Asian Journal of Engineering and Applied Technology
ISSN: 2249-068X (P) Vol.12 No.2, 2023, pp.34-39
© The Research Publication, www.trp.org.in
DOI: https://doi.org/10.51983/ajeat-2023.12.2.3968

Smart Attendance System Using Face Recognition

J. T. Thirukrishna[1], A. M. Revathi[2], Y. Shashank[3], Thejas Pandith[4] and N. Samarth[5]
[1]Associate Professor, [2]UG Student,
Department of Information Science and Engineering,
Dayananda Sagar Academy of Technology and Management, Bengaluru, Karnataka, India
E-mail: revathiganiga04@gmail.com, shashankmanushashank@gmail.com, t.pandith21@gmail.com, ssamarth4123@gmail.com
(Received 15 October 2023; Revised 1 November 2023, Accepted 30 November 2023; Available online 5 December 2023)

***Abstract* - Implementing an attendance system in schools and colleges is crucial, and relying on manual methods poses challenges such as reduced accuracy and maintenance issues. Utilizing face recognition techniques can significantly enhance accuracy and efficiency compared to traditional methods. Various existing systems incorporate technologies like face recognition using IoT, PIR sensors, and hardware devices, but maintaining these sensors can be challenging. We aim to address these challenges by implementing a system based on the Haar Cascade Algorithm, known for its high accuracy. This algorithm can capture images effectively within a range of 50-70cm. To simplify the process, we are developing a user-friendly graphical interface that enables image capture, dataset creation, and one-click dataset training. Upon successful face recognition, the system will display the student's name and roll number, automatically recording this information in an attendance sheet with the corresponding time and date.**
***Keywords:* Face Detection, Face Recognition, Haar Features, Histogram of Oriented Gradients**

I. INTRODUCTION

In educational institutions, faculty members grapple with the challenge of managing manual attendance records, often contending with issues like proxy attendance and the cumbersome task of maintaining handwritten documents for each class or batch. To alleviate this burden, various technological solutions have emerged:

RFID System: Students are equipped with RFID cards designed for attendance purposes. These cards contain a chip that, upon swiping through a card reader, transmits student details to the system, automating the attendance marking process. Biometric System: Utilizing unique body parts such as fingerprints, this system requires the initial storage of each candidate's fingerprints in a database. During attendance, the system cross-checks the presented fingerprint with the stored data to verify attendance.

Bluetooth System: This system addresses proxy attendance within a limited population. However, its limitation lies in allowing only eight connections at a time, restricting its scalability for larger groups. While these systems predominantly rely on hardware devices, software-based solutions leverage various face recognition techniques for attendance management in educational settings. These techniques encompass a range of methods to ensure accurate and efficient attendance tracking.

The system primarily operates on hardware devices. However, in software-based systems, several face recognition techniques such as Eigenfaces, LBPH, fisher faces, and SIFT are commonly employed. Face detection relies on algorithms like AdaBoost, SVM-based, and Viola-Jones face detectors. In our implementation, we employ the Haar cascade algorithm and AdaBoost classifier for both face detection and recognition. The procedure is organized into four main stages. The first step involves extracting features and facial expressions by analysing all captured images. This process computes various pixel calculations, generating an internal image based online features, edge features, and four-rectangle patterns. features, among others.

Internal Image: After gathering all features, the system generates an internal image by processing the collected features, including line features, edge features, and other pixel calculations. AdaBoost Classifier: Here, all features extracted from faces are combined, emphasizing their uniqueness. The AdaBoost classifier operates to enhance the discriminatory power of these features.

Cascading Classifier: This step focuses on effectively classifying faces and non-faces, primarily for testing purposes. It aims to discern and distinguish between facial features and non-facial elements, contributing to the accuracy and reliability of the system's performance.

II. LITERATURE REVIEW

A. An Attendance and Security System Integrating Face and Biometric Recognition with RFID and Arduino Technology

The paper introduces a novel employee attendance and security system that combines face recognition and biometric technology with Smart RFID cards using Arduino. It focuses on integrating RFID-based attendance with face recognition for individual employees, enhancing security through the addition of fingerprint authentication. The system includes an audio welcome message upon valid employee attendance registration and introduces audio alerts and a sound alarm for unauthorized entry [2].

This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

B. Attendance System Based on Face Recognition

The paper aimed to revolutionize attendance systems in educational institutions like schools and colleges, addressing the drawbacks of manual attendance such as cost, potential for falsification, and inconsistent accuracy. It highlighted the limitations of traditional face recognition methods and advocated for the integration of biometric and face recognition technologies. The proposed solution focused on leveraging face recognition techniques to streamline attendance processes, utilizing images captured by cameras or CCTV systems within educational settings. It emphasized process and working of attendance system based on face.

The initial step of detecting faces by analysing various facial features like eyes, nose, mouth, and hair, accommodating different facial poses in images. The paper discussed several face detection methods, including AdaBoast, SQMT, LBP, and SNOW classifier methods, followed by the application of face recognition techniques such as Histogram of Oriented Gradient features (HOG) and Haar Cascade features once a face was successfully detected by using method.

1. Histogram of Oriented Gradient features (HOG),
2. Haar Cascade features.

C. Classroom Attendance System using Face Recognition

1. The fundamental principle underlying face recognition is image processing, which comes in two forms: Analog processing is employed for hard copies like photographs and printouts, while digital processing manipulates digital image content through a computer (PC). Attendance systems typically fall into two categories: Manual Attendance Systems and Automated Attendance Systems.
2. Manual attendance systems present numerous challenges, such as the need to manage papers and manually mark attendance with a pen every day, making it labour-intensive and time-consuming. The shortcomings of manual systems are overcome by automated attendance systems, which aim to capture images or videos of students' faces, their positions, and attendance status.
3. Various existing attendance systems have limitations:
4. Biometric-based systems, which scan unique body parts like fingerprints, are time-consuming.
5. Bluetooth systems lack scalability and require up to 8 connections simultaneously.
6. RFID systems involve using RFID cards for attendance, but face difficulties if cards are lost.

Among the existing algorithms is Eigenfaces, which extracts essential features from faces/images and encodes them. This algorithm requires a set of images to calculate variance and covariance matrices, with each image representing an eigen vector.

D. Automated Attendance Management System Utilizing Face Recognition

The core idea behind face recognition revolves around image processing, which can be classified into two main types: Analog processing, employed for hard copies like photographs and printouts, and Digital processing, which involves manipulating digital image content through a computer. Attendance systems can be broadly categorized into Manual Attendance Systems and Automated Attendance Systems.

Manual attendance systems present challenges such as paper maintenance, manual marking of attendance with a pen, and time-consuming efforts. Automated attendance systems address these limitations. The primary aim is to capture images or videos of students' faces, their positions, and record attendance. Existing attendance systems like biometric, Bluetooth, and RFID-based systems have their drawbacks.

Several existing algorithms contribute to face recognition.

1. *Eigenfaces:* Extracts essential facial features and encodes them by creating a set of images, calculating variance and covariance matrices, with each image representing an eigen vector.
2. *Line Edge Map:* Focuses on extracting features of eyes, nose, and mouth, mapping lines on faces after converting color images to grayscale.
3. *Histogram of Oriented Gradient:* Utilizes grayscale conversion and assigns each pixel to an integer, aiming to identify darker regions of the face.
4. The suggested solution aims to leverage face recognition for augmenting the attendance system, thereby mitigating proxy attendance and enhancing accuracy. The necessary hardware components comprise an Arduino Uno microcontroller and a Passive Infrared Sensor (PIR) designed for detecting object radiation and motion. The system operates in several steps.
5. Student registration details and images are stored in the college database.
6. A camera, sensor, and microcontroller are set up at the class entrance, with the PIR sensor measuring object radiation and motion.
7. When a student enters the class, the PIR sensor activates the camera, capturing images.
8. Captured images are compared with the database, updating it for attendance.
9. Database updates are communicated to parents through mail or SMS daily.

The system also extends to faculty attendance with a separate database. This comprehensive solution addresses attendance challenges through an integrated face recognition system.

III. METHODOLOGY

Building upon a comprehensive literature survey that delved into various topics directly relevant to our project, we are now poised to devise a viable solution. This section articulates our proposed methodology, providing an overarching view of our project's approach and the strategic avenues to be pursued. The inadequacy of prior research has driven us to develop this project in the most practical and effective manner possible.

The envisaged face detection module for our project centres around the Viola-Jones algorithm. Simultaneously, we propose a neural network architecture coupled with Local Binary Pattern Histogram (LBPH) for the face recognition modules.

A visual representation of the project's systemic circuit design is depicted in the accompanying figure. This schematic illustrates the interconnections and components integral to our system's architecture.

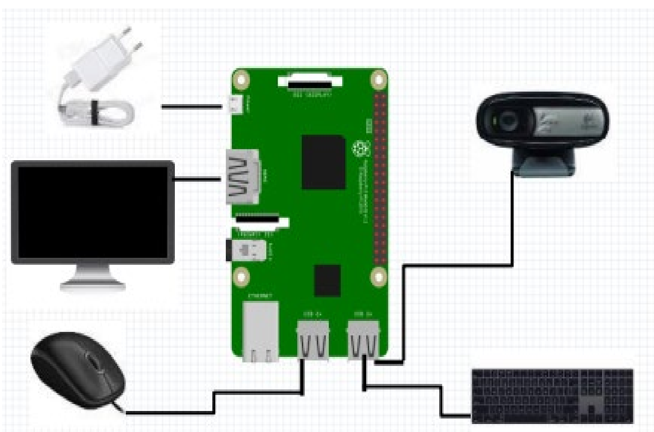

Fig. 1 Proposed System Circuit Diagram

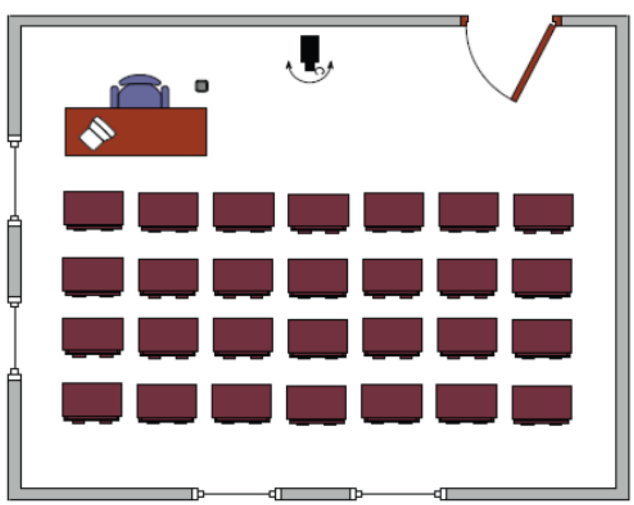

Fig. 2 Proposed System Structure

Figure 2 represents the schematic representation of the attendance monitoring system and its application within a specific classroom context. Notably, the inclusion of a teacher's desk, positioned to face the students, exempts the teacher from being considered as a student in the attendance tracking process. A camera is strategically positioned at the center of the classroom, set at an optimal height to capture a comprehensive view of the entire class, extending to the last bench.

Once the students are seated, the camera captures an initial image, initiating the face detection process employing the methodologies detailed in the earlier sections. Following this, the system autonomously generates a dedicated folder within the database for the recognition of the seated students. Utilizing pre-existing images stored in the database for each student, the program proceeds with image recognition.

During operation, the system retrieves and compares these stored images against real-time captured data. The comparison is conducted for each entry in the database, determining the presence or absence of the student in the class. In instances where no match is found, the program seamlessly advances to analyse the next image in sequence, systematically checking the entire database until the attendance status of all students is determined.

IV. WORKING SYSTEM

Our methodology employs the Haar features and the AdaBoost classifier for execution. We are currently developing a Graphical User Interface (GUI) that will save the names and roll numbers of each student in a specified file.

At the same time, while collecting student information, we compile a dataset containing images of student faces, preserving it in an assigned folder. Subsequently, the trained images are also archived in a folder, playing a crucial role in the subsequent face recognition process.

In a real-time setting, a strategically positioned camera near the classroom door continuously captures live data. The camera extracts images from its live stream, comparing them with the ones stored during registration. Upon detecting a match, the system presents the student's name and roll number on the identified or recognized face. This information is automatically logged in an attendance sheet, complete with the date and time. Images that do not yield matches are stored in a designated unknown folder. This attendance system serves as a valuable tool for faculty members, facilitating effortless tracking of student attendance for each lecture, along with corresponding time-stamps.

The suggested system is flexible and can accommodate diverse attendance scenarios, such as laboratory attendance, government office attendance, institutional/organizational attendance, and library attendance.

The collected data is systematically stored in a file. Subsequently, we generate a dataset comprising student faces and conduct training. The application of face recognition techniques, specifically Haar features and the AdaBoost classifier, follows. Live images are captured from a video stream and saved in a designated file. During storage, the system cross-references these images with registered students. In case of a match, the system marks the student as present, simultaneously logging the time and date. If no match is found, the image is archived in an unknown file.

A smart attendance system using face recognition is a sophisticated solution that leverages advanced technology to streamline the attendance tracking process. This system employs facial recognition algorithms to identify and authenticate individuals, eliminating the need for traditional methods like manual roll calls or card swiping. A working system typically consists of a camera or a set of cameras strategically placed to capture facial images, which are then processed by the facial recognition software.

The system compares the captured faces with a pre-existing database of authorized individuals, accurately marking attendance for those recognized. This not only enhances accuracy and efficiency but also provides real-time monitoring and reporting capabilities. Additionally, the system can incorporate features such as access control, ensuring that only authorized individuals gain entry. In general, a face recognition-based smart attendance system provides a dependable, secure, and convenient solution for contemporary attendance management across diverse settings, including educational institutions and corporate environments.

The operational structure of our face recognition-based smart attendance system is crafted to ensure smooth and effective attendance management. Utilizing state-of-the-art technology, our system employs advanced algorithms, including Haar features and the AdaBoost classifier, to precisely detect and recognize faces. The core of this system is a Graphical User Interface (GUI) that streamlines the process, allowing for the swift capture of facial images, dataset creation, and one-click training. As a student's face is recognized, the system automatically records pertinent information, including the student's name and roll number, in an organized file along with the corresponding date and time. This automated approach eliminates the challenges associated with traditional methods, providing a streamlined and accurate solution for attendance tracking in educational institutions.

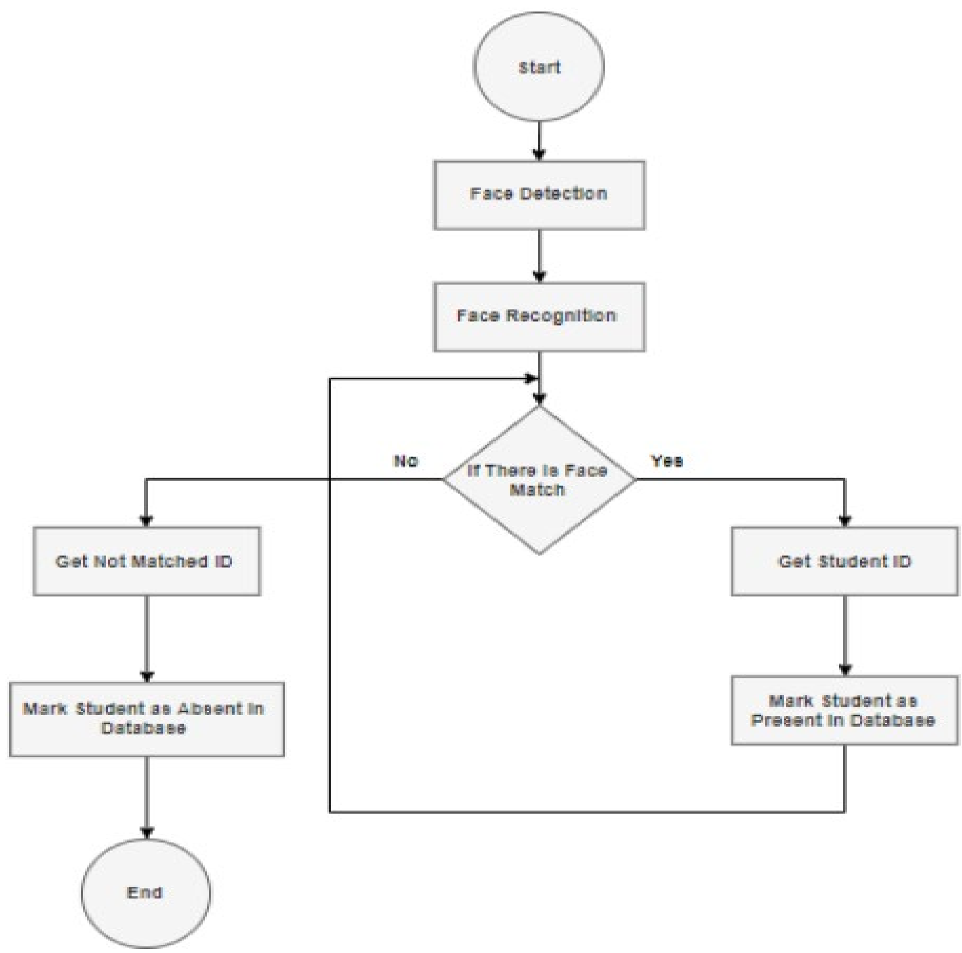

Fig. 3 Flowchart for Proposed System

A. Classroom Attendance System using Face Recognition

To track an image, users can click on the “Track Image” icon, revealing the name and ID of the detected student on their face. This information is then stored in the database by clicking on the “Quit” icon, resulting in the creation of an Excel file containing details of present students. The system’s operation can be understood through various scenarios as follows.

1. Single Student Entry

When a single student enters the classroom, the camera captures their image. This image is then trained to recognize the student’s face based on stored images in the dataset. Recognition generates an Excel file containing information such as the student’s name, roll number, date, and time. The system marks the student as present, fulfilling its primary objective of recording attendance for the present students.

2. Multiple Students Entering Simultaneously

In the scenario where multiple students enter the classroom simultaneously, the system functions seamlessly. During entry, it has the capability to detect or recognize multiple faces simultaneously and display the names of the recognized students. Upon successful recognition, selecting the exit button triggers an attendance notification within the attendance box. This attendance data is automatically recorded in the attendance sheet, capturing details such as the student’s ID, name, date, and time. Whether students enter the class individually or in groups, their recognition triggers the storage of attendance details in the system, associating their ID and name with the current date and time.

V. ADVANTAGES OF THE STUDY

1. The system has the capability to manage extensive databases and accommodate a large number of images for training purposes.
2. The algorithm employed in this system boasts higher accuracy compared to alternative algorithms.
3. It can accurately capture images from a distance ranging between 60 to 80 centimeters.
4. In the event of a student mistakenly entering multiple roll numbers during face recognition, the system displays all roll numbers in the output.
5. The system operates without the need for network connectivity, eliminating potential issues related to network connectivity.
6. The time consumption for creating a dataset and training images is minimal.
7. The system minimizes human and machine direct interface, reducing errors and significantly enhancing accuracy.
8. It is straightforward to operate the system, ensuring simplicity coupled with high accuracy in student attendance tracking.
9. The system effectively handles multiple faces, ensuring successful attendance updates.
10. The image capturing speed is commendable, capturing images seamlessly without any interruptions.

VI. CONCLUSION

This system is designed to revolutionize attendance management across various domains: schools, colleges, organizations, institutions, and companies. By capturing live images through cameras and employing advanced face detection and recognition techniques, it aims to streamline and modernize traditional attendance processes. Our solution involves creating an interface to generate a dataset, training images using Haar Cascade and AdaBoost classifiers. Once training is complete, the system effectively identifies and distinguishes between faces and non-faces. Matching stored images with captured ones automatically updates the attendance sheet with the respective time and date, providing faculty members with a convenient way to monitor students’ arrival times. Additionally, the paper proposes an innovative algorithm based on Convolutional Neural Networks (CNN) for face detection and recognition, showcasing superior performance compared to traditional methods. The goal is to introduce an automatic attendance system that minimizes human errors inherent in conventional methods. This proposed algorithm aims to automate systems and implement smart classrooms beneficial for educational institutions. It leverages Faster Region Convolutional Neural Networks in conjunction with Edge technology to enhance efficiency and accuracy. Advanced computing techniques have been instrumental in achieving cutting-edge results. Our system successfully identified 30 out of 35 faces detected, showcasing a commendable accuracy rate. However, further improvements could be attained by capturing clearer images of students. Despite achieving higher accuracy, the primary limitation lies in distance. As the distance increases, image clarity diminishes, leading to occasional false results, particularly on blurry faces. The system operates at its best when capturing images from a distance of approximately 20-25 feet. Despite this, the current results show great promise and encouragement. To improve data latency and response time between devices, we have incorporated edge computing techniques.. This method not only ensures security and reliability but also simplifies usability without the need for additional hardware or software components. Our system is currently integrated with the Learning Management Systems (LMS) of various educational institutes. Looking ahead, our focus is on fortifying the system’s robustness by addressing specific challenges like tilted faces, facial hair such as Mustaches and beards. Moreover, our future endeavours include exploring behavioural observations based on our face recognition algorithm, particularly in delineating introvert and extrovert behaviours. These avenues represent the next phase of development for our system.

REFERENCES

[1] H. Li, K. Ota, and M. Dong, “Learning IoT in edge: Deep learning for the Internet of Things with edge computing,” *IEEE Netw.*, vol. 32, no. 1, pp. 96-101, Jan-Feb. 2018.

[2] W. Shi, J. Cao, Q. Zhang, Y. Li, and L. Xu, "Edge computing: Vision and challenges," *IEEE Internet Things J.*, vol. 3, no. 5, pp. 637-646, Oct. 2016.

[3] G. B. Huang, M. Mattar, T. Berg, and E. Learned–Miller, "Labelled faces in the wild: A database for studying face recognition in unconstrained environments," in *Proc. Workshop Faces 'Real-Life' Images, Detection, Alignment, Recognition.*, pp. 1-11, Oct. 2008.

[4] R. G. Cinbis, J. J. Verbeek, and C. Schmid, "Unsupervised metric learning for face identification in TV video," in *Proc. ICCV*, pp. 1559-1566, Nov. 2011.

[5] C. Lu and X. Tang, "Surpassing human-level face verification performance on LFW with Gaussian face," in *Proc. AAAI*, pp. 2307-2319, 2015.

[6] J. Sivic, M. Everingham, and A. Zisserman, "Person spotting: Video shot retrieval for face sets," in *Proc. CIVR*, pp. 226-236, 2005.

[7] L. Wolf, T. Hassner, and I. Maoz, "Face recognition in unconstrained videos with matched background similarity," in *Proc. CVPR*, pp. 529-534, Jun. 2011.

[8] O. M. Parkhi, K. Simonyan, A. Vedaldi, and A. Zisserman, "A compact and discriminative face track descriptor," in *Proc. CVPR*, pp. 1693-1700, Jun. 2014.

[9] K. Simonyan, O. M. Parkhi, A. Vedaldi, and A. Zisserman, "Fisher vector faces in the wild," in *Proc. BMVC*, pp. 4, 2013.

[10] J. Sivic, M. Everingham, and A. Zisserman, "'Who are you?' - Learning person-specific classifiers from video," in *Proc. CVPR*, pp. 1145-1152, Jun. 2009.

[11] D. Chen, X. Cao, L. Wang, F. Wen, and J. Sun, "Bayesian face revisited: A joint formulation," in *Proc. Eur. Conf. Comput. Vis.*, Berlin, Germany: Springer, pp. 566-579, Oct. 2012.

[12] C. Lu and X. Tang, "Surpassing human-level face verification performance on LFW with Gaussian face," in *Proc. AAAI*, pp. 3811-3819, Mar. 2015.

[13] O. M. Parkhi, A. Vedaldi, and A. Zisserman, "Deep face recognition," in *Proc. BMVC,* vol. 1, no. 3, pp. 6, Sep. 2015.

[14] F. Schroff, D. Kalenichenko, and J. Philbin, "FaceNet: A unified embedding for face recognition and clustering," in *Proc. IEEE Conf. Compute. Vis. Pattern Recognition.*, pp. 815-823, Jun. 2015.

[15] Z. Liu, P. Luo, X. Wang, and X. Tang, "Deep learning face attributes in the wild," in *Proc. IEEE Int. Conf. Compute. Vis.*, pp. 3730-3738, Dec. 2015.

[16] Y. Wu, T. Hassner, K. Kim, G. Medioni, and P. Natarajan, "Facial landmark detection with tweaked convolutional neural networks," in *Proc. IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 40, no. 12, pp. 3067-3074, Dec. 2018.

[17] Y. Sun, D. Liang, X. Wang, and X. Tang, "DeepID3: Face recognition with very deep neural networks," Feb. 2015, *arXiv:1502.00873*. [Online]. Available: https://arxiv.org/abs/1502.00873.

[18] Y. Taigman, M. Yang, M. Ranzato, and L. Wolf, "Deep Face: Closing the gap to human-level performance in face verification," in *Proc. IEEE Conf. Compute. Vis. Pattern Recognition*, pp. 1701-1708, Jun. 2014.

[19] Y. Sun, X. Wang, and X. Tang, "Deep learning face representation from predicting 10,000 classes," in *Proc. IEEE Conf. Comput. Vis. Pattern Recognition*, pp. 1891-1898, Jun. 2014.

[20] Y. Taigan, M. Yang, M. Ranzato, and L. Wolf, "Web-scale training for face identification," in *Proc. IEEE Conf. Compute. Vis. Pattern Recognition*, pp. 2746-2754, Jun. 2015.