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MINI PROJECT REPORT
(18ECMP68)

ON

"Face Shape Classifier using Deep learning"

Submitted in partial fulfillment of the requirements for the award of degree of

BACHELOR OF ENGINEERING
in
ELECTRONICS AND COMMUNICATION ENGINEERING

by

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B.N.M. Institute of Technology

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Department of Electronics & Communication Engineering

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CERTIFICATE

Certified that the mini project work entitled **"Face Shape Classifier using Deep Learning"** carried out by **Neeraj H Gowda(1BG18EC072), Rohan S(1BG18EC095),** and **Suhas R Vittal(1BG18EC111),** bonafide students of **VI semester** in partial fulfillment for the award of **Bachelor of Engineering** degree in **Electronics and Communication Engineering** of the Visvesvaraya Technological University, Belagavi during the year **2020-2021**. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the department library. The mini project report has been approved as it satisfies the academic requirements in respect of Mini Project work prescribed for the said degree.

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ABSTRACT

Beauty and cultural activities, such as hairstyles and makeup, require the knowledge of face shape of a person which, is not always accurate or efficient and requires the expert knowledge. In this mini project, we present a computer aided system based on image processing and deep learning to identify the face shape automatically without having to seek an expert. The system gets face images as input and then sends them to a pre-trained neural network model. The network handles the classification tasks and produces the predictions according to the face shape and gives results for the best matching categories. The network designed using convolutional neural network model and a dataset was prepared after pre-processing database from Kaggle.com.

The prototype system managed to perform at 82.62% accuracy level on classifying the shapes of five basic face shapes. The experimental results indicate that the proposed approach is a valuable approach, which can significantly support an accurate detection of face shapes with a little computational effort. After identifying the shape of the face, the recommendation system proposes suitable hairstyles for the face image. Here, we have used Python programming language and image processing techniques to develop the algorithm. The system will allow users to upload a preferred face image, process it and will automatically determine the shape of the face. The empirical study of our prototyping system has proved the effectiveness of our recommendation algorithm.

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INTRODUCTION

CHAPTER 1

1.1 INTRODUCTION

Our faces reflect everything about us and create the first and lasting impressions with everyone we meet. So, it is important to know how to use this to our advantage. Identifying our face shape can help us in making the best out of it and expands our potential. With just a little knowledge in this department, we will have the control to use our features to emphasize or conceal certain characteristics. And by determining our face shape, we will be able to understand the best approach in styling our self so we can look stunning and natural rather than harsh and drab. Finding our face shape is instrumental to help us style ourselves. Our clothing choices are benefited from our face shape. Several commercials software has been developed for allowing users to simulate how they look with different hairstyles by manually changing. Other researches use face modelling techniques for face detection and face recognition works. The major objective of the work is a proposed method to determine the shape of a face and build a recommendation software for hairstyles, clothing, accessories etc.

In this project, we present a computer aided system based on image processing and powered by Machine Learning to identify face shape automatically without having to seek an expert and is helpful in describing about a person's physical attributes and how these face shapes can be used to their advantage.

1.2 MOTIVATION

Having prior knowledge about our face shape assist us in our clothing and fashion choices. The cohesiveness of our face shape and fashion choices helping in styling our self to look our best without an expert consultation how our clothing choices relate to our face shape:

Clothing

- Wearing necklines that follow the shape of our jawline will accentuate its shape. For example, a V-neck with a diamond or heart shaped face or a scoop neck with an oval face shape will make the shape of our jawline more prominent. Creating contrast by wearing opposing necklines, for example a V-neck with a round face shape, will help camouflage a particularly pointed or round jawline.

- The width of our neckline links to the width of our face and wearing a neckline that is wider than our face will make it appear wider than it is. Face shapes with a wider jawline or single width face shapes, like triangle or oblong, may want to avoid this while oval and diamond shapes may want to use this to balance a longer face.

- This is also true when it comes to the depth of our neckline and how it relates to the length of our face. Lower necklines accentuate length while high necklines camouflage length. For example, a low V-neck will elongate our face while a high crew neck will shorten it.
- Clothing features, like necklines and pattern, that reflect the features of your face, round or angular, will work harmoniously with your look. Wearing opposing shapes to your facial features will create contrast for a more statement making look.

Accessories

- Creating a focal point with your accessories is key as this is where attention will be drawn. Wearing a crew neck top with a V-shaped necklace means the necklace will be the link to your face shape, while a V-neck top with a neck scarf actually creates a rounded link to your face shape.

- Accessory shapes and proportions link back to not only your body but also your face shape especially jewellery which is worn close to your face. A necklace with rounded features will compliment a round face shape while wearing long earrings with an oval face shape will accentuate its length. Hence finding our face shape without consulting an expert helps in bringing individualized styling to everyone.

1.3 PROBLEM STATEMENT

The aim of this project is to provide a recommendation system for hairstyles, clothing and accessories by determining the face shape of a person.

First thing a stylist does during a makeover is guess your face shape and your style is decided to compliment your face shape, not everyone can have an access to a stylist and get a fashion overhaul based on their features to make this accessible to everyone and get results in an instance, we plan to harness the power of CNN to identify face shapes based on an input picture and get the result instantly.

1.4 OBJECTIVES

The purpose of this research is to design and develop a neural network to identify a person's face shape using facial images and display the results on the screen. This system, is most suitable for identifying the face shape at opticians, beauty salons and even at home. Our main objective is to make sure that our users get to choose a best style on basis of their face shape. This helps women to choose the best among the wide range of stylish clothes, hairstyle, makeup depending on specific occasions and events.

This project can be integrated in e-commerce platforms where, we could determine if our apparel choices using our face shape and help eliminate merchandise that don't suit or highlight our features. This project finds application in all areas where we buy merchandise as face shape classification helps to narrow down choices for us.

1.5 SUMMARY

The application allows the user to input a facial photograph and provides best prediction of the face shape. Each image is compared and the results indicate that the system was trained, validated and tested. The implemented system can identify face shape with good accuracy rate. However, there is room for some potential enhancements. This system will be trained with 5000 faces of women aging from 20-40 years to identify shape mainly square, oval, oblong, round and heart. Applications can be implemented using this system to include eyeglasses, hairstyles, clothing to provide a good sense of fashion.

CHAPTER-2

DESCRIPTION OF THE PROJECT

CHAPTER 2

2.1 INTRODUCTION

With the advent of re-trainable custom image classifiers, it has become a lot easier to make specialized image classifiers like face shape classifiers. That is, given a frontal view image of a human face, the classifier should be able to identify whether the given face is heart, oblong, oval, round, or square shaped. Knowledge of one's face shape is more commonly used by fashion stylists in recommending eyewear frames and hairstyles that accentuate or tone down facial features. For example, when choosing an eyewear, OPSM Opticians recommend that people with oblong-shaped faces consider frames with oversized frames to balance long and wide features and avoid clear rimless frames that exaggerate length and width. Other similar applications include recommendation systems for hats, make-up, jewelry, and other fashion accessories.

In the future, these recommendation systems can form part of a larger personal digital assistant that is linked to social media and product advertisers. Such recommendation systems could also be used to suggest virtual or cosmetic facial alterations that can further enhance one's looks. Face-shape classification schemes could also be used in facial profiling to speed up facial recognition but more abstracted profiling schemes using system-learned classes may be more useful. Face shape classifiers that are readily accessible in the literature come as online guides, online applications, and mobile applications. A couple of peer-reviewed scientific articles are also available. Published methods on face shape classification extract pre-defined features from an image which are then used to train classifiers using the following approaches: k-nearest neighbors (KNN), linear discriminant analysis (LDA), support vector machines with linear kernel (SVM-LIN), support vector machines with radial basis function kernel (SVM-RBF) [2], and artificial neural networks or multi-layer perceptron (MLP). While published overall accuracies look promising in the range of 64.2% to 85.0%, it would be interesting to compare these results with that of a classifier using convolutional neural networks (CNNs) which are becoming more and more popular in image classification problems.

2.2 LITERATURE SURVEY

As one of the most successful applications of image analysis and understanding, face recognition has recently received significant attention, especially during the past several years. At least two reasons account for this trend: the first is the wide range of commercial and law enforcement applications, and the second is the availability of feasible technologies after 30 years of research. Even though current machine recognition systems have reached a certain level of maturity, their success is limited by the conditions imposed by many real applications. For example, recognition of face images acquired in an outdoor environment with changes in illumination and/or pose remains a largely unsolved problem. In other words, current systems are still far away from the capability of the human perception system.

Another spin off from advancements in face recognition is face shape detection that has a large scope of application in industries that cater individual, like fashion and e-commerce, we referred papers and articles pertaining to face classifications that branched off from facial recognition forming a hybrid between face recognition and then image classification. From our survey it was favorable to use CNN for our approach as we need not train our model to recognize specific features rather itself find and cluster these features of each category. There are two underlying motivations for us to this survey: the first is to provide an up-to-date review of the existing literature regarding face classification, and the second is to offer some insights into the studies of machine recognition of faces.

2.3 METHODOLOGIES

2.3.1 DESCRIPTION

Face shape classifiers that are readily accessible in the literature come as online guides, online applications, and mobile applications. There are also a couple of peer-reviewed scientific articles available. The more rudimentary approach to face shape classification involves tracing the outline of one's face in a mirror and then comparing the resulting shape to one of several pre-defined classes. An online application removes the need to use a mirror by allowing the user to superimpose one of five available face shape outlines on an uploaded picture. Both approaches need the subjective judgment of the user to choose which shape best matches his or her face shape. Other online guides employ a rules-based approach requiring the user to answer a question including whether one's face is longer than it is wider or whether one's jaws are rounded or angular. While this approach may best approximate how humans determine face shape, this approach is not easily automated in a computer. One online application takes a picture of one's face via a webcam and extracts from this the global face shape, measurement ratios, and skin, eye, and hair color to recommend eye wears for the user to try-on virtually in real-time. It is not known what specific computer vision approach and classification algorithm is used. Another online application allows the user to manually trace the following four pairs of points in an uploaded picture: chin-hairline points, left-right forehead points, left-right cheekbone points, and left-right jaw bone points. The application then determines the face shape from these four measurements.

Deep Learning

Deep learning is part of a broader family of machine learning methods based on artificial neural networks with representation learning. Learning can be supervised, semi-supervised or unsupervised. Deep-learning architectures such as deep neural networks, deep belief networks, deep reinforcement learning, recurrent neural networks and convolutional neural networks have been applied to fields including computer vision, speech recognition, natural

language processing, machine translation, bioinformatics, drug design, medical image analysis, material inspection and board game programs, where they have produced results comparable to and in some cases surpassing human expert performance. Artificial neural networks were inspired by information processing and distributed communication nodes in biological systems.

Deep learning is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability—allowing it to “learn” from large amounts of data. While a neural network with a single layer can still make approximate predictions, additional hidden layers can help to optimize and refine for accuracy.

Deep learning drives many artificial intelligence (AI) applications and services that improve automation, performing analytical and physical tasks without human intervention. Deep learning technology lies behind everyday products and services (such as digital assistants, voice-enabled TV remotes, and credit card fraud detection) as well as emerging technologies (such as self-driving cars).

Deep learning has power, flexibility, and simplicity. That's why we believe it should be applied across many disciplines. These include the social and physical sciences, the arts, medicine, finance, scientific research, and many more. Here's a list of some of the thousands of tasks in different areas at which deep learning, or methods heavily using deep learning, is now the best in the world.

While deep learning was first theorized in the 1980s, there are two main reasons it has only recently become useful:

1)Deep learning requires large amounts of labeled data. For example, driverless car development requires millions of images and thousands of hours of video.

2)Deep learning requires substantial computing power. High-performance GPUs have a parallel architecture that is efficient for deep learning. When combined with clusters or cloud computing, this enables development teams to reduce training time for a deep learning network from weeks to hours or less.

How Deep Learning Works

Most deep learning methods use neural network architectures, which is why deep learning models are often referred to as deep neural networks.

The term “deep” usually refers to the number of hidden layers in the neural network. Traditional neural networks only contain 2-3 hidden layers, while deep networks can have as many as 150.

Deep learning models are trained by using large sets of labeled data and neural network architectures that learn features directly from the data without the need for manual feature extraction.

CNN

One of the most popular types of deep neural networks is known as convolutional neural networks (CNN or ConvNet). A CNN convolves learned features with input data, and uses 2D convolutional layers, making this architecture well suited to processing 2D data, such as images.

CNNs eliminate the need for manual feature extraction, so you do not need to identify features used to classify images. The CNN works by extracting features directly from images. The relevant features are not pretrained; they are learned while the network trains on a collection of images. This automated feature extraction makes deep learning models highly accurate for computer vision tasks such as object classification.

How to Create and Train Deep Learning Models

The three most common ways people use deep learning to perform object classification are:

1)Training from Scratch

To train a deep network from scratch, you gather a very large labeled data set and design a network architecture that will learn the features and model. This is good for new applications, or applications that will have a large number of output categories. This is a less common approach because with the large amount of data and rate of learning, these networks typically take days or weeks to train

2)Transfer Learning

Most deep learning applications use the transfer learning approach, a process that involves fine-tuning a pretrained model. You start with an existing network, such as AlexNet or GoogleNet, and feed in new data containing previously unknown classes. After making some tweaks to the network, you can now perform a new task, such as categorizing only dogs or cats instead of 1000 different objects. This also has the advantage of needing much less data (processing thousands of images, rather than millions), so computation time drops to minutes or hours.

3)Feature Extraction

A slightly less common, more specialized approach to deep learning is to use the network as a feature extractor. Since all the layers are tasked with learning certain features from images, we can pull these features out of the network at any time during the training process. These features can then be used as input to a machine learning model such as support vector machines (SVM).

Fast Ai

fast.ai, with the mission of making deep learning more accessible fast.ai can be described as a research lab bundled with courses, an easy-to-use Python library with a huge community. Their library wraps popular deep learning and machine learning libraries for common workflows and provides a user-friendly interface.

Most importantly, it follows the "top down" approach. "Top down" is exactly like how we learn a sport. We start by trying to play it, without worrying about rules. Once we are confident, we learn the rules and tricks one by one. Similarly, fast.ai allows us to build a model using only a few lines of code.

Confusion Matrix

A confusion matrix is a tabular summary of the number of correct and incorrect predictions made by a classifier. It can be used to evaluate the performance of a classification model through the calculation of performance metrics like accuracy, precision, recall, and F1-score.

Block Diagram

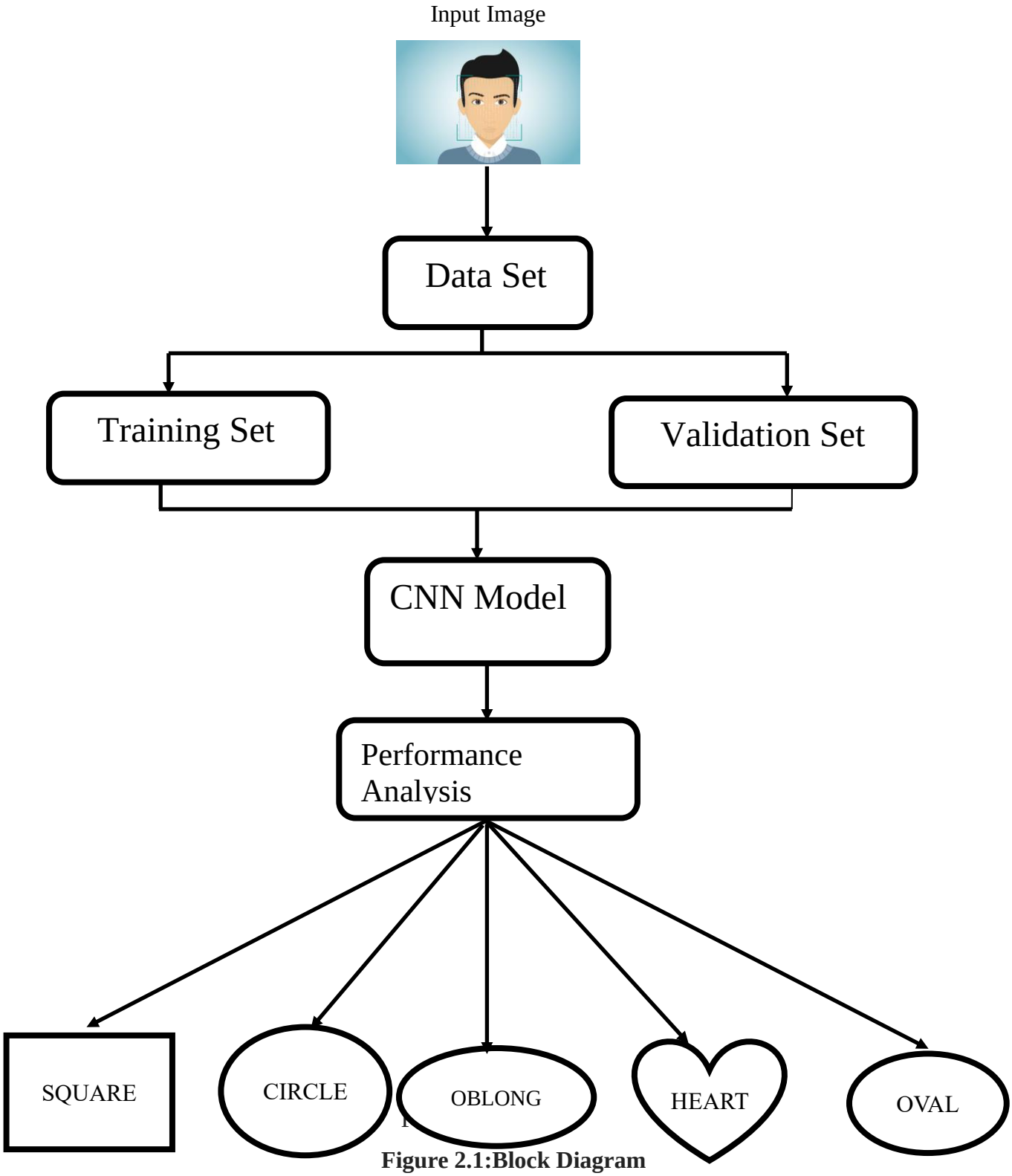

Figure 2.1:Block Diagram

2.3.2 ALGORITHM

Step 1: Start

Step 2: Give a sample image as input image

Step 3: The pre trained data set performs deep learning on the input image

Step 4: The detected image is now given to the CNN model to classify

Step 5: The output of the CNN model shows the shape of the input image

Step 6: The performance analysis of the output image is done through confusion matrix

Step 7: The result is displayed with accurate face shape

Step 8: Stop

An automatic analysis of facial appearance-based problems with machine learning techniques based on Convolutional Neural Network (CNN) has been introduced. CNNs can overcome the problem of feature alignment and its strong performance in difficult test images is experimentally demonstrated. A system that uses a hierarchical procedure in which it first locates roughly the eyes, nose and mouth and then refines the result by the detection of different facial feature points.

Finally, a face recognition system having a specific CNN architecture which can team a nonlinear mapping of the area of the image into a lower dimensional subspace where it is easier to separate into different classes is proposed. The method was applied to several public face databases and could achieve better recognition rate than conventional face recognition logics.

This dataset consists of thousands of images of handwritten digits and people can uses this dataset to train and test the accuracies of their own convolutional neural networks. There are many popular datasets that were created and collected by many individuals to help further the advancement and research of convolutional neural networks.

- We analyse performance of our model using confusion matrix.

A confusion matrix is a table that is often used to describe the performance of a classification model (or "classifier") on a set of test data for which the true values are known

2.4 SOFTWARE REQUIREMENTS AND LIBRARIES

2.4.1 Software Requirements

PYTHON- Python is an interpreted, object oriented and high-level programming language. Python's extensive selection of machine learning-specific libraries and frameworks simplify the development process and cut development time. Python's simple syntax and readability promote rapid testing of complex algorithms and make the language accessible to non-programmers. It also reduces the cognitive overhead on developers, freeing up their mental resources so that they can concentrate on problem-solving and achieving project goals. Finally, the simple syntax makes it easier to collaborate or transfer projects between developers. Python also boasts a large, active community of developers who are happy to offer help and support, which can be invaluable when dealing with such complex projects. While other programming languages can also be used in AI projects, there is no getting away from the fact that Python is at the cutting edge and should be given significant consideration. This is why we have chosen Python as our programming language for our model.

2.4.2 Libraries Used

PANDAS- It is a software library written for the Python programming language for data manipulation and analysis. In particular, it offers data structures and operations for manipulating numerical tables and time series.

NumPy- NumPy stands for Numerical Python. NumPy is a Python library used for working with arrays. It also has functions for working in the domain of linear algebra, Fourier transform, and matrices.

2.5 OUTPUT SCREENSHOTS

```
In [19]: interp.plot_confusion_matrix()
```

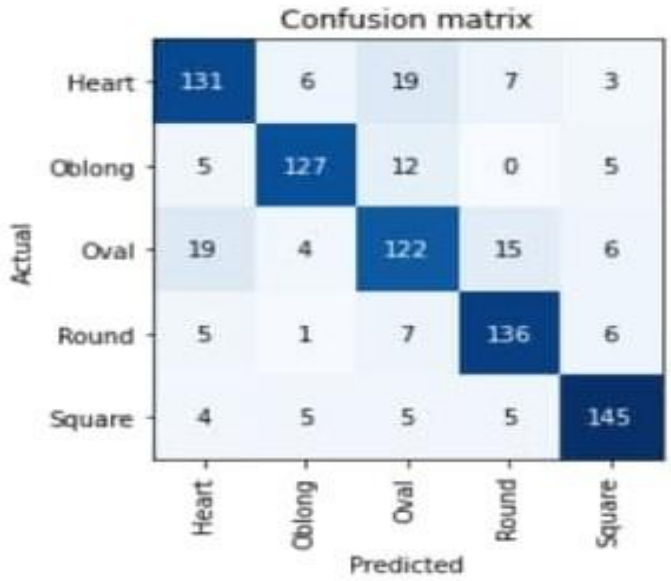

Figure 2.5.1 Confusion Matrix

```
Out[13]: SuggestedLRs(valley=tensor(0.0030))
```

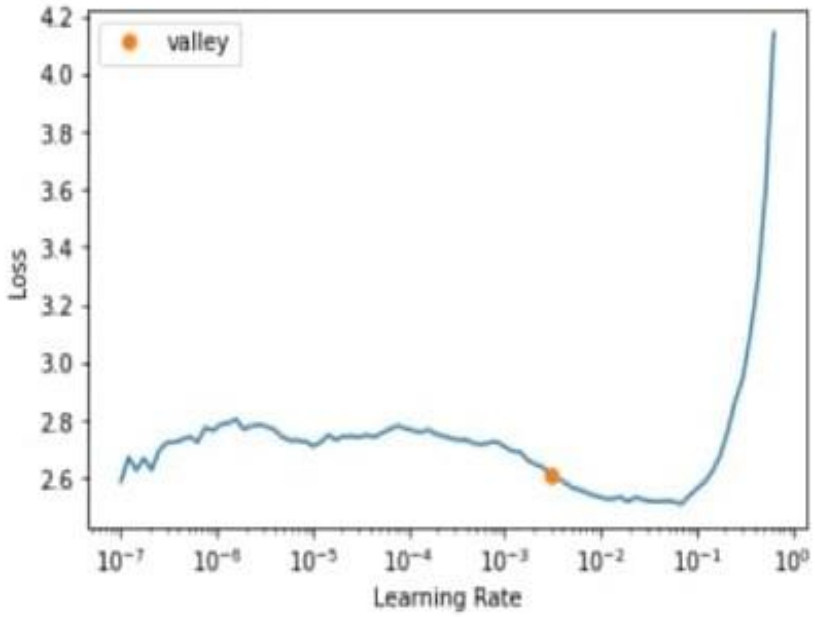

Figure 2.5.2 Learning rate of CNN model

```
In [14]: learn.fine_tune(10, 10e-3)
```

epoch	train_loss	valid_loss	accuracy	time
0	2.178339	1.545776	0.456250	20:37

epoch	train_loss	valid_loss	accuracy	time
0	1.262536	1.076123	0.607500	19:57
1	0.873222	1.090557	0.652500	13:29
2	0.697785	1.401260	0.641250	12:49
3	0.523694	1.342047	0.685000	13:03
4	0.389929	1.067941	0.692500	12:51
5	0.262922	0.833553	0.756250	12:34
6	0.157744	0.662112	0.818750	13:02
7	0.082655	0.704086	0.812500	13:20
8	0.045938	0.708419	0.818750	11:37
9	0.024223	0.671172	0.826250	12:45

Figure 2.5.3 Accuracy of CNN Model

```
In [38]: print(learn.predict(r'C:\Users\neera\mini project\archive\seminar pics\men7.jpg'))
         Image(r'C:\Users\neera\mini project\archive\seminar pics\men7.jpg',width=300)

('Oblong', tensor(1), tensor([1.4956e-04, 9.9465e-01, 5.1703e-03, 6.7723e-06, 2.7486e-05]))

Out[38]:
```

Figure 2.5.4 Output 1

```
In [32]: print(learn.predict(r'C:\Users\neera\mini project\archive\seminar pics\square1.jpg'))
         Image(r'C:\Users\neera\mini project\archive\seminar pics\square1.jpg',width=300)

         ('Square', tensor(4), tensor([8.2567e-05, 2.5438e-05, 3.0366e-03, 2.5656e-04, 9.9660e-01]))
```

Out[32]:

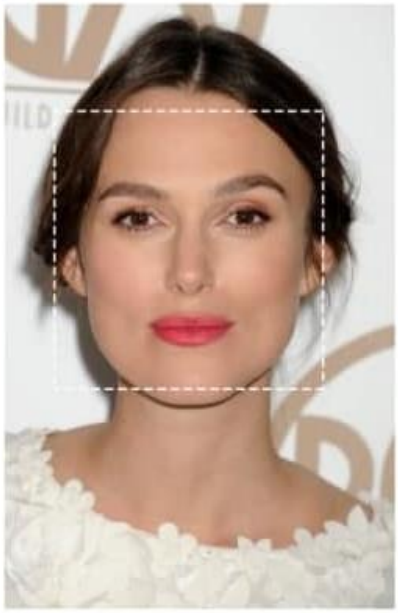

Figure 2.5.5 Output 2

2.6 SUMMARY

The application allows the user to input a facial photograph and provides best prediction of the face shape. Each image is compared and the results indicate that the system was trained, validated and tested. The implemented system can identify face shape with good accuracy rate. However, there is room for some potential enhancements. This system will be trained with 5000 faces of women aging from 20-40 years to identify shape mainly square, oval, oblong, round and heart. Applications can be implemented using this system to include eyeglasses, hairstyles, clothing to provide a good sense of fashion.

Figure 2.6.1 Women Face Shapes

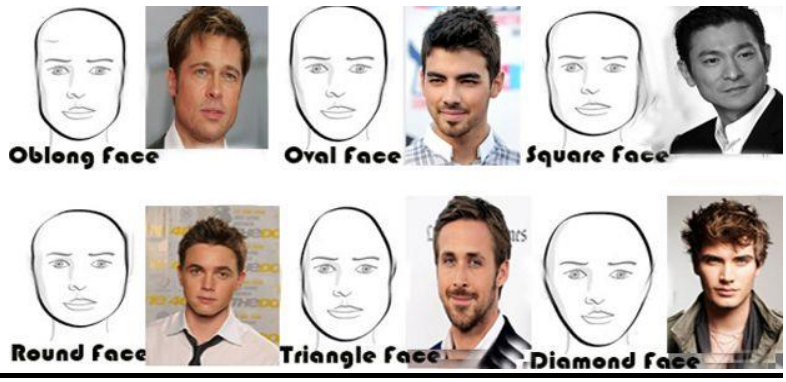

Figure 2.6.2 Men Face Shapes

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