

**AGE ESTIMATION FROM FACE AND HAND IMAGES USING
CONVOLUTIONAL NEURAL NETWORK
BY**

**ZUHAYER MOHTASIM BIN SARWAR
ID: 172-15-10133**

**MD. KAUSARUZZAMAN
ID: 172-15-10142**

**ABDULLAH AL NOMAN
ID: 172-15-10134**

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

Supervised By

Md. Abbas Ali Khan
Designation: Lecturer (Senior Scale)
Department of CSE
Daffodil International University

Co-Supervised By

Zerin Nasrin Tumpa
Designation: Lecturer
Department of CSE
Daffodil International University

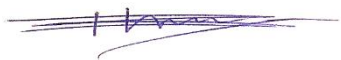


**DAFFODIL INTERNATIONAL UNIVERSITY DHAKA,
BANGLADESH
SEPTEMBER 2021**

APPROVAL

This Project titled “Age Estimation from Face and Hand Images using Convolutional Neural Network”, submitted by Zuhayer Mohtasim Bin Sarwar, Md. Kausaruzzaman and Abdullah Al Noman 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 09-09-2021.

BOARD OF EXAMINERS



Chairman

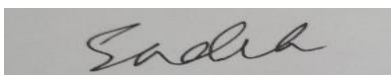
Dr. Touhid Bhuiyan

Professor and Head

Department of Computer Science and Engineering

Faculty of Science & Information Technology

Daffodil International University



Internal Examiner

Md. Sadekur Rahman

Assistant Professor

Department of Computer Science and Engineering

Faculty of Science & Information Technology

Daffodil International University



Internal Examiner

Gazi Zahirul Islam

Assistant Professor

Department of Computer Science and Engineering

Faculty of Science & Information Technology

Daffodil International University



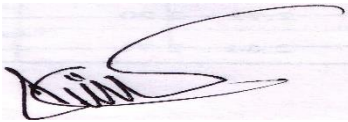
External Examiner

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. Abbas Ali Khan, Lecturer (Senior Scale), 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. Abbas Ali Khan
Lecturer (Senior Scale)
Department of CSE
Daffodil International University

Co-Supervised by:



Zerine Nasrin Tumpa
Lecturer
Department of CSE
Daffodil International University

Submitted by:

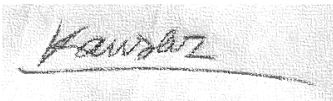


Zuhayer Mohtasim Bin Sarwar

ID: -172-15-10133

Department of CSE

Daffodil International University

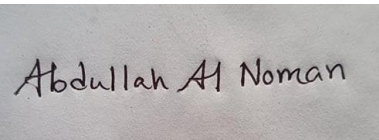


Md. Kausaruzzaman

ID: -172-15-10142

Department of CSE

Daffodil International University



Abdullah Al Noman

ID: -172-15-10134

Department of CSE

Daffodil International University

ACKNOWLEDGEMENT

First, we express our heartiest thanks and gratefulness to almighty Allah for His divine blessing makes us possible to complete the final year project successfully.

We really grateful and wish our profound our indebtedness to **Md. Abbas Ali Khan, Lecturer (Senior Scale)**, Department of CSE Daffodil International University, Dhaka. Deep Knowledge & keen interest of our supervisor in the field of “*Machine Learning, Convolutional Neural Network*” to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stage have made it possible to complete this project.

We would like to express our heartiest gratitude to **Md. Abbas Ali Khan** and **Zerin Nasrin Tumpa**, and the Head, Department of CSE, for his kind help to finish our project and also to other faculty members and the staff of CSE department of Daffodil International University.

We would like to thank our entire course mates in Daffodil International University, who took part in this discuss while completing the course work.

Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

These days, age estimation is attracting a lot of attention. It has been a mystery long since researchers started working on it. They are still trying to find out what genetical and biological factors are responsible for it. Facial images are widely used to estimate age of a person. Since facial image contains a huge number of biological characteristics, it can say a lot about a person's age. But we can't pinpoint what indicates this age. Lots of factors are playing important role here, such as Environment, habit, mental pressure, biological age and so on. Moreover, a male person may grow beard and uses antiaging cosmetics and other chemicals. A female may use antiaging cosmetics, makeups and other chemicals which effect their facial skin. Some research indicates, rear of a person's hand contains important biological data as well. Ridge or crease of hand may contain biological markers of a person's age, which normally do not get affected by cosmetics and chemicals, though environmental affect is impossible to avoid. In this research, we tried to find out a way of age estimation from face and hand images using convolutional neural network (CNN). Though there are lots of age estimation methods available which used only facial images, we tried to do it better by including hand images. We have worked on a hypothesis that hand images may provide important details to this research area and will improve efficiency of age estimation process. When it comes to process image features, CNN have an incomparable advantage. CNN has proven to be much more accurate at estimating age of facial images than traditional methods. We have applied same algorithms and codes on hand images, but could not get effective result as we expected. Since there are no works on age estimation from hand images available, there is no way to implement and try any algorithms specifically designed for this purpose. Thus, we had to do it from the scratch. We could not get expected result, but we think this research may provide a ground to the future works on this field.

Keywords: CNN; age estimation; classification;

TABLE OF CONTENTS

CONTENTS	PAGE
Approval	ii
Board of examiners	ii
Declaration	iii-iv
Acknowledgements	v
Abstract	vi
CHAPTER	
CHAPTER 1: INTRODUCTION	1-3
1.1 Introduction	01-02
1.2 Motivation	02
1.3 Problem Definition	02
1.4 Research Questions	03
1.5 Research Methodology	03
1.6 Research Objective	03-04
1.7 Representation of ages	04
CHAPTER 2: BACKGROUND	5-8
2.1 Introduction	05
2.2 Literature Review	05-07
2.3 Bangladesh Perspective	07-08
2.4 Data Availability	08
2.5 OpenCV DNN Module	08
CHAPTER 3: RESEARCH METHODOLOGY	9-20

3.1 Introduction	09
3.2 Data Collection	10-13
3.3 Preprocessing	13-15
3.4 Implemented Algorithms	16-19
3.5 Evaluation	19-21
 CHAPTER 4: RESULT COMPARISON AND DISCUSSION	22-24
 CHAPTER 5: CONCLUSION AND FUTURE WORK	25-26
5.1 Conclusion	25
5.2 Future Work	25-26
5.3 Limitation	26
 APPENDIX	27-28
 REFERENCES	29-30

LIST OF FIGURES

FIGURE	PAGE NO
Figure 2.1 Classification Time Comparisons (Avg of 3 Images)	8
Figure 3.1: Methodology diagram	9
Figure 3.2 Data Sample	11
Figure 3.3 CSV Data Sheet	12
Figure 3.4 Database	12
Figure 3.5: Load Image from database	14
Figure 3.6: OpenCV Face Recognition Module	16
Figure 3.7: <i>CaffeNet</i> Architecture	17
Figure 3.8: Human Vision vs CNN Visualization	18
Figure 3.9: Human Vision vs CNN Visualization	18
Figure 3.10: Loss and Accuracy History	21
Figure 4.1: Accuracy graph for facial images	22
Figure 4.2: Loss graph for facial images	22
Figure 4.3: Accuracy Model graph for hand images	23
Figure 4.4: Loss Model graph for hand images	24

CHAPTER 1

Introduction

1.1 Introduction

Automatic age estimation plays a vital role in biological security related issues. From government employment to child marriages problem or surveillance monitoring, it can be an important factor to solve serious social problems which are hurting the society severely. Facial images are widely used to do this. There are lots of study and researches that approaches to this issue from various perspective, but each and every one of them are facial images based. As a branch of face recognition, automatic age estimation from facial images includes face detection, feature extractions and estimation of the age accordingly. There is a problem, however, that is not solved yet. Lots of adult males grows beard in their face. Some shave regularly, but not everyone. Moreover, anti-aging cosmetics, such as sunscreen cream and other chemicals affect people's skin. That's why some people look different of ages than their biological ages. Same goes for adult female. Usage of makeups, cosmetics and anti-aging chemicals affect their skin as well. Moreover, environment, mental pressure, food habit and other factors are also affected one's facial skin. That is why there is a high error rate exists in automatic age estimation methods. On the other hand, chemicals and cosmetics are not frequently used on hands, nor any beard or other external layers cover any parts of it. It is affected less from mental pressure and other factors as well than facial skin. That is why it may play vital role to estimate people's age from the rear of one's hands. Study says, after face, hand is the second most visible, tell-tale sign of one's age. [1] But this hypothesis is not explored or researched ever. To explore this possibility and to improve automatic age estimation system, this research tries to use Convolutional Neural Network (CNN) based algorithm on hand images to extract features and estimate age from there. There are three phases to this project, Image preprocessing is the first step in the process. There is noise reduction, face detection, size normalization, and clipping applied. As for the second phase, it is a data mining process involving three stages: feature extraction, feature selection, and classification. Estimation and evaluation are part of the

third phase. Using the dataset, eight age classes are categorized; the first class represents (0-5), (6-10), (10-15), (16-20), (21-25), (25-30), (30-60), and (61-100). Estimate age from several body parts and then reach to an informed decision at the end.

1.2 Motivation

There is no specific rate, but lots of people lower their age in birth certificate to extend their age limit to apply for a government job in Bangladesh. This is misuse of age and a morally corrupt thing to do. It encourages people to lie easily and more frequently and give mass people a false sense that lying is okay. Another important issue is child marriage. Bangladesh has a 51% of child marriage rate (2021). [2] Moreover, age is an important factor in customer targeting campaign. Different ages of people have different liking and different priority and so on. Hope age issues should be solved as soon as possible All these problems can be solved if there is no need to put age manually and can be automatically detected accurately. But there is no integrated work which took anything other than facial data into account. This is what inspired this research.

1.3 Problem Definition

The main problem is, no genetic marker or visual marker is identified yet that is directly responsible for age. So, there is no simple way to estimate one person's age. These days, 'Machine Learning (ML)' and 'Artificial Intelligence (AI)' are frequently used in almost everything. To build an automatic age estimation system, this is the most sophisticated and capable way to take. Machine can then study images of people's faces and hands, and learn to estimate their age as humans do by experience. Here is another problem—there is no existing research on hand images to estimate age. The only way there is to apply algorithms on hand images which are implemented on facial images already, then merge these two results and build an integrated system.

1.4 Research Questions

The key questions this study focuses are given below:

- From where we get all the data necessary for this research?
- Is it even possible to estimate age from hand images?
- How to estimate age from facial and hand images?
- How to merge these two results and reach to a conclusion?
- Will this system be more accurate than existing systems?

1.5 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 facial images are studied and one is selected. Then it was applied on facial and hand images, and were evaluated carefully. All the data here are taken from interested people who give them voluntarily. At the end of this research paper, performance of this proposed method is described. Based on an age representation, the next step is to determine the individual's age based on ageing features. A person's age can be seen as a discrete set of characteristics the learning methods of classification and regression can use classes or continuous label spaces.

1.6 Research Objectives

The aim of this research was to make an integrated system that takes into account more than one body parts, in this case, facial and hand images and then reach to an informed decision if it give more accurate age estimation. So, the objectives are:

- Estimate age from several body parts and then reach to an informed decision at the end
- Find out if it is possible to deduce age using more than one body-part's images
- Calibrate the algorithm for Bangladeshis

Some technical issues are pointed below:

- Covid-19 situations make it impossible to collect data directly from people
- No algorithm exists for hand images to estimate age yet

1.7 Representation of ages

Identifying the features that will represent the ageing patterns is a very important step in an age estimation process. The age representation should contain enough variation of the data to convey the full complexity of the problem. In the literature, there are many ways to represent ageing factors using images. Next, we will analyze those with the greatest influence.

The concept of human age should be defined beforehand:

- Real age: the actual age (the time since the person was born).
- Apparent age: Human perception of age based on appearance.
- Estimated age: it is the age that is predicted by a machine from a visual appearance.

CHAPTER 2

Background

2.1 Introduction

There is no integrated system for age estimation that works with more than one body parts. But there are some works that estimate age from facial images. This chapter focuses on that research which are used as the base of this research.

2.2 Literature Review

Automatic age estimation from facial images using Machine Learning (ML), Convolutional Neural Network (CNN), and Deep Learning (DL) etc. are used frequently these days. There are some researches which focused on comparative study of these existing systems. Some are focused on image recognition and face identification from an image.

Xinhua Liu et. al [3] in this paper worked with Data Augmentation and Lightweight Convolutional Neural Network to estimate age from facial images. They used 1002 color images of 82 peoples face and used Mean Absolute Error (MAE), Cumulative Score (CS) as the evaluation parameter. They have got MAE of 3.79.

Henry A. Rowley et. al [4] used Neural Network (NN) for face detection from an image. They have used 23 images which contain a group of people. They were able to detect face from an image 77.9% - 90.3% accurately. Though it was not age detection, it is related because, detecting faces and hands from images accurately was an important part of this research.

Ayad R. Abbas et. al. [5] used Machine Learning Techniques for intelligent age estimation from facial images. They have used FG-NET dataset which consists of facial images of 82

peoples. Their accuracy rate is 89.13%. J48 classifier is used here. They have concluded that the greater the number of sample images provided, the greater the accuracy they got. Marc Oliu Simón et. al. [6] showed in their research that real age and apparent age of a person can be different. They have developed a Facebook-API based web application to collect data. They have used deep learning (DL) algorithm on images of people of ages from 19 to 40. The MAE of the method predicted real age is most of the times 40.77% higher than the apparent age.

Yuan Dong et. al. [7] used deep learning algorithm to develop an automatic age estimation system. They have concluded that age range 0-2 and 66+ can be estimated easily. Their error rate was 0.4. Accuracy of an Exact Match (AEM) was between 4050%.

Erik Westerberg et. al. [8] used a dataset consisting of 12811 X-ray hand images of persons ranging from infant age to 19 years of age. It was a comparison of object detection and deep learning models. You Only Look Once (YOLO) algorithm is used here. Exception achieved an MAE of 12.08723898 months. Though it did not use hand image, but used hand features (bone).

Grigory Antipov et. al. [9] estimated apparent age from facial images combining general and children-specialized deep learning models. It was done in the ChaLearn LAP AAE Competition. Their work did 8% better than other participants, but no specific accuracy percentage is mentioned. It was focused on apparent age estimation and the difference between biological age and apparent age.

Ali Maina Bukar et. al. [10] used a supervised appearance model to develop an automatic age and gender classification system. This demonstrates that SAM with quadratic fit has the most accurate estimation at all error levels with over 85% of the test data achieved estimation error below 10 years.

Daksha Yadav et. al. [11] did an interesting approach to check first how human detect age from face and then implement it with AI. They have used Three Patch Local Binary Pattern:

Face Parts Extraction, LBP Calculation, and Score Fusion via Learned Weights. 21.54% accuracy was achieved.

Raphael Angulu¹ et. al. [12] did a comparative study among various available age estimation method. They showed CNN works better than other algorithms and has a MAE of 3.27. It is actually worked better than the works of Xinhua Liu et. al. [1]

Darko Šterna et. al. [13] did another work with hand features. They developed an automated age estimation system from MRI volumes of the hand. They have used it on MRI hand images for less than 18 years old peoples. They achieved MAE of .387 +/- .51. But MRI is costly, and is not available for everyone. Moreover, it cannot be used for security reasons. It can be only used in medical practices.

K. Ricanek Jr and T. Tesafaye.[20] Two main issues for age estimation are: how should face images be presented and how should ages be calculated? Specifically, they are face representation and estimation function learning. The current estimation functions learning methods are regarded as multiclass classification methods.

M. Mathias, R. Benenson. [17] The age estimation problem has not been addressed by the six-layer CNN used for gender and age grouping.

Y. Zhu, Y. Li, G. Mu, and G. Guo, [31] proposed a deeper and wider structure compared with Alex-Net to improve the classification performance.

All these works are related to this research and worked as a base. But no study is found that tries to take account more than one body parts, which inspired this research.

2.3 Bangladesh Perspective

The main motivation behind this research was to solve some serious problems of Bangladesh. In Bangladesh everyday doing so many ages related illegal work. There is no

age estimation work done on Bangladeshi people. So, it was necessary to implement an algorithm on Bangladeshi people and find out how existing algorithms can be calibrated and used to solve age-related social issues existed in this country.

2.4 Data Availability

A copy of the data used to support the findings of this study is available from the corresponding author.

2.5 OpenCV DNN Module

Only images and videos can be used with the OpenCV DNN module for deep learning. The software does not support fine-tuning or training. Even so, OpenCV's DNN module can serve as a perfect entry point for any beginner interested in learning more about deep-learning based computer vision.

OpenCV's DNN module offers a number of benefits, including highly optimized performance on Intel processors. When running inference on real-time video for object detection and image segmentation applications, we can achieve good FPS. With a pre-trained model from a specific framework, we can often get higher FPS when using the DNN module. The image classification inference speed for various frameworks, for instance.

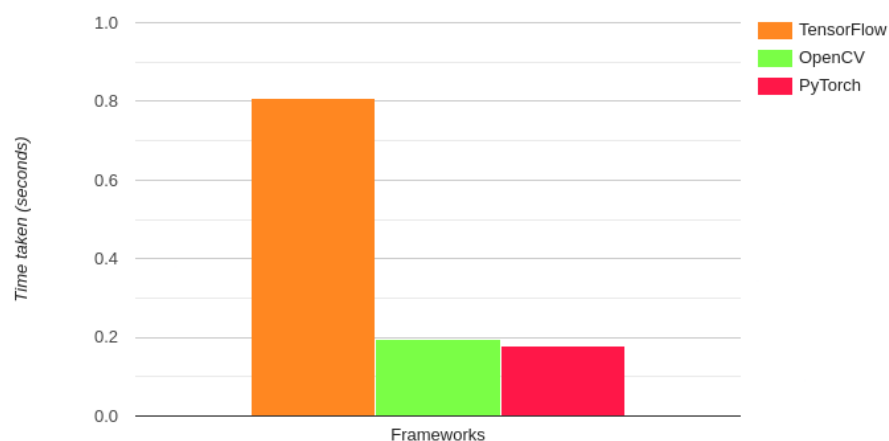


Figure 2.1 Classification Time Comparisons (Avg of 3 Images)

CHAPTER 3

Research Methodology

3.1 Introduction

This methodology covers every step followed along the way. Fig 3.1.1 shows the methodology diagram.

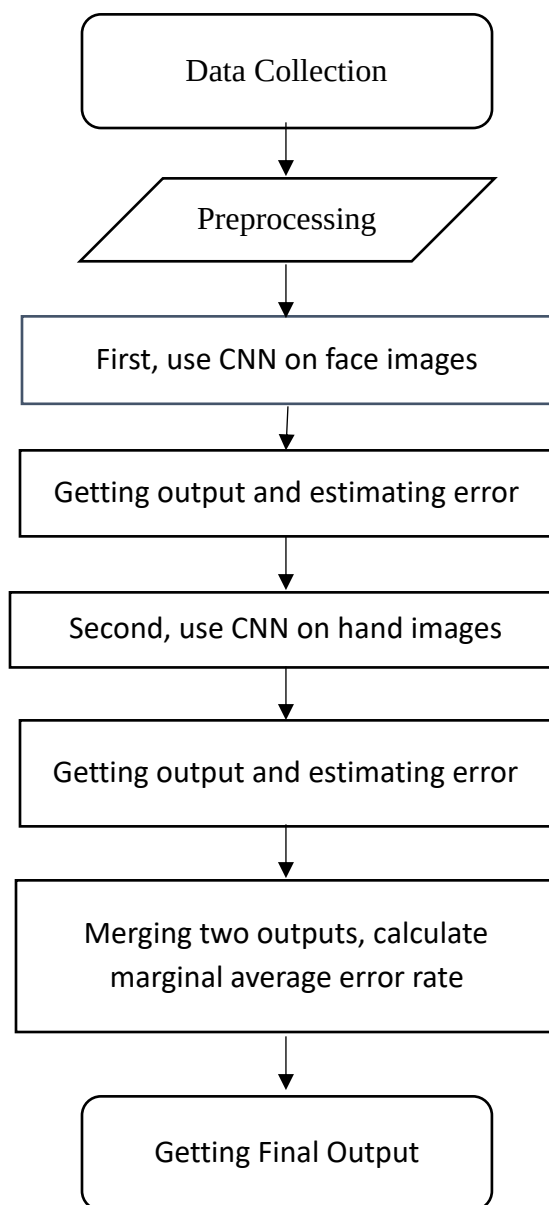


Figure 3.1 Methodology diagram

3.2 Data Collection

A data collection form is created and all the data are collected through it. All the participants gave their data voluntarily. Total 95 data are collected. In this Covid-19 situation, data could not be collected directly from participants. Three images of face (from front side, right side and left side) are collected, as well as two rear images of hand from each participant. So total 475 (95×5) data are collected. Moreover, everyone's real age is taken. 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
4. Back of Left Hand
5. Back of Right Hand
6. Age

There was other three fields in data collection form as optional. These were given as incentive for participants.

1. E-mail for update of this research, optional
2. Your mobile number for mobile recharge or bkash, optional
3. Mobile recharge or bkash? (Yes/No question)

3.2.1 Data Collection for Age Estimation from Facial and Hand Images

We have got small funding. That's why for every person's data, 10 Taka mobile recharge or bkash will be sent. One person can collect other's data and fill up this form as many times as possible. But the same data cannot be filled up twice. Any irrelevant data will not be counted. After filling up this form, Taka will be sent within 48 hours.

But before fill up this form, please, read it carefully

Disclaimer: We are conducting research, age estimation from facial and hand images. We will use image processing and some other methods here. So, we need lots of data, face, and hand images. If you are interested in helping us kindly, please upload your face and hand images in this form.

We want to work with the data of age of 15-40 years first.

For your information, collected data won't be used for any other purposes but this research. We will keep your data in a database and may use them in our research paper. We will keep them safe to the best of our ability and will not publish them anywhere else. Moreover, we won't take any identifiable information such as your name.

If you are interested in getting an update about this research, you may give us your email. It is optional and entirely up to you. But if you do, we will keep you updated.

Since you are giving us your data willingly for this research, or share this Google Form to let others know about it or inform anyone to contribute to this research, we are really grateful. We appreciate your help. Thank you so much.

These data collected via google form and manually ,after collecting data we processed for our research .

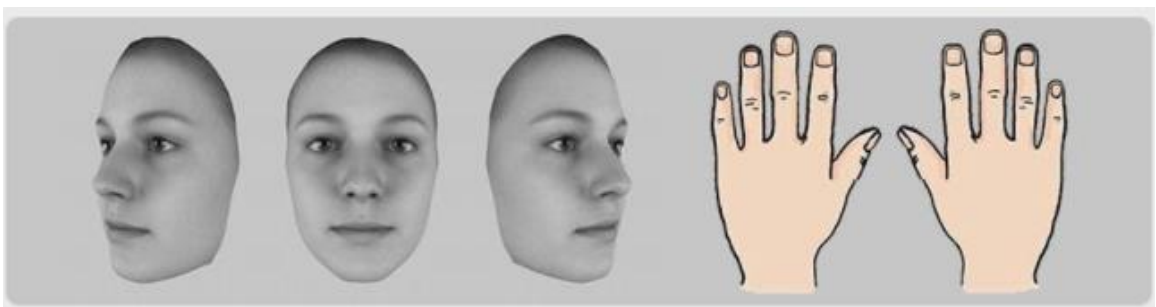


Figure 3.2 Data Sample

3.2.2 Data Collection for Age Estimation from Facial and Hand Images (Response)

Timestamp	Facial Image, Front	Facial Image, Right Side	Facial Image, Left Side	Back of Left Hand	Back of Right Hand	Age
8/12/2021 17:03:49	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	19
8/12/2021 17:10:04	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	15
8/12/2021 17:12:32	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	16
8/12/2021 17:14:51	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	25
8/12/2021 18:23:42	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	22
8/12/2021 19:06:22	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	23
8/12/2021 19:24:59	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	24
8/12/2021 19:28:56	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	24
8/12/2021 19:31:52	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	24
8/12/2021 19:42:05	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	24
8/12/2021 21:00:12	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	18
8/12/2021 21:17:46	https://drive.google.com/	https://drive.google.com/op	https://drive.google.com/	https://drive.google.com/oper	https://drive.google.com/ope	21
8/12/2021 21:44:32	ht	WhatsApp Image 2021-08...	ht	https://drive.google.com/oper	https://drive.google.com/ope	20
8/12/2021 22:01:56	ht	https://drive.google.com/oper	ht	https://drive.google.com/oper	https://drive.google.com/ope	21
8/12/2021 23:41:13	ht	https://drive.google.com/oper	ht	https://drive.google.com/oper	https://drive.google.com/ope	23
8/13/2021 10:16:49	ht	https://drive.google.com/oper	ht	https://drive.google.com/oper	https://drive.google.com/ope	27
8/13/2021 18:26:32	ht	https://drive.google.com/oper	ht	https://drive.google.com/oper	https://drive.google.com/ope	21
8/13/2021 18:50:09	ht	https://drive.google.com/oper	ht	https://drive.google.com/oper	https://drive.google.com/ope	21
8/13/2021 20:37:19	ht	https://drive.google.com/oper	ht	https://drive.google.com/oper	https://drive.google.com/ope	27
8/14/2021 12:14:31	ht	https://drive.google.com/oper	ht	https://drive.google.com/oper	https://drive.google.com/ope	23

Figure 3.3 CSV Data Sheet

3.2.3 Database Implementation



Figure 3.4 Database

We used direct IDE google Co-Lab directory database, there we have made images as a parent's directory there three sub directories alive which per directory contain two sub directory face and hand for each directory test, training, validation.

3.3 Preprocessing

1. Data cleaning: Though left side and right side of facial images were taken in our initial data collection; these were not needed that much. Besides, some people gave fake age (not at all consistent with their images). These data were omitted at the end.
2. Preparing Data for ingesting for Caffe Model:
 - 2.1 Load Image
 - 2.2 Resizing
 - 2.3 Rescaling
 - 2.4 RGB to BRG

3.3.1 Load Image

```
#Required module for image load from database
from tensorflow.keras.preprocessing.image import ImageDataGenerator,load_img
from google.colab.patches import cv2_imshow
import matplotlib.pyplot as plt

# Load and show function
img = image.load_img("/content/agefromimage/images/u3_f9.jpg")
```

```
plt.imshow(img)
```

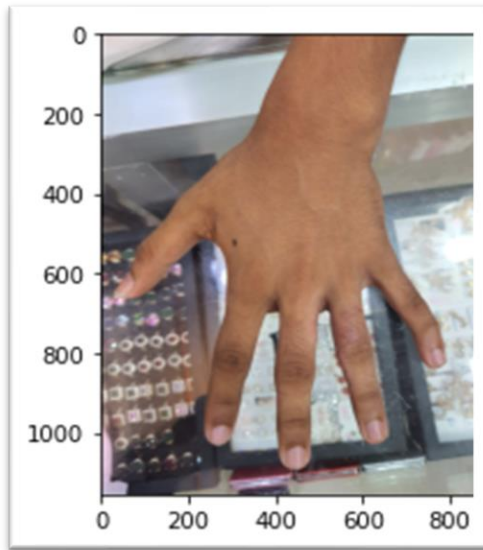


Figure 3.5: Load Image from database

Here, `load_img` working for images load from dataset and `imshow` working for print image to display exactly which data loaded.

3.3.2 Resizing

We know we collect data from so different way, so people given data directly using their smart phone but all data provider device not same so many variations of device using they are, so when we have done collect data, we can see so many sizes variation in our data set. Then we decided to fix each data size to same size for better accuracy else we should not get better output from our research.

```
#Required module for image load from database
```

```
from tensorflow.keras.preprocessing.image import ImageDataGenerator,load_img
```

```
from keras.preprocessing.image import img_to_array
```

```
import math
```

```
# Shape function
```

```
model = tf.keras.models.Sequential([tf.keras.layers.Conv2D(16,(3,3),activation =  
'relu',input_shape = (300,300,3)), tf.keras.layers.MaxPool2D(2,2),])
```

3.3.3 Rescaling

For calculation first of all have to resize all of data to exactly same size, like when we have collected data, we can see so many data are different size of shape, some data are 1000 x 1200, some are 758 x 1100, so we decided to fix each data size to a specific shape. It's helps us to take good decision for better accuracy result.

```
# Required module  
from tensorflow.keras.preprocessing.image import ImageDataGenerator,load_img  
  
# Rescaling function  
train = ImageDataGenerator(rescale= 1/300)  
validation = ImageDataGenerator(rescale= 1/300)
```

we used this function for rescaling our all of data.

3.3.4 RGB to BRG

RGB means Red Green Blue similarly BRG is the reverse of RGB Blue Red Green. but we know our collection of data has so many variations of color, some data are high, some are low light that's why we take decision to make same color of each data so far algorithm could calculation perfectly. like example if R=0, G =0, B=0 that code means data color will be black, so we know each data has more color that why we reverse the color RGB to BRG.

```
# Required module  
from keras.preprocessing.image import img_to_array
```

This module work for preprocess image data.

```
cv2.imread("/content/agefromimage/images/train/face/u2_f5.jpeg").shape  
(1156, 867, 3)
```

3.4 Implemented Algorithm

OpenCV Face Recognition model is mainly used here, which usage CaffeNet model as Convolutional Neural Network. These were pre-trained and pre-weighted model for image processing and age estimation, which were calibrated and validated carefully using collected data and then tested to found out accuracy and loss function.

3.4.1 OpenCV Face Detection

While using OpenCV's deep neural network with *CaffeNet* models, two sets of files were needed.

1. The. prototxt files which define the model architecture (i.e., the layers themselves)
2. The. caffemodel file which contain the weights for the actual layers

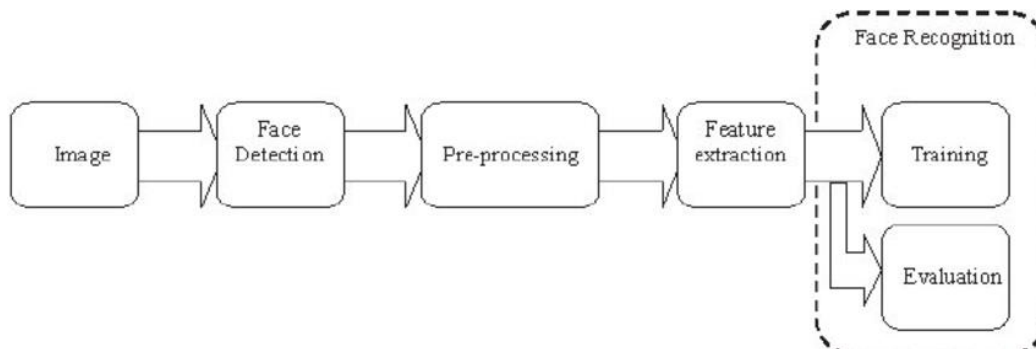


Figure 3.6: OpenCV Face Recognition Module

3.4.1.1 Prototxt

```
faceProto = "modelNweight/opencv_face_detector.pbtxt"
```

```
faceModel = "modelNweight/opencv_face_detector_uint8.pb"
```

```
handProto = "modelNweight/opencv_hand_detector.pbtxt"
```

```
handModel = "modelNweight/opencv_hand_detector_uint8.pb"
```

3.4.1.2 Caffemodel

```
ageModel = "modelNweight/age_net.caffemodel"
```

3.4.1.3 CaffeNet Model

CaffeNet is a CNN framework which allows researchers to develop a complex neural network and train it without need to write a lot of code. When convolution neural network is used to estimate age, a large dataset is needed to train the algorithm. It is a very time-consuming job. The dataset needs to be processed carefully to get the final output. A 19 layered Neural Network is implemented here. The architecture is shown below:

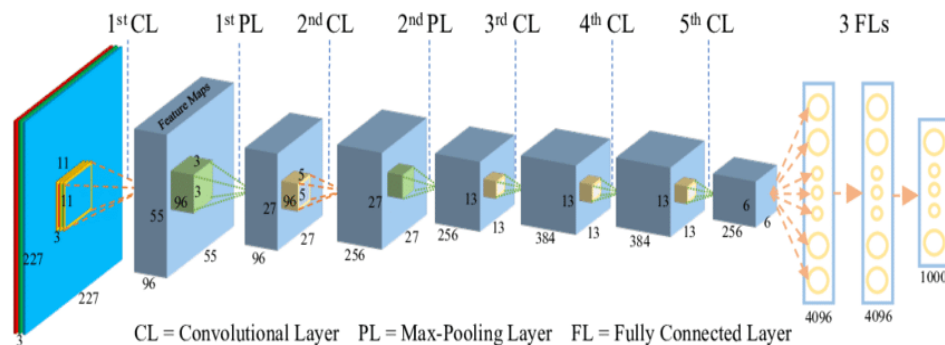


Figure 3.7: *CaffeNet* Architecture

3.4.1.4 Pre-Training Process

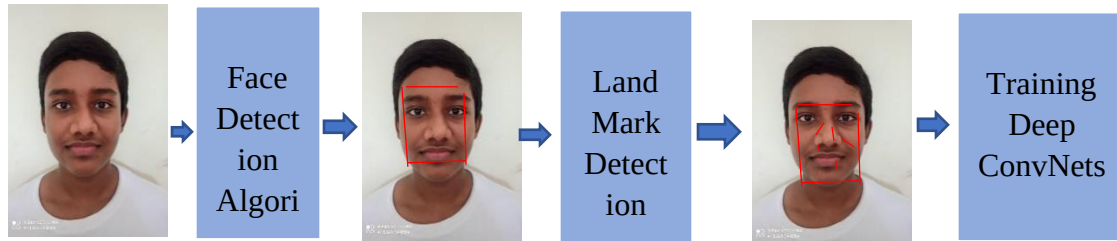


Figure 3.8: Human Vision vs CNN Visualization

3.4.1.5 Convolutional Neural Network

Main work is done here by the convolutional Neural Network layer. Convolution is a mathematical operation to merge two sets of information. the convolution is applied on the input data using a convolution filter to produce a feature map extracting features from image. Then it uses these features to reach to final output and visualize it. It imitates human vision and biological neural network.

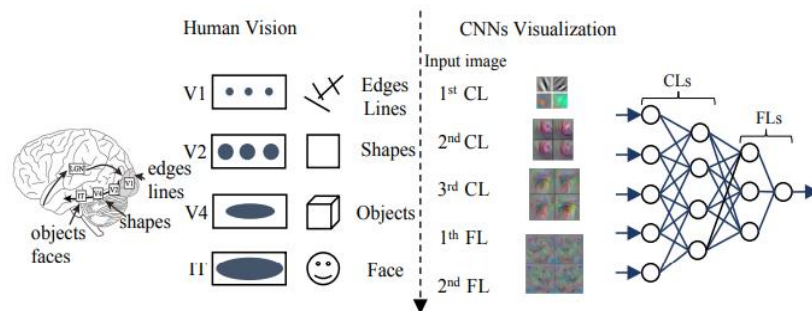


Figure 3.9: Human Vision vs CNN Visualization

3.4.1.6 Training Dataset

After preprocessing then trading dataset, when train dataset there two steps of process has done first process training and second process validation data.

Train whole dataset using this method.

```
train_dataset =  
train.flow_from_directory('/content/agefromimage/images/train',  
                           target_size= (300,300),  
                           batch_size = 3,  
                           class_mode ='binary')
```

```
validation_dataset =  
train.flow_from_directory('/content/agefromimage/images/validation',  
                           target_size= (300,300),  
                           batch_size = 3,  
                           class_mode ='binary')
```

After that Found 22 images belonging to 2 classes.

3.4.1.7 Model Optimizations

```
model.compile(loss = 'binary_crossentropy',  
              optimizer = RMSprop(lr = 0.001),  
              metrics =['accuracy'])
```

This model optimizes the model

3.5 Evaluation

In this research, facial and hand images of 95 people is used to validate and test. First this algorithm is applied on facial images, then on hand images. Output from both data is tried to merge to develop an integrated system to estimate age. Now we are using GitHub for version controlling tools and ide is google Co-Lab for estimate age.

By in this function evaluate training dataset accuracy and loss value to make decision what should be end value.

```
history=model_fit = model.fit(train_dataset,  
                               steps_per_epoch = 3,  
                               epochs = 30,  
                               validation_data = validation_dataset)
```

Accuracy and loss value evaluation

Epoch 1/30

3/3 [=====] - 7s 2s/step - loss: 13.4299
- accuracy: 0.3750 - val_loss: 0.7996 - val_accuracy: 0.5000

Epoch 2/30

3/3 [=====] - 5s 2s/step - loss: 0.9391
- accuracy: 0.5556 - val_loss: 2.2992 - val_accuracy: 0.5000

Epoch 3/30

3/3 [=====] - 5s 2s/step - loss: 1.6228
- accuracy: 0.2222 - val_loss: 0.9922 - val_accuracy: 0.5000

Epoch 4/30

3/3 [=====] - 5s 2s/step - loss: 0.8151
- accuracy: 0.6667 - val_loss: 0.6214 - val_accuracy: 0.5312

Epoch 5/30

3/3 [=====] - 5s 2s/step - loss: 0.6930
- accuracy: 0.7500 - val_loss: 0.5964 - val_accuracy: 0.5938

Epoch 6/30

3/3 [=====] - 6s 2s/step - loss: 0.5080
- accuracy: 0.6667 - val_loss: 1.2814 - val_accuracy: 0.5000

3.5.1 Evaluation Loss and Accuracy History

```
Type: dict
String form: {'loss': [13.429939270019531, 0.9391463398933411, 1.6227672100067139, 0.8151127099990845,
0.6930093765258789, 0.507952094078064, 1.120607852935791, 0.5424789786338806, 0.7894326448440552, 0.3125303089618683,
0.19253665208816528, 2.3791909217834473, 0.7026009559631348, 0.30220794677734375, 0.3279922902584076,
0.14265170693397522, 0.13806115090847015, 0.5287476778030396, 0.06582595407962799, 0.15115907788276672,
0.049423277378082275, 0.00880307238548994, 0.02603745460510254, 0.005292007699608803, 0.001096242223866284,
0.0015929584624245763, 0.03127473220229149, 0.1113157644867897, 0.07863930612802505, 0.005733472760766745],
'accuracy': [0.375, 0.5555555820465088, 0.222222238779068, 0.66666666865348816, 0.75, 0.66666666865348816,
0.66666666865348816, 0.66666666865348816, 0.875, 0.875, 1.0, 0.3333333432674408, 0.5555555820465088, 0.8888888955116272,
0.7777777910232544, 1.0, 0.8888888955116272, 0.7777777910232544, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0,
0.8888888955116272, 1.0, 1.0], 'val_loss': [0.7996042966842651, 2.2991905212402344, 0.9922069907188416,
0.621441006604614, 0.5963887572288513, 1.281420111656189, 0.5207828879356384, 0.4508453905582428, 0.4911189079284668,
0.3244863748550415, 1.9912450313568115, 0.7100592851638794, 0.32319381833076477, 0.28203481435775757,
0.2930765450000763, 0.2564886808395386, 0.34295719861984253, 0.105894535779953, 0.04794169217348099,
0.03683513030409813, 0.038014721125364304, 0.026289183646440506, 0.003793571377173066, 0.0033831691835075617,
0.002373760798946023, 0.0021685310639441013, 0.4467148780822754, 0.19304245710372925, 0.005191329400986433,
0.002063032239675522], 'val_accuracy': [0.5, 0.5, 0.5, 0.53125, 0.59375, 0.5, 0.6875, 0.75, 0.625, 0.84375, 0.5,
0.5625, 1.0, 0.9375, 0.8125, 0.84375, 0.8125, 0.96875, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 0.78125, 0.9375, 1.0,
1.0]}
Length: 4
```

Figure 3.10: Loss and Accuracy History

CHAPTER 4

Result comparison and discussion

After validating the algorithm, it was run on test data (95 face images). The algorithm gave almost 98% accuracy for facial image. The accuracy graph is shown below:

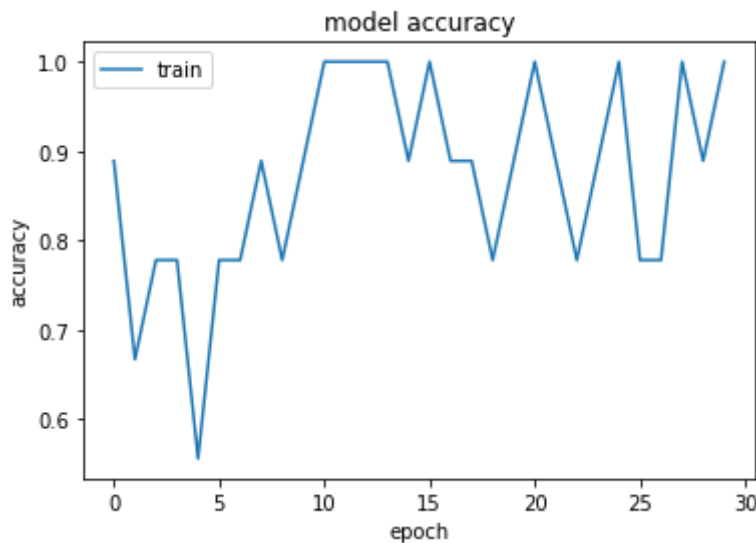


Figure 4.1: Accuracy graph for facial images

Here, it can be seen that the algorithm is getting better estimating age from facial images after each epoch. After total 27 epoch, it gave almost 98% accuracy. It was manually checked and could detect age from 92 images (from 95 images) correctly.

So, almost 2% of error rate is found on the graph. The loss model graph shows that in total 27 epoch. It can be seen that loss of this model is reducing in each epoch. The graph is shown below:

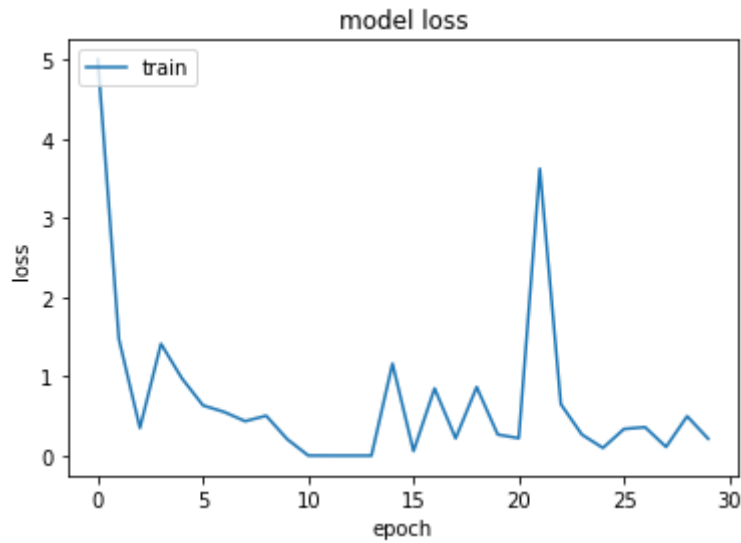


Figure 4.2: Loss graph for facial images

After validating the algorithm, it was run on test data (95 hand images). The algorithm gave almost 0% accuracy for facial image. The algorithm gave poor output for hand images. It did not work. The accuracy graph is shown below:

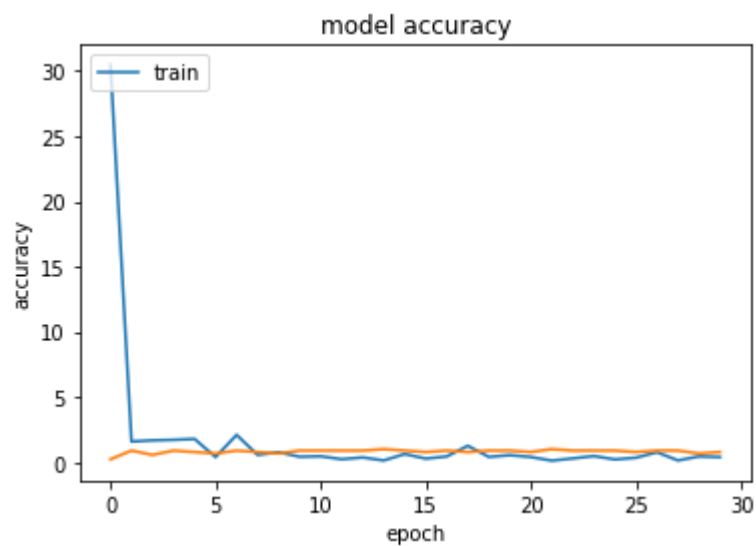


Figure 4.3: Accuracy Model graph for hand images

Here, it can be seen that the algorithm is getting very worsts estimating age from hand images after each epoch. After total 27 epoch, it gave almost 0% accuracy. It was manually checked and could detect age from 92 images (from 95 images) correctly.

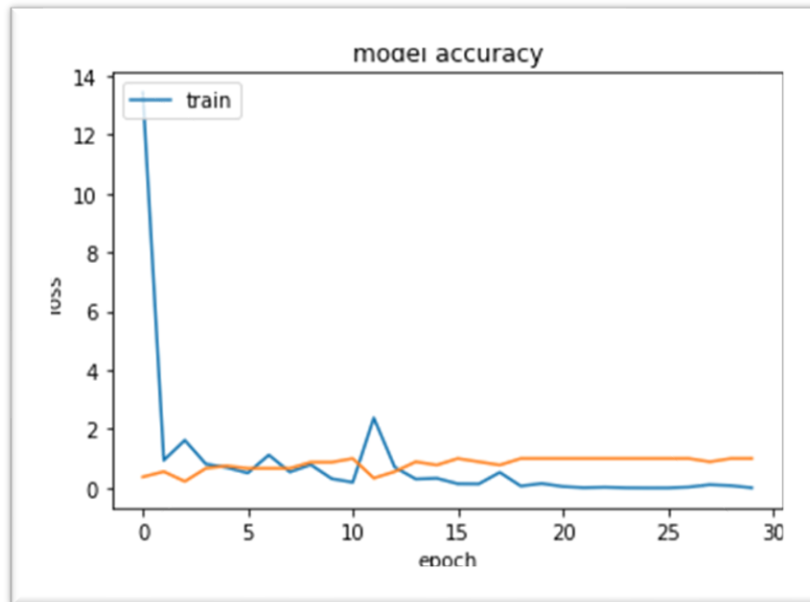


Figure 4.4: Loss Model graph for hand images

CHAPTER 5

Conclusion and Future Work

5.1 Conclusion

The purpose of this research was to develop an integrated system that takes into account more than one body parts, in this case, facial and hand images. The hypothesis was that it could give better performance than existing methods and improve automatic age estimation systems. In that sense, this hypothesis did not work out.

This research estimated age from facial images with high accuracy, but could not detect age from hand at all. But it can be still used as a ground work in making an integrated age estimation system from facial and hand images or more than one body parts.

Building integrated system needs more working theoretically, it's not impossible, but couldn't be done with this algorithm.

5.2 Future Work

This hypothesis did not work out, but it is still important to try to develop an integrated system which takes more than one body parts into account for several reasons. The most important reason is, only facial image cannot provide 100 percent real age estimation. [6] A study shows, real age is most of the times 40.77% higher than the apparent age.

Which may not be achieved in the near future. But this research may become the groundwork of achieving in future goals.

- to prevent child marriage
- to prevent misuse of age
- Improve visual surveillance

-Improve targeting consumers

These studies can be used to solve age-related social issues in future.

5.3 Limitation

There was no existing algorithm specifically designed to estimate age from hand images. Another problem arises from this Covid-19 situation. It was not possible to meet people and ask data from them directly. Which is why a very few data could be collected for this research. Insufficient amount of data is a huge obstacle to get correct result from machine learning algorithms. In future, more data needs to be collected and tested out with this algorithm to improve or maybe invent a way to detect age from hand images.

APPENDIX

Appendix A: Data collected from Survey

There was no research done in age estimation field in Bangladesh. Moreover, Covid-19 situation made it harder to reach or meet people directly to ask data from them. So, data is collected with a google form. [14]

Appendix A.1: Data collected from Directly

Data collection Using google form was not enough data for our research , that's why we are facing trouble to collecting data , our data quantity was 5 for per persons that's why it was difficult .And so many people are scared to provide their data ,moreover we have data collection and storage policy ,still people are scared .Then we decided to collect by ourselves ,then day by day we collect data manually ,asking to known people to share their personal data and if they are agreed with us then we taken their data .

Appendix B: Algorithm used from OpenCV

Right now, computer vision is one of the hottest fields in any industry. Thanks to rapid technological advancements and research, the industry is thriving. Newcomers, however, may find the space intimidating. When transitioning from data science to computer vision, data scientists face some common challenges, including:

1. What are the best methods for cleaning image datasets? Different images have different shapes and sizes
2. Data acquisition is an ever-present problem. Would it be better to collect more images before developing a computer vision model?
3. To build computer vision models, is it necessary to learn deep learning? Is it not possible to use machine learning techniques?

4. What kind of computer simulations can we build on our own machines? Many people do not have access to GPUs or TPUs!

It certainly was challenging for us, and we are sure others must have encountered these issues as well. As a beginning computer vision student, you are asking the right questions! Through the awesome OpenCV library, we will be able to answer most of these questions. This is one of the most popular CV libraries and stands out like a beacon for tasks involving computer vision.

However, OpenCV is not without its drawbacks. It can be hard for beginners to navigate. In OpenCV, there are a variety of useful functions, but they can also be confusing:

- Understand the wide range of functions available
- Use the appropriate function for the problem you are facing

Developing an understanding of OpenCV is crucial for computer vision enthusiasts. This article will provide a detailed overview of the different (common) functions that are available within OpenCV and their applications, as well as how you can get started with each one. You will need your notebooks for this article since it notes books code.

In this research, no new algorithm is invented. Age estimation from OpenCV database was used here with CaffeNet Model.

Appendix C: Using GitHub for version controlling

In this project used GitHub for version control. GitHub is most popular tools for manage project easily. we should update day by day.

REFERENCE

- [1] Henry A.Rowley, Student Member,IEEE, Shumeet Baluja, and Takeo Kaneda, Fellow, IEEE Transaction on Pattern Analysis and Machine Intelligence VOL. 20, No. 1, January 1998
- [2] Anadolu Agency, “Bangladesh: Child Marriage Rises Manifold in Pandemic”, available at <<<https://cutt.ly/mWNJxun>>> last accessed on 08-07-2021
- [3] Symmetry, available at <<<https://cutt.ly/zWNJEYv>>> last accessed on 08- 07-2021 at 12:00 PM.
- [4] Ayad R. Abbas, Asaad R. Kareem,” Intelligent Age Estimation from Facial Images Using Machine Learning Techniques” Iraqi Journal of Science, 2018, Vol. 59, No.2A, pp: 724-732, DOI:10.24996/ij.2018.59.2A.1
- [5] Pablo Pardo García, “Apparent and Real Age Estimation in Still Images with Deep Residual Regressors on Appa-Real Database”, Ieeexplore, 30 May-3 June 2017, INSPEC Accession Number:16996496, DOI:10.1109/FG.2017.20.
- [6] Yuan Dong, Yinan Liu, Shiguo Lian, “Automatic age estimation based on deep learning algorithm”, Neurocomputing, Volume 187, Pages 4-10, 26 April 2016.
- [7] Digital Vetenskapliga Arkivet, available at << Digitala Vetenskapliga Arkivet>> last accessed on 09-07-2021 at 10:00 PM
- [8] Automatic age and gender classification using a supervised appearance model, available at <<<https://cutt.ly/NnKpNjq>>>,last accessed on 07-08-2021
- [9] Recognizing Age-Separated Face Images: Humans and Machines, available at <<<https://cutt.ly/7myhK5y>>> last accessed on 09-07-2021 at 10:00 PM
- [10] Age Estimation of Face Images Based on CNN and Divide-and-Rule Strategy, available at <<<https://cutt.ly/tn7BIQu>>> last accessed on 09-07-2021 at 10:00 PM
- [11] Age estimation via face images: a survey , , available at << <https://cutt.ly/VmyhCKM> >> last accessed on 09-07-2021 at 10:00 PM
- [12] Automated age estimation from MRI volumes of the hand, available at << <https://cutt.ly/mmyb99h>>> last accessed on 09-07-2021 at 10:00 PM
- [13] Face Image Age Estimation Based on Data Augmentation and Lightweight Convolutional Neural Network, available at <<<https://cutt.ly/WnJYmM6>>> last accessed on 09-07-2021 at 10:00 PM
- [14] Yuan Dong, Yinan Liu, Shiguo Lian,” Automatic age estimation based on deep learning algorithm”, Neurocomputing, Volume 187, Pages 4-10, 26 April 2016
- [15] Kirti A. Patil¹, R. P. Bhavsar², B. V. Pawar³ “Features and Methods of Human Age Estimation: Opportunities and Challenges in Medical Image Processing” Vol.12 No.1S (2021), 294-318 Accepted: 27 January 2021

- [16] X. Liu, S. Li, M. Kan, J. Zhang, S. Wu, et al. Agenet: Deeply learned regressor and classifier for robust apparent age estimation. In Proceedings of IEEE International Conference on Computer Vision Workshops, 2015.
- [17] M. Mathias, R. Benenson, M. Pedersoli, and L. Van Gool. Face detection without bells and whistles. In Proceedings of European Conference on Computer Vision, 2014.
- [18] B. Ni, Z. Song, and S. Yan. Web image and video mining to-wards universal and robust age estimator. IEEE Transactions on Multimedia, 13(6):1217–1229, 2011.
- [19] O. M. Parkhi, A. Vedaldi, and A. Zisserman. Deep face recognition. In Proceedings of British Machine Vision Conference, 2015.
- [20] K. Ricanek Jr and T. Tesafaye. Morph: A longitudinal image database of normal adult age-progression. In Proceedings of IEEE conference on Automatic Face and Gesture Recognition, 2006.
- [21] R. Rothe, R. Timofte, and L. V. Gool. Dex: Deep expectation of apparent age from a single image. In Proceedings of IEEE International Conference on Computer Vision Workshops, 2015.
- [22] O. Russakovsky, J. Deng, H. Su, J. Krause, S. Satheesh, et al. ImageNet Large Scale Visual Recognition Challenge. International Journal of Computer Vision, 115(3):211–252, 2015.
- [23] K. Simonyan and A. Zisserman. Very deep convolutional networks for large-scale image recognition. CoRR, abs/1409.1556, 2014.
- [24] Y. Sun, X. Wang, and X. Tang. Deeply learned face re-presentations are sparse, selective, and robust. In Proceedings of IEEE conference on Computer Vision and Pattern Recognition, 2015.
- [25] C. Szegedy, W. Liu, Y. Jia, P. Sermanet, S. Reed, et al. Going deeper with convolutions. In Proceedings of IEEE conference on Computer Vision and Pattern Recognition, 2015.
- [26] Y. Taigman, M. Yang, M. Ranzato, and L. Wolf. Deepface: Closing the gap to human-level performance in face verification. In Proceedings of IEEE conference on Computer Vision and Pattern Recognition, 2014.
- [27] M. Uricar, V. Franc, D. Thomas, A. Sugimoto, and V. Hlaváč. ‘Real-time multi-view facial landmark detector learned by the structured output svm. In Proceedings of IEEE conference on Automatic Face and Gesture Recognition, 2015.
- [28] H.-F. Yang, L. B-Y, C. K-Y, and C. C-S. Automatic age estimation from face images via deep ranking. In Proceedings of British Machine Vision Conference, 2015.
- [29] D. Yi, Z. Lei, and S. Z. Li. Age estimation by multi-scale convolutional network. In Proceedings of Asian Conference on Computer Vision, 2014.
- [30] L. Zhang, R. Chu, S. Xiang, S. Liao, and S. Z. Li. Face detection based on multi-block lbp representation. In Proceedings of IEEE International Conference on Biometrics, 2007.
- [31] Y. Zhu, Y. Li, G. Mu, and G. Guo. A study on apparent age estimation. In Proceedings of IEEE International Conference on Computer Vision Workshops, 2015.

AGE ESTIMATION FROM FACE AND HAND IMAGES USING CONVOLUTIONAL NEURAL NETWORK

ORIGINALITY REPORT

6%	%	%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Essex Student Paper	2%
2	Submitted to National University Of Science and Technology Student Paper	1%
3	Submitted to Eastern Mediterranean University Student Paper	1%
4	Submitted to Queen Mary and Westfield College Student Paper	1%
5	Submitted to Nottingham Trent University Student Paper	<1%
6	Submitted to costa rica tec Student Paper	<1%
7	Submitted to University of Westminster Student Paper	<1%
8	Submitted to City University Student Paper	<1%
9	Submitted to Prairie View A&M University Student Paper	<1%

Exclude quotes Off
Exclude bibliography Off

Exclude matches Off