Apex Journal of Business and Management
Volume 01, Issue 01, 2023. PP. 103-120
https://doi.org/10.61274/apxc.2023.v01i01.008
Research Article

An Automated Attendance System Using Facial Detection and Recognition Technology

Phul Babu Jha[1], Arjun Basnet[2], Biraj Pokhrel[3], Bishnu Pokhrel[4], Gopal Kumar Thakur[5] & Surya Chhetri[6]

[1,] *Assistant Professor, Madan Bhandari Memorial College, Kathmandu, Nepal*

[2, 3,4] *B.Sc. CSIT Scholars, Madan Bhandari Memorial College, Kathmandu, Nepal*

[5]*Software Engineer, Axle IT Inc, USA*

[6]*Walden University, Minnesota, USA*

ARTICLE INFO

Corresponding Author
Phul Babu Jha

Email
head_schoolsot@mbmc.edu.np

Article History
Received: 17 July 2023
Accepted: 24 August 2023

Orcid
https://orcid.org/0009-0001-3645-5678

Cite
Jha, P.B., Basnet, A., Pokhrel, B, Pokhrel, B., Thakur, G.K., & Chhetri, S. (2023). An Automated Attendance System Using Facial Detection and Recognition Technology. *Apex Journal of Business and Management (AJBM)*. 1(1), 103-120.
https://doi.org/10.5281/zenodo.8402721

ABSTRACT

The proposed system utilizes Haar Cascade algorithms for facial detection and recognition. The system accurately detects and recognizes individuals based on their unique facial features. Facial detection algorithms identify and extract facial regions from input images or video frames, isolating the necessary facial details for further analysis. Subsequently, facial recognition algorithms, LBPH, compare these features with pre-registered faces stored in the system's database, calculating confidence scores to determine individual identities.The system incorporates a user-friendly interface, enabling administrators to easily manage attendance records. They can effortlessly add or remove students from the system's database, access attendance reports, and monitor real-time attendance data.

The proposed Attendance Management System revolutionizes the conventional attendance tracking process by offering enhanced accuracy, efficiency, and security while providing real-time monitoring and comprehensive reporting capabilities. With the potential for adoption in various educational institutions, organizations, and industries, this system represents a significant advancement toward streamlined and intelligent attendance management.

Keywords: *face detection, face recognition, attendance, LBPH*

Introduction

Automated attendance systems using facial detection and recognition technology have been developed and implemented in various environments such as educational institutions, workplaces, and event venues. These systems utilize biometric data, specifically facial features, to identify individuals and monitor their attendance, offering higher accuracy and efficiency compared to traditional approaches like sign-in sheets or roll calls (Omari, & Jardat, 2020; Mishra, et al., 2022).

One proposed system for automated attendance tracking in classroom settings captures students' images upon entering the classroom and employs a facial recognition algorithm to identify and record their attendance. This system is designed to be user-friendly and efficient, utilizing commonly available devices. By continuously analyzing

facial information, this method aims to enhance the accuracy and efficiency of existing attendance tracking methods (Akbar, Md Sajid, et al., 2018; Hairis, et. al, 1997; Anitha, G. et al., 2020).

Facial detection and recognition technology has the potential to transform conventional attendance tracking methods by offering higher accuracy and efficiency. However, there are potential challenges and concerns associated with using this technology, such as privacy concerns and the potential for bias in the recognition algorithms. These concerns must be addressed to ensure the ethical and responsible use of this technology (Gornale & Kiran, 2020; Bhagat, et al., 2022; EUDL, 2018; EUDL, 2022).

Overall, automated attendance systems utilizing facial detection and recognition technology represent a significant advancement toward streamlined and intelligent attendance management in various environments. Further research and development are needed to address potential challenges and concerns associated with this technology and ensure its ethical and responsible use.

Problem Statement

Marking attendance in a classroom during lectures can be tedious and time-consuming, especially when dealing with many students. The traditional methods of attendance marking are vulnerable to proxy attendance, making it challenging to maintain accurate records. To address these issues, a facial recognition-based student attendance system is proposed as a replacement for manual attendance marking, which can be burdensome and cause distractions for students. The system aims to simplify the attendance marking process and save time by using face detection and recognition algorithms (Anitha, G., et al., 2020; Hapani, Smit, et al., 2018; Jayaswal, R., & Dixit, M., 2020).

The following are the key points to consider when developing a facial recognition-based student attendance system:

The system should eliminate traditional techniques such as calling out names, a fingerprint-based system, or checking identification cards, which not only disrupt the teaching process but also create distractions for students, particularly during exam sessions (Jha, et al., 2023: Jones, B., 2021; Kamencay, P., et al., 2017).

Attendance sheets being passed around the classroom can also be complicated, especially in large lecture classes (Lukas, samuel, et al., 2016; Truk and Pentland, 1991).

The issues with fingerprint-based attendance systems include inaccurate recognition, hygiene concerns, complex setup and maintenance, privacy risks, and compatibility limitations, hindering their reliability and effectiveness (Okokpujie, Kennedy O., et al., 2017).

The development of a real-time student attendance system is necessary, ensuring that the identification process is performed within defined time constraints to avoid omissions (Onur, & Bahar, 2016; Kamencay, et. al., 2017).

The extracted facial features, which serve as the student's identity representation, should remain consistent despite variations in background, lighting conditions, pose, and facial expressions.

The performance of the system will be evaluated based on high accuracy and fast computation time.

Research Objective

To develop an automated attendance system using facial detection and recognition technology that can detect the face segment from the camera frame, extract useful features from the face detected, classify the features to recognize the face detected, record the attendance of the identified student, and filter and save the report of attendance details for 30 days of a particular student.

Methodology

The incremental methodology is chosen for this project as the requirements for the project are known, defined as well as understood. As the methodology supports the process of design, implementation, and testing with each increment added over the course of time, increment methodology would be a great

fit for the project as face detection and recognition task needs a lot of hit and trial in order to fulfill the proposed requirements and functionalities of the aimed project as well as to achieve good accuracy. However, in the making process of the system, some minor features can be added but as the main requirements are understood this methodology is a great fit (Jain, A.K., Ross A. & Hong, L. 2002).

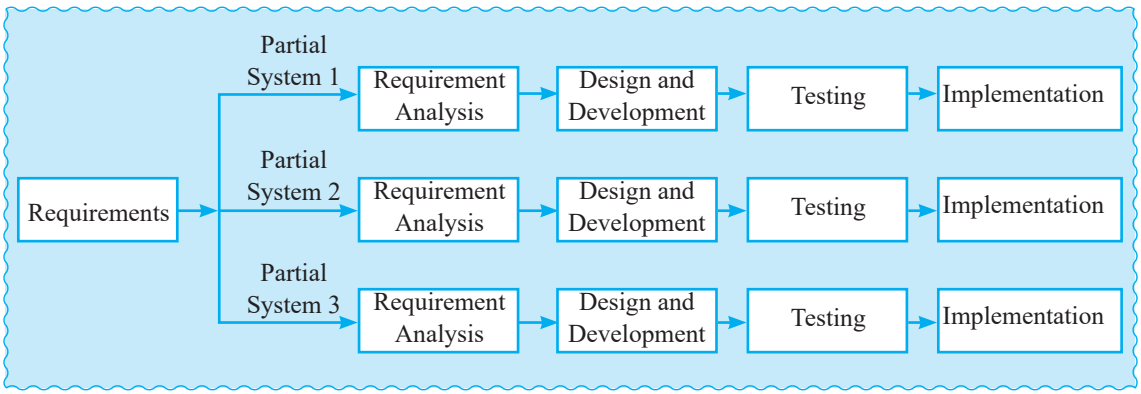

Figure 1: Block Diagram of Incremental Model

The main requirement of the attendance system is to be able to input photo in the system and get classification/attendance as output. Based on this, the system development is broken down into many partial development projects. These partial system development projects were:

- The development of the system that takes the images as input and passes it to the model.
- The system that takes an image as the input and passes it to the model.
- The system that takes the output generated by the model and gives an output result.

Face Detection

Facial detection is a computer vision technique that involves identifying and locating human faces in images or video streams. It uses algorithms to detect facial landmarks and distinguish faces from other objects or backgrounds. Several methods are used for facial detection, including Haar cascade, Support Vector Machines (SVMs), and Convolutional Neural Networks (CNN). These methods analyze visual patterns, geometric features, and texture information to accurately detect faces in real-time (Bhola P. & Jones M.J., 2001).

Face Recognition

Facial recognition is an advanced technology that goes beyond facial detection by identifying and verifying an individual's identity based on their facial features. It involves capturing facial images or video frames, extracting unique facial attributes, and matching them against a pre-existing database of known individuals. Various approaches are used for facial recognition, such as Eigenfaces, Fisherfaces, Local Binary Patterns Histogram (LBPH), and Deep Learning-based methods (e.g. Convolutional Neural Networks). These methods enable high accuracy and robustness in recognizing individuals across different poses, expressions, and lighting conditions (Truk M. & Pentland, A., 2001).

An Automated Attendance System

Facial detection and recognition technology provides a robust and efficient solution for developing online attendance systems. By leveraging computer vision algorithms and deep learning techniques, these systems enable accurate identification and tracking of individuals, ensuring a streamlined and secure attendance management process. As the technology continues to evolve, it holds immense potential for enhancing attendance tracking across various sectors and promoting a more efficient and reliable environment. Integrating

facial detection and recognition technology into an online attendance system offers several advantages. First and foremost, it eliminates the need for manual check-ins, saving time and reducing administrative efforts. Students or employees can simply present their faces to a camera or webcam, and the system will automatically detect and recognize their identities. This process ensures a streamlined and contactless attendance experience (Wang, Y., Wang H. & Zhang, Y., 2021)

Literature Review

Face recognition is a technology created by Woodrow Wilson Bleadsoe in 1966 that works to match human faces through digital images or video footage through a facial database. Face recognition became an idea to allow computers to find and recognize human faces quickly and precisely. Many algorithms have been developed to improve the performance of face recognition (Jayaswal, R. & . Dixit, M., 2020)

In general, facial recognition algorithms are divided into two: algorithms whose facial features are regulated by humans and algorithms that let the system choose the best facial features themselves. Good face recognition can contribute to high feature extraction, and better classification. Currently, face recognition can be used for many things, one of which is student attendance at universities (Kamencay, P., Benco, M., Mizdos, T & Radil, R., 2017). Face recognition can improve and manage the attendance system, reduce errors in the manual recording process by providing an automatic and reliable attendance system, increase privacy and security, prevent fake attendance, and provide regular attendance reports (Anitha, G., Devi, P., Sri, J. & Priyanka, D., 2020). Such face recognition can be used to save time for educators and students and to stop false attendance. The steps taken in facial recognition include recording student videos, converting them into frames, connecting them to a database to ensure their presence or absence, and marking the presence of certain students to maintain records. All the data will be stored and displayed using the display screen. One of the examples is a web page (Gornale, B & Kiran, P., 2020). In general, the use of an attendance system with facial recognition is influenced by many things, such as the database and algorithm. Research suggests providing more precise specifications on our database to improve the training of our facial recognition system. In addition, in the paper, the data/images that we enter in the database affect our facial recognition systems, such as the use of makeup, glasses, or hairstyle changes (Sylaj, 2019). The traditional algorithm widely used is LBPH, a combination of LBP with an Oriented Gradient Histogram (HOG). Local Binary Patterns (LBP) is a visual descriptor used for computer vision classification. LBP was first described in 1994 by Timo Ojala and David Harwood at the University of Maryland and has since been found to be a powerful feature for texture classification. This amalgamation significantly improves the detection performance across multiple data sets (Khan, M.A. et al. 2014). According to Sanyukta Santosh Pawaskar and Ashwini Mandar Chavan, performing attendance automatically using face recognition and detection algorithms such as LBPH and Haar Cascade is a reliable and efficient system. Haar Cascade provides a high degree of accuracy regardless of lighting. The system can provide an accuracy of about 96.68%. In the paper, it can be seen that the accuracy of LBPH has been seen to be superior to the other two facial recognition algorithms whose facial features are set by humans (Eigenface, Fisherface; Chavan, A.M. et al., 2019).

According to Mohd Suhairi Md Suhaimin et al., LBPH outperformed Eigenfaces for face recognition with 100% accuracy compared to Eigenfaces which only got 73.3%. According to Onur Sanli and Bahar Ilgen, Face recognition using PCA and Viola-Jones algorithms obtained from 10 images of students' faces showed 75-95% results. In the paper, when the three face recognition algorithms (LBPH, Eigenface, Fisherface) were compared with external factors, such as expression, angle, position, light, and other factors, the LBPH algorithm itself was still superior to the other facial recognition algorithms whose facial features are set by humans (Eigenface, Fisherface) (Suhaimin, M.S.M., et al., 2012).

The Face Recognition algorithm that we know is divided into two: algorithms that work traditionally and algorithms that use deep learning. The working principle of the traditional method is to take an image as input, then resize the image to fit the algorithm. After that, the image that was originally RGB will be changed to gray or according to the filter in the algorithm. Then, a face detection algorithm is needed so that the face recognition algorithm can recognize the faces that are successfully detected, the datasets were obtained from the predefined number of the image that was taken by the camera. A comparison of the accuracy between traditional facial recognition algorithms from research of several papers is for LBPH to get 86.47% accuracy, Eigenfaces get 15.09% accuracy, Fisherfaces gets 36.4% accuracy. the LBPH algorithm is proven better than the fisherface and eigenface algorithms. Furthermore, it has been explained in that the LBPH Algorithm's accuracy is better than the other because the LBPH Algorithm can recognize not only the front face but also the side face and also the faces under any light (S. Onur & I. Bahar, 2016). After the successful review of the literature, we conclude to use the Haar cascade algorithm for face detection and the LBPH algorithm for face recognition (Vola & Jones, 2001; Jaiswal and Dixit, 2020; Pokhrel, et al., 2021; Rathod, et al., 2017).

Existing System

Register-Based Attendance System

A register-based attendance system is a commonly used method for monitoring attendance, where individuals are required to physically sign a register or logbook upon arrival at a specific location. This approach is widely employed in various settings such as schools, workplaces, events, or any situation where it is crucial to keep track of the individuals present at a given time. In a register-based attendance system, individuals typically provide their signature, along with the date and time of their arrival. Sometimes, additional information such as the purpose of their visit or the duration of their stay may also be recorded. The completed register serves as a record of attendance, providing insights into who was present at a particular time.

The primary advantage of a register-based attendance system is its simplicity and low-tech nature, as it only requires basic tools such as pen and paper or digital equivalents. Moreover, it is a cost-effective solution that can be easily implemented and maintained. However, there are some drawbacks associated with this method. It can be time-consuming for individuals to sign the register, and there is a risk of errors or fraudulent activities if the register is not properly managed or if individuals sign in on behalf of others. Nonetheless, the register-based approach remains a popular choice for attendance tracking in various environments (Omari, & Jaradat, 2020).

Fingerprint-Based Attendance System

A fingerprint-based attendance system is a widely adopted approach for monitoring attendance, where individuals are required to scan their fingerprints to register their presence at a specific location. This system finds applications in schools, workplaces, and other environments where accurate attendance tracking is crucial.

In a fingerprint-based attendance system, individual place their finger on a fingerprint scanner, which captures and analyzes the unique patterns of their fingerprint. The captured fingerprint is then compared to a database of stored fingerprints to identify the individual and verify their identity. Once the identification process is successful, the system records their attendance and updates its records accordingly (Hari, et al., 1997; Onur & Bahar, 2016).

One notable advantage of a fingerprint-based attendance system is its high level of accuracy and difficulty to counterfeit, as fingerprints are distinct for each individual. Moreover, the process is relatively quick and efficient, as individuals only need to place their finger on the scanner to register their attendance. However, it is important to note that implementing and maintaining a fingerprint-based system may involve higher costs compared to other attendance tracking methods. Additionally, concerns regarding privacy and the potential misuse of fingerprint data may arise among some individuals.

Problem with the Existing System

The register-based attendance system suffers from drawbacks such as time-consuming sign-in processes for individuals and a higher risk of errors and inconsistencies in the recorded data. Additionally, the manual nature of this system makes it susceptible to fraudulent activities, where individuals can sign in on behalf of others.

Similarly, fingerprint-based attendance systems have their own set of challenges. They may encounter issues with unreadable fingerprints due to factors like dry or damaged skin, affecting the accuracy of attendance tracking. Technical problems with the fingerprint scanners can also hinder the system's performance. Moreover, privacy concerns arise from the collection and storage of individuals' biometric data, as it raises questions about data security and potential misuse (Jones, 2021).

Requirement Analysis

Attendance system using Face Detection and Recognition is a desktop-based system to detect faces to help in attendance of students in a classroom. It primarily focuses on the detection of faces with a higher level of accuracy. The requirement of this project is given with reference to (Sai, E., et al., 2021; Salim, et al., 2018; Siswanto, et al., 2014; Wang, Y. et al., 2021).

- System Camera
- Student Details
- Photo Sample of the Student

These are the basic requirements of the project. Also, there are various functional and non-functional requirements of this particular project, An Automated Attendance System using Face detection and Face Recognition.

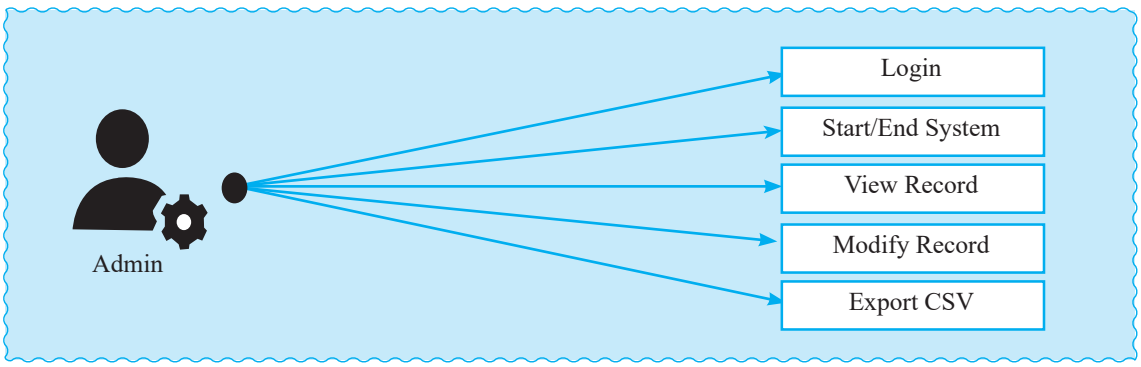

Figure 2: Use-Case Diagram of An Automated Attendance System

Analysis

This system is developed based on the Object-Oriented Approach. In this analysis phase, necessary Class and Object Diagrams using Object modelling, State and Sequence Diagrams using Dynamic modelling, Activity Diagrams using Process modelling are designed for the proper analysis of the system.

Analysis

This system is developed based on the Object-Oriented Approach. In this analysis phase, necessary Class and Object Diagrams using Object modeling, State and Sequence Diagrams using Dynamic modelling, Activity Diagrams using Process modelling are designed for the proper analysis of the system.

Class Diagram

A class diagram is a visual representation of the structure and relationships of classes in an object-oriented system. It shows the classes, their attributes, methods, and relationships with other classes. It helps in understanding the system's organization and facilitates communication among stakeholders and developers (Mishra, et al., 2022; Jha, et al., 2023) Mishra, et al., 2023; Pokhrel, et. al., 2021; Rathod, et al., 2017; Onur and Bahar, 2016).

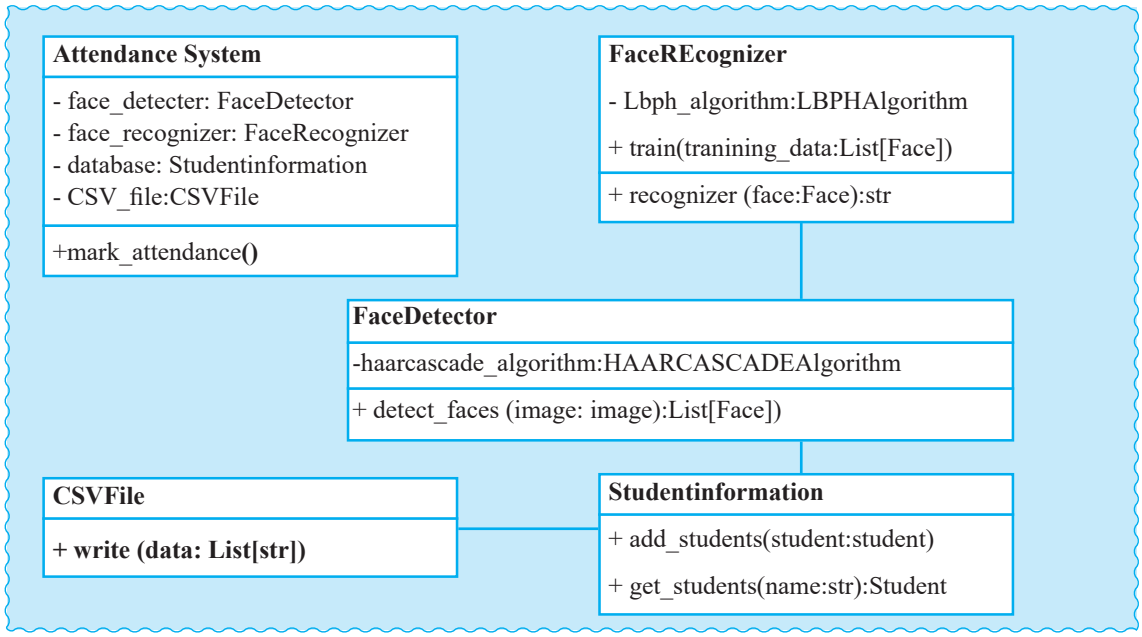

Figure 3: Class Diagram of an Automated Attendance System

Activity Diagram

An activity diagram is a visual representation that shows the flow and sequence of activities or actions within a system or process. It helps understand the order of activities, decisions, and the control flow between them. Activity diagrams are useful for modeling business processes and software workflows, aiding in communication and identifying

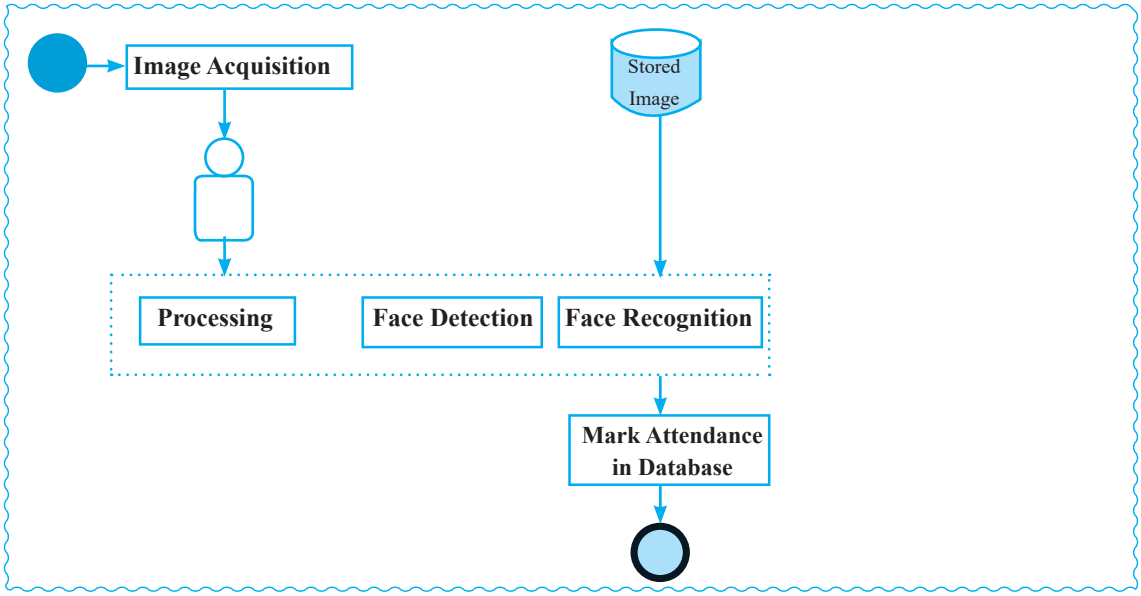

Figure 4: Activity Diagram of an Automated Attendance System

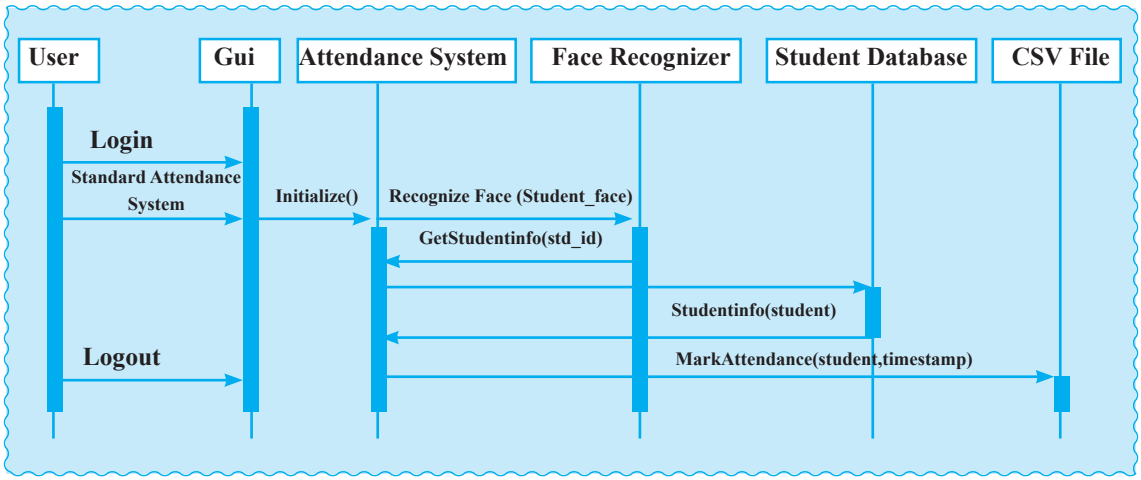

Figure 5: Sequence Diagram of an Automated Attendance System

Sequence Diagram

A sequence diagram is a visual representation that illustrates the interactions and message flow between objects or components in a system. It shows the chronological order of events and how different entities communicate with each other. Sequence diagrams help in understanding the dynamic behavior of a system and ensure effective collaboration between components.

Design

Design is not about how it looks like, but how it works. First of all, the system take input from the use and preprocesses the input. The preprocessing phase includes face detection, passing the detected faces to the model etc. The system then performs recognition on the input generated after preprocessing.

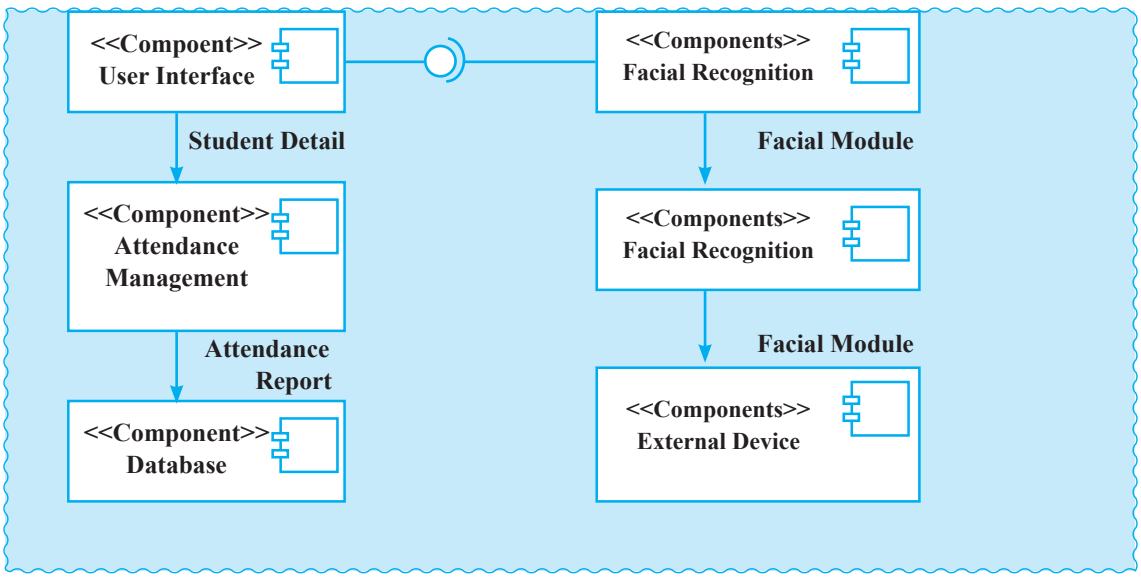

Figure 6: Component Diagram of an Attendance System

Algorithm Details

The project will implement two algorithms namely Haar Cascade and LBPH algorithms. Haar cascade algorithm is used for face detection and LBPH algorithm for face recognition. After successful review of the literature we concluded to make the use of Haar cascade and LBPH collaboratively for better accuracy and faster processing.

Haar Cascade Algorithm

The Haar cascade algorithm is a machine learning-based object detection method used to identify and locate objects within images or video frames. It is widely used for tasks such as face detection, pedestrian detection, and object detection.

The algorithm works by training a classifier using positive and negative samples. Positive samples contain images or examples of the object we want to detect, while negative samples contain images without the object. During the training process, the algorithm extracts Haar-features from these samples. Haar-like features are simple rectangular patterns that capture contrast differences in the image. They can represent various aspects like edges, lines, and textures. These features are calculated at different scales and positions in the image, creating a feature vector that is fed into a classifier.

During the training phase, the algorithm iteratively selects the best features and adjusts their weights to accurately classify positive and negative samples. This process creates a strong classifier capable of distinguishing the object of interest from the background.

Once the classifier is trained, it can be used to detect the object in new images or video frames. This is done by sliding a window of different sizes across the image and applying the classifier to each window. If the window matches the object's characteristics, it is considered a detection].

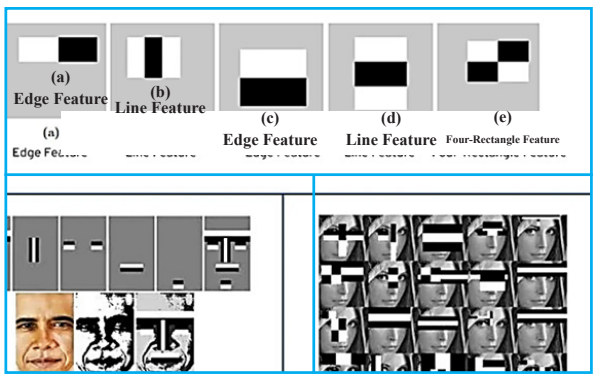

*Figure 7: The matrix of the threshold of 3*3 of LBPH*

Advantages

- **Efficiency:** It efficiently rejects non-object regions, enabling real-time applications.
- **Robustness:** It handles variations in lighting, object orientations, and backgrounds.
- **Training:** It learns from positive and negative samples to distinguish objects.
- **Multiple Objects:** It can detect multiple objects simultaneously.
- **Pre-Trained Models:** Pre-trained models are available for common objects.
- **Adaptability:** It can be trained for specific object detection tasks.

Local Binary Patterns Histogram

For the training purpose of the dataset of the facial images of the people to be recognized along with the Unique ID is required so that the presented approach will utilize the provided information for receiving an input image and providing the output. Same images require same ID. Facial image is converted into gray scale. A 3x3 pixels window is taken which can also be expressed as

a 3x3 matrix which contains the intensity of each pixel (0-255). After this we consider the central value of the matrix which we take as the threshold. This value defines the new values obtained from the 8 neighbors. A new binary value is set for each neighbor of the central value. For the values equal to or greater than the threshold value 1 will be the output otherwise 0 will be the output. Only binary values will be present in the matrix and the concatenation is performed at each position to get new values at each position. Then the conversion of this binary value into a decimal value is done which is made the central value of the matrix.

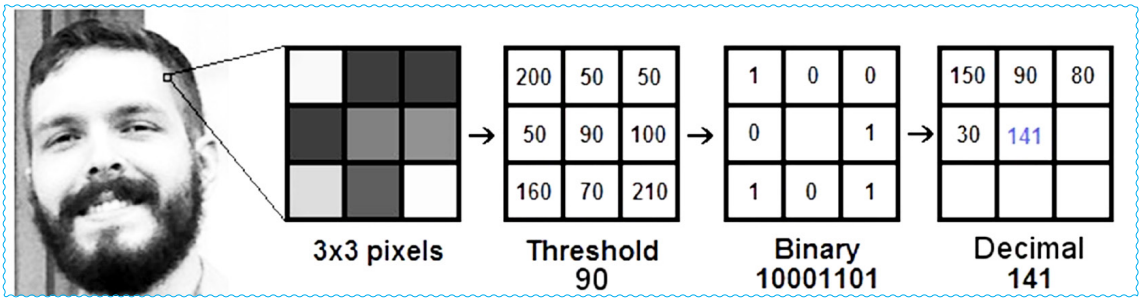

*Figure 8: The matrix of the threshold of 3*3 of LBPH*

Advantages

- It is one of the simplest algorithms for face recognition.
- The local features of the images can be characterized by this algorithm.
- Using this algorithm, considerable results can be obtained.
- Open CV library is used to implement LBPH algorithm.

Extraction of Histogram

The image obtained in the previous step uses the Grid X and Grid Y parameters and the image is split into multiple grids. The training of the algorithm is done. For finding the image which is same as the input image, the two histograms are compared and the image corresponding to the nearest histogram is returned. The result is to show the ID of the image which has the nearest histograms. It should return the distance calculated in the form of 'confidence'. Then the threshold and the confidence can be used automatically to evaluate if the image is correctly recognized. If the confidence is less than the given threshold value, it implies that the image has been well recognized by the algorithm.

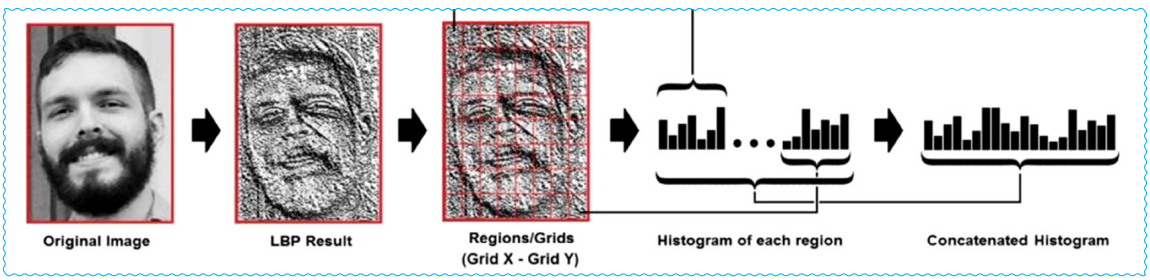

Figure 9: Extracting the Histogram from the sample

So, for example: Arjun will be the user with id = 0; Biraj: id=1, etc. Next, we will detect a face, same we did before with the Haar Cascade classifier. The recognizer Predict (), will take as a parameter a captured portion of the face to be analyzed and will return its probable owner, indicating its id

and how much confidence the recognizer is in relation with this match. Note that the confidence index will return "zero" if it will be considered a perfect match. And at last, if the recognizer could predict a face, we put a text over the image with the probable id and how much is the "probability" in % that the match is correct ("probability" = 100 — confidence index). If not, an "unknown" label is put on the face block.

Implementation

The process starts with training the system with face of students for whom the attendance has to be marked in the near future. Different faces are assigned different names in the system. Algorithms such as Eigenface, Fisherface and LBPH can be used in varying light scenarios, as light plays an important role in image processing. Also, a webcam with high specifications should be used as it plays a key role in face detection and recognition. Hence, the better is the webcam used, the more is the efficiency in the system attained.

Although the process of documentation proceeds throughout the Lifecycle, it receives formal attention during the implementation phase. This form of document is prepared to reveal the information accumulated about the system during development and implementation of this system. Finally, this phase ensured that the system meet all the specifications and objectives developed in earlier project phases. The tools and technologies used to implement this project are briefly discussed on the following section.

CASE Tools

Server Side : Python programming language was used as the server-side programming language. OS is used for file handling. NumPy and OpenCV were used for array processing and data framing respectively

Client Side: Tkinter Library of the Python was used for making GUI.

Hardware Components: Laptop camera was used to capture the images. External memory used to save the sample images of the students.

Software Components: S Code IDE was used for developing the application. Canva was used to make the necessary logos for the application. Draw.io was used for making the necessary diagrams such as class diagram, activity diagram, use case diagram etc.

Database Platform: My SQL database was used for storing the student information and fetching the attendance details.

Implementation Detail of Modules

- Student Management Module

Table 1: Implementation Details of the Student Management Module

Purpose	This module is responsible for collecting facial images of individuals for training and identification purposes.
Dependencies	None
Input	Webcam or camera device for capturing facial images
output	Facial images in a standardized format (e.g., JPEG)

Preprocessing Module

Table 2: Implementation details of the Preprocessing Module

Purpose	This module processes the collected facial images to enhance their quality and prepare them for recognition.
Dependencies	Student Management Module
Input	Facial images
output	Preprocessed facial images

Face Detection Module

Table 3: Implementation Details of the Face Detection Module

Purpose	This module detects and localizes human faces within the preprocessed images.
Dependencies	Preprocessing Module
Input	Preprocessed facial images
Output	Coordinates of detected faces within the images

Face Recognition Module

Table 4: Implementation Details of the Face Recognition Module

Purpose	This module detects and localizes human faces within the preprocessed images.
Dependencies	Preprocessing Module
Input	Preprocessed facial images
output	Coordinates of detected faces within the images

Attendance Management Module

Table 5: Implementation Details of the Face Recognition Module

Purpose	This module manages the attendance records based on the recognized identities.
Dependencies	Face Detection Module
Input	Recognized identities
Output	Attendance records with timestamps

User Interface Module

Table 6: Implementation Details of the User Interface Module

Purpose	This module provides a user-friendly interface for administrators and users to interact with the system.
Dependencies	Student Management Module, Attendance Management Module
Input	User commands and settings
Output	Visual display of attendance records, system status, and user prompts

Reporting Module

Table 7: Implementation Details of the Reporting Module

Purpose	This module generates reports based on the attendance records, allowing administrators to view and analyze attendance data
Dependencies	Attendance Management Module
Input	Attendance records
Output	Attendance reports in various formats (e.g. CSV)

Testing

Testing in application development is the process of evaluating software to ensure it meets requirements and functions properly. It involves detecting bugs, validating functionality, evaluating performance, assuring quality, testing security, and ensuring a positive user experience. Testing is an iterative process performed at various levels to identify and resolve issues before deploying the application. It plays a crucial role in delivering reliable and high-quality software. A primary purpose of testing is to detect software failures

so that defects may be discovered and corrected. Thus, Testing is performed in order to meet the conditions, designing and executing of project and for checking results and reporting on the System process and Performance.

Test Cases for Unit Testing

Unit testing is a type of testing where individual units or components of a software application are tested in isolation. It focuses on verifying the correctness and functionality of each unit independently, typically at the code level. Unit tests are small, automated tests that check specific inputs and outputs of a unit to ensure it behaves as expected. It helps identify defects early in the development process, facilitates code refactoring, and promotes modular and maintainable code. All the unit testing of this system is also performed by oneself in the code level so, the table showing the test cases for the unit testing is not made. Instead, all the test cases for the functionality testing of the system are tabulated.

Test Cases for System Testing

System testing is a level of testing where the entire software system is tested as a whole to ensure that all components work together correctly and meet the specified requirements. It evaluates the behavior of the system in different scenarios and checks if it functions properly in its intended environment. System testing verifies the integration of various modules, the system's performance, functionality, security, reliability, and other aspects. It aims to uncover defects that might occur due to interactions between different components and to validate the system against the desired outcomes.

Table 8: System Testing of an Attendance System

ID	Test Senario	Test Case	T%est Steps	Expected Result	Actual Result	True
T001	Verify Sign up Functional	To Check Whether the user can be registered or not	(a) Open the application (b) Click sign up button (c) fill the sign up from	User should be registered	User is registered successful y and redirected towards sing in	True
T002	Verify SignIn Functionality	To check whether a person is signed in or not.	(a) Open the (b) App (c) Fill the signin credentials	User should be signed in	Home window is displayed	True
T003	Verify button functionality	To check whether all buttons in home window are clickable	(a) Open the app (b) Click on different buttons	The user should be able to click onto different functionalities	User access different windows on application	True
T004	Verify student management system functionality	To check whether students are being registered or not	(a) Fill the students details from (bh) Click save button	User should be able to register students	Student details added successfully	True
T005	Verify student management system functionality	To check whether the students sample is taken or not	(a) Click take photo (b) Face the camera	System camera should open and samples must be collected	Student's samples collected successfully	True
T006	Verify student management functionality	To check whether students sample trained or not	(a) Click train sample	All the samples should start training	All the stores samples are trained	True
T007	Verify Student management system functionality	To check whether the student's details can be updated or not	(a) Select any student from the table (b) Make changes in the details (c) Click update Button	Students details should be updated	Students details are updated with the details and stored in the table again	True

ID	Test Senario	Test Case	T%est Steps	Expected Result	Actual Result	True
T008	Verify Student Management system functionality	To check Whether the student	(a) Select any student form the table (2) Click the delete button	Student's details should be deleted	Student's details are deleted from the table and database as well	True
T009	Verify take attendance functionality	To check whether the students face is recognized or not	(a) Click the take attendance button	Camera should open and the detected face should be labeled with a name if recognized else unknown face	Student's face is labeled with a name and the attendance is marked present in the system	
T010	Verify attendance management system functionality	To check whether the attendance status recognized faces are marked or not	(a) Attendance Management system	Attendance details of the students should be tabulated in the attendance information table	Attendance details are tabulated	True
T011	Verify search functionality	To check if the attendance details of searched student can be filtered or not	(a) Fill the search by form (b) Click search button	Attendance details of the particular searched student should be filtered out	Attendance details of the particular student only shown in the table	True
T012	Verify attendance management system functionality	To check whether the admin can modify the attendance status or not	(a) Select any attendance detail from the table (b) Toggle the attendance status options	Admin should be able to modify the attendance status to absent, present or late arreid	Attendance status modified by the admin	True
T013	Verify attendance management system functionality	To check whether the admin can filter the attendance details of student of 30 days	(a) Fill the necessary filter by information (b) Click search button	Attendance details of the 30 days of the only particular student should be generated	Attendance details of the particular student for 30 days it filtered	Ture
T014	Verify attendance management system functionality	To check whether the filtered formation can be exported to CSVd or not	(a) Filter the information (b) Click export button (c) Save the CSV file	CSV file of the filtered information should b e saved	CSV file saved to the desired directory	True

Discussion

After conducting Unit Testing for the above-mentioned test cases, we determined that each individual component successfully passes the test with expected results. We then conducted System Testing to determining proper functionality of all the limited features of the application. For this we selected a data set, trained it and activated the system to get a desired result. With this we were able to find the strength and weakness of our application. The application was able to successfully detect the faces. Given ideal condition such as proper lighting, absence of shadows and plain background, the more accurate result can be expected. The application showed the correct result of the image which was taken for prediction. Likewise, different images were taken for prediction in which result was accurate for some image while some images showed incorrect result. Regression testing was also performed to verify every feature of the application. The Buttons clicking functionalities, camera functionalities, image gallery functionalities all of these tests were carried out in system testing. The overall running of the application can be characterized as smooth and functional. However, it should be noted that the smoothness and fluidity of the application depend on the hardware of the system. Sometimes the application crashed because the integrated model takes more time to load. Also, during the hit and trial phase of our system for increasing the accuracy, we tried taking the 1000 samples of the student but our system was being crashed continuously so we concluded it to be technically not feasible. Similarly, the results of the face recognition were less accurate on taking 10-50 samples. So, taking the 100 samples was the standard fit for our project to be technically feasible along with high accuracy and effectiveness.

Thus, the aim of this project is to capture the video of the students, convert it into frames, relate it with the database to ensure their presence or absence, mark attendance to the particular student to maintain the record. The Automated Classroom Attendance System helps in increasing the accuracy and speed ultimately achieve the high precision real-time attendance to meet the need for automatic classroom evaluation.

Conclusion

This system has been proposed for maintaining the attendance record. The main motive behind developing this system is to eliminate all the drawbacks which were associated with manual attendance system. The drawbacks ranging from wastage of time and paper, till the proxy issues arising in a class, will completely be eliminated. Hence, desired results with user friendly interface expected from the system is made. The efficiency of the system could also be increased by integrating various steps and techniques in the future developing stages of the system. Eventually, the system is able to meet our desired objective which are mentioned as follows:

- The face segment from the camera frame is detected.
- The useful features from the face detected are extracted
- The features to recognize the face detected are classified.
- The attendance of the identified student is recorded.
- The attendance details for 30 days of a student is generated.

Recommendations

This project is constructed by targeting a small group of institutions or people only. There are multiple enhancements that can be done to commercialize this project such as:

- Auto Train the sample after registering the new student
- Proper Validation during Signin/Signup
- Creation of Profile section for the Administrative User also a Dashboard to show overall details of the Institute/Organization
- Can be implemented for period wise attendance
- Assigning fix amount of time slot for taking attendance

- Integrating the CCTV camera for taking input and automatically mark the presence with real timestamps with 24-hour surveillance

Limitations of the Study

Followings are the limitations of the study:

- The system may require a certain level of lighting and image quality to accurately recognize faces.
- The system may have difficulty recognizing individuals with facial abnormalities or disguises.
- The system may raise privacy concerns, as it involves the collection and analysis of biometric data.

References

Akbar, Md Sajid, et al. (2018). Face Recognition and RFID Verified Attendance System. 2018 *International Conference on Computing, Electronics & Communications Engineering (iCCECE)*. IEEE,

Anitha, G., Devi, J. Sri & Priyanka, D. (2020) "Face Recognition Based Attendance System Using Mtcnn and Facenet, *Zeichen Journal*, vol. 6, no. 1, pp. 89-95.

Bhagat, C., Mishra, A. K., & Aithal, P. S. (2022). Model for Implementation of e-Government Services in Developing Countries like Nepal. *International Journal of Case Studies in Business,IT, and Education (IJCSBE)*, 6(2), 320-333.

Chavan, M., & Pawaskar, S. S. (2019). According to Sanyukta Santosh Pawaskar and Ashwini Mandar Chavan, performing attendance automatically using face recognition and detection algorithms such as LBPH and Haar Cascade is a reliable and efficient system. Haar Cascade provides a high degree of, In 2019 *2nd International Conference on Inventive Communication and Computational Technologies (ICICCT)*, pp. 1-6,

EUDL. (2018). *Smart Attendance Management System Using Face Recognitio*n. http://dx.doi.org/10.4108/eai.13-7-2018.159713

EUDL. (2022). *Algorithmic approach for automating attendance authentication in online classes*. http://dx.doi.org/10.4108/eai.16-12-2022.2326170

Gornale, B., & Kiran, P. (2020). Classroom Attendance Management System Using Camera. *International Journal of Research in Engineering, Science*, 8(8), 27-30.

Hairi, Al., Duwaisan M., & Khalaf, A. (1997). Feasibility Study of a Proposed System for the Detection of Landmines, *IEEE Transactions of System, Man, and Cybernetics, Part A: Systems and Humans*, vol. 27, no. 4, pp. 631-638.

Hapani, Smit, et al. (2018). Automated Attendance System Using Image Processing. 2018 *Fourth International Conference on Computing Communication Control and Automation (ICCUBEA)*. IEEE, 2018.

Jain, A. K., Ross, A., & Hong, L. (2002). Incremental Learning for Face Recognition. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 24(3), 349-362.

Jayaswal, R., & Dixit, M. (2020). Comparative analysis of human face recognition by traditional methods and deep learning in real-time environment. In 2020 IEEE *9th International Conference on Communication Systems and Network Technologies (CSNT)* (pp. 1-6). IEEE.

Jha, P. B., Mishra, A. K., & Aithal, P. S. (2023). Operation of Vehicle Maintenance Systemin Context of Developing Countries Emphasizing Nepal. *International Journal of CaseStudies in Business, IT, and Education (IJCSBE)*, 7(1), 267-279. https://doi.org/10.5281/zenodo.7790868

Jones, B. (2021). How to Choose the Right Attendance Tracking System. *Forbes*.

Kamencay, P., Benco, M., Mizdos T., & Radil, R. (2017). A new method for face recognition using convolutional neural network. *Advances in Electrical and Electroic Engineering*, vol. 15, no. 4, pp. 63-72, 2017.

Khan, M. A., Islam, M. I., Hossain, M. A., Islam, M. M., & Razzaque, M. A. (2014). Face Recognition Using Local Binary Patterns Histograms (LBPH) with Improved Illumination and Pose Robustness. *IEEE Access*, 2(2), 1188-1197.

Khan, M., Rehman, M. Awan and M. Aslam. (2019). Efficient face recognition using local binary pattern histogram, IEEE.

Lukas, Samuel, et al. (2016) "Student attendance system in classroom using face recognition technique." *2016 International Conference on Information and Communication Technology Convergence (ICTC)*. IEEE. https://becominghuman.ai/face-detection-using-opencv-with-haar-cascade-classifiers-941dbb25177

Mishra, A. K. (2020). *Project management: theoryand practice from different countries*. Tamilnadu: DK International Research Foundation. http://doi.org/10.5281/zenodo.4817542

Mishra, A. K., Jha, P. B., & Aithal, P. S. (2023). Business Operation Using Identification of Product in Context of Developing Countries Emphasizing Nepal. *International Journalof Applied Engineering and Management Letters (IJAEML)*, 7(1), 112-126. https://doi.org/10.5281/zenodo.7798162

Mishra, A. K., Nepal, A., & Aithal, P. S. (2022). Industry 4.0 Concept for Nepal - Operating Virtual Farming Industry. PP- 31-35, *Proceedings on Future Trends in ICCT and its Applications in IT, Management and Education*, Editors: Dr. Krishna Prasad, K., Dr. P. S. Aithal, & Dr. A. Jayanthiladevi, ISBN: 978-81-949961-8-7. https://doi.org/10.5281/zenodo.7215189

Mohd Suhairi Md Suhaimin, Mohd Izzat Md Noor, Rosli Ismail and Wan Rosli Wan Hamat. (2012). Face Recognition Using Local Binary Pattern and Eigenface, *3rd International Conference on Intelligent and Advanced Systems (ICIAS)*, pp. 1-6.

Okokpujie, Kennedy O., et al. (2017). Design and implementation of a student attendance system using iris biometric recognition. *2017 International Conference on Computational Science and Computational Intelligence (CSCI)*. IEEE.

Omari, Al., & Jaradat, A. (2020). Attendance Tracking Systems: A Review of the Literature, *International Journal of Advanced Computer Science and Application*, vol. 11, no. 4, pp. 194-202.

Onur, S., & Bahar, I. (2016). Face Recognition Using Principal Component Analysis and Viola-Jones Algorithm, in *International Conference on Computer Science and Engineering (UBMK)*, Bursa, Turkey.

Pokharel, R., Mishra, A. K., & Aithal, P. S. (2021). Practicability Assessment of Smart VillageProject: A Case of Sandakpur Rural Municipality, Ilam Nepal. *International Journal ofManagement, Technology, and Social Sciences (IJMTS)*, 6(2), 265-281. https://doi.org/10.5281/zenodo.5799392.

Rathod, Hemantkumar, et al. (2017). Automated attendance system using machine learning approach. *2017 International Conference on Nascent Technologies in Engineering (ICNTE)*. IEEE.

SAI, E.C. and Hussain, S.A., Khaja, S.M., & Amara, S. (2021). Student Attendance Monitoring System Using Face Recognition. https://ssrn.com/abstract=3851056

Salim, Omar Abdul Rhman, Rashidah Funke Olanrewaju, and Wasiu Adebayo Balogun. (2018). Class attendance management system using face recognition. *2018 7th International Conference on Computer and Communication Engineering (ICCCE)*. IEEE.

Shalini, T. (2023) Face Recognition based Attendance System Using CNN Architecture. *International Journal for Innovative Engineering & Management Research, Forthcoming*. https://ssrn.com/abstract=4447364

Siswanto, Adrian Rhesa Septian, Anto Satriyo Nugroho, and Maulahikmah Galinium. (2014). Implementation of face recognition algorithm for biometrics based time attendance system." *2014 International Conference on ICT For Smart Society (ICISS)*. IEEE.

Truk, M., & Pentland, A. (1991). Eigenfaces for recognition. *Journal of Cognitive Neuroscience*, 3(1), 71-86.

Viola, P., & Jones, M. J. (2001). Rapid object detection using boosted cascade of simple features. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 23(1), 20-38.

Wang, Y., Wang, H., & Zhang, Y. (2021). A review of face recognition for online attendance management in the era of big data. *Journal of Ambient Intelligence and Smart Environments*, 13(1), 1-17.