits

The automated attendance system has been in use for a semester, yielding several benefits:

1) Efficiency: Attendance-taking time has significantly reduced, allowing more teaching time.
2) Accuracy: Attendance records are more precise, reducing the margin for errors.
3) Security: Impersonation and proxy attendance have been almost entirely eradicated.
4) Data Analysis: History of electronic records facilitate in- depth data analysis and reporting, enabling data-driven decisions.
5) Minimized Paper Consumption: By replacing manual paper-based attendance registers, the automated system contributes to environmental sustainability by reducing paper consumption and waste.
6) Enhanced Compliance: The system assists educational institutions in following attendance regulations and funding requirements by providing a trustworthy and easily audited record of student attendance.

F. Challenges

While the automated attendance system offers numerous advantages, challenges were encountered, including:

1) Privacy Concerns: Addressing student privacy concerns regarding facial data collection and storage.
2) Costs: Initial setup costs for cameras and software development.
3) Technical Issues: Occasional technical problems, such as lighting conditions affecting recognition

accuracy.

4) False Positives and Negatives: Addressing issues related to false positives (incorrectly marking attendance for someone not present) and false negatives (missing genuine attendance) that can arise from facial recognition technology limitations.
5) User Adoption: Overcoming potential reluctance from students, teachers, or staff who may be uncomfortable with the collection of biometric data or the transition to an automated system. Ensuring user training and support is essential.
6) Accessibility: Ensuring that the system is accessible to all students, including those with disabilities, and that alternative methods are available for students who may not be able to use facial recognition technology.
7) Maintenance: Ongoing maintenance and software up- dates for hardware and software components (e.g., cam- eras, facial recognition algorithms) to maintain system accuracy and reliability.

G. Future Enhancements

The system will undergo continuous improvement with these enhancements in mind:

1) Privacy Compliance: Implementation of stringent data protection policies to address privacy concerns.
2) Adaptive Learning: Employing machine learning to enhance recognition accuracy under diverse conditions.
3) Mobile App: Developing a mobile app for faculty to take attendance from their mobile devices.

H. Conclusion

The automated attendance system, powered by face recognition technology, has significantly enhanced attendance management in educational institutions. It provides an efficient, accurate, and secure method for recording attendance, benefiting both faculty and students. With ongoing improvements and the resolution of challenges, this system is poised to become an integral part of modern education management, contributing to more streamlined and data-driven educational institutions.

X. FUTURE WORK

- Continuous Improvement in Accuracy: Future research can focus on refining facial recognition algorithms to achieve even higher accuracy, especially in challenging conditions such as low light, partial occlusions, or variations in facial expressions.
- Machine Learning Advancements: Incorporating state-of-the-art machine learning techniques, such as deep learning, to further enhance the accuracy and speed of facial recognition.
- Privacy-Preserving Solutions: Developing techniques that allow for secure and privacy-preserving facial recognition, including methods that protect user data while still providing the desired functionality.
- Large-Scale Deployment: Exploring the feasibility of deploying this technology on a large scale, such as in smart cities, public transportation systems, or healthcare facilities.
- Multi-face Detection: For people who are aged or children who do not have access to technology, for instance one person from a family would want pictures of all family members, he/she could upload one family picture and the system will scan all the faces and return pictures of all the members in the database
- Types of Images: Making the model more and more accurate with respect to huge group photos and multiple faces which result in small region for the algorithm to detect.
- Regulatory Compliance: Staying up-to-date with evolving regulations and compliance standards related to facial recognition technology to ensure that implementations are legally sound.
- Security Enhancements: Continuously improving security measures to protect user data and system integrity, including robust encryption, intrusion detection, and access control mechanisms.
- Customization and Personalization: Allowing users to customize their settings and preferences for facial recognition, ensuring that the system adapts to individual needs and preferences.

These future directions can help advance the field of facial detection and image retrieval in QR-driven face scanning applications, making the technology more accurate, secure, and user-friendly while addressing important ethical and privacy considerations.

XI. CONCLUSION

In conclusion, this research paper has presented a novel and innovative approach to facial detection and image retrieval through the utilization of QR-driven face scanning applications. The project's core objective was to enhance user convenience, security, and personalization in accessing images from a database. By offering a comprehensive solution that combines QR codes, facial recognition, and image clustering, this research has demonstrated several significant merits. Our system simplifies the user experience, reduces search time, and improves security through the collection of contact details and the requirement of a user-uploaded picture. The model's ability to create clusters of faces in the database and accurately identify the user's cluster adds a layer of efficiency and personalization that distinguishes this system. Its contribution to the technological advancement of facial recognition and image retrieval has the potential to transform the way we interact with and utilize visual data in various domains. However, it's important to acknowledge the challenges and demerits associated with this technology, including privacy concerns, accuracy limitations, and legal considerations. These challenges need to be addressed to ensure the responsible and ethical implementation of this technology. In essence, this research paper not only presents a practical solution for image retrieval but also contributes to the ongoing evolution of facial recognition and image retrieval technology. As the technology continues to advance, it is our hope that the merits and insights from this research will pave the way for even more secure, efficient, and user-friendly applications in the future.

REFERENCES

[1] E. K. M. Sanchez, N. B. Linsangan and R. E. Angelia, "Three Triangle Method for Face Recognition using Dlib and OpenCV," 2020 IEEE 12th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM), Manila, Philippines, 2020, pp. 1-5, doi: 10.1109/HNICEM51456.2020.9400134

[2] Heming Zhang, Xiaolong Wang, Jingwen Zhu, C.-C. Jay Kuo, Fast face detection on mobile devices by leveraging global and local facial characteristics, Signal Processing: Image Communication, Volume 78, 2019, Pages 1-8, ISSN 0923-5965, https://doi.org/10.1016/j.image.2019.05.016

[3] Kumar, A., Kaur, A. & Kumar, M. Face detection techniques: a review. Artif Intell Rev 52, 927–948 (2019). https://doi.org/10.1007/s10462-018-9650-2

[4] S. Meshkinfamfard, A. Gorban and I. Tyukin, "Tackling Rare False-Positives in Face Recognition: A Case Study," 2018 IEEE 20th International Conference on High Performance Computing and Communications; IEEE 16th International Conference on Smart City; IEEE 4th International Conference on Data Science and Systems (HPCC/SmartCity/DSS), Exeter, UK, 2018, pp. 1592-1598, doi: 10.1109/HPCC/SmartCity/DSS.2018.00260.

[5] R. Ranjan et al., "A Fast and Accurate System for Face Detection, Identification, and Verification," in IEEE Transactions on Biometrics, Behavior, and Identity Science, vol. 1, no. 2, pp. 82-96, April 2019, doi: 10.1109/TBIOM.2019.2908436.

[6] S. Dodge and L. Karam, "A Study and Comparison of Human and Deep Learning Recognition Performance under Visual Distortions," 2017 26th International Conference on Computer Communication and Networks (ICCCN), Vancouver, BC, Canada, 2017, pp. 1-7, doi: 10.1109/ICCCN.2017.8038465.

[7] S. Suryavanshi, A. Dubey and P. Sharma, "Detection of Facial Components Utilizing a Modified Version of the Viola-Jones Algorithm," 2022 4th International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2022, pp. 1-8, doi: 10.1109/ICIRCA54612.2022.9985518.

[8] Chen, W., Huang, H., Peng, S. et al. YOLO-face: a real-time face detector. Vis Comput 37, 805–813 (2021). https://doi.org/10.1007/s00371-020-01831-7

[9] Xianghua Fan, Fuyou Zhang, Haixia Wang and Xiao Lu, "The system of face detection based on OpenCV," 2012 24th Chinese Control and Decision Conference (CCDC), Taiyuan, 2012, pp. 648-651, doi: 10.1109/CCDC.2012.6242980.

[10] Y. Liu et al., "Grand Challenge of 106-Point Facial Landmark Localization," 2019 IEEE International Conference on Multimedia & Expo Workshops (ICMEW), Shanghai, China, 2019, pp. 613-616, doi: 10.1109/ICMEW.2019.00117.Y. Liu et al., "Grand Challenge of 106-Point Facial Landmark Localization," 2019 IEEE International Conference on Multimedia & Expo Workshops (ICMEW), Shanghai, China, 2019, pp. 613-616, doi: 10.1109/ICMEW.2019.00117.

[11] A. R. Kansakar and R. Gupta, "A survey on classification of Geospatial Clustering," 2023 International Conference on Computational Intelligence, Communication Technology and Networking (CICTN), Ghaziabad, India, 2023, pp. 441-446, doi: 10.1109/CICTN57981.2023.10140721.

[12] Fan, W., Bouguila, N. Face detection and facial expression recognition using simultaneous clustering and feature selection via an expectation propagation statistical learning framework. Multimed Tools Appl 74, 4303–4327 (2015). https://doi.org/10.1007/s11042-013-1548-z

[13] A. T. R. Angus, J. A. P. Guillen, M. L. G. Lenon, R. J. C. Principe, G. P. Feudo and K. K. D. Serrano, "A clustering system utilizing acquired age and gender demographics thru facial detection and recognition technology," 2017IEEE 9th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM), Manila, Philippines, 2017, pp. 1-6, doi: 10.1109/HNICEM.2017.8269504.

[14] Yunze Chen, Junjie Huang, Zheng Zhu, Xianlei Long, Qingyi Gu, Boosting semi-supervised face recognition with raw faces, Image and Vision Computing, Volume 125, 2022, 104512, ISSN 0262-8856, https://doi.org/10.1016/j.imavis.2022.104512.

[15] Lin, CW., Hong, S. High-order histogram-based local clustering patterns in polar coordinate for facial recognition and retrieval. Vis Comput 38, 1741–1758 (2022). https://doi.org/10.1007/s00371-021-02102-9

[16] Bhaswati Barman, Rupesh Kumar Dewang, Arvind Mewada, Facial recognition using grey wolf optimization, Materials Today: Proceedings, Volume 58, Part 1, 2022, Pages 273-285, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2022.02.161.

[17] D. Meltzer and D. Luengo, "An efficient clustering-based non-fiducial approach for ECG biometric recognition," 2022 30th European Signal Processing Conference (EUSIPCO), Belgrade, Serbia, 2022, pp. 623-627, doi: 10.23919/EUSIPCO55093.2022.9909751.

[18] S. Jain, M. U. Farooque and V. Sharma, "Comparative Analysis of Clustering Algorithm for Facial Recognition System," 2018 IEEE 8th International Advance Computing Conference (IACC), Greater Noida, India, 2018, pp. 102-107, doi: 10.1109/IADCC.2018.8692091.

[19] Garain, J., Kumar, R.K., Kisku, D.R. et al. Addressing facial dynamics using k-medoids cohort selection algorithm for face recognition. Multimed Tools Appl 78, 18443–18474 (2019). https://doi.org/10.1007/s11042-018-7132-9

[20] Zhong, R., Wu, H., Chen, Z. et al. Fusion facial semantic feature and incremental learning mechanism for efficient face recognition. Soft Comput 25, 9347–9363 (2021). https://doi.org/10.1007/s00500-021-05915-x

[21] C. Otto, D. Wang and A. K. Jain, "Clustering Millions of Faces by Identity," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 40, no. 2, pp. 289-303, 1 Feb. 2018, doi: 10.1109/TPAMI.2017.2679100.

[22] Rajasekaran R., Goyal R., Mahesh V.G.V. (2020) Building Personal Marionette (Ritchie) Using Internet of Things for Smarter Living in Homes. In: Bindhu V., Chen J., Tavares J. (eds) International Conference on Communication, Computing and Electronics Systems. Lecture Notes in Electrical Engineering, vol 637. Springer, Singapore. https://doi.org/10.1007/978-981-15-2612-1_57

[23] Rajasekaran R., Rasool F., Srivastava S., Masih J., Rajest S.S. (2020) Heat Maps for Human Group Activity in Academic Blocks. In: Haldorai A., Ramu A., Khan S. (eds) Business Intelligence for Enterprise Internet of Things. EAI/Springer Innovations in Communication and Computing. Springer, Cham. https://doi.org/10.1007/978-3-030-44407-5_16