REPUBLIC OF TÜRKİYE

ALTINBAŞ UNIVERSITY

Institute of Graduate Studies

Informatıon Technologies

RECORDING STUDENT ATTENDANCE AND RECOGNIZING THEIR FACES USING DEEP LEARNING

Hayder Hamid Hammoodi AL-INIZI

Master's Thesis

Supervisor

Assoc. Prof. Dr. Sefer KURNAZ

İstanbul, 2024

RECORDING STUDENT ATTENDANCE AND RECOGNIZING THEIR FACES USING DEEP LEARNING

Hayder Hamid Hammoodi AL-INIZI

Information Technologies

Master's Thesis

ALTINBAŞ UNIVERSITY
2024

The thesis titled RECORDING STUDENT ATTENDANCE AND RECOGNIZING THEIR FACES USING DEEP LEARNINGPREPARED by HAYDER HAMID HAMMOODI AL-INIZI and submitted on 26/01/2024 has been **accepted unanimously** for the degree of Master of Science in Informatıon Technologies.

Assoc. Prof. Dr. Sefer KURNAZ

Supervisor

Thesis Defence Committee Members:

Assoc. Prof. Dr. Sefer KURNAZ	Department of Computer Engineering, Altınbaş University	_____
Asst. Prof. Dr. Abdullahi Abdu IBRAHIM	Department of Computer Engineering, Altınbaş University	_____
Asst. Prof. Dr. Serdar KARGIN	Department of Biomedical Engineering, İstanbul Arel University	_____

I hereby declare that this thesis meets all format and submission requirements of a Master's thesis.

I hereby declare that all information and data presented in this graduation project has been obtained in full accordance with academic rules and ethical conduct. I also declare all unoriginal materials and conclusions have been cited in the text and all references mentioned in the Reference List have been cited in the text, and vice versa as required by the abovementioned rules and conduct.

Hayder Hamid Hammoodi AL-INIZI

Signature

ABSTRACT

RECORDING STUDENT ATTENDANCE AND RECOGNIZING THEIR FACES USING DEEP LEARNING

AL-INIZI, Hayder Hamid Hammoodi

M.Sc., Information Technologies, Altınbaş University,

Supervisor: Assoc. Prof. Dr. Sefer KURNAZ

Date: January / 2024

Pages: 64

There are several methods available to monitor student attendance in classes, such as biometric, radiofrequency, face recognition, and paper-based systems. However, the face recognition-based approach has been found to be both efficient and secure. In this study, a threshold to confidence has been implemented through Euclidean distance values to enhance the identification process. The Local Binary Pattern Histogram (LBPH) algorithm has been utilized for this purpose, as it has been demonstrated to be more effective than other methods such as Eigenfaces and Fisher faces. The Haar cascade method has been used for facial detection due to its robustness. The system's performance has been assessed in various scenarios, including recognition rates, false-positive rates, and detecting unknown individuals with or without a threshold. The system has demonstrated an impressive 79% recognition rate for students, with a 24% false-positive rate, and can identify students wearing glasses or a beard. The LBPH algorithm and Haar Cascade method contribute to the system's exceptional performance. The recognition rate for unregistered individuals in facial recognition technology is noteworthy even without the use of a threshold value, sitting at a commendable 64%. Moreover, the rate of false positives is impressively low, remaining at approximately 15% and 31%.

Keywords: Csharp, Opencv, Deep Learning, Face Detection, LBPH.

TABLE OF CONTENTS

Pages

TABLE OF TABLES

Pages

TABLE OF FIGURES

Pages

1. INTRODUCTION

1.1 OVERVIEW

Attendance plays a crucial role in most institutions and organizations, as it informs the recording of lectures, tracks working hours, and determines salaries. While some organizations still rely on manual methods and paper-based documentation, some have transitioned to using biometrics. For example, at the university, professors manually fill out forms or make phone calls to report student attendance, which is then forwarded to the administration for updating the final database on the SQL server. This process is both labor-intensive and time-consuming. Biometric systems are also used, but only for professors or employees. However, an automated attendance system that incorporates facial recognition technology could be a solution. This technology can mark the presence of students, professors, and staff using facial recognition algorithms such as the Convolutional Neural Network (CNN) algorithm. The main features of the technology include face detection and recognition. By implementing this technology, organizations can streamline the attendance-taking process and reduce the time and effort involved in manual tracking methods.

1.2 STATEMENT OF THE PROBLEM

The process of taking attendance through a manual system can be both inefficient and time-consuming, especially when employees are required to queue up to input their names before and after office hours. Furthermore, employees assigned to record attendance are burdened with the task of transferring data from the time book to Microsoft SQL Server each month, which is a laborious and time-intensive process. Identifying latecomers from the time book also proves to be a challenge, as it is prone to inaccuracies due to potential misremembrance of information. Consequently, there is a possibility that attendance staff might overlook certain details, leading to incomplete records.

1.3 OBJECTIVES

The main objective is to utilize facial recognition technology as a comprehensive approach to achieve efficient student management, The implementation of facial recognition technology can provide a precise and secure means of identifying students. This state-of-

the-art system can replace traditional methods of identification, seamlessly integrating into the educational environment.

One way to capture student presence is through facial recognition technology, which can automate the process of attendance tracking in real-time. This offers the benefits of reducing errors associated with manual attendance management and streamlining administrative processes.

Utilize the data obtained from facial recognition technology to create comprehensive performance reports. By examining records of student attendance, the goal is to extract meaningful conclusions about punctuality, attendance trends, and overall academic dedication. This information is fundamental in facilitating informed decision-making and efficient academic performance management.

The primary goal of the educational institution is to elevate the management of students through a series of objectives. This includes increasing efficiency, accuracy, and data-driven insights to enhance academic engagement and facilitate better decision-making.

1.4 SCOPE AND DIRECTION OF THE PROJECT

The document in question bears the title of "Project Overview." Its contents expound on the various aims, purposes, undertakings, and schedule that have been set for the project.

The objective of this undertaking is to furnish a novel and smoother system that addresses the concerns of its predecessor. The system in question is powered by an intelligent gadget capable of recognizing every individual and storing their data in a database. This will take the place of the outdated attendance system while also providing added ease to the educational institution. A web page is presently under construction to present data in a more captivating fashion.

The venture encompasses the following:

a. The target audience for any control system is made up of employees and students.
b. The database for the attendance management system has the capacity to hold as many as 2000 individual records of personal information.
c. The process of facial recognition is limited to the identification of a single individual at any given time, For this project to function correctly, it is imperative that the selected area has Wi-Fi connectivity. It is also crucial that the system database receives routine updates.

1.5 PROJECT FIELD

The goal of the project is to create a network of interconnected smart devices, which act as a nervous system. This requires the integration of all devices, including those in the existing infrastructure. This system is similar to the way the nervous system of a living body connects everything within it. AI technology processes data collected by physical devices to make intelligent decisions and is used in various systems to enhance their efficiency and solve problems. This is facilitated by special sensors and chips that collect information in real time. Smart cities leverage information and communications technology (ICT) to enhance efficiency and reduce human consumption. The development agenda for these cities is to integrate smart devices and smart attendance monitoring systems, which is one of the many applications of this project.

2. LITERATURE REVIEW

2.1 RELEVANT STUDIES

According to Xin Geng, face recognition systems often necessitate specific configurations in order to function properly. This comprises appropriate lighting, a specific location, a certain angle of view, and limited obstructions in the surrounding area. Such systems are known for their ability to recognize faces in controlled environments. However, these constraints impede the use of facial recognition in many real-time applications where such conditions cannot be guaranteed. Real-time systems necessitate input in the form of images, which in turn requires human intervention for processing. This paper presents a system that uses image input, but it is limited by its reliance on human processing and is therefore not optimal for real-time applications such as attendance systems. [1]

Edy Winarno, a member of the 3WPCA Anticheat Presence-System, has developed a technique using dual vision cameras that generates a composite image of an individual. The two images captured by each lens are combined to detect any signs of cheating. Winarno discovered this method by merging two separate photographs of a person's left and right halves into a single image. By analyzing this image, he was able to develop the 3WPCA approach, which has a remarkable 98% success rate in identifying fraudulent behavior. In a recent paper, an expert in the field details modifications made to a system that tracks attendance through image recognition. Since many students are easily identifiable by their faces, it is crucial to implement precise identification techniques swiftly. [2] This novel approach could potentially replace current biometric devices like fingerprint scanners. The school currently employs a picture-based registration system, requiring students to re-enroll periodically to maintain accuracy. Uploading photographs is a crucial aspect of the school's overall process. The existence of this program is supported by substantial evidence. Utilizing a sophisticated identification system, it can be employed for online certification exams. Biometric technology provides a superior alternative to traditional data collection methods due to its enhanced accuracy, despite its more complex and error-prone nature. Although this aspect is often overlooked due to the prevalence of similar systems, the author suggests incorporating a mobile attendance system and a facial recognition feature with NFC security functions to acquire fingerprint scans. Additionally, cloud storage for Raspberry Pi data and data collection through a mobile app are

recommended to address challenges associated with dirty, wet, peeling, or dry fingers. The previous system is replaced with a new approach incorporating cloud space, NFC, facial recognition, and microcomputer to increase efficiency and minimize paper usage while reducing time spent searching for misplaced items. The mobile attendance system is inclusive of a clipboard.[3]

The capability of computers to interact with individuals from diverse angles and viewpoints is undeniable. However, this interaction is commonly accepted if the computer system is built on a specific framework. An essential aspect of the verification process is the integration and advancement of student identities. [4] Furthermore, facial recognition technology employs embedding to categorize faces. This system's applications encompass security, attendance, and other relevant fields. Once the system is established, its outcomes are exhibited in the designated workspace. [5]

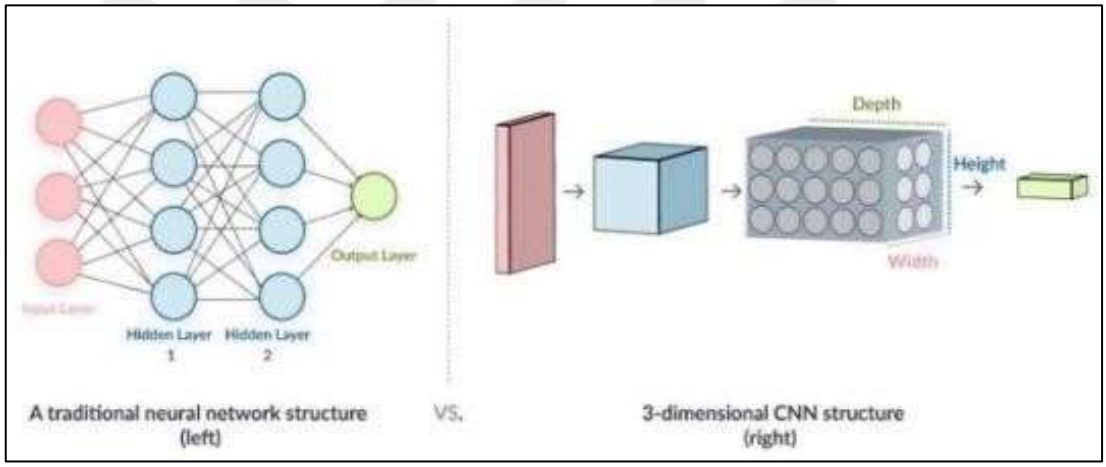

Figure 2.1: Comparison Between a Conventional Neural Network and CNN.

RadhikaC's article, entitled "A Facial Recognition-Based Attendance System Using ML Algorithms," outlines a system that monitors and records the attendance of each student through facial recognition technology.

During the time period in which the novel is set, facial recognition was the term used to describe the identification of individuals based on their facial features. Computer vision algorithms that utilize facial capabilities have been developed, such as emotion detection and facial recognition systems, which are utilized for surveillance purposes. Facial recognition systems have been examined by numerous scientists, who have explored various tools, including Support Vector Machine, Multilayer Perceptron, and Convolutional Neural Network. A Deep Neural Network, which is capable of recognizing

faces, is created by utilizing features extracted through LDA and PCA. Machine learning algorithms such as MLP and CNN are used alongside SVM to extract features. CNN can identify images by inputting them as features, resulting in a high level of accuracy. CNN, MLP, and SVM achieve accuracy percentages of 86.5%, 86.5%, and 98%, respectively, on their respective databases.[6]

Priyanka Wagh submitted an image to a class face recognition system, claiming that it contained human faces. Upon analyzing the image's histogram, it was discovered that the last column of benches had more faces than the other columns. This document highlights the various advantages of Ada Boost computing. One such advantage is using this technology to isolate the efficiency of a specific task, like identifying the unique features of a college student's face. This process involves removing any extraneous characteristics such as facial hair, lines, textures, and any other additions like face art. The features are then separated and compared with databases containing information on faces and their appearances. Ultimately, the investigation aims to create a catalog of every face they encounter. [7]

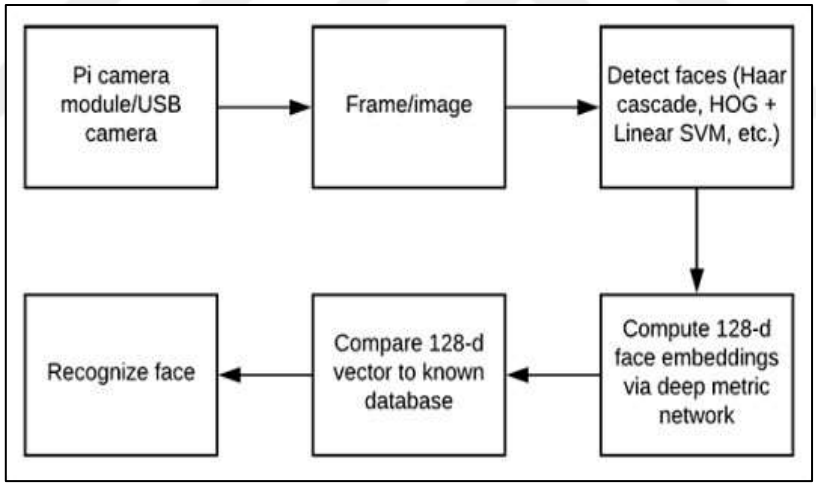

Figure 2.2: Model For Face Recognition.

The ROCLY facial recognition technology and camera scene monitoring are the foundation of the attendance system. As a student swipes their campus card, an event is triggered that captures an image of their face, processes their information, and ensures that unauthorized individuals are not granted access to the classroom.

A novel framework called Akshara Jadaf, Akshay Jadaf Toshur Lah, Krishna Yelikar has been developed for face re-imaging. The first step of this framework involves separating and processing confined faces. Additionally, the scope of the extracted face images is

expanded to 100 x 100 to eliminate graphs. The framework also includes updating the names that were previously re-planned, which exceeded expectations. To accomplish this, a schedule of expected outcomes is created using transactional tools within the database framework. Face detection accounts are utilized to identify faces in images, and the Rectangle FlexBox mutation is removed from the scene. Finally, the image is converted to dark scale, graphic modifications are applied, and its size is altered to 100x100. Alternatively, PCA/LDA/LBPH can be employed to extract highlighting. [8].

To teach the system how to reconfigure faces, specialists employ a method called the "hair workbook." The process begins with the camera detecting a face, which is then turned into grayscale before being processed with this technique. All subsequent images are saved on the server for later modification and enhancement. [9]

The authors propose utilizing a novel strategy that involves the frame serving as an online web server. This would allow the results of the particles to be accessed by authenticated web customers. The process of facial re-imaging is executed by updating the local bank patterns (LBP). First, the face serves as the initial point of purchase and editing language for the return on investment. Subsequently, successive accounts are applied based on hair features. The LBP is then used to extract the bright points of the images, and these are compared to a prepared data collection by the LBP account. Finally, the results in English language are stored in an SQL Server database using 'C' in Catch in the Console Box and can be accessed via a web server. [10]

The method for recording attendance relies on the process of taking a new photograph of an employee's face while they are at work.

According to Nandhini R., the primary function of the company is to convert recorded identity data and video footage into visual images. The process involves using CNN technology to identify faces, with CNNS (convolutional neural networks) employing a hierarchical perception model that enables faster hypothesis treatment. Once faces have been identified and organized, they are compared to those in the student database to accurately reflect the identities of the students in question. Any additional or alternate names are updated in a separate table to maintain accuracy. Finally, records of student participation can be maintained on a weekly or monthly basis according to the expectations set forth by the company. [11]

The attainment of proxy with a DCT factor of 16 is facilitated by utilizing a component-based approach which involves gray normalization, graphic equations, conversion of individual waves through DWT, and conversion of individual perfection pockets via DCT.
According to Venkata Kalyan PolaraSetty, Muralidhar Reddy Reddem, Dheeraj Ravi, and Mahith Sai Madala in their paper "The Attendance System," the homepage for home duty is reliant on the type of camera utilized.
Our next item of discussion is the presence of a minimum of 500 to 1000 traps. In order to produce more precise results, high-resolution cameras have been installed across various locations in the United States. To enhance facial recognition, the element category is utilized alongside B-Box technology. The faces that are identified are converted into small theme images that measure 112 x 92, which translates to an area of approximately 11 km. The Swix facts are then recorded within a database that is accessible within our workspace. It is here that we can capture images of the exhibition. The most notable pigs are individually archived and categorized in exhibition lists that can be modified to fit a particular message or purpose. [12]

2.2 HISTORICAL PROGRESSION IN FACIAL RECOGNITION

During the years of 1964 and 1965, several pioneers in the field, including Woody Bledsoe, Helen Chan Wolf, and Charles Bisson, were among the first to utilize computer technology to identify the features of a face. This was accomplished by manually identifying specific areas of the face, such as the center of the eyes, nose, and mouth. To ensure the subject's identity, a computer was used to perform mathematical rotations, marking the first step towards developing methods of facial recognition. The popularization of facial recognition in commercial businesses was spearheaded by Sirovich and Kirby, who employed linear algebra to automate the process, creating LBPH, or Local Binary Pattern Histogram. This creation requires only a small amount of data to accurately encode an image of a face. This groundbreaking discovery was made in 1991 by Turk and Pentland and led to the invention of automatic face recognition shortly thereafter. In the early 1990s, the FERET program was launched by the NIST and DARPA, which collected 2,413 facial images from 856 individuals. These images were then utilized for commercial facial recognition purposes by NIST and DARPA. In the early 2000s, the Facial Recognition Vendor Test (FRVT) was established to conduct impartial evaluations of

prototype facial recognition systems. The evaluations provide crucial data for the use of facial recognition in government and law enforcement. In 2006, the Face Recognition Grand Challenge was introduced to evaluate the leading algorithms for face recognition. This challenge included the testing of high-resolution images, 3D face scans, and iris images. The results illustrated that the updated algorithm was over 100 times more accurate than its 1995 predecessor and 10 times more accurate than the 2002 algorithm. The study concluded that daily updates for the new algorithm are feasible. In 2017, Apple released the iPhone X, which featured facial recognition as a means of unlocking the phone. This feature allows users to access their device merely by looking at it. [13]

2.3 EVOLUTION OF FACE RECOGNITION

In the mid-20th century, Woodrow Bladero, Helen Chan Wolf, and Charles Bisson were among the first to observe the distinguishing features of human faces. By 1964 and 1965, they utilized the power of computer technology to categorize people based on their facial characteristics, such as eyes, mouth, and nose. Today, physical education courses teach students to challenge the notions of positivism by refuting its falsehoods with the use of computer programs. These programs compute the distance between facial features and compare them to a pre-existing image to confirm identity, marking the inception of contemporary facial recognition technology. Linear algebra was the key to unlocking the potential of this technology for biometric purposes, as Kirby and Serofic demonstrated. They developed a Domestic Bi-Style Chart, also known as LBPH, that can accurately distill images into just a few values. Further advancements were made in 1991 when Turk and Pentland discovered that facial recognition technology could recognize images with great accuracy.

The advent of automatic facial recognition can be traced back to a specific event. This event was the creation of a database by NIST and DarPa in the early 1990s, which was intended for commercial applications. The database contained 2,413 images of faces belonging to 856 individuals, and it served as a catalyst for the development and progression of facial recognition technology. In the early 2000s, the Facial Recognition Vendor Test (FRVT) was established to assess facial recognition models and technologies. These evaluations are crucial for optimal facial recognition performance in government and other operations. In 2006, the Grand Face Recognition Challenge was created to assess

existing algorithms. Recently, Facebook has incorporated facial recognition technology into their platform to identify individuals in images with a high degree of accuracy. This new algorithm has been found to be ten times more accurate than the 2002 algorithm and over 100 times more accurate than the 1995 algorithm. To test their algorithm, Facebook utilized 3D face swabs and high-resolution images. [14]

2.4 SIGNIFICANCE OF FACE RECOGNITION SYSTEMS

Facial recognition technology is employed in various tasks in the workplace, including security systems, authentication systems, and monitoring systems, and it has become ubiquitous worldwide. Despite its widespread use, this technology often goes unnoticed. Face recognition has a multitude of applications, with businesses in the US, UK, and Australia utilizing it to manage their business districts, factories, airports, and government buildings. Retailers like Alibaba also use facial recognition technology for their scanners. The use of facial recognition and machine learning algorithms is becoming increasingly prevalent in society, facilitated by software like Workspace that can track employees as they arrive at work. Public places are often equipped with cameras featuring facial recognition systems, which law enforcement agencies use to locate missing individuals and identify criminals. [15]

2.5 OBSTACLES ENCOUNTERED BY FACE RECOGNITION SYSTEMS

There is a growing apprehension regarding the misuse of facial recognition systems by both businesses and governments. These systems gather and analyze an individual's image, which may contain sensitive and confidential information. The advent of this technology has the potential to significantly alter the way people interact with each other. Prior to adopting new technology, companies and institutions must take into account its safety measures, implications, and assurances. An individual's unique biometric data, such as facial features, is erased every time they use a new technology. However, this data could be stolen, leaked, or misused without the owner's knowledge or consent. To ensure the accuracy of facial recognition systems, a significant amount of data is required for training. Without adequate data, there is a risk of inaccurate results. Furthermore, new technologies have created new opportunities for criminal activities. Systems have often wrongly identified individuals with darker skin tones and genders. This is a result of a lack of data

about them in the larger population. The acquisition of facial recognition data by criminals is a possibility through the breach of databases and surveillance of an individual's location, message content, and movements. Such data may be misused to perpetrate identity theft or other criminal activities. The lack of proper regulation of these systems poses a grave threat to society, as they can cause significant harm.

Facial recognition technologies can be widely utilized but with caution. To implement such technologies, institutions must adhere to data protection frameworks that are designed specifically for this purpose. Following these frameworks will enable the use of facial recognition technology. It is important to note that this information is based on source [**16**].

2.6 FRAMEWORK OF FACE RECOGNITION SYSTEMS

The figure depicts four key characteristics of identity verification systems. These include the pre-processing of facial features, the detection of faces, the extraction of features, and the identification of faces.

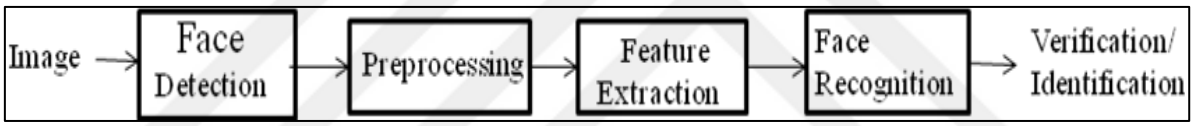

Figure 2.3: Framework of a Facial Recognition System.

To initiate the process of identifying an individual by their facial features, the first step is to capture an image of their face using a camera, video recording, or retrieving it from a database. This is the preliminary stage in a multitude of facial recognition systems, which will be elaborated on in the upcoming section entitled "Figure 2.3".

2.6.1 Facial Detection

The analysis stage following face recognition focuses on identifying faces within an image, and determining whether or not an image contains any faces at all. Once this has been established, the ensuing output is directed to the preprocessing stage for further manipulation.

2.6.2 Data Preprocessing

The pre-processing stage is completed prior to face detection. This stage involves several techniques, such as eliminating noise, blurring facial features, removing shadow and

lighting effects, and other similar processes. Subsequently, the face detection process uses feature extraction methods to scrutinize the data.

2.6.3 Extraction of Features

The objective of this procedure is to decrease the dimensionality of the face and collect salient features while eliminating any extraneous data or interference via an algorithm known as feature extraction. The end result is a facial patch that has been transformed into a mathematical entity with predetermined dimensions. Each of these dimensions is linked to one of the points that make up the facial patch's fiducial system.

2.6.4 Facial Recognition

The process's final stage involves identifying the face by cross-referencing an input image with a comprehensive database of faces. This is accomplished by first processing the input image's features, then extracting them to create unique distinctions between each face. The next step is face recognition, followed by feature extraction. Multiple images of each individual are captured and stored in the database. When an input face image is presented for recognition, the initial steps are repeated before comparing its features to those in the database.

Using facial recognition algorithms, a person's identity can be determined by analyzing images of their face. These algorithms can perform this task surreptitiously and are typically used for identification purposes. On the other hand, face verification algorithms are utilized to determine whether an identity guess is accurate or not. Rather than ascertaining an identity, they are used to validate someone's conjecture.

When categorizing faces, they can be separated by either their local or global characteristics. Global characteristics are simpler to identify due to their more general nature. In comparison, local characteristics may be more precise, but can be impacted by partial obstructions or changes in facial appearance. For future face recognition systems, identifying faces will involve analyzing multiple viewpoints of the face. To achieve this, some experts propose using diverse perspectives such as front, top, right, bottom, and side views when identifying faces [17].

2.7 NEURAL NETWORKS

Artificial neurons or nodes are joined together in a neural network to predict data, whether it be known or unknown. These networks are especially adept at distinguishing between linear and non-linear datasets. They have been utilized for a variety of purposes such as facial, iris, and fingerprint recognition, as well as speech recognition. The nodes within the network are connected to one another, with individual connection strengths being measured between -1.0 and 1.0, with a maximum value of 1.0 for strong connections, and low inhibition or high excitation for weak connections. Each node also contains a transfer function that shifts input values to the output. While some ANNs contain hidden nodes, others only have input and output nodes.

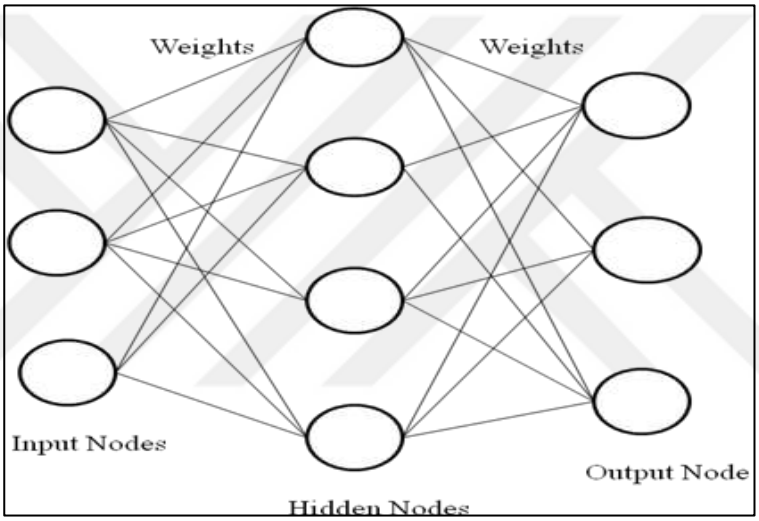

Figure 2.4: Representation of an Artificial Neural Network.

The collection of information in numerical expression is achieved through nodes. Each node holds an activation value that corresponds to the data it collects. Higher activation values indicate a greater degree of data collection. These values are then dispersed throughout the entire system. Connections between nodes are determined by the strength of the connection, which can be influenced by factors such as inhibition, excitation, transfer functions, and weight. When a node receives an activation value, it adds it to its existing value before adjusting it according to its transfer function. Output nodes are responsible for reviewing input data before it is passed along.

Concealed within the system's hidden layers, activation values travel towards the exit node. Only once activation has passed through all subsequent nodes does the output node reflect any findings.

2.7.1 Neural Network Architectures

2.7.1.1 A feed-forward network

The layer above receives input data, which is then subjected to calculations based on weighted sums. The signal is then transmitted in a downward direction, going through the processing element layers until it reaches the layer below. Input data can only move in one direction through a feedforward network. To obtain the next layer's input value, one must interpret the output of the previous layer. This process is repeated until all layers have been processed and the output is determined. Threshold transfer functions are sometimes employed to quantify the outputs of neurons in the output layer. Feedforward networks encompass linear and non-linear BBF networks, as well as radial basis function networks [18].

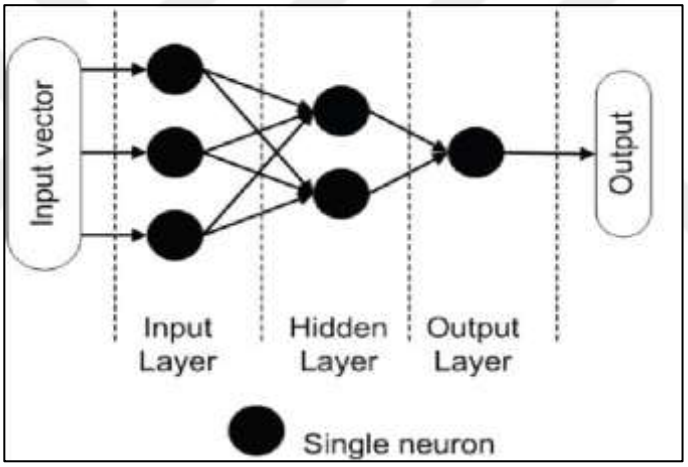

Figure 2.5: Feed-forward Neural Network (FNN).

The acyclic graph, also known as a simple topology or line of communication, is depicted in Figures 2.3 and 2.4. These figures illustrate how information flows in a singular direction: from the input point to the output point. Figure 2.3 shows an example of this progression. A mathematical representation of artificial neural networks is presented in Figure 2.4, which helps us comprehend this concept more easily.

We organize our neurons into vertical columns to enhance their power, resulting in four groups of neurons. An artificial neural network consists of input, hidden, and output layers. Once this structure is established, we can use our artificial neural network to tackle problems. We then learn the correct values for weights and biases.

The following step is to set them in accordance with the training data, which can be accomplished through supervised, unsupervised, or reinforcement learning methods. Ultimately, a researcher must carefully select a cost function to minimize. [18]

2.7.1.2 Recurrent (RNN) neural network

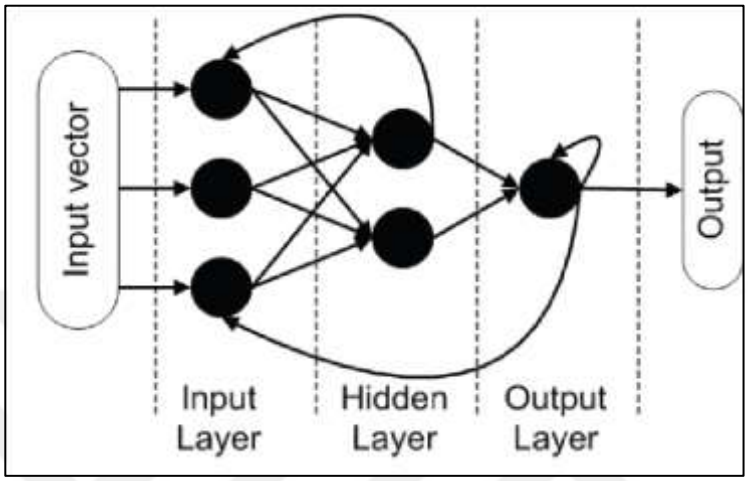

Figure 2.6: Topology of a Recurrent Neural Network (RNN).

The term "repetitive" is often used when discussing neural networks due to their cyclical structure, especially those that resemble a spiral or semi-spiral. These networks can allow information to flow in both directions, also known as loopbacks, which means that information is not only passing through the network in one direction but also the other. Through this feedback, an artificial neural network can change its state over time. These networks have built-in memory that allows them to process any input sequence. The basic topology for these networks is iterative, with each structure interconnected in all directions [19].

2.7.1.3 Types of artificial neural networks

Single layer feed forward network

When the output layer of neurons is connected to the input layer of a source node, the resulting neural network is referred to as a single feed forward or acyclic network. The figure illustrates a single-layer network, where the output layer of a compute node is the only layer present. This is in accordance with the reference [5].

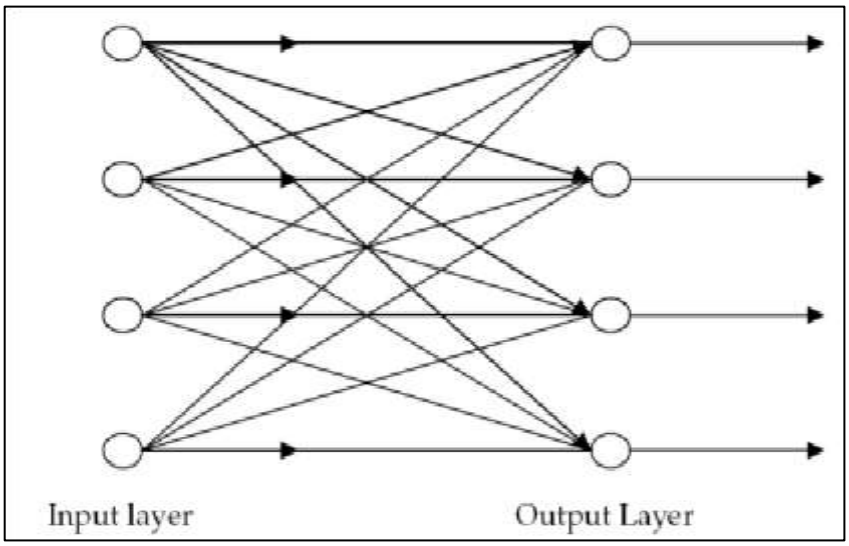

Figure 2.7: Single-Layer Feed-Forward Network.

Multilayer feed forward network

This type of network is composed of at least two layers that are not visible. Each of these hidden layers contains a set of neurons that are responsible for connecting the input and output layers. These neurons perform calculations that take place between the input and output signals.

The source node, which is located between the input and output layers, transmits input data to the first and second hidden layers. The third layer receives input from the output of the second layer, and this process continues for the subsequent layers. The output layer of the network generates a collection of signals that reflect the network's response to the input received from the initial input layer that comprises the source nodes. The second layer's neurons process this input, which is then processed by the third layer's neurons, with the sequence of processing being reversed. This process is documented in [19].

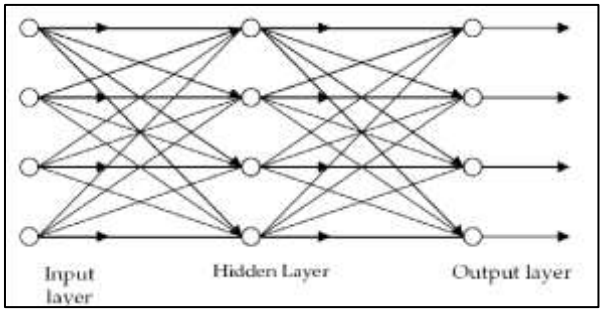

Figure 2.8: A Multilayer Feed-Forward Network.

2.7.1.4 Recurrent network

The architecture of a network such as this one is composed of at least two concealed layers. Every layer contains a cluster of concealed units known as neurons, which interconnect with both the input and output layers. These units are responsible for performing various computations between the input and output signals.

The source node, situated between the input and output layers, transmits input data to the first and second hidden layers. The third layer, in turn, receives the output of the second layer, and so forth. The output layer's neurons generate a set of signals that constitute the network's complete response to the initial input provided by the first input layer, which contains the source nodes. The second layer's neurons process this input, reverse its sequence, and pass it on to the third layer's neurons.

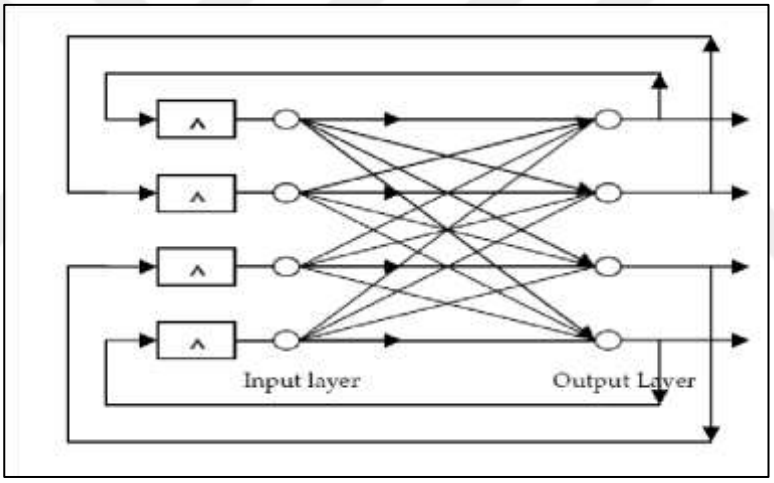

Figure 2.9: Recurrent Connected Network.

Artificial Neural Networks (ANNs) possess numerous layers and are categorized as either single or multilayer networks. Additionally, they can be forward-looking or recurrent. When it comes to facial recognition, several algorithms have been introduced that utilize multilayer feedforward neural networks, with some even incorporating recurrent neural networks.

2.8 APPROACHES ARTIFICIAL NEURAL NETWORKS IN FACE DETECTION

The identification of faces is achieved through the help of artificial neural networks (ANNs). These networks replicate the way in which neurons operate in the human brain, thereby allowing them to be highly efficient at recognizing faces. The reason for this is that

numerous types of ANNs have been leveraged for the purposes of detecting and recognizing faces, each with their own unique architectures and models.

2.8.1 Principal Component Analysis (PCA) with Artificial Neural Networks

Vikas Kumar and Navneet Jindal utilized artificial neural networks (ANN) to recognize facial features in a dataset of reduced dimensionality through principal component analysis (PCA). They accomplished this by initially extracting images from the data using PCA. Additionally, they utilized the information obtained from this process to encode facial images. The ANN calculates eigenvectors for various angles, which are then used to form a column matrix. Next, it normalizes each provided facial image by removing the faces to calculate the facial images' covariance matrix. From there, it calculates the largest eigenvalue and the mean of the facial images before subtracting each image from that value to calculate the LBPH. This procedure is utilized to project an image by selecting the highest information among all the provided facial images. To determine the maximum change in a data point, one must convert from a high-dimensional image space to a low-dimensional image space, which requires processing facial image projections extracted through the PCA method. This serves as the foundation for selecting faces for training and testing artificial neural networks. Facial image features can be decomposed through principal component analysis, which reduces their dimensionality, thereby increasing the variation in these features. Subsequently, these features are transformed into Local Binary Pattern Histograms (LBPH).

As a result, these histograms can serve as training data for an artificial neural network that is trained to identify facial images.[20]

2.8.2 Utilization of Deep Convolution Neural Networks

A face recognition algorithm, called Dense Face Detector (DDFD), was designed by Sachin Sudhakar Farfade, Mohammad Saberian, and Li-Jia Li [21], using deep convolutional neural networks. The algorithm's training and implementation process was explained in great detail. DDFD employs the high capacity of deep convolutional networks for classification and feature extraction, generating a single multi-view face recognition classifier. To increase the number of positive examples that pass the test, the authors randomly chose images from the AFLW dataset to include as positive examples. This

technique improved face recognition abilities when paired with Alex Net [22]. The complexity of the detector was reduced by minimizing computation.

The authors trained a fine-tuned model of Alex Net [22] with a deep neural network, which involved a batch size of 128 images and 50,000 iterations. Upon completion, the dimensions of these windows are 227 × 227 pixels, and they encase the model. This feature permits access to the frontal scanner in various ways, including sliding a window or using region-based functionality. Furthermore, selective search is an alternative to other modules, such as the search module. [21].

2.8.3 Analysis of Radial Basis Function Neural Networks

A facial recognition system was developed by Sung-Hoon Yooa, Sung-Kwun Oha and Witold Pedrycz [23], which combines histogram equalization and AdaBoost to analyze face regions. The images were then processed using PCA and ASM algorithms. To analyze the subjects' shapes and silhouettes, ASM used Amspec. A custom radial basis function neural network was then employed to evaluate each person's unique characteristics by extracting the contour and shape of their face. PCA was used to reduce the dimensional complexity of the data before employing the neural network. By reducing the internal structure of the image, the PCA step made it easier to process the data through the proposed RBF-NN architecture. This architecture includes three functional modules: a conditional, a conclusion, and an inference stage. The RBF-NN functional components are represented by four polynomials: constant, linear, quadratic, and reduced quadratic. The first two functional modules represent the initial two stages of RBF-NN's functional components, while the final stage combines all three functional modules. The C-Means (FCM) clustering utilizes fuzzy rules. The implementation of Fuzzy Neural Networks (NNs) involves utilizing the model outputs of RBF-NNs to determine essential parameters of the network. These parameters include the spike coefficient and learning rate that are utilized by FCM. Designers of the network can adjust key parameters, such as coefficients, through the use of differential equations and Degenetic evolution. P-RBF-NN, also recognized as the Polynomial-based RBF-NN, implements ASM to eliminate unnecessary data from its inputs, resulting in a more efficient method than B-RBF-NN. The accuracy and power output of the detected data are used to measure the efficiency of P-RBF-NN. [24]

2.8.4 Application of Convolutional Neural Network Cascade

Utilizing a CNN cascade, Gang Hua, Jonathan Brandtz, Zhe Linz, Haoxiang Liy, and Xiaohui Shen collaborated on a face recognition technique. The researchers discovered that their method is highly effective at distinguishing between faces, while also maintaining high performance. The technique works across a variety of resolutions and quickly dismisses regions outside of the head during the low-resolution phase. Calibration is employed after each detection stage to increase precision. The final high-resolution stage analyzes only a small number of challenging candidates, which results in a better assessment of the face with fewer delays. According to CNN technology expert Cristian Magda, runtime detection problems often impact object detection. In his research, Magda investigated the issue and wrote a paper on it. He found that single-class calibrated CNNs can be easily trained with minimal data. However, multi-class calibrated CNNs require a greater amount of data before they can be trained. In his pursuit to train neural network models with high-calibration, he discovered that dividing his data into smaller segments made it more manageable. This discovery prompted him to develop a more streamlined version of his CNNs, referred to as "mini-CNNs," which boast superior accuracy in facial localization while using fewer scales. The calibration grid of these models is more adept at accurately positioning the detection bounding boxes around the center of the face. With each calibration level, a new acquisition window is generated by incorporating data from the previous level. When using a single CPU core, this technique achieves a speed of 14 frames per second.

When utilizing the GPU, this technique can operate at a speed of 100 frames per second. Its effectiveness has been validated by achieving the highest level of performance on two well-known face recognition benchmarks, according to reference [25].

2.8.5 Bilinear Convolutional Neural Network

According to Erik Learned-Miller, Subhranshu Maji, a bilinear CNN can be utilized to accurately identify faces. To bridge the gap between other approaches, he combines texture models with a second CNN that specializes in facial recognition. The first CNN's result is multiplied by the outer product of each filtered point after being convolved with a layer. To create a single outcome, modeling procedures combine various descriptors. One feature

extractor differentiates itself by generating partial detectors and local features. The second stage filters images through non-overlapping regions to generate a consistent descriptor.
Bilinear vectors are created by combining Fisher vectors with outer products. By utilizing the gradient of the loss function in both Networks A and B, errors are automatically corrected. This model combines multiple local features with soft x2 memberships within cluster centers to create part-based models. Image recognition networks that can perform any task are created by training networks to recognize images on ImageNet. This eliminates the need to create a face recognition database from scratch, resulting in a more efficient B-CNN. [26]
In order to apply B-CNN to a new face recognition benchmark, it is important to take note of the symmetric feature network, which is derived from B-CNN with the same kernel. While B-CNN shares a similar kernel with SVM in terms of using quadratic polynomial features, it distinguishes itself by using a bilinear kernel for all pixels. This modification leads to greater accuracy in B-CNN models with the aid of its fine-tuning protocol. The author notes that B-CNN's results are 26% superior to those of standard CNNs. For instance, FaceScrub, an AlexNet-like image recognition network pre-trained on ImageNet, was provided as an example. The author also suggested adjustments to the protocol's training data to enhance its performance. Nevertheless, AlexNet-like networks continue to outshine FaceScrub by 26%.

2.8.6 Back Propagation Network (BPN) and Radial Basis Function Network (RBF)

Inspired by the work of M. Nandini, P. Bhargavi, and G. Raja Sekhar [27] on radial basis function and backpropagation neural networks for face recognition, a novel approach to this task was developed by the same researchers. This new method involves comparing the facial features of unfamiliar individuals with those of previously encountered persons to determine their identity. The system employs a neural network utilizing both backpropagation networks and radial basis functions. Additionally, the network incorporates a section that locates the position of the eyes and mouth in order to calculate the distance between them. This calculation is carried out by dividing the length of each eyeliner endpoint by the distance between the eyes.

2.8.7 Retinal Connected Neural Network (RCNN)

According to Henry A. Rowley, a scholar of the American Institute of Electrical and Electronic Engineers, an artificial retina that integrates with the eye and utilizes a neural network is proposed for detecting individuals in an image. To recognize faces in all windows, the first step of the system involves the implementation of a filter that operates on each 20x20 pixel section of the image.

The output of this filter is within the range of 1 to -1 and indicates whether or not there is a face in the window. The face recognition images are reduced in size to ensure that the applied filters are not lost in the scaling process. To decrease the size of an image, the filters must maintain position and size invariance. A smaller version of the original image is applied to each pixel location to achieve this. The artist filters every individual pixel location to shrink the image by 1.2 times its original size. As a result, the image must remain within six different positions and scales.[28]

2.8.8 Rotation Invariant Neural Network (RINN)

In a study by Shumeet Baluja, Henry A. Rowley, and Takeo Kanade[29], a system for facial recognition was introduced. This system has the ability to recognize faces regardless of their angle in the image plane. The approach taken consists of multiple networks and routers that are utilized to process each input image window. The orientation of the image is then determined and used by one or more detector networks to prepare a succession of windows for face detection. Baluja notes that this program is capable of automating the learning process by training on examples. A neural network is utilized within the system, which learns parameters automatically by analyzing image intensities. Notably, existing facial recognition systems can be applied to identify faces in any position. One simple way to implement this technology is by creating a neural network designed to detect faces at any angle.

2.8.9 Fast Neural Network

A rapid NN system for facial recognition was developed by HazemM.El-Bakry. To achieve this, he divided the primary image into multiple sub images and reduced their size. The method involves the assessment of a frontal view of the human face, which results in

faster search times for fast neural networks through the implementation of the divide-and-conquer strategy. By breaking the images into sub images, each is individually tested using a fast neural network. This new technology exceeds traditional neural networks in face detection by utilizing a frequency-domain cross-correlation between sub images and neural network weights to create a faster algorithm. Additionally, simulations show that parallel processing techniques can detect faces in a fraction of the time by examining each sub image with a fast NN on a single processor or separate node in a clustered system. The normalization of Fourier space and field galloping can solve problems to obtain a faster algorithm. Furthermore, larger problems dealing with detecting other objects in an image can also achieve increased speed-up ratios. [30]

2.8.10 Evolutionary Optimization of Neural Networks

The combination of genetic algorithms and gradient-based learning has been proposed by Christian Igel, Stefan Wiegand, and Uwe Handmann as an evolutionary method for face recognition using neural networks. According to their research, their hybrid algorithm is the most precise neural network approach. Viisage-Face FINDER's face recognition neural network is hardware-friendly and contains a linear number of hidden neurons for classification. This means that the connections in the network do not affect the classification speed. In fact, each hidden neuron decreases the detection cost by around one percent. As a consequence, minimizing the number of hidden nodes in the network is a critical goal of any optimization efforts.[31]

2.8.11 Multilayer Perceptron (MLP)

To enhance the precision and swiftness of identifying faces, the integration of an MLP neural network and an MRC classifier is imperative. This is because multilayer perceptron networks have demonstrated superior proficiency in recognizing faces as compared to conventional networks. The technique involves a preliminary processing stage that eliminates the majority of non-face patterns in the background. The outcome is a reduction in the time and cost associated with image processing. The uniform structure of the new system makes it well-suited for use in programmable devices. A new classifier that combines MRC and MLP was implemented to replace the previous facial recognition system. Comparative testing was done between the new system and other facial

recognition systems that use cutting-edge technology. The algorithm employed has the ability to detect between 78% and 91% of faces in images of any size background. The results are superior to those of standard MLP neural network systems when tested against a set threshold.

A threshold setting between 0.5 and 0.6 provides the optimal results. The facial recognition system is capable of identifying faces within images that have either simple or complex backgrounds. With no prerequisite knowledge of the number or size of faces, the system can pinpoint each individual face. Our suggested approach substantially minimizes the cost of training and detection, while achieving unparalleled precision in facial recognition. This technique boasts a satisfactory detection rate, minimal false positives, and a standard time to recognize faces.[32]

2.8.12 Integration of Gabor Wavelet Faces with Artificial Neural Networks

A new technique for facial recognition has been introduced by Hossein-Sahoolizadeh, Davood, Sarikhani-moghadam, and Hamid-Dehghane [33]. They posit that Gabor wavelets are the ultimate method for face action detection and facial recognition. The proposed method involves down sampling faces using linear discriminant analysis and dimensionality reduction. The next step is to identify faces by using discriminant analysis and edge detection. Gabor wavelet surfaces are particularly effective in object recognition, as they blend a neural network feature space classifier with an improved recognition algorithm. By incorporating a classifier, the classification process can identify more similar objects than before. For instance, a Gabor wavelet surface with an expanded neural network feature space classifier can differentiate between various measures of similarity compared to standard surfaces.

In computer vision and image analysis, Gabor wavelet transforms are frequently employed due to their speed and efficiency in analyzing images. They also offer a comprehensive model for comprehending the orientation and spatial frequency selectivity of simple cortical neurons. The decay of the exponents' frequency and infinite smoothing provide notable benefits over approximation techniques that can be found in other animals' visual cortices to the sensitivity distributions of the neurons that closely approximate the desired result.

3. RESEARCH METHODOLOGY

3.1 METHODOLOGY OVERVIEW

Included within this segment is relevant data regarding the equipment and methods implemented throughout the duration of the project. Additionally, theories pertaining to the project's foundations are also discussed. It is essential that these tools and technologies are utilized in order to successfully carry out the project in its entirety.

3.1.1 Approach and Resources Tools and Technologies

Within this section of the thesis, an overview of the tools and techniques employed for the project will be presented. Specifically, the project centered around the development of C#-based Windows applications in conjunction with libraries and programming found within SQL Server Management Studio

The system is a Windows Form application designed to run on the Windows operating system, featuring two main areas: the Administrator Area and the Public Screen. The Administrator Area provides administrators with access to all system functionalities, while the Public Screen displays incoming employee information along with the date and time. The backend is supported by a database that facilitates the storage and retrieval of information in real-time.

Development Tools:

a. Visual Studio 2019:

An Integrated Development Environment (IDE) used for building the Windows Form application.

b. C# Programming Language:

The primary programming language employed in the development of the system, offering flexibility and compatibility with Windows applications.

c. Microsoft SQL Server 2012:

Chosen as the Database Management System (DBMS) for its seamless integration and communication capabilities with C#.

Photoshop: Utilized in the design process for creating and enhancing the graphical user interface (GUI) of the application.

Visio: Employed for designing diagrams, aiding in the visualization and planning of system components and interactions.

Eigen Face Library: An open-source library integrated with Visual Studio, enhancing C#'s capability to work with images and facilitate facial recognition.

Emgu.CV Library: Another open-source library integrated with Visual Studio, specifically designed to assist C# in image processing, facial recognition, and detection tasks.

Development Process:

Frontend:

d. Platform: Visual Studio (C# Windows Form Application).
e. Resource Integration: Emgu.CV and Eigen Face libraries were imported to facilitate image processing, facial recognition, and detection within the application.

Backend:

f. Database: Microsoft SQL Server was employed to create and manage the database, ensuring efficient storage and retrieval of information.

The integration of these tools and technologies allowed for the creation of a robust Windows Form application that seamlessly combines frontend and backend functionalities. The choice of open-source libraries and established software applications contributed to the effectiveness and efficiency of the development process.

3.1.1.1 C-sharp

C# (pronounced "C-sharp") is a versatile programming language developed by Microsoft. It is widely used for developing various types of applications, including desktop applications. When it comes to creating Windows applications using C#, the combination often involves utilizing the .NET framework, specifically the Windows Presentation Foundation (WPF) for creating rich and interactive user interfaces.

Windows applications developed in C# often leverage Visual Studio, Microsoft's integrated development environment (IDE). Visual Studio provides a comprehensive set of

tools for C# development, including a powerful code editor, debugger, and designer for building user interfaces.

SQL Server Management Studio (SSMS) is a tool designed for managing SQL Server databases. While C# is primarily used for application development, SQL Server Management Studio is used for database-related tasks, such as creating and managing databases, writing and executing SQL queries, and performing database maintenance activities.

The integration of C# Windows applications with SQL Server Management Studio allows developers to build robust applications that interact seamlessly with a SQL Server database.

Here's a brief overview of how this integration works:

a. C# applications can use ADO.NET (Active Data Objects for .NET) to connect to a SQL Server database. ADO.NET provides a set of classes for data access, including Sql Connection and Sql Command.
b. Developers can establish a connection to a SQL Server database from their C# application using connection strings that specify the server name, database name, authentication method, etc.
c. C# code can include SQL queries to retrieve, insert, update, or delete data in the connected SQL Server database. Sql Command class is commonly used for executing SQL commands from C# code.
d. Windows applications often use data binding to display and manipulate data from a database. C# provides features for binding data to UI controls, ensuring that changes in the data source are reflected in the user interface.
e. Entity Framework is an Object-Relational Mapping (ORM) framework that simplifies database interactions in C# applications. It allows developers to work with databases using .NET objects.
f. Proper error handling is crucial in database applications. C# provides exception handling mechanisms that allow developers to manage errors gracefully, providing feedback to users and logging information for debugging purposes.

C# Windows applications integrated with SQL Server Management Studio offer a powerful solution for creating feature-rich desktop applications with robust database functionality. This integration enables developers to build applications that efficiently

manage and interact with SQL Server databases, providing a seamless and user-friendly experience.

3.1.1.2 Open cv

Back in 1999, Intel granted access to OpenCV, a software library designed for the processing of images and videos on computers. Cine paint, an open-source program, was developed with a significant focus on video and image analysis and was created to help computers handle more challenging applications. Cine paint is a cross-platform software program that utilizes both C-sharp and Java programming languages, and it offers features such as face and object detection. Its programming language, C++, is the language utilized by Cine paint. Huge companies, including Google, Yahoo, and Microsoft, frequently use OpenCV, which enables users to capture images and videos and identify faces, vehicles, and other objects.

3.1.1.3 Local binary patterns histograms (LBPH)

The LBPH algorithm generates a graph utilizing local binary operators to identify facial features. However, the performance of this algorithm is limited when it encounters expression variations, confusion, and high-intensity lighting. Its detection rate is consequently low under these circumstances.

The process of recognizing faces in images and associating them with individuals has been made possible through an algorithm created by LBPH. This widely-used technology is referred to as "facial recognition.

Distinguishing between face recognition and facial recognition is crucial. Face recognition is defined as the capacity to recognize faces in photographs, whereas facial recognition is the ability to recognize faces in general. Developing face recognition abilities can lead to a greater aptitude for identifying faces.

One method of training a face recognition model involves utilizing its internalized concepts to conduct a series of tests. This process can provide valuable insight into the model's effectiveness.

To accelerate the process of learning, algorithms and rules can be utilized. These tools work by streamlining the process through the use of data analysis to determine the anticipated outcomes. By enforcing predetermined parameters, these rules guarantee that

the resulting decision adheres to specific criteria. Moreover, algorithms are capable of extracting relevant data to correspond with the input, further enhancing the learning experience.

To demonstrate its precision and efficacy, the program undergoes a sequence of tests using various images.

The LBPH-Algorithm is a method of facial recognition that involves the use of a histogram to represent the image's texture. This technique has been widely used in the field of computer vision due to its simplicity and effectiveness. It works by dividing the image into small regions and comparing each region to its neighboring pixels. This allows for the creation of a histogram that can be used to identify specific features of the face. The LBPH-Algorithm has proven to be highly accurate in identifying individuals, making it a popular choice for security systems and other applications that require reliable identification.

The LBPH algorithm necessitates four distinct input values, whereas it only necessitates three input values and one parameter.

The length between the center of a pixel and its edge in a circular local binary pattern is referred to as the radius.

A local binary pattern is comprised of data points that repeat themselves. Specifically, this pattern is made up of eight neighboring data points, which are referred to as Neighbor #8.

The plane along the horizontal axis consists of eight cells, commonly referred to as Grid X.

The number of cells in the vertical plane is typically determined by an 8 by Y grid.

Given the above parameters, LBPH works as follows;

a. create a record, a camera is utilized to capture either a photo or recording. This information is then added to a database, along with the name of the individual featured and a distinctive identifier that is stored in the camera. It is crucial to gather numerous samples from a single individual in order to effectively teach an algorithm and assess its outcomes. The algorithm is trained with a portion of the collected data, while the remainder is reserved for testing purposes.
b. The task of comparing data within a graph is achieved through the computation of underlying similarities. This is accomplished by analyzing the comparison graph and grouping similar LBP symbols together to form a histogram. To determine which pixels are to be examined, circular neighborhoods are utilized.

c. By grouping labels into smaller regions, a hierarchy is established in a histogram. These regions then come together on a per-pixel level to produce a comprehensive histogram that conveys an individual's complete story.

Two face recognition modes

There are typically two modes in which face detection algorithms operate:

a. When the face recognition mode is activated, this particular feature employs a 1x1 comparison to locate faces. It identifies the image being scanned by comparing it to a specific image that already exists in the database. This specific image is usually the one that requires identification in order for authentication to take place.
b. The process of face recognition involves the comparison of an individual's facial image to a database of previously stored images. This mode specifically compares one image to the entire database to find a match. Once a matching image is found, the system will display the result to the user.

The process of LBPH facial recognition involves several stages. These stages include image acquisition, preprocessing, feature extraction, and classification.

The procedure for face recognition using the LBPH algorithm involves several distinct stages. These steps can be divided into two primary categories and are outlined below:

A learning algorithm is a set of instructions or mathematical formulas that allow a machine or computer program to improve its performance on a task over time, based on feedback or data. These algorithms can be designed to learn from supervised data, where the correct output is known, or unsupervised data, where the algorithm must find patterns or structure in the data on its own. Learning algorithms are critical in the development of artificial intelligence, machine learning, and predictive modeling.

In order to facilitate the recognition process, a dataset of personal photos is utilized. The initial stage of this process involves familiarizing oneself with the algorithm. By assigning individualized identifiers, like numerical values or names, to each picture, the algorithm can accurately identify a given image. It should be noted that photographs of the same individual will share identical identifiers.

Arithmetic steppes

a. The initial stage of the LBP Method involves the implementation of a calculation process. In order to more accurately represent images, a sliding window concept is

utilized with additional consideration given to the radius and neighboring images. The creation of binary numbers is achieved by comparing the values of eight adjacent images, which is determined by a predefined boundary.

In order to generate a 1-dimensional binary array, each binary number is assigned a value of 1 if its neighboring value exceeds the threshold, and 0 if it falls below the threshold. This creates an array without a fixed threshold. To more accurately reflect the visual appearance of the original image, a matrix is used to average the pixels and convert them to decimal format.

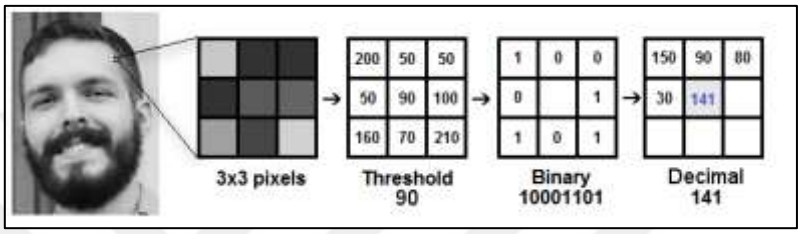

Figure 3.1: Application of LBP Operations on Images.

b. begin analyzing the image, measurements for both the x and y axes must be taken. These measurements are then used to divide the image into multiple grids, with the aid of X and Y grid parameters. The image in question is grayscale, and by combining histograms, a new image with similar characteristics to the original is created. Each histogram tracks the intensity frequency of each pixel, which is then aggregated to create a comprehensive dataset.

The image below shows the above resolutions:

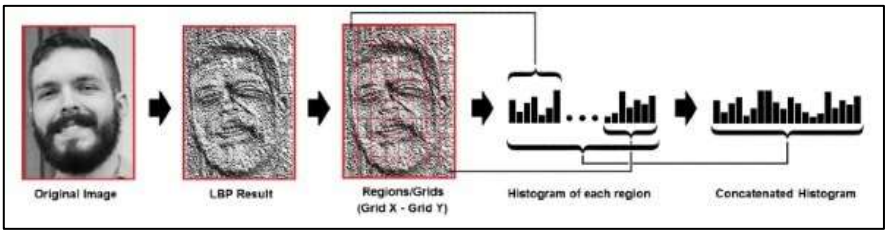

Figure 3.2: Extraction of Histograms.

c. During training, individuals pay attention to the histogram of their own subject. Afterward, they compare their image's histogram with the most fitting match on another subject's histogram. The outcome of this comparison is the ID or name of the image, along with a confidence measure and distance as calculated by the algorithm. Establishing a confidence rating and minimum threshold level is crucial in determining

the accuracy of image recognition algorithms. The combined confidence rating and threshold levels serve as an indicator of the algorithm's precision.

When a histogram possesses a high confidence value, it is indicative of the fact that the data point represented therein is accurately portrayed. A low confidence value, on the other hand, implies that the histogram is unclear and cannot be detected with ease.

The process of recognizing a new face image involves repeating the same procedure for each subsequent image.[34]

LBPH application field

The potential applications of LBPH's facial recognition technology are multifarious, spanning across several fields.

a. The utilization of a simplified image analysis is a common practice among medical professionals in order to enhance the clarity of their data. The segmentation of image textures is responsible for this increased lucidity.
b. Biometrics technology allows for the identification of an object through a variety of classification methods including age, fingerprint, iris and palm print recognition, gait recognition, posture sequence recognition, and wristband recognition.
c. The field of computer vision encompasses the study of motion analysis, including the application of LPH to enable computers to comprehend the intricacies of a given shape and integrate its significance.
d. The effectiveness and accuracy of LBP's image recognition capabilities can be enhanced by making common modifications to its primary local binary pattern. This modification can help address some of the limitations of LBP.

3.1.1.4 Haar cascading

Viola and Jones developed an object recognition system based on data gathered from an augmented series of basic features in 2001. This system can identify faces in live videos or photographs. A classifier is selected by the machine after analyzing both positive and negative images. This is a type of computer-based pattern recognition known as machine learning. Finally, an algorithm is used to process the images and generate a comprehensive set of positive and negative images.

The utilization of machine learning in classification algorithms allows for the comprehensive dissection of sequential images. Each image is inspected for specific, identifying characteristics which are then correlated with subsequent images. This process, known as sequential pattern learning, is capable of recognizing both facial expressions and facial recognition. Upon finishing the assigned workbook exercises, students are presented with positive and negative images taken from the text. From these images, data is extracted and systematically organized. By merging images, Har-like features can be calculated to determine each attribute's singular value. Each of these attributes is established by computing the difference between the number of pixels found in a black area and those in a white area. This is due to the various environments in which distinct faces are detected, each with differing lighting conditions.[35]

XML files contain Open-CV methods that can be utilized to read various models. These models encompass a wide range of features, including facial, ocular, upper and lower body, license plate recognition, and more. The quest for distinct characteristics involves a continuous scroll of hair from the top left corner to the bottom right corner.

The complete objective of the Hair Traversal Function is exemplified in this illustration. The transfer of hair attributes is achieved through the hair function, pixel by pixel, throughout the image. The function can be utilized by individuals with varying hair lengths. When individuals search for a house, they typically look for three distinct criterias. These criterias include the detection of vertical or horizontal edges within a rectangle, as depicted above. The second set of the machine is equipped with an additional three horizontal bars, which determine whether neighboring areas are dark or light. Within this set of four is a line that tracks variations in pixel intensity along the diagonal.

Hair Cascade Detection is one of the earliest and most influential algorithms for face recognition. This algorithm was developed prior to the widespread adoption of deep learning techniques. The models generated through this technique have the ability to not only identify items located on the head, but also other parts of the face such as the eyes, mouth, and license plates. These models are available on GitHub, and can be accessed through Open CV [36].

3.2 DEVELOPMENT OF SOFTWARE

As shown in the accompanying diagram, the software development process necessitates the implementation of two fundamental system processes:

a. It is imperative to construct a database of faces.
b. Participation in the registration process is mandatory for all students and involves attendance.

The formation of the attendance management system relies heavily on two key procedures. These procedures serve as the backbone for the system's success. In the following chapter, a more detailed examination of these procedures and their requirements will be provided.

3.2.1 The Creation of the Face Database

To commence with any further procedures, it is absolutely crucial to establish a face database. This is because the establishment of such a database serves as an initial benchmark for the recognition process that will be explicated later on. Part of this procedure involves the creation of a SQL QUERY file, which helps to identify and label multiple images of each student. In order to reduce the time required for training, newly captured images of students are automatically incorporated into the database after completing their training. This measure is taken to avoid any need for additional training as the size of the database grows. Instead, new students are promptly labeled and appended to the database immediately following their training so that they can be included during the subsequent training session.

Once the necessary data has been gathered for training purposes, the program's capabilities extend to other tasks via the programming language c-sharp. One such task is the initialization of B, followed by the loading of the trained data into the recognizer. It can then proceed to perform additional initializations, including A.

In order to streamline the storage of data, a SQL Server database was developed. This facilitates the tracking and retrieval of information by allowing for efficient filtering. The attendance capture system utilizes a looping mechanism to capture, identify, and record attendance data for each individual student through the employment of a camera. Chapter 4 delves into the specifics of this process. Chapter 5 provides further insight into the database, while also exploring programming elements.

3.3 ESTABLISHMENT OF THE FACIAL DATABASE

3.3.1 Specific Requirements

Meeting specific guidelines is an imperative factor in the construction of a face database.
To achieve this objective, what supplementary programs or software are necessary?
In order to accomplish this task, a fundamental understanding of the programming language C# is necessary.
Through the use of the tkinter package, a graphical user interface is made available to the user.

3.3.2 Methodology

The fundamental information required for an attendance tracking system includes a person's identification number and facial features. In order to function effectively, this system needs to input this data. Thus, the first step is to capture a portrait photograph using a camera to determine the presence of a face. The system mandates 12 full facial images of the individual and prompts them to retake the photo if the face is not detected. Subsequently, several processing steps are executed to procure grayscale and equi-sized images. These images are crucial to the operation of the LBPH detector, which is a pivotal component of the project's overall process. A diagram outlining these prerequisites is provided below.

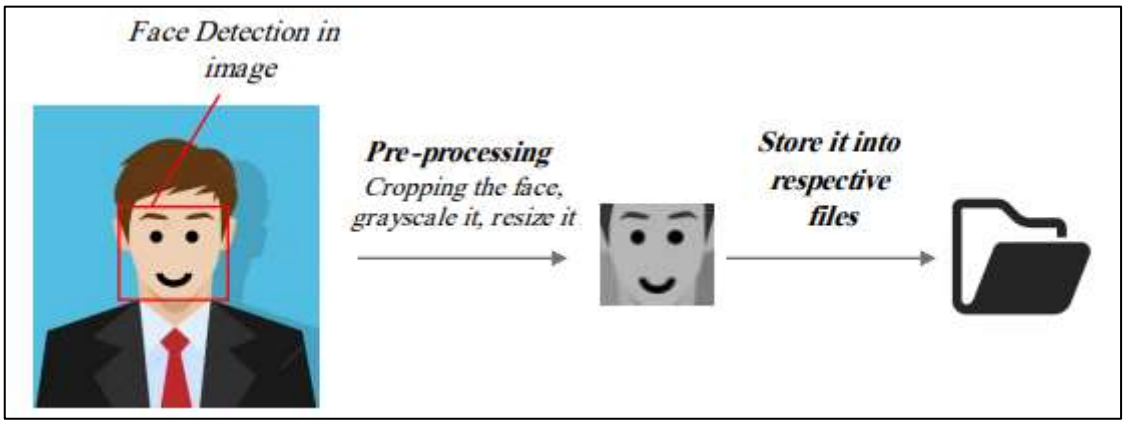

Figure 3.3: Procedures for Image Acquisition and Preprocessing.

The database folders store all faces hierarchically, with additional subfolders being added as more individuals are included in the database. Upon completion of the image processing, the resulting layers are saved in a file. In this particular project, all facial

portraits of one individual are stored in a designated database folder, which is allocated a unique number that serves as a name for the subfolders. The organization's database contains a script that generates and archives the identities of all members within the group. This process is known as image retrieval, preprocessing, and storage.

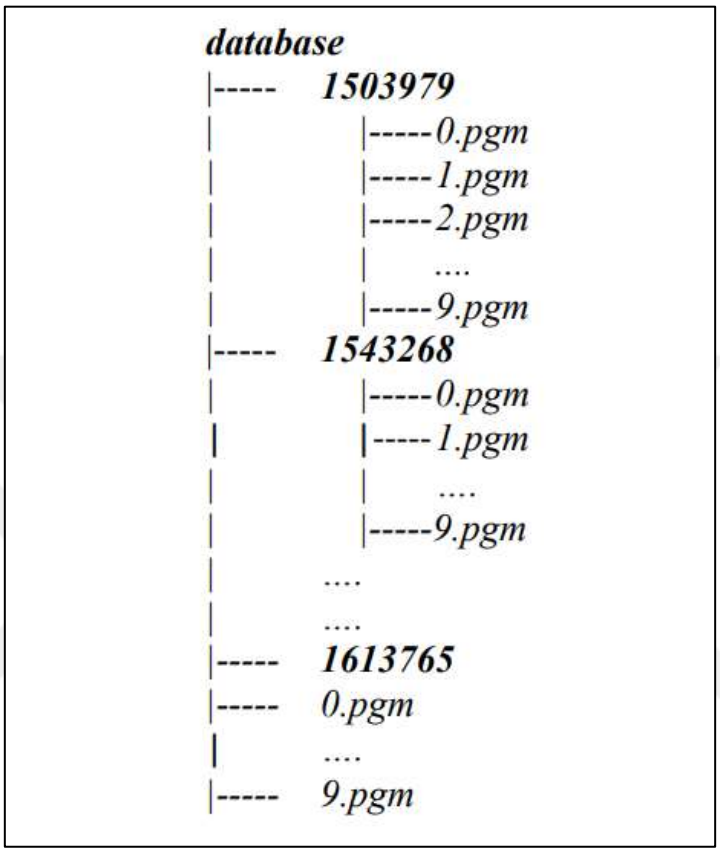

Figure 3.4: Layering Method for Face Database.

The following step in the extraction process involves the creation of a SQL QUERY file. This file is responsible for containing relevant data regarding the images that have been successfully extracted, as well as their designated directory path. The SQL QUERY file is then utilized in the subsequent step of the process, which entails the training of the facial recognition software. In this step, images are imported into the software using the SQL QUERY file. The image within the SQL QUERY file is illustrated below.

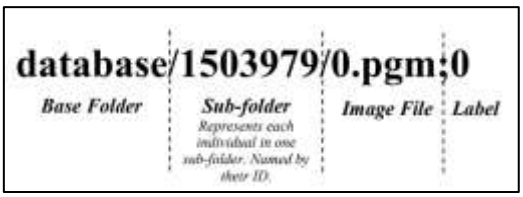

Figure 3.5: Content Structure in SQL QUERY File.

OpenCV 3.4 includes three distinct training mechanisms, namely LBPH, Fisher Faces, and LBPHs. Out of these three, this project will concentrate specifically on the LBPH training algorithm. Once a sufficient number of images are uploaded into the database, they are then fed into the training mechanism. LBPHs achieve this by creating histograms that accentuate facial features through their maximum differences between each image. They gather information by identifying particular faces and encoding their appearance changes into a data list for comparative analysis. During the training phase, a SQL QUERY file is utilized to load the images and their respective label definitions. This creates a list of lists called a Variable List, which is then passed to the training function along with the images and labels. The duration of this process is measured by the creation of the LBPH itself, which takes longer the more faces are present in the database. For instance, it takes about 50 seconds for a single subject to have their 400 images loaded into the training database. Each of these subjects provides 40 photos for training.

Upon the completion of training, a .xml file is created to ensure the system's efficiency. Rather than redoing the entire training process, this file is only utilized during recognition. The system's training process requires a total of 50,000 images, which would take approximately 1.3 hours to complete.

3.3.3 Flow Chart of the Image Acquisition Process

In order to conduct face recognition, the first step involves the creation of a face database. This process entails collecting numerous photos of faces and merging them into a single database. Once this step is finished, the database entries can be compared to identify individuals. Note that the system only allows input of 12-digit numbers to prevent duplication in the database and solely permits unregistered IDs to be used. To ensure accurate identification, every image captured must undergo processing to eliminate dust, blur, and color distortion. The images are then organized into folders that correspond to each person, with each folder containing 12 portraits of the subject.

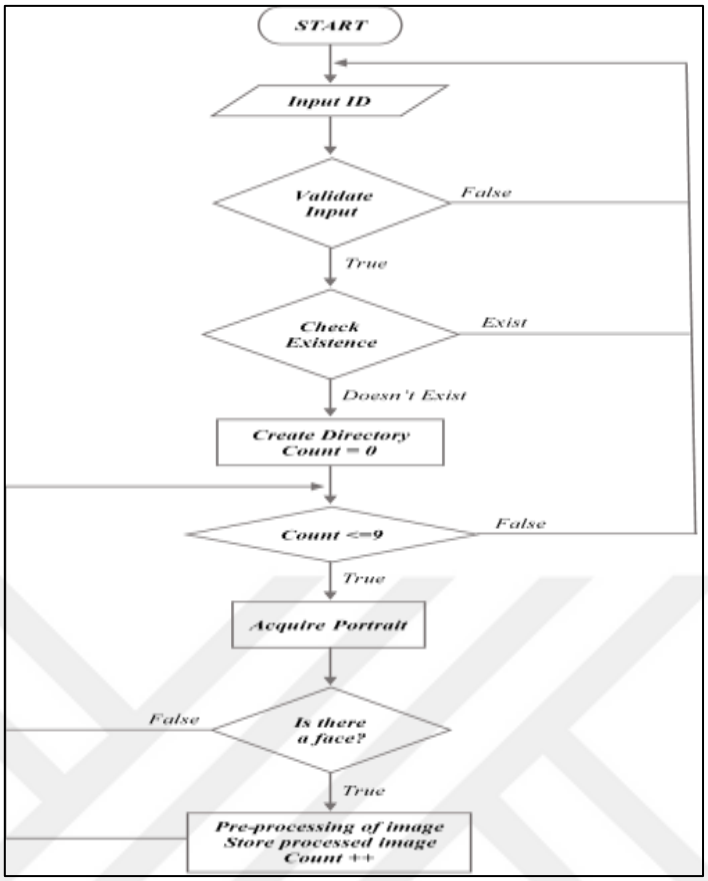

Figure 3.6: Flowchart of Image Retrieval Process.

This chart represents the step-by-step program flow of the image capture process. The program itself is implemented by the ras_database.sql script. Meanwhile, two other scripts are responsible for handling the remaining procedures, which will be elaborated on in the upcoming section.

3.3.4 Files Included

There are two important folders inside the system folder. The first is the haarcascade_frontalface_default.XML Ten pictures of it are taken when the student registers. It also contains the database script for which the database is designed inside SQL Server, which must be executed manually until the database is designed. Distinctive cases of the C# programming language. One of these cases is implemented for the purpose of registering new students and their corresponding photographs. After successful setup of the environment, the need for the uncertain step of transferring the database containing images or information that is not desirable to be shared during installation can be eliminated more than once.

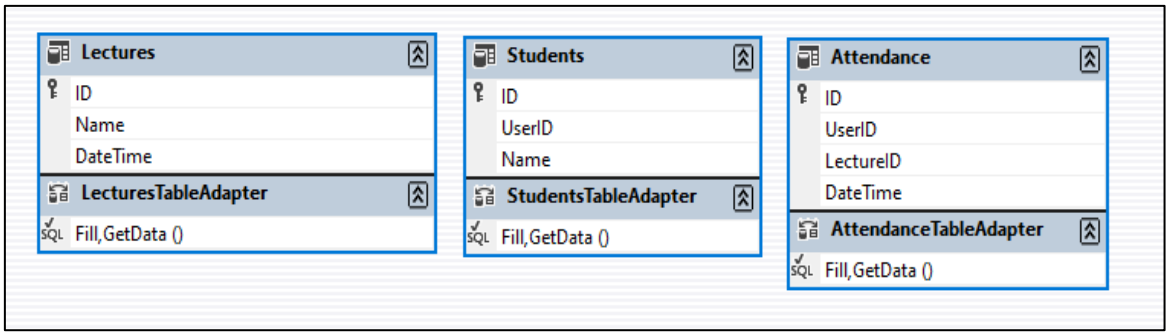

Figure 3.7: structure of Dataset for Database System.

The database design of these files is explained in the section below.

	ID	UserID	Name
▶*	NULL	NULL	NULL

Figure 3.8: Database Data Structure for System Design Student Table.

	Column Name	Data Type	Allow Nulls
▶🔑	ID	int	☐
	UserID	int	☑
	UserName	varchar(100)	☑
	SignTime	datetime	☑
	LectureName	varchar(100)	☑
	LectureTime	datetime	☑
			☐

Figure 3.9: Database Data Structure for System Design Lectures Table.

	Column Name	Data Type	Allow Nulls
▶🔑	ID	int	☐
	Name	varchar(100)	☑
	DateTime	datetime	☑
			☐

Figure 3.10: Database Data Structure for System Design Attendance Table.

design a database for a system that manages student information, lecture times, student attendance times, as well as attendance records using facial recognition, you will need to create schedules of students, subjects, and attendance. Above is a simplified example of a data structure using SQL Server syntax. Note that this is a basic architecture, and you may need to extend it based on your specific requirements.

4. SYSTEM IMPLEMENTATION

4.1 INTRODUCTION

In the realm of software development, the integration of programming language libraries, particularly in C#, plays a pivotal role in harnessing the capabilities of connected cameras. This software project extends its functionality to both webcams and conventional camcorders, leveraging Application Programming Interfaces (APIs) to extract valuable information from these devices. Through seamless interaction with the cameras, the software transforms raw data into a practical format for real-time analysis.

A primary objective of this project is the meticulous recording of attendance records through the individualization of faces. Authorities can register facial features using the system's camera, initiating a process that involves the real-time processing of video data to detect and recognize faces. Upon arrangement of faces into a grid system, they are stored within a matrix, enabling subsequent identification.

The system offers versatile features, allowing users to access on-demand video content featuring recognized individuals. Simultaneously, it exhibits the capability to identify multiple faces in real-time scenarios. Biometrics, the utilization of biological characteristics for identification, has become integral in contemporary technology. Our team is currently engaged in developing an affordable security system that excels in accurately identifying and analyzing individuals, even in adverse weather conditions.

This development is influenced by the need to address challenges posed by background noise, fog, rain, and other environmental factors that may impact system efficiency. The discussion here focuses on the creation of a facial recognition system, be it fully automated or semi-automated, poised to match facial images with precision. The aim is to contribute to the evolution of reliable and efficient security solutions in the ever-advancing landscape of biometric technology.

Such a system is designed to automatically match faces with a high degree of accuracy. In order to recognize an individual's face, various techniques are employed, one of which is Principal Component Analysis (PCA). This method examines data to identify similarities and differences between values, allowing individuals to visualize the features present in their own faces.

fulfill the objectives and meet the requirements of stakeholders, the project employs an uncomplicated interface and a requisite algorithm. Comprised of both a database and a windows application, the development of this project utilized open-source tools including C# and SQL for both front-end and back-end development.

The phase of integration and testing begins after the implementation of all units. As a first step, each unit undergoes thorough testing before being integrated into the system. Once all units have been integrated, the system as a whole is subjected to rigorous testing to detect any faults or failures that may have arisen during the integration process.

Unit testing is an essential part of the software development process. It involves the systematic testing of individual components of code to ensure that they function as intended. This testing process is highly effective in identifying and isolating any errors or issues early on in the development process, which can save significant amounts of time and resources in the long run. Additionally, unit testing allows developers to test their code in a controlled environment, making it easier to identify and fix any potential problems. Overall, the implementation of unit testing is a crucial step in ensuring the quality and reliability of software applications.

The IEEE Standard defines unit testing as the examination of individual units of software or hardware, or a cluster of related units. The project in question has undergone extensive testing to guarantee that no information is missed. The attendance marking, enrollment, addition, and pay slip generation features have been thoroughly tested to ensure their accuracy and real-time functionality. Moreover, both the functional and non-functional requirements have been tested to ensure that they are all met.

Integration testing is an essential process in software development that involves testing how different modules of a system interact and work together. It is a crucial step in ensuring that the software functions as intended and that all components are fully integrated. Through this process, developers can identify and address any issues that arise when integrating different modules, ensuring that the end product is of the highest quality and meets all expectations.

When it comes to software development, integration testing is a crucial step. This testing process involves the merging of all software components and assessing the level of interactivity between them. By doing so, the effectiveness of each application's functionality in conjunction with one another can be determined. Interface testing and

usability testing are both included within this type of testing to ensure optimal performance.

Our team implemented a bottom-up approach in our testing process, which involved conducting tests on lower-level components prior to moving onto higher-level ones.

The Cutover Phase in the RAD model bears a resemblance to the final steps of the implementation phase in the SDLC. This includes the conversion of data, conducting tests, transitioning to the new system, and providing training to users. In contrast to conventional methods, the entire process is condensed, allowing for the construction, delivery, and implementation of the new system to occur much more quickly.

Upon the completion of both functional and non-functional testing, the product is either deployed within the customer environment or released onto the market for consumer use.

Maintenance involves addressing various issues that arise in a client's environment. These issues are resolved through the release of patches, while product enhancements are introduced through the release of better versions. The ultimate goal of maintenance is to ensure that these changes are successfully implemented within the customer's environment.

4.2 FACIAL RECOGNITION

The concept of face recognition can be divided into two types. The first type involves the identification of a detected object as either a previously seen face or an unfamiliar face to the system. The second type deals with identifying faces that the system has not encountered before, as depicted in Figure 4.1. It is a common occurrence to mistake the identity problem for face detection. The task at hand involves the identification of a facial feature in an input image. This is accomplished through the utilization of a face detection mechanism.

The process of face recognition involves utilizing a collection of faces in a database to determine whether or not the given face has been previously identified. This function enables the validation of the input face through the use of face recognition technology.

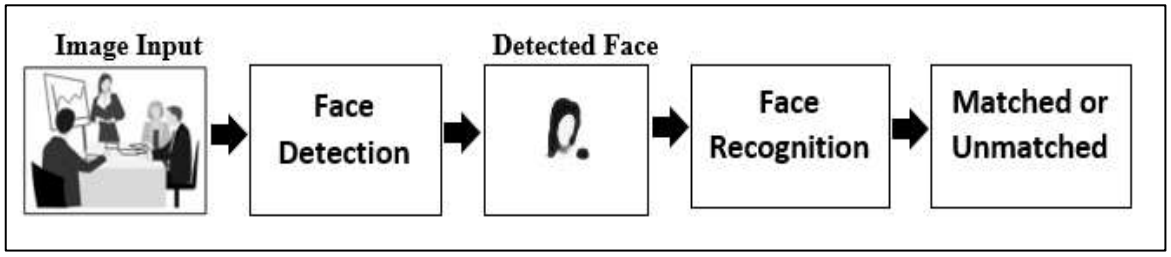

Figure 4.1: Configuration of the Face Recognition Structure.

The current system, as it stands, has been subject to a great deal of scrutiny and debate. While some believe that it is adequate, many others see significant flaws that need to be addressed. There are those who argue that it is too complex and difficult to navigate, while others feel that it is too rigid and inflexible. Still, there are others who argue that it is simply outdated and no longer suited to the needs of modern society. Regardless of the specific criticisms, it is clear that there is a need for change and improvement in the existing system.

When a student signs their attendance form by hand, it is crucial that the form is maintained correctly. The storage area, whether it be a file folder or cabinet, must have enough room for future forms to be included. Moreover, it is necessary to ensure that the form is stored fittingly in a file or cabinet that has enough rack space to accommodate additional forms.

The present system of using manual attendance sheets in classes is vulnerable to abuse as students can easily falsify their own attendance and that of their peers. This system is not only inefficient but also lacks a systematic approach to tracking attendance. Instructors are burdened with the task of manually reviewing each student's attendance record, tracking all attendance sheets, and compiling a final report. Moreover, instructors must collect attendance sheets from all students in the class, which adds to their workload.

There are numerous shortcomings within the present system.

a. Maintaining a system poses numerous challenges that can be difficult to overcome.
b. It is possible that the results obtained may not be entirely accurate.
c. The app's lack of intuitive design makes it challenging to navigate and operate smoothly.
d. The completion of various tasks necessitates a greater amount of time for processing.

4.3 PROPOSED SYSTEM

a. The utilization of a camera to process image input from a user is a common practice.
b. The preferred method of capturing class photos is through the use of a camera. Teachers utilize these images to compile a visual representation of each lecture's students.
c. The camera possesses the ability to detect faces as one of its significant features.
d. The process of face recognition involves a series of established procedures.
e. Facial recognition is a feature of the device.

f. To accurately identify a person, additional comparisons must be conducted to match their face with their identity.
g. The content of this particular section involves a side-by-side analysis of the characteristics of one item in comparison to another.
h. The process involves the comparison of computed attributes to those that have been stored beforehand.
i. The collection of information regarding attendees is organized into a database.
j. The back-end of the system houses a registry of enrolled students. Upon the completion of data collection, all findings are entered into this database.
k. Every day, the Daily Report publishes a fresh report.
l. Every day, the institute produces a report that conforms to its regulations.
m. The newly proposed system substitutes traditional attendance marking with facial recognition and detection. With the implementation of this system, a final report is automatically generated in accordance with the regulations of the school.
n. The two main phases of the facial recognition system are enrollment and authentication/verification. The figures below illustrate the diagrammatical representation of the system's framework.
o. Once a user has been authenticated, the system proceeds to collect their biometric information to be utilized in their subsequent actions.

Creating a template from extracted features of a user's face is the first step in enrolling and verifying their identity. Once this is done, the template is used for signal processing during the analysis of video footage. In the event that the extracted face templates are of low quality, new images must be obtained. The stored data in the database is exclusively from facial images that meet specific standards.

Sophisticated digital mathematics and imaging techniques are employed by computer programs to precisely identify human faces. In order to obtain dependable outcomes in a shorter amount of time than other approaches, these programs process images in a grid pattern. The issue of facial recognition in contemporary society is addressed by leveraging these programs.

4.4 DESIGN OF THE SYSTEM

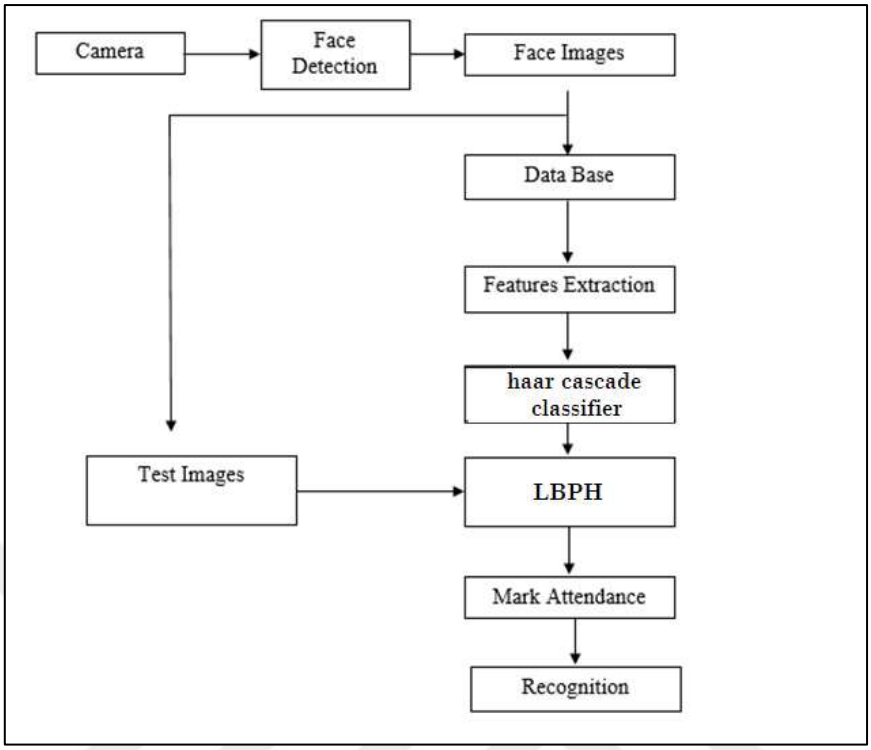

Figure 4.2: Flowchart Design for a Face Recognition-Based Attendance System.

4.5 PROJECT EXECUTION

The development project utilizes programming languages such as the C# programming language to program and construct its attributes. In order to create databases, including the database where SQL queries are written or tables are produced, the SQL Server is utilized. All of these elements are upheld by the programmer in the Visual Studio 2019 environment.

a. Hardware Requirement: -

i. A computing device equipped with an i5 processor.

ii. Furthermore, the computer is equipped with a RAM of 16 gigabytes.

iii. The computer comes equipped with an SSD drive that has a storage capacity of 512 gigabytes.

iv. Camera

b. Software Requirement:

i. The utilization of the software necessitates a Windows operating system surpassing version 8.

ii. One of the primaries uses for Visual Studio 2019 is as a programming language to develop software applications.
iii. In order to contain the information necessary for the game, a database is utilized that operates on SQL Server technology.
iv. The utilization of the software necessitates an adeptness in the C# programming language.

4.6 PROJECT BENEFITS

a. The process of extracting comparable regions of the face is accomplished through a repetitive procedure.
b. The distinctive facial characteristics of a person serve as a means of validation and recognition.
c. The adaptability of IT systems is a well-known attribute.
d. Incorporating the plug-in into video monitoring systems is a simple process.
e. It is imperative to find a match.
f. The software has the ability to accommodate an extensive variety of video and graphic formats, in addition to live camera feeds.
g. The utilization of multiple face recognition techniques is a fundamental aspect of Open CV's ability to accurately identify faces.
h. The camera system is programmed to identify faces and prioritize the eye region for optimal focus.
i. Recognition is bestowed through the utilization of neural network technology.
j. With a high rate of recognition, the processing time is kept brief.
k. People have the ability to recognize individuals even when their facial features are obscured by glasses or facial hair.
l. Accurate results enable swift identification.
m. The wallet's security measures are noteworthy, and its user-friendliness is unparalleled.
n. The simplicity of the app's design contributes to its ease of use and makes navigating it a straightforward and intuitive experience.

Figure 4.3: Login Interface Attendance Management System.

A login interface in an Attendance Management System (AMS) serves as the gateway for users to access the system and perform various tasks related to attendance tracking. This interface is a crucial component that ensures secure and authorized entry into the system.

Figure 4.4: Main System for Face Recognition Attendance Management.

Displayed in this figure is the main interface of our program, which showcases buttons for various functions, such as capturing an image, managing lectures, displaying students Additionally, it allows for the detection of attendance and manual recording of attendance.

Figure 4.5: Student Registration in the Face Recognition Attendance Management System.

The student registration process for this feature includes filling in the serial number and student name in the designated fields. Upon completion, the student presses a button to take a total of 12 photos, the information of which is added to the database with the photos taken in a subfolder named Face next to the program. The figure above provides a visual representation of this process.

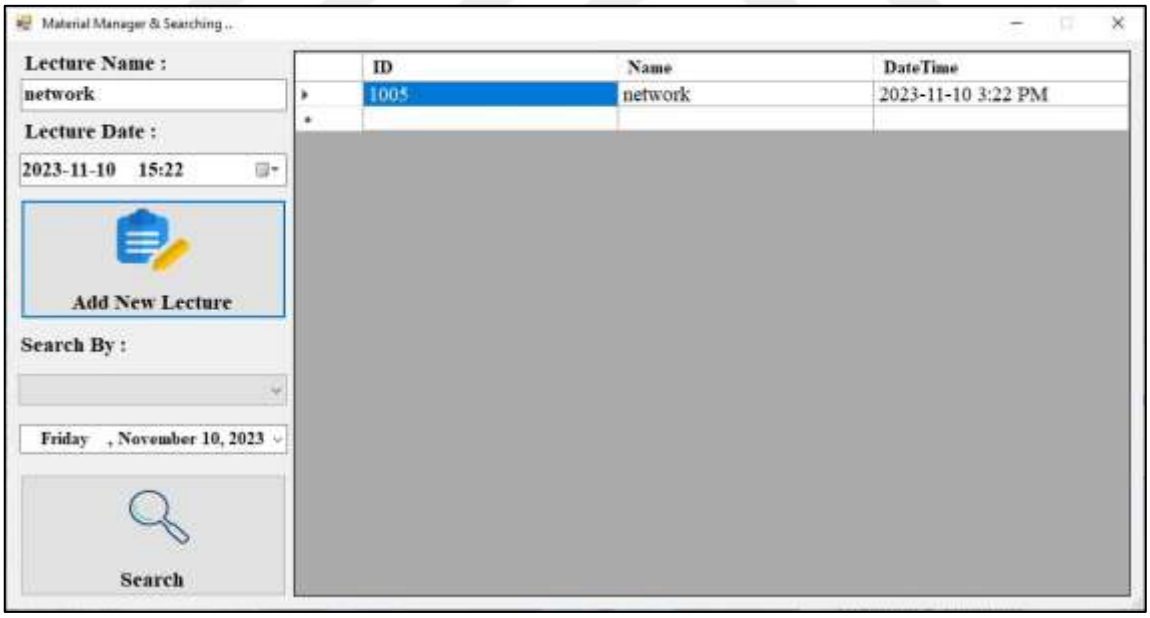

Figure 4.6: Addition of Lectures to the Face Recognition Attendance Management System.

The following illustration shows the process of merging lectures for professors of a particular subject, including the specific time and date of said lecture. This is achieved by entering the name of the topic in the designated field and choosing the required time period for the lecture. Once this information is entered, the user can click the “Add New Lecture”

button to complete the process. In addition, searches can be performed through the added materials for the students who attended the lecture and through the added search features and the sorting process by date.

Figure 4.7: Automatic Attendance in the Face Recognition Attendance Management System.

The following diagram shows the advantage of incorporating facial recognition technology to record attendance. When the Attendance Recording option is selected, a user interface is created, prompting the user to enter the name of the lecture. Once the name of the lecture is registered, the user can proceed to fill in the attendance automatically through the program that relies on the camera to record attendance for students using the Haar Cascade algorithm, which helps in identifying parts, objects, and faces as well.

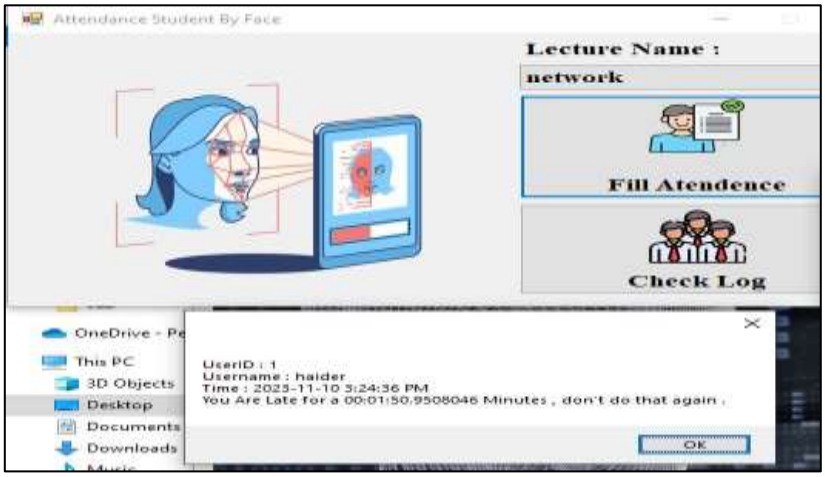

Figure 4.8: Attendance Registration in the Face Recognition Attendance Management System.

As shown in the illustration, once the fields on the previous page were completed, the camera was triggered to recognize the student's face and record their attendance through

the C# programming language. In addition, the student provided his or her name, date of registration, and time of registration. The student also specified the name of the lecture, its start time, its end time, and the period during which the student was late for the lecture

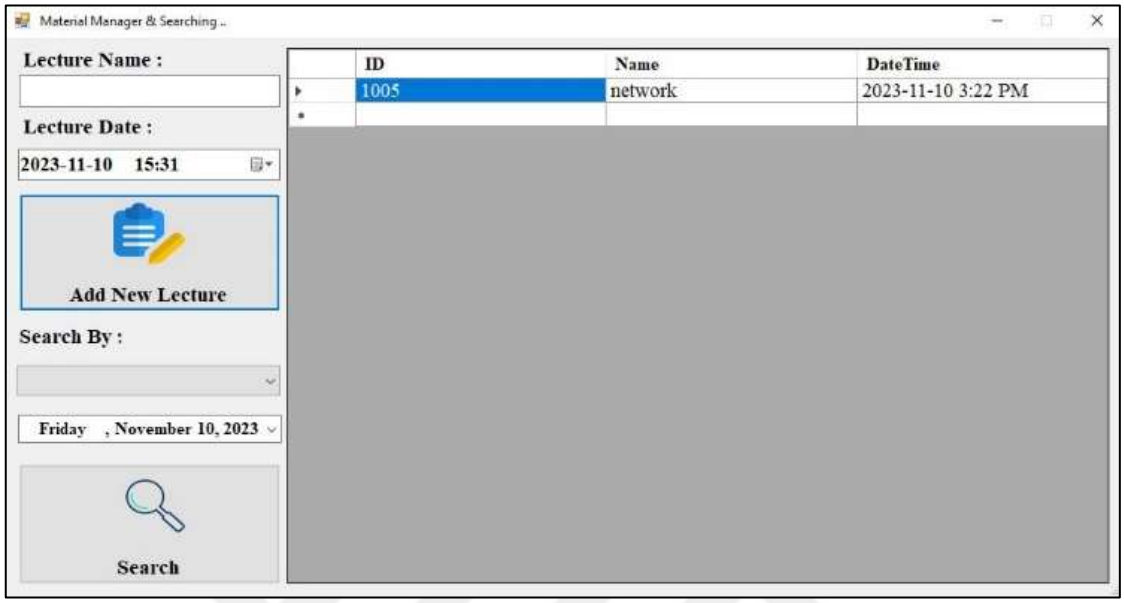

Figure 4.9: Viewing Lecture Attendance Records in the Face Recognition Attendance Management System.

Upon clicking the "Add a new lecture" button in this layout, a roster of registered students for each lecture and the date on which they were registered becomes visible.

Figure 4.10: Manual Attendance Recording for Lectures in the Attendance Management System for Face Recognition.

The inclusion of this particular feature is intended for emergency situations, such as when the camera or other technical equipment experiences a malfunction. In these circumstances, the feature is activated by clicking on the attendance record manually. This

prompts the lecture name to appear, which can then be filled out and submitted to record attendance, The method of recording attendance involves inputting the student's identification number and name, followed by pressing the data entry button to save the information.

5. DISCUSSION AND RESULTS

5.1 DISCUSSION

Testing is a crucial step in successfully completing any project. Every aspect of a project must meet stringent quality standards to ensure its success. The new system undergoes rigorous testing to ensure that it performs as intended. The system is coded using Tinker GUI, and users test it for functionality. All parts of the user test the apps to ensure that no bugs are present before public release. In the event of bugs, the development team implements fixes before releasing the application. A comparison of the two forms' designs reveals numerous similarities. Financially, the project makes sense because no additional expenses are required. The cost and time invested in creating the new system are weighed against its expected returns to determine its viability. The new system is feasible if the benefits outweigh the costs and expenses.

5.2 RESULT AND ANALYSIS

System performance evaluation is a critical task involving the thorough analysis of a system's effectiveness, efficiency, reliability, durability, and overall functionality. This comprehensive assessment is essential to ensure the system meets the necessary standards and expectations. ensure accurate identification, we have established a parameter of a 3-foot distance. In Table 5.1, it is shown that students have a 79% success rate in recognizing faces with only a 24% chance of false positives, even if the subject is wearing glasses or has a beard. However, this success rate drops to 65% for unknown individuals in both the existing and proposed models, primarily due to the identification of non-faces as faces by the face detection algorithm.

The false positive rate in the proposed model is 15%, while the existing model has a 31% false positive rate. Interestingly, the false positive rate only changes with threshold values when identifying unknown individuals. Nonetheless, the system is currently functioning well by using a favorable filter value of 50, which tags individuals as unknown if their head turns beyond a certain angle [35]. [34] typically sets the favorable filter value. The system operates under the premise that an individual is marked as unknown only if their degree of confidence is above 50 and 95. Upon being identified as such, the system proceeds to store a snapshot of the individual as an anonymous entity.

Table 5.1: System Performance Evaluation.

System performance evaluation	percent
The act of delving into the daily lives of students through live webcams is an intriguing prospect.	79%
The frequency of erroneous positive outcomes in regards to students.	24%
The present model's success rate in accurately discerning the identity of an unfamiliar person.	65%
According to the present model, the rate of erroneous positive identifications for an unknown person is noteworthy.	31%
The proposed system's efficacy in identifying an unfamiliar individual success rate is under scrutiny.	64%
The proposed model examines the probability of an erroneous identification for an unidentified person.	15%

5.3 FUTURE WORK PROSPECTS

The technology of facial recognition is the most sophisticated method for identifying biometric data. According to human knowledge, its algorithm is ten times more intricate than that of fingerprint identification. The system is able to function even without direct contact or conscious awareness from the individual. In comparison to fingerprints, facial recognition boasts several advantages, such as superior accuracy and speed. The foremost industrial algorithms for facial recognition are capable of processing more data than those for fingerprints. It is also highly convenient and secure, with an error rate for control that is less than 0.0002%. Unlike fingerprint technology, facial recognition is unaffected by cold, wet, peeling, or aging skin. While fingerprint identification is unable to register approximately 7% of people, facial recognition is able to capture images that cannot be replicated by fingerprints.

5.4 RECOMMENDATIONS

Our approach involves the use of a novel concept referred to as the subjective scale image and a 3D face whiteness reflection model. This combined framework is designed to tackle both position and illumination issues. While our prototype image synthesis technique is effective for generating new images, it is not intended as a replacement for traditional methods like photography. We aim to enhance the aesthetics and technological capabilities

of the current lda system by implementing our proposed system overhaul. Our plan is to integrate additional 3D facial models, optimize their fit to the user, and ultimately improve the overall visual appeal.

5.5 CONCLUDING REMARKS

The introduction of AFR technology has brought about a revolutionary change in older methods. Attendance tracking in classrooms has always been a cumbersome and time-consuming process due to the large number of students attending lectures, making it difficult to distinguish between those who participated and those who didn't. The implementation of automatic facial recognition and smart presence has made our data more secure and easier to manage, reducing the need for paper and manual attendance. This approach uses biometrics to identify students by measuring their physical features and storing the information in memory for later processing. The computer can then identify which student's information is stored in the database and display their attendance. To improve the face recognition process, various techniques and algorithms have been implemented, including the use of OpenCV, which automatically records new information in a database through pictures. Typically, students use a conventional method of recording that automatically archives their participation in academic papers or through the use of hardware such as Near Field Communications Identification Journal International Scientific Research in Science and Technology, which is combined with software. However, our system operates differently. It eliminates the need for students to wear any devices or undergo any biometric identification procedures. Instead, the system captures a student's image during a lecture or class and stores it for future reference. The image is then matched with training images to recognize the student. While neural network classifiers have shown promise, further research is necessary to improve their accuracy. One way to achieve this is by learning how to configure the neural network for optimal performance.

REFERENCES

[1] Geng, X., Zhou, Z.-H., & Smith-Miles, K. (2008). "Individual Stable Space: An Approach to Face Recognition Under Uncontrolled Conditions." *IEEE Transactions on Neural Networks.*

[2] Winarno, Wiwien Hadikurniawati, Imam Husni Al Amin, Muji Sukur. "Anti-Cheating Presence System Based on 3WPCA Dual Vision Face Recognition." *Faculty of Information Technology Universitas Stikubank Semarang Indonesia.*

[3] Malik, R., Kumar, P., Verma, A., Rawat, S. "Prototype model for an Intelligent Attendance System based on facial Identification." *Amity University Uttar Pradesh.*

[4] Ara, N. M. "Convolutional Neural Network Approach for Vision Based Student Recognition System." *Dept. of CSE, SUST, Sylhet, Bangladesh.*

[5] Masruroh, S. U., Fiade, A., Julia, I. R. "NFC Based Mobile Attendance System with Facial Authorization on Raspberry Pi and Cloud Server."

[6] Damale, R. C. "Face recognition-based Attendance System using Machine Learning Algorithms." *Cummins College of Engineering for Women, Pune, Maharashtra, India.*

[7] Wagh, P. "Class Attendance system based on Face Recognition."

[8] Zeng, W. "Design of Classroom Attendance System Based on Face Recognition."

[9] Jadhav, A., Jadhav, A., Ladhe, T., Yeolekar, K. "Automated Attendance System Using Face Recognition."

[10] Puthea, K., Hartanto, R., Hidayat, R. "An Attendance Marking System based on Face Recognition."

[11] Salim, O. A. R. "Class Attendance Management System Using Face Recognition." *International Islamic University Malaysia.*

[12] R, N., N. Duraimurugan. "Face Recognition Based Attendance System."

[13] Lukas, S., Mitra, A. R., Desanti, R. I., Krisnadi, D. "Student Attendance System in Classroom Using Face Recognition Technique." *Universitas Pelita Harapan Karawaci, Indonesia.*

[14] "A brief history of facial recognition." (2020). [NEC New Zealand](https://www.nec.co.nz/market-leadership/publications-media/abrief-history-of-facial-recognition/).

[15] Andrejevic, M., & Selwyn, N. (2020). "Facial recognition technology in schools: critical questions and concerns." *Learning, Media and Technology.* [Online](https://www.tandfonline.com/doi/full/10.1080/17439884.2020.1686014)

[16] "C sharp programming language Documentation." [W3Schools](https://www.w3schools.com/csharp/).

[17] Krenker, A., Bešter, J., Kos, A. "Introduction to Artificial Neural Networks." *InTech, Croatia.*

[18] Kumar, P., Sharma, P. "ARTIFICIAL NEURAL NETWORKS- A Study." *International Journal of Emerging Engineering Research and Technology.*

[19] Jindal, N., Kumar, V. "Enhanced Face Recognition Algorithm using PCA with Artificial Neural Networks." *International Journal of Advanced Research in Computer Science and Software Engineering.*

[20] Sudhakar Farfade, S., Saberian, M., Li, L.-J. "Multi-view Face Detection Using Deep Convolutional Neural Networks." *International Conference on Multimedia Retrieval, Shanghai, China.*

[21] Krizhevsky, A., Sutskever, I., Hinton, G. E. "Image net classification with deep convolutional neural networks." *Curran Associates, Inc.*

[22] Koestinger, M., Wohlhart, P., Bischof, H. "Annotated facial landmarks in the wild: A large-scale, real-world database for facial landmark localization." *IEEE International Workshop on Computer Vision Workshops, Barcelona.*

[23] Yoo, S.-H., Oha, S.-K., Pedrycz, W. "Optimized face recognition algorithm using radial basis function neural networks and its practical applications." *International journal on Neural Networks.*

[24] Liy, H., Linz, Z., Shenz, X., Brandtz, J., Hua, G. "A Convolutional Neural Network Cascade for Face Detection." *IEEE Conference on Computer Vision and Pattern Recognition, Boston, MA.*

[25] Roy Chowdhury, A., Lin, T.-Y., Maji, S., Learned-Miller, E. "Face Identification with Bilinear CNNs." *Computer Vision and Pattern Recognition.*

[26] Nandini, M., Bhargavi, P., Raja Sekhar, G. "Face Recognition Using Neural Network." *International Journal of Scientific and Research Publications.*

[27] Rowley, H. A. "Neural Network-Based Face Detection." *IEEE Computer Society Conference on Computer Vision and Pattern Recognition, San Francisco, CA.*

[28] Rowley, H. A., Baluja, S., Kanade, T. "Rotation Invariant Neural Network-Based Face Detection." *IEEE Computer Society Conference on ComputerVision and Pattern Recognition, Santa Barbara, CA.*

[29] El-Bakry, H. M. "Fast Face Detection Using Neural Networks and Image Decomposition." *International Computer Science Conference, Hong Kong, China.*

[30] Wiegand, S., Igel, C., Handmann, U. "Evolutionary Optimization of Neural Networks for Face Detection." *European Symposium on Artificial Neural Networks, Bruges.*

[31] Boughrara, H., Chtourou, M., Amar, C.B. "MLP neural network based face recognition system using constructive training algorithm." *International Conference on Multimedia Computing and System, Tangier.*

[32] Sahoolizadeh, H., Sarikhanimoghadam, D., Dehghani, H. "Face recognition system using neural network with Gabor and discrete wavelet transform parameterization." *International Conference of Soft Computing and Pattern Recognition, Tunis.*

[33] Samet, R., Tanriverdi, M. "Face Recognition-Based Mobile Automatic Classroom Attendance Management System." *2017 International Conference on Cyberworlds (CW), Chester.*

[34] Ahmed, A., Guo, J., Ali, F., Deeba, F., Ahmed, A. "LBPH based improved face recognition at low resolution." *2018 International Conference on Artificial Intelligence and Big Data (ICAIBD).*

[35] Haarcascades,https://github.com/kipr/opencv/blob/master/data/haarcascades/haarcascade_frontalface_default.xml

[36] "Facial Recognition Technology in Schools: Critical Questions and Concerns" by Mark Andrejevic & Neil Selwyn. [Learning, Media and Technology](https://www.tandfonline.com/doi/full/10.1080/17439884.2020.1686014).