NEURAL NETWORK BASED FACE RECOGNITION SYSTEM FOR STUDENTS

BY

Shrijon Deb Tushar
ID: 181-15-11303

Md. Alimozzaman Durjoy
ID: 181-15-11017

Anika Hossain Bristy
ID: 181-15-10697

This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

Supervised By

Md Azharul Islam Tazib
Lecturer
Department of CSE
Daffodil International University

Co-Supervised By

Mr. Narayan Ranjan Chakraborty
Assistant Professor
Department of CSE
Daffodil International University

DAFFODIL INTERNATIONAL UNIVERSITY
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APPROVAL

This Project titled "Neural Network based Face Recognition System for Students", submitted by Shrijon Deb Tushar, Md. Alimozzaman Durjoy and Anika Hossain Bristy to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 5th December,2021.

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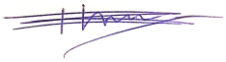

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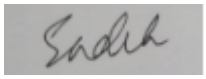

Internal Examiner

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Assistant Professor
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

Internal Examiner

Afsara Tasneem Misha (ATM)
Lecturer
Department of Computer Science and Engineering
Faculty of Science & Information Technology
Daffodil International University

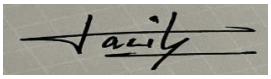
External Examiner

Shah Md. Imran
Industry Promotion Expert
LICT Project, ICT Division, Bangladesh

DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md Azharul Islam Tazib, Lecturer, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

Supervised by:

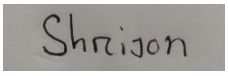


Md Azharul Islam Tazib
Lecturer
Department of CSE
Daffodil International University

Co-Supervised by:

Mr. Narayan Ranjan Chakraborty
Assistant Professor
Department of CSE
Daffodil International University

Submitted by:



Shrijon Deb Tushar
ID: 181-15-11303
Department of CSE
Daffodil International University

(Md. Alimozzaman Durjoy
ID: 181-15-11017
Department of CSE
Daffodil International University

Anika Hossain Bristy
ID: 181-15-10697
Department of CSE
Daffodil International University

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ABSTRACT

Face recognition systems are part of biometric information processing. Face recognition is easier to apply and requires a longer work area than scanning fingerprints, irises, signatures**,** etc. Due to the variety of facial expressions, lighting effects, and background complexity of images, taking real-world data-based facial recognition, photographs, sensor images, and database images can be a daunting task. Face recognition is one of the triumphant and important uses of image processing. This research describes facial recognition methods and algorithms developed by various researchers with the help of convolutional neural networks (CNNs) and applied in the fields of image processing and pattern recognition. This research will also describe how CNN will be utilized for face recognition and how it is more successful than other approaches. There is a slew of CNN-based algorithms that provide a high-level overview of facial recognition. Accordingly, this study includes a comprehensive review of facial recognition experiments and systems based on different techniques and algorithms from CNN. Here in this research project, we proposed a facial recognition system through convolutional neural networks. In the field of computer vision, neural networks are a set of algorithms that seek to discover the fundamental connections of a dataset through a process. Our approach to the face recognition problem involves combining principal components and neural networks. We describe the app on vertically oriented front-facing views of human faces specifically designed for universities to recognize their students.

Keywords: Face Recognition, CNN, Deep Learning, Image Processing

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Face recognition is a pivotal area of human-machine interaction, has aided artificial intelligence progress tremendously. There have been various methods for implementing facial recognition since the notion was proposed in the 1960s, including the neural network method. Deep learning approaches use neural networks to extract more complex data like corner points and planes. When we think of neural network face recognition, we usually think of approaches like Convolutional Neural Network (CNN). CNN can use images as direct input and is unaffected by image rotation, translation, or scale. Furthermore, manually extracting specific facial traits from face photos is challenging, whereas CNN can automatically extract useful facial features. In gray-scale photos, we offer a neural network-based approach for detecting frontal perspectives of faces.' The algorithms and training methods are generic, and they can be used to recognize various types of faces as well as related objects and patterns. Training neural networks for face recognition is difficult because it is difficult to characterize a prototype "non-face" image. In face detection, in contrast to face recognition, where the two distinct classes are "face found" and "face not found. Obtaining a representative sample of images with faces is relatively easy, but obtaining a representative sample of images without faces is far more difficult. The second-class training set's size could quickly grow.

1.2 Motivation

Facial recognition has recently attracted considerable interest and attention from the science community and the general population. In this research, we propose a system that would help in identity checks. In many institutions, they used many identities check systems for students, teachers, and others people associated with that particular institution. They are provided an ID card to get entry in or access to many facilities the institutes there.

But what we see, sometimes there can happen identity violence by identity theft or hampering privacy issues. Then modern science is also developing day-by-day, so hacking technologies are also increasing. So, it is not that much hard for an outsider to create an ID fraud issue. That's why we thought of a system that can help people to get access through the face recognition process. We know facial recognition system is combined with biometric technologies, so it can be a great opportunity to prevent this kind of violence. Then a situation may occur that one has forgotten their ID card or entry pass accidentally, they can also get access without facing any difficulties. Primarily we will work keeping students as the prior for the system, where it will take their face or image as input and then it will give the information of the students, entry permission into the institution, or access for any other discipline maintenance issues as output.

1.2 Problem Definition

To recognize the people in the database, a convolution neural network (CNN) must be created and trained. There is an imaging technology available that transforms each facial picture centered in the system's field of vision. Face recognition must be done in real-time, and the system's performance, measured in frames per second, must be improved.
Recognize using a high-resolution camera.

1.3 Research Questions

- From where we get all the data necessary for this research?
- How accurate is Neural Network for face recognition?
- Does it automatically locate the face?
- Will this system be more accurate than existing systems?

1.4 Research Methodology

In the methodology section of this research paper, data are collected as much as possible and are analyzed. All the algorithms available for face recognition are studied and one is selected. Then it was applied to facial images and was evaluated carefully.

All the data we used are from an open-source dataset named Kaggle. The dataset was filtered according to our needs. At the end of this research paper, the performance of this proposed method is described.

1.5 Research Objective

The purpose of this research is to develop a face recognition system that can detect faces in a data set and compare it with the live feed and then reach to an informed decision if the person is verified or not. Here are some objectives of our research:

- To describe and interpret the face recognition method.
- To build a system capable of real-time identification of students and staff through face recognition.
- To examine the current state of facial recognition technology.
- To design and develop a robust facial recognition system.

Some technical issues are pointed below:

- Covid-19 situations make it impossible to collect data directly from people.
- Training a model requires huge time for low-end hardware.

CHAPTER 2

BACKGROUND

2.1 Introduction

Facial recognition is a method of recognizing a person's face using technology. A renowned branch of Machine Learning, Deep Learning is used to solve a wide range of issues, including face recognition. Neural Networks-based Face Recognition has become increasingly popular and widely used as deep learning has progressed. It has made it easier to conduct facial recognition studies.

2.2 Literature Review

In recent years, several analysts and researchers have focused primarily on grayscale facial images (Ojala, Pietikainen, & Maenpaa, 2002). Some have no prior knowledge of facial models and are entirely based on pattern-finding models, while others rely on AdaBoost. (Kim, Park, Woo, Jeong, & Min, 2011), a strong training classifier. Next came the Viola-Jones detector. This enables real-time face recognition. It possessed a lot of flaws that made it difficult to intercept, such as the direction and brightness of the face. So, in a nutshell, it didn't work in a dim or dismal light. Consequently, experts have continued to explore a new alternative approach that can identify faces efficiently.

Haarcascades employ a variety of features that are initially taught using a training set that includes both positive and negative images. (P.Viola, MJona,2001).

Using the proposed method, the researchers achieved an accuracy of 97.05 percent. They performed feature extraction using HaarCascades, which, instead of raw pixel data, fed the network. (Dr. Priya Gupta a., Nidhi Saxena a., Meetika Sharma a., and Jagriti Tripathi.,2018).

It should be emphasized that the bulk of DNN-based facial recognition techniques are based on a vast authentic dataset. (Guo & Zhang, 2019; Sun & Meng, 2016; Zhang et al., 2015)

Face recognition with DNN, notably, has gotten a lot of researcher attention in recent years. A convolutional neural network achieved 99.5 percent accuracy on a short dataset, while an artificial neural network achieved 80.3 percent accuracy. (Peng Lu, Baoye Song, and Lin Xu,2020).

Deep neural networks (DNNs) have been found effective in a number of tasks, such as character identification, image classification, and voice recognition. (Hinton et al., 2012; Jurgen, 2015; Liu et al., 2016; Ptucha et al., 2019; Zeng et al., 2018).

Wang investigated the effects of age and gender on facial recognition. A deep learning algorithm was used to classify the face features. A recognition rate of 83.73 percent was obtained on average. (2021).

Using the proposed Yale technique, some academics also applied SIFT and SURF descriptors for the face's feature areas and obtained an accuracy of 99.70 percent. (Surbhi Gupta1, Kutub Thakur, Munish Kumar, 2021).

Neural Network-based face recognition also helped researchers to get 70.9% to 90.5% accurate results in finding faces from images using bootstrap algorithm adding false detection.

Fisher Linear Discriminant (FLD) is a face and object recognition algorithm. The algorithm can identify faces even when some aspects of the faces change, such as expressions or the use of glasses. (R.Rahim, 2018).

Another research compares the various strategies for doing facial detection and recognition. (F Ahmad, A Najam, Z Ahmed, 2013). Using the Adaboost classifier, in conjunction with Haar features, the scientists attained an accuracy of 96.7 percent. (A. Tikare, S. Kadam, and K. T. Talele, 2012). For the face detection application, the Support Vector
Machine (SVM) classifier had an accuracy of 90.88 percent. (I Kukenys, B McCane,

2008). There has also been working on establishing an automated attendance system based on this face recognition technology, capable of recognizing faces in each frame for real-time video employing cutting-edge implementation. (S Kumar, D Kathpalia, and D Singh,2020).

These are the kind of relative works which inspired us to move forward with our proposed system and try to get a much better result from a system.

2.3 Bangladesh Perspective

When it comes to detecting a human face in images or videos, a face recognition system is a very demanding and also crucial step. The system transforms analog information of a face of a person into digital data and helps a system to recognize the person. And face recognition library along with many classifiers and algorithms helps them to do this. In Bangladesh, there are many institutions, product provider companies, telecommunication companies, or security sectors that use this system, and day by day, the demand for an automated system like this also increasing. But a facial recognition-based attendance system has not been very popular here yet. Moreover, any research like this cannot be found also. So we intend to start our research on this area.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction:

The faces are located using the Haarcascade classifier, and the RGB image is converted to grayscale using OpenCV. Then data is preprocessed and Convolutional Neural Network is used to recognize the face.

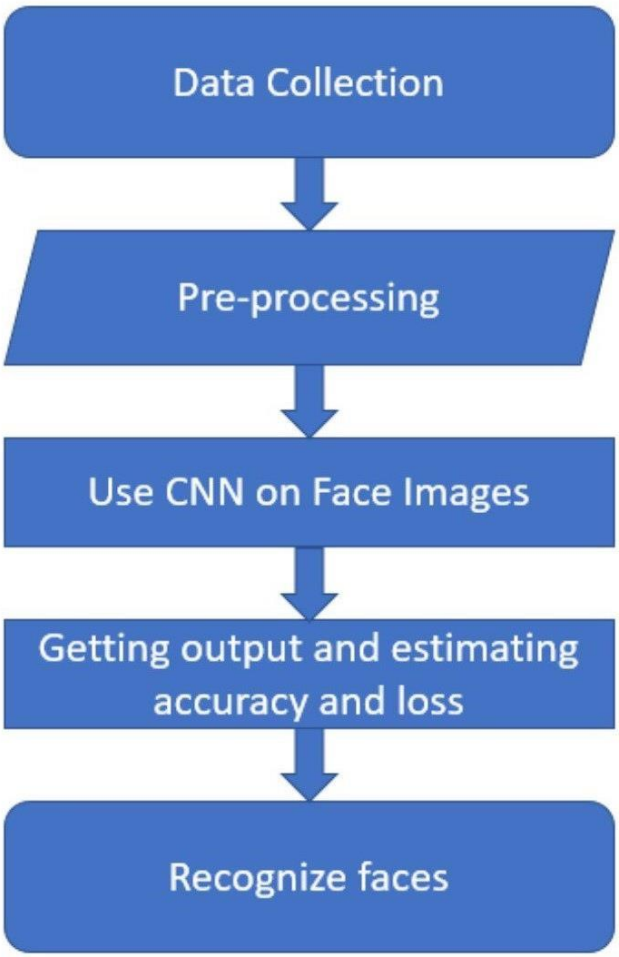

Figure 3.1.1 Methodology diagram

3.2 Research Instrumentation

Table 3.2.1: Required Instruments

Language	Python
Framework	TensorFlow
Library	Keras
Feature extractor	HaarCascade
Face recognizer	CNN
Scientific computing with python	NumPy

Another required instrumentation:

i. TensorFlow
ii. OpenCV-python
iii. Keras
iv. pillow
v. NumPy
vi. Anaconda
vii. Windows10 Operating System

Hardware requirements:

i. RAM 8GB
ii. Processor speed 3.0GHZ
iii. Processor i5 8^{th} gen or above.
iv. SSD 256gb for better performance
v. Webcam

3.3 Data Collection:

Data is gathered from the webcam, and HaarCascade and OpenCV are utilized to get facial images. The rest of the data is collected from an Open-Source dataset (Kaggle). Total 14000 approx. images are collected. In this Covid-19 situation, data could not be collected directly from participants. Images of the face (from the front side, right side, and left side) are collected. All these data were potentially important for this research. The questions that were asked are:

1. Facial Image, Front
2. Facial Image, Right Side
3. Facial Image, Left Side

3.4 Preprocessing

Data cleaning: Though the left side and right side of facial images were taken in our initial data collection; these were not needed that much. These data were omitted at the end. Preparing Data for ingesting for CNN Model:

- Resizing
- Rescaling

VGG16 is used to do these processes.

3.5 Implemented Algorithm

VGG16's most unique feature is that, rather than having lots of hyper-parameters, they focused on having 3x3 filter convolution layers with a stride 1 and always used the same padding and max pool layer of 2x2 filter stride 2. The convolution and max pool layers are arranged the same way throughout the architecture. It concludes with two FC (fully connected layers) and a SoftMax for output. The name VGG16 comes from the fact that it comprises 16 layers of varying weights. With around 138 million people (estimated).

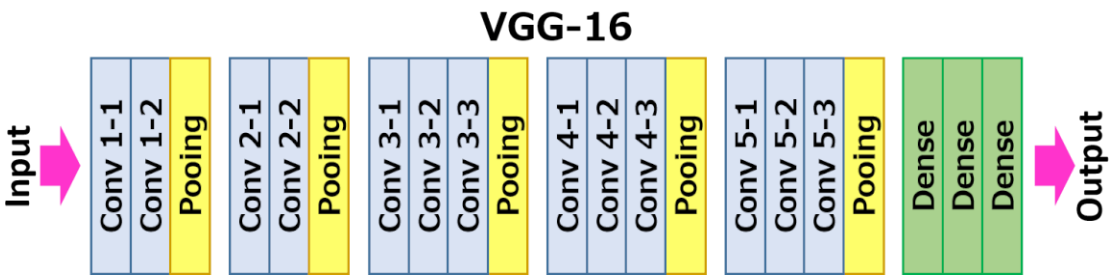

Figure 3.5.1: VGG16 Model

```
Model: "model_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_2 (InputLayer)         (None, 224, 224, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 224, 224, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 224, 224, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 112, 112, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 112, 112, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 112, 112, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 56, 56, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 56, 56, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 28, 28, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 28, 28, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 14, 14, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 7, 7, 512)         0
_________________________________________________________________
flatten_2 (Flatten)          (None, 25088)             0
_________________________________________________________________
dense_2 (Dense)              (None, 2965)              74388885
=================================================================
```

Figure 3.5.2: Implemented VGG16 Model

```
=================================================================
Total params: 89,103,573
Trainable params: 74,388,885
Non-trainable params: 14,714,688
_________________________________________________________________
Found 7706 images belonging to 2965 classes.
Found 7906 images belonging to 2965 classes.
```

Figure 3.5.3: Implemented VGG16 Model Output

3.5.1 Convolutional Layer

The fundamental concept of using a filter on an input to create an activation is known as convolution. A feature map is formed when the same filter is applied numerous times to an input, presenting the locations and strengths of detected features in the input, such as an image.

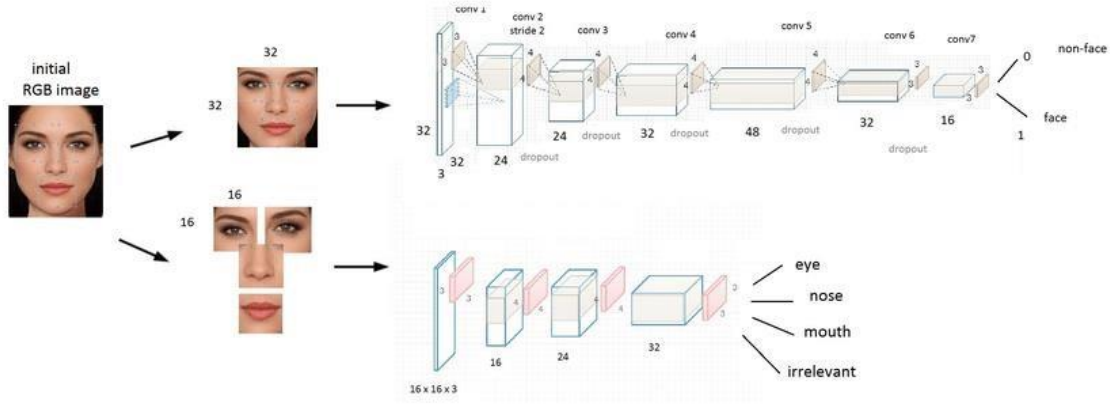

Figure 3.5.4: Facial Data Extraction by CNN

The receptive field of VGG's convolutional layers is rather small (3x3). Additional 1x1 convolution layers perform a linear transformation of the input until it is sent via a ReLU unit. The convolution layer is set at 1 pixel to keep pixel density after convolution. VGG is composed of three layers, each with 4096 channels (the first two) and 1000 channels (the third) (one for each class). All the hidden layers of VGG use ReLU. Local Response Normalization is not used by VGG since it increases memory use and training time without reducing accuracy.

3.5.2 Max Pool

Max pooling selects the largest value in the matrix. The matrix's size might be 2 X 2 or 3 X 3. It's usually used to reduce image sizes because a bigger number of pixels means more variables, which might include enormous amounts of data. As a consequence, we require fewer parameters where the CNN model can still recognize the images perfectly. With maximum pooling, the size of the resulting picture is lowered while keeping image information.

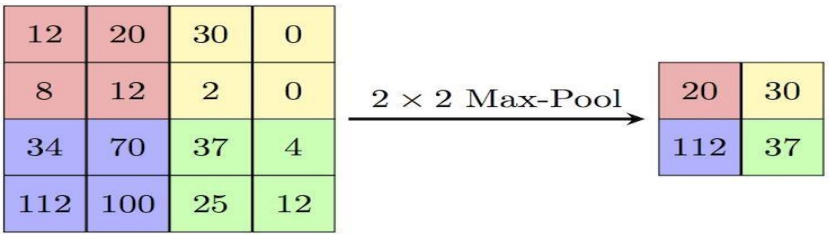

Figure 3.5.5: Max Pool 2*2

3.5.3 Flatten and Dense Layer

The strategy for changing over information into a one-dimensional array for use in the following layer is called flattening. We flatten the result of the convolutional layers to make a single long element vector. It is additionally connected with the last classification model, shaping what is known as the completely associated class.

When there is a possibility of an association between any feature and any other feature in a data point, dense layers are used. Because there can be n1n2 connections between two layers of size n1 and n2, they are referred to as Dense.

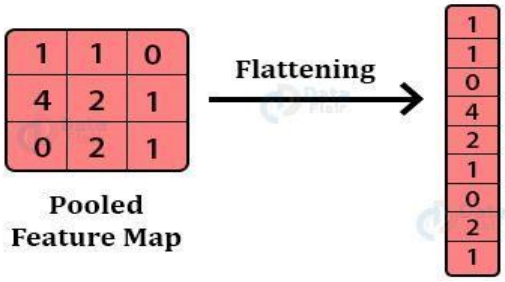

Figure 3.5.6: Flattening Layer in VGG16

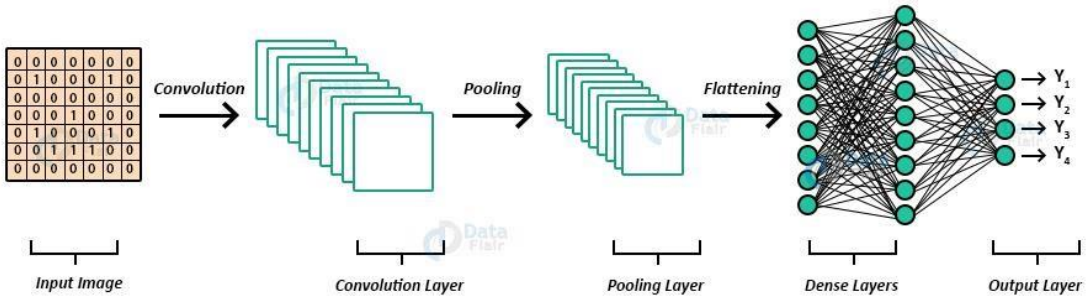

Figure 3.5.7: Input Image to Output Layer

3.6 Evaluation

In this research, total of 15612 face images of 2965 people has been used to validate and test. First, this algorithm is applied to face images. Output from the data is used to develop an integrated system to correctly predict people using face recognition.

CHAPTER 4

RESULT AND DISCUSSION

In our proposed model the number of epochs was 10, Out of the total 89,103,573 total parameters 74,388,885 parameters were trainable and 14,714,788 parameters were omitted because they were non-trainable.

```
Epoch 1/10
241/241 [==============================] - 8981s 37s/step - loss: 9.4905 - accuracy: 0.1753 - val_loss: 3.5462 - val_accuracy: 0.5804
Epoch 2/10
241/241 [==============================] - 182s 755ms/step - loss: 4.7664 - accuracy: 0.4887 - val_loss: 3.5212 - val_accuracy: 0.6328
Epoch 3/10
241/241 [==============================] - 180s 747ms/step - loss: 3.6792 - accuracy: 0.6060 - val_loss: 2.0943 - val_accuracy: 0.7714
Epoch 4/10
241/241 [==============================] - 180s 747ms/step - loss: 2.5110 - accuracy: 0.7263 - val_loss: 1.4196 - val_accuracy: 0.8488
Epoch 5/10
241/241 [==============================] - 179s 744ms/step - loss: 1.9030 - accuracy: 0.7858 - val_loss: 1.0735 - val_accuracy: 0.8695
Epoch 6/10
241/241 [==============================] - 177s 735ms/step - loss: 1.3710 - accuracy: 0.8418 - val_loss: 0.7319 - val_accuracy: 0.8986
Epoch 7/10
241/241 [==============================] - 180s 746ms/step - loss: 0.9866 - accuracy: 0.8771 - val_loss: 0.7903 - val_accuracy: 0.9070
Epoch 8/10
241/241 [==============================] - 182s 755ms/step - loss: 0.8032 - accuracy: 0.9003 - val_loss: 0.4576 - val_accuracy: 0.9352
Epoch 9/10
241/241 [==============================] - 182s 757ms/step - loss: 0.6752 - accuracy: 0.9138 - val_loss: 0.3274 - val_accuracy: 0.9594
Epoch 10/10
241/241 [==============================] - 183s 758ms/step - loss: 0.7741 - accuracy: 0.8994 - val_loss: 0.4227 - val_accuracy: 0.9412
```

Figure 4.1: Implemented model Epochs

The epoch number is a tuning parameter that governs how frequently the training algorithm executes in the total training dataset. Each data in the training dataset had the chance to modify the interior model parameters once every epoch. We performed 10 epochs to train the dataset. Each epoch includes 241 steps for evaluating the dataset. After developing the model, we obtained a loss of 0.77 percent and an accuracy of 89 percent. We also obtained a validation loss of 0.44 percent and a validation accuracy of 94 percent. There is a lot of missing data and low-quality images in Kaggle's dataset. For this, we also have a system in place where we can manually collect data from the user or admin. As a result, the precision will be improved.

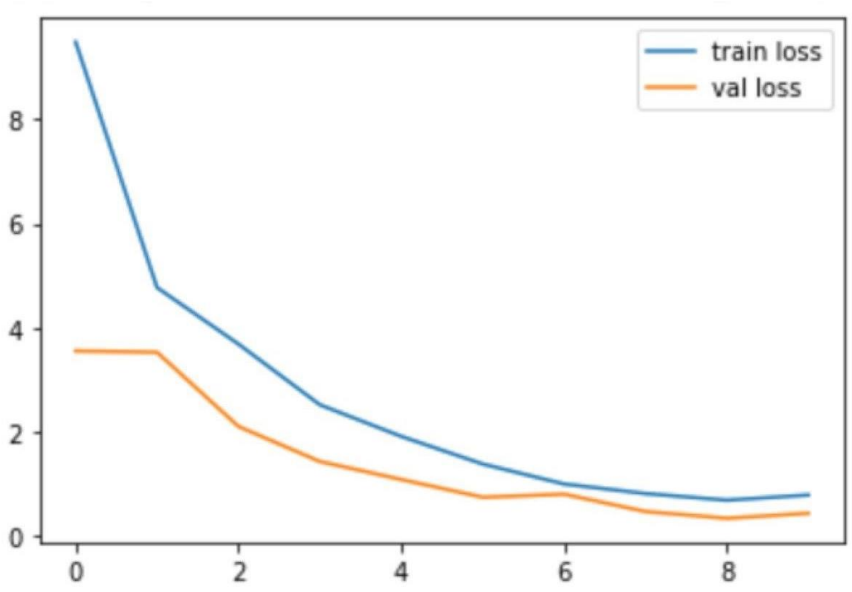

Figure 4.2: Model loss graph for Face Images

As we can see our loss and validation loss started from 9.49 and 3.52 respectively and after 10 epochs it was 0.77 and 0.42.

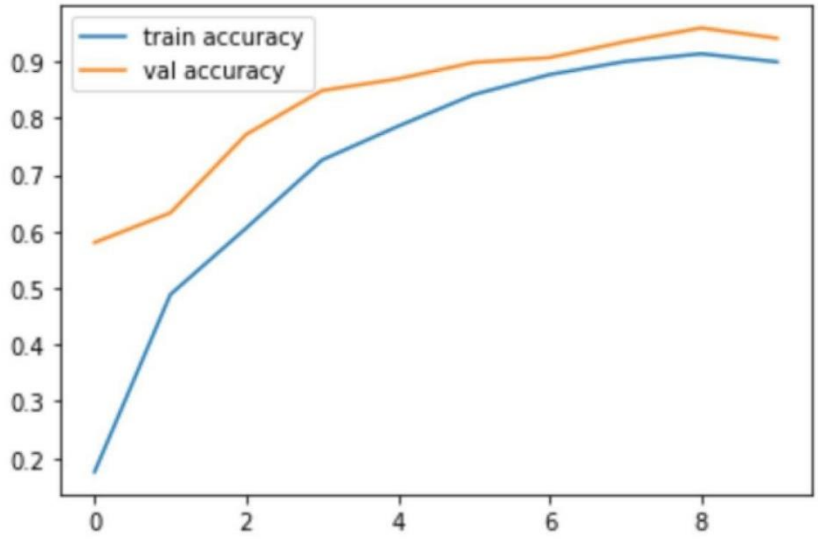

Figure 4.3: Model accuracy graph for Face Images

Currently, our model has a training set with an accuracy of 89.94 percent and a validation set with an accuracy of 94.12 percent. On new data, we can expect our model to execute with an accuracy of 94.12 percent.

Plotting Results:

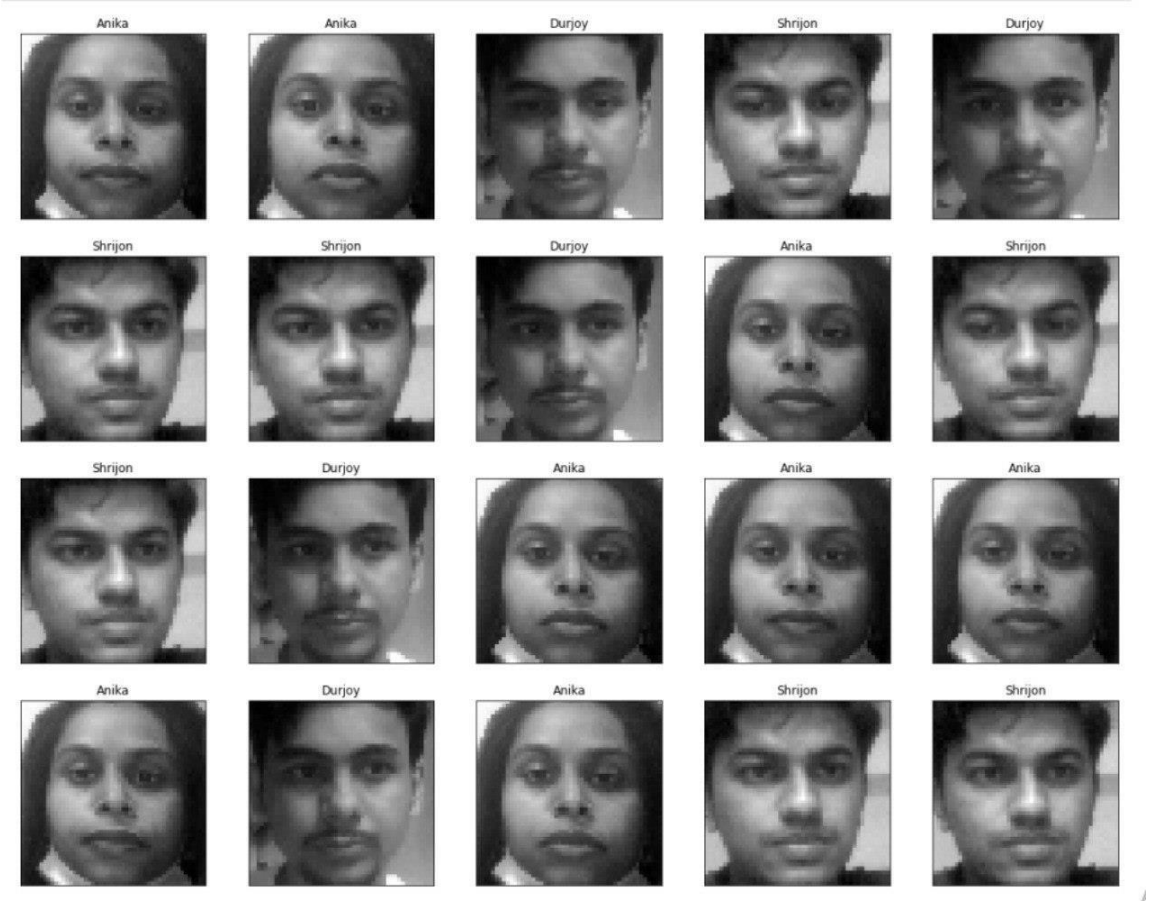

Figure 4.4: Plotting Test Results

Our model successfully predicted our faces from images.

Recognizing faces from Live Camera Feed:

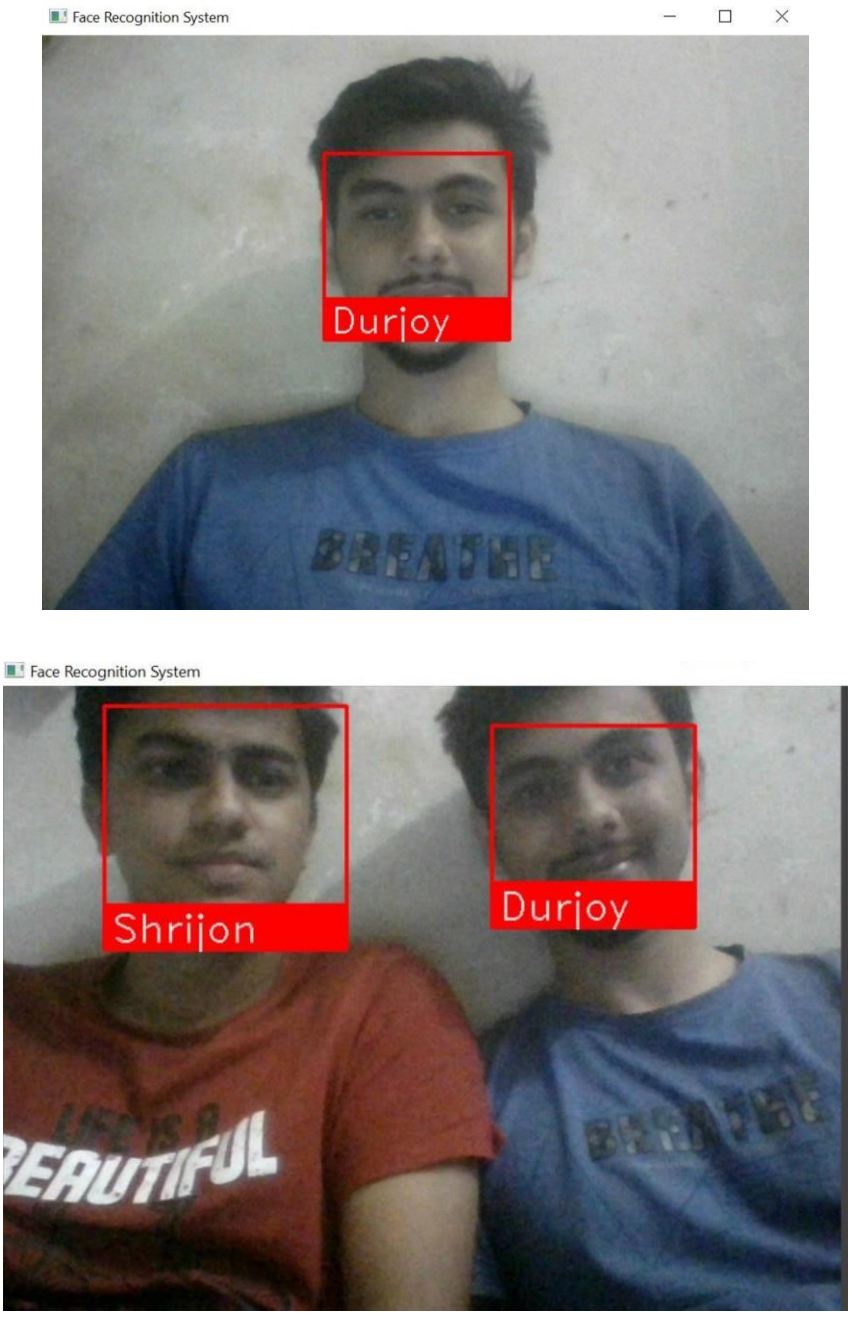

Figure 4.5: Live Predicting

CHAPTER 5
IMPACT ON SOCIETY, ENVIRONMENT, AND SUSTAINABILITY

5.1 Impact on Society

A facial recognition system will profit the society in an exceedingly style of ways that, like reducing unnecessary human interaction, preventing crimes, and improving safety and security. It can even help medical efforts in exceptional circumstances. As our system is to take attendance mainly, it can be used in any kind of Institution not only school colleges but also other industrial institutions, hospitals, offices, etc. In this way, they would be able to use the time, they used to enter their presence for a certain day, more efficiently towards their responsibilities.

5.2 Impact on Environment

Facial recognition technology has become quite popular over the past decade. There are many advantages of facial recognition. There are also some issues related to this technology. Like it can lead to higher unemployment, hackers may steal personal data, this technology is able to prevent fraud but has not matured yet. But technology is improving day by day. That's the point where we can be optimistic. As we are expecting our project to help people to prevent any kind of fraud issues and ensure authenticity while recognizing people, so in near future it can bring more positive impact to our environment.

5.3 Ethical Aspects

Our detection techniques for face recognition are implemented for using it for the advancement of science and technology with no intention to use it in an unfair way. Data has been collected with permission from the owner and not used for any advertisement or illegal

things. We have thought to use it to prevent crime and make biometric security tighter. It will not be used for anything which will hamper the property of any human being.

5.4 System Sustainability

The system works on face recognition where each student in the class will be photographed and their details will be stored in a server, and the teachers will record attendance by just clicking some pictures of the classroom. The system will then recognize the faces and verify the presence or absence of any student. So it will be a helping hand to the teachers and administration to keep track of the presence of students. And also we look forward to making the system more reliable to other institutions.

CHAPTER 6

CONCLUSION

5.1 Conclusion

A neural network provides us with a highly accurate face recognizer; the system's accuracy is quite good. The accuracy might vary depending on the lighting and the webcam's quality. The room light and camera quality should be improved for maximum accuracy. This approach can save a lot of time and eliminate human mistakes. In a short amount of time, one may readily verify himself. An unauthorized person cannot enter this Face recognition system. As a result, the security level will be maintained.

5.2 Future Work

- Deploy the system in a real-life scenario.
- Get the student database API to build it for the University in Django.
- We will modify this to use some secured place like Airport, Train station, Seaports, Private companies and so on for security issue.
- Make the system more advanced so that it can be used in crime investigations.

5.3 Limitations

A problem was raised from the Covid-19 situation. It was not possible to meet people and ask for data from them directly. This is why limited data were collected for this research. Data was taken from a dataset resided in Kaggle where there was an insufficient number of images of a single person also data was noisy, a low quality that’s why many data became redundant. Insufficient and unusable data is a huge obstacle to getting correct results from machine learning algorithms. Another problem was it takes an enormous amount of time and computational power to train the method with a higher number of epochs. As a result, we had to limit the number of epochs used to train the model. More data must be collected and evaluated with this algorithm in the future to improve.

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