University of Mumbai

**Face recognition with the help of Image Classification**

Submitted at the end of semester VI in partial fulfillment of requirements

For the degree of

**Bachelors in Technology**

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**Batch 2018 -2022**

# K. J. Somaiya College of Engineering, Mumbai-77

(Autonomous College Affiliated to University of Mumbai)

## Certificate

This is to certify that the dissertation report entitled submitted **Face recognition with the help of Image Classification** by at the end of semester VI of TY B. Tech is a bonafide record for partial fulfillment of requirements for the degree of Bachelors of Technology in Electronics and Telecommunication Engineering of University of Mumbai



Guide/Examiner1 Expert/Examiner2

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Place: Mumbai-77

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We certify that this dissertation report entitled **Face recognition with the help of Image Classification** is a bonafide record of project work done during semester VI. This project work is submitted at the end of semester VI in partial fulfillment of requirements for the degree of Bachelors of Technology in Electronics and Telecommunication Engineering of University of Mumbai.



Internal Examiners



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# Abstract

Detection of patterns in images using classifiers is one of the most promising topics of research in the field of computer vision. A large number of practical applications for face detection exist and contemporary work even suggests that any specialized detectors can be approximated by using fast detection classifiers. In this project, I have developed an algorithm which will detect face from the input image with less false detection rate using combined effects of computer vision concepts. This algorithm utilizes the concept of detecting edges and extracting different features from face. The result is supported by the statistics obtained from calculating the parameters defining the parts of the face. The project also implements the highly powerful concept of Support Vector Machine that is used for the classification of images into face and non-face class. This classification is based on the training data set and indicators of luminance value, chrominance value, saturation value, elliptical value and nose, eye & mouth map values.

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# Nomenclature

1. Vcc = 5 Volts
2. Ground = 0 Volts
3. E+ = Excitation +
4. E- = Excitation -
5. A+ = Amplifier +
6. A- = Amplifier -
7. DT = Digital Output
8. SCK = Serial Clock

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# Chapter 1 Introduction

**1.1 Background**

The intent of the classification process is to assign pixels in the image to categories or several classes. Normally, multi-spectral data are used to perform the classification and, indeed, the spectral pattern present within the data for each pixel is used as the numerical basis for categorization. The objective of image classification is to identify and portray, as a unique gray level (or color), the features occurring in an image in terms of the object these features actually represent on the ground. Image classification is perhaps the most important part of **digital image analysis**. Classification between objects is a complex task and therefore image classification has been an important task within the field of **computer vision**. Image classification refers to the labelling of images into one of a number of predefined classes. There are potentially n number of classes in which a given image can be classified. Manually checking and classifying images could be a tedious task especially when they are massive in number and therefore it will be very useful if we could automate this entire process using computer vision. The advancements in the field of **autonomous driving** also serve as a great example of the use of image classification in the real-world. The applications include automated image organization, **stock photography** and video websites, **visual search** for improved product discoverability, large **visual databases**, image and face recognition on social networks, and many more; which is why, we need classifiers to achieve maximum possible accuracy.

**Concept of Image Classification**

* Image classification is a process of mapping numbers to symbols
* f(x): x D; x ∈ R n , D = {c1 , c2 , …, cL } Number of bands = n; Number of classes = L.
* f(.) is a function assigning a pixel vector x to a single class in the set of classes.
* In order to classify a set of data into different classes or categories, the relationship between the data and the classes into which they are classified must be well understood
* To achieve this by computer, the computer must be trained Training is key to the success of classification
* Training is key to the success of classification
* Classification techniques were originally developed out of research in Pattern Recognition field
* Computer classification of remotely sensed images involves the process of the computer program learning the relationship between the data and the information classes
* Important aspects of accurate classification
  + Learning techniques
  + Feature sets

**Features**

* Features are attributes of the data elements based on which the elements are assigned to various classes.
* E.g., in satellite remote sensing, the features are measurements made by sensors in different wavelengths of the electromagnetic spectrum – visible/ infrared / microwave/texture features
* In medical diagnosis, the features may be the temperature, blood pressure, lipid profile, blood sugar, and a variety of other data collected through pathological investigations
* The features may be qualitative (high, moderate, low) or quantitative.
* The classification may be presence of heart disease (positive) or absence of heart disease (negative)

**1.2 Motivation**

**1.3 Scope of Image classification**

* Automotive sector: In developing advanced drivers assist for semi-autonomous cars and also heavily used in autonomous/driverless cars
* Image enhancing: The camera apps in smartphones and digital cameras using image processing to enhance the image quality, video stabilization and noise removal etc.
* Robotics: Mobile robot's navigation in unknown environment (SLAM), control of the robot by processing the video feed from the camera on robot to extract the live scene around it
* Gaming: Advanced gaming consoles like Xbox kinect use image processing from motion analysis of the human player.
* Problem specific solutions: image processing is used as a solution to a variety of problems, starting from facial recognition access to defects identification in manufacturing industries
* Manufacturing: To identify defects in the processes and also to control the robots in performing certain tasks. for ex. defects in manufacturing of a Printed Circuit Board (PCB) can be observed using high resolution image processing
* Human machine interface: machines are made smart by adding gestural interface, or human action response interfaces, which decodes the actions of the human user to perform certain tasks.

**1.4 BRIEF DESCRIPTION OF PROJECT UNDERTAKEN:**

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# Chapter 2 Literature Survey

* + 1. For understanding load cell completely we need to search for its basics working principal first. Then we got to know the importance of assembling it properly on a wooden board to maintain perfect strain. Got to understand the design and functions of load cell. Load cell basically converts physical measurable weights to a low voltage output signal. Also the wiring configuration.
    2. Now to convert low voltage output signal generated from load cell to high voltage output signal. So for this purpose we need HX711 module which amplify the voltage signal and also work as an Analog to Digital Converter (ADC). Then we got to understand the pin configuration of this module and this provided us the importance of every pin.
    3. Now perfect interfacing or connection of load cell with hx711 module was done with proper precautions that any of the connections won’t touches each other. Because the contact of any connection, with other connection leads to false calculation of load. Such false calculation leads to making product less secure. Even because of connection contacts module can get damage.
    4. We need to install arduino ide software on laptop so that the coding and interfacing is done. For this we also need to download basic library which used in arduino code frequently. Even we understood how to upload our code to arduino board and how to see the output on ide software.
    5. To understand arduino properly we need to understand its pin configuration so that we can connect the pins with proper vcc and ground. Also understood the input/output (I/O) pins in and arduino board.
    6. To connect hx711 module to arduino board so that the arduino gets proper input which is generated with the help of load cell. Thus, connection of all 4 output pins of module (vcc, ground, DT, SCK) with arduino board was done.
    7. Now after the connection of hx711 to arduino we need to download the hx711 interfacing library on arduino ide software so that arduino can read output from hx711 module and the interfacing can be proper.
    8. After the library is installed the commands are run on arduino ide software to get proper weight. For this we need to calibrate our load cell using a calibration factor and to get the calibration factor we need to do trial and error method with a known load.

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* + 1. As arduino reads the weights perfectly then we need to take a weight which need to be secured. Now as we got a secured weight we need to modify our previous code more accurately and add some looping commands so that anyone touches the secured weight the LED turn ON indicating that someone touching the secured weight and want to pick it.
    2. To connect LED properly with arduino and get proper output one should know how to connect LED without supplying it high voltage.

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# Chapter 3 Project Design



## 3.1 PROBLEM STATEMENT:

Given still or video images of a celebrity, identify or verify the person in the images using a stored database of faces.

## 3.2 ANALYSIS OF PROBLEM STATEMENT:

## A complete face recognition system includes face detection, face preprocessing and face recognition processes. Therefore, it is necessary to extract the face region from the face detection process and separate the face from the background pattern, which provides the basis for the subsequent extraction of the face difference features. Face recognition of the separated faces is a process of feature extraction and contrast identification of the normalized face images in order to obtain the identity of human faces in the images.

## 3.3 OBJECTIVES:

The objective of this project is to train the model to successfully identify the image given as an input and show the % similarity with all the celebrities stored in the database. We also aim to achieve decent accuracy for the same. In this project our objective is to learn:

1. How basic machine learning algorithms are implemented in projects

2. How to collect images using web scraping from the internet.

3. How to successfully do image classification using OpenCV

4. How to do data cleaning

5. How to do feature engineering on a dataset

6. Concepts like Wavelets transform

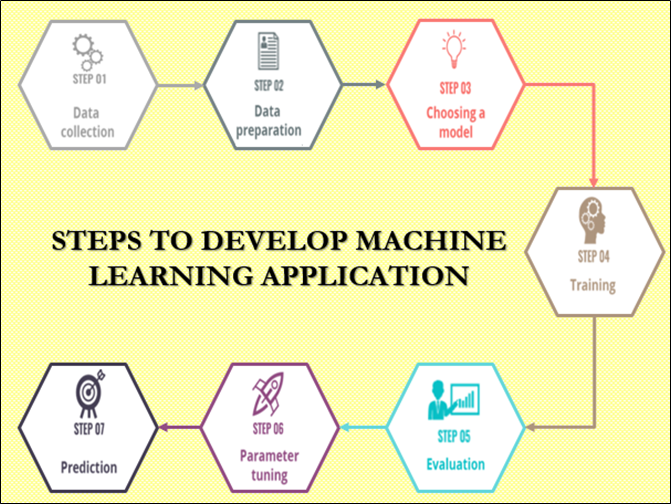
7. How images can be used to train SVM classifier or logistic regression classifier

8. How to deploy machine learning projects on the website using flask as a server and using HTML5, CSS3, JS to build the frontend of the website.

## 3.4 TOOLS AND IMAGE DATASET

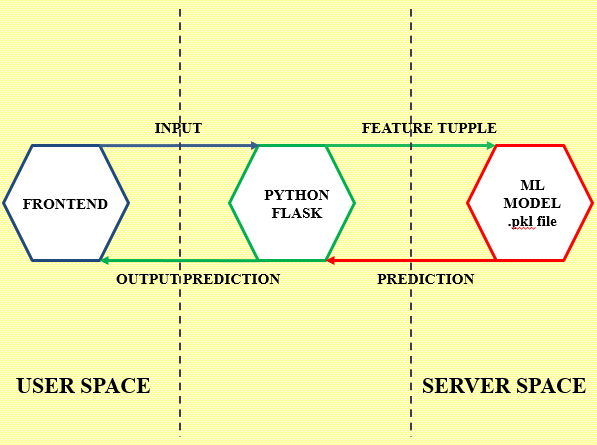
The tools which we have used in our projects are Microsoft Visual C++, Jupyter Notebook from Anaconda Navigator, Google Colab and Git. The image dataset used for training in this project was scrapped using an image scraper. Also, some photos were taken from the internet (not containing copyright issues) to test varying conditions.

## 3.5 BLOCK DIAGRAM:



## *Made using Lucidchart*

## BACKEND DEPLOYMENT USING FLASK



## 3.6 SUPERVISED LEARNING

## Supervised learning, also known as supervised machine learning, is a subcategory of [machine learning](https://www.ibm.com/cloud/learn/machine-learning) and [artificial intelligence](https://www.ibm.com/cloud/learn/what-is-artificial-intelligence). It is defined by its use of labeled datasets to train algorithms to classify data or predict outcomes accurately. As input data is fed into the model, it adjusts its weights through a reinforcement learning process, which ensures that the model has been fitted appropriately.

## Working of supervised learning:

## Supervised learning uses a training set to teach models to yield the desired output. This training dataset includes inputs and correct outputs, which allow the model to learn over time. The algorithm measures its accuracy through the loss function, adjusting until the error has been sufficiently minimized.

**Classification:** Classification uses an algorithm to accurately assign test data into specific categories. It recognizes specific entities within the dataset and attempts to draw some conclusions on how those entities should be labeled or defined. Common classification algorithms are linear classifiers, support vector machines (SVM), decision trees, k-nearest neighbor, and random forest, which are described in more detail below.

**Supervised learning algorithms:** Various algorithms and computation techniques are used in supervised machine learning processes. Below are brief explanations of some of the most commonly used learning methods, typically calculated through use of programs like R or Python.

### 1. Neural networks

Primarily leveraged for deep learning algorithms, [neural networks](https://www.ibm.com/cloud/learn/neural-networks) process training data by mimicking the interconnectivity of the human brain through layers of nodes. Each node is made up of inputs, weights, a bias (or threshold), and an output. If that output value exceeds a given threshold, it “fires” or activates the node, passing data to the next layer in the network. Neural networks learn this mapping function through supervised learning, adjusting based on the loss function through the process of gradient descent. When the cost function is at or near zero, we can be confident in the model’s accuracy to yield the correct answer.

### 2. Naive Bayes

Naive Bayes is a classification approach that adopts the principle of class conditional independence from the Bayes Theorem. This means that the presence of one feature does not impact the presence of another in the probability of a given outcome, and each predictor has an equal effect on that result. There are three types of Naïve Bayes classifiers: Multinomial Naïve Bayes, Bernoulli Naïve Bayes, and Gaussian Naïve Bayes. This technique is primarily used in text classification, spam identification, and recommendation systems.

### 3. Linear regression

Linear regression is used to identify the relationship between a dependent variable and one or more independent variables and is typically leveraged to make predictions about future outcomes. When there is only one independent variable and one dependent variable, it is known as simple linear regression. As the number of independent variables increases, it is referred to as multiple linear regression. For each type of linear regression, it seeks to plot a line of best fit, which is calculated through the method of least squares. However, unlike other regression models, this line is straight when plotted on a graph.

### 4. Logistic regression

While linear regression is leveraged when dependent variables are continuous, logistic regression is selected when the dependent variable is categorical, meaning they have binary outputs, such as "true" and "false" or "yes" and "no." While both regression models seek to understand relationships between data inputs, logistic regression is mainly used to solve binary classification problems, such as spam identification.

### 5. Support vector machine (SVM)

A support vector machine is a popular supervised learning model developed by Vladimir Vapnik, used for both data classification and regression. That said, it is typically leveraged for classification problems, constructing a hyperplane where the distance between two classes of data points is at its maximum. This hyperplane is known as the decision boundary, separating the classes of data points (e.g., oranges vs. apples) on either side of the plane.

### 6. K-nearest neighbor

K-nearest neighbor, also known as the KNN algorithm, is a non-parametric algorithm that classifies data points based on their proximity and association to other available data. This algorithm assumes that similar data points can be found near each other. As a result, it seeks to calculate the distance between data points, usually through Euclidean distance, and then it assigns a category based on the most frequent category or average. Its ease of use and low calculation time make it a preferred algorithm by data scientists, but as the test dataset grows, the processing time lengthens, making it less appealing for classification tasks. KNN is typically used for recommendation engines and image recognition.

### 7. Random forest

Random forest is another flexible supervised machine learning algorithm used for both classification and regression purposes. The "forest" references a collection of uncorrelated decision trees, which are then merged together to reduce variance and create more accurate data predictions.

## 3.7 SUPPORT VECTOR MACHINE

## In machine learning, the task of deducing a category from supervised training data is known as Supervised Learning. In supervised learning the training data consist of a set of training examples, where each example is a pair consisting of an input and an anticipated output value. A supervised learning algorithm analyzes the training data and then predicts the correct output categorization for given data-set input. For e.g. Teachers teach students to identify apples and oranges by giving some features of that. Next time when a student sees apple or orange, he can easily classify the object based on his learning from his teacher, this is called supervised learning. He can identify the object only if it is apple or orange, but if the given object was grapes the student cannot identify it.

**ADVANTAGES AND DISADVANTAGES OF SUPPORT VECTOR MACHINE**

**ADVANTAGES:**

* There are many advantages of using the supervised learning approach of Support Vector Machine (SVM).
* They are very effective when we have very high dimensional spaces. Also, when the number of dimensions becomes greater than the existing number of samples, in such cases too SVM is found to be very effective.
* SVM uses a subset of training points also known as support vectors to classify different objects hence it is memory efficient.
* Support Vector Machines are versatile, for different decision functions we can define different kernels as long as they provide the correct result.
* Depending upon our requirement and application we can choose the types of kernel which is most productive for our application.

**DISADVANTAGES:**

* The disadvantage of SVM is that if the number of features is much greater than the number of samples, the method is likely to give poor performances.
* SVM gives efficient results for small training samples as compared to large ones.
* SVMs do not directly provide probability estimates, so these must be calculated using indirect techniques. Also, we can have Non-traditional data like strings and trees as input to SVM instead of featured vectors.
* Lastly selecting appropriate kernel for the project is a big issue which depends upon the user's requirement.

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**3.8 HAAR CASCADE CLASSIFIER**

In statistical model based training, we take multiple positive and negative samples and extract different features from these samples. These distinctive features are then compressed into statistical model parameters which are used as special property to classify different objects. By making adjustments in these parameters we can improve the accuracy of classification for these algorithms. The fundamental concept for detecting objects from images for Haar classifier is the Haar-like features. These features exploit the difference in contrast values between contiguously grouped pixels instead of using the intensity values of that particular pixel. These contrasting values between the grouped pixels are used to detect relative light and dark spots from the images. These two to three contiguous groups with comparatively contrasting values form a Haar-like feature. In images we have objects of different sizes, these Haar features can be scaled by increasing or decreasing the size of the grouped pixel being examined. This scaling of the pixels makes it possible to detect and extract objects with varying sizes.

**3.9 OPEN CV**

OpenCV acronym for Open Source Computer Vision Library is a library containing functions for computer vision. It is developed by Intel and now handled and supported by Willow Garage. The library is a functional cross platform and runs on Windows, Android, FreeBSD, Maemo, iOS, OpenBSD, Linux and Mac OS. The current release of the library is obtained from the Sourceforge and they also provide the binaries for the user, so that they can develop according to their requirements. OpenCV makes use of CMake to compile source files to start using the library [12]. The main focus of this library is on the real-time image processing functionality and implementing the machine learning algorithms. By using this we can improve the cost of computation and take an initiative to advance the CPU – intensive applications. The areas of application where openCV can be useful are facial recognition system, mobile robotics, gesture recognition, segmentation, object identification, motion tracking and many more. OpenCv also includes a statistical machine learning library that supports the above areas of application. The name of the functions that supports this library are decision tree learning, expectation maximization, gradient boosting trees, Naïve Bayes classifier, k- nearest neighbor, artificial neural network, support vector machine (SVM) and many more

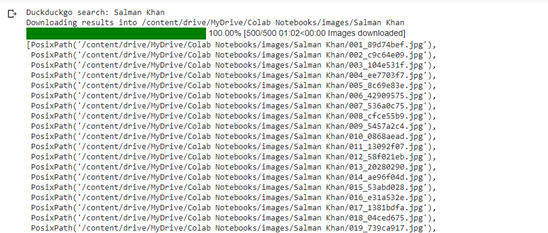
# Chapter 4 Implementation

**Tech Stack Used**

|  |  |
| --- | --- |
| **Front End** | **Backend** |
| HTML, CSS, Bootstrap, JavaScript | Python, OpenCV(Haarcascades), Flask |

**1.** **Collection of data**:

500 images of each celebrity were collected by web scraping and extracting data using python image scraper.



**2.** **Analyse the collected data**:

#### Once the data was collected, we needed to make sure it was in a usable format. The benefit of having this standard format was that we could mix and match algorithms and data sources. We needed to do some algorithm-specific formatting here. Some algorithms need features in a special format. When we look at any image, most of the time we identify a person using a face. An image might contain multiple faces, also the face can be obstructed and not clear. For optimal face detection, we needed the facial features of the input data to be clearly visible.

#### 3. Preparation of input data:

#### The first step in our preprocessing pipeline is to detect faces from an image and we have done that using Haarcascades(OpenCV). Once face is detected, we will detect eyes, if two eyes are detected then only, we keep that image otherwise discard it.

#### But it will even detect the faces which are with the desired person in the images. So we have to remove them manually from the pre-processed dataset.

#### In a wavelet transformed image, you can see edges clearly and that can give us clues on various facial features such as eyes, nose, lips etc.

#### 

#### *Detection of facial features Wavelet transformation*

#### Train the algorithm:

### Images in the cropped folder can be used for model training. We used these raw images along with wavelet transformed images to train our classifier. We used SVM with rbf kernel tuned with heuristic finetuning to train the data.

**Test the algorithm:**

#### After training the model we tested its precision and recall values.

#### 

#### Test for different algorithms:

#### We used GridSearchCV to test accuracy for different algorithms and to select the algorithm having the best accuracy and get the best set of values for the parameters.

#### Analyse the results:

#### We plotted the heat map of the confusion matrix using the seaborn library to analyse the trained model’s efficiency.

#### Saved the model:

#### We saved the model as pickle file and labels(dictionary) as json file which will be used in the backend functionality of this application by the flask server.

**Backend(flask server) :**

Flask is a micro web framework written in Python. It is classified as a microframework because it does not require particular tools or libraries.[2] It has no database abstraction layer, form validation, or any other components where pre-existing third-party libraries provide common functions. However, Flask supports extensions that can add application features as if they were implemented in Flask itself. Extensions exist for object-relational mappers, form validation, upload handling, various open authentication technologies and several common framework related tools.

After this the model was saved as a pickle file using joblib and class dictionary was saved as a json file which is used in flask server. Both the json and pickle files are kept in artifacts folder in server folder.After this the python flask server is built.

Flask is a very light micro web server. A new project named server is opened in pycharm. First we imported all the necessary libraries. Then in server.py file a flask instance is created. Then the main method of flask will run python flask server on a particular port.

After this we write a simple api call “hello” having the hello method, return some string to check whether our server is running or not. After confirming that screen is rendering the string returned we will create a new file called util.py. We want to modularize our code, so the server will have a method classify\_image having get and post methods in it. This method will do the image classification using the saved model in the artifacts directory.

After this we will add the main method in util.py to perform the test first. Here the UI sends the backend base 64 string of the image for prediction.

## 

## CODE:

#include <HX711.h> #define DOUT 3

#define CLK 2 HX711 scale; float weight;

float calibration\_factor =-650000; // for me this value works just perfect -650000 void setup()

{

Serial.begin(9600); scale.begin(DOUT,CLK);

Serial.println("HX711 calibration sketch"); Serial.println("Remove all weight from scale");

Serial.println("After readings begin, place known weight on scale"); Serial.println("Press + or a to increase calibration factor"); Serial.println("Press - or z to decrease calibration factor");

scale.set\_scale();

scale.tare(); //Reset the scale to 0

long zero\_factor = scale.read\_average(); //Get a baseline reading

Serial.print("Zero factor: "); //This can be used to remove the need to tare the scale. Useful in permanent scale projects.

Serial.println(zero\_factor);

}

void loop()

{

scale.set\_scale(calibration\_factor); //Adjust to this calibration factor Serial.print("Reading: ");

weight = scale.get\_units(5); int y = weight\*100;

if(y == 20 )

{

Serial.print(" right "); digitalWrite(5,LOW);

}

else

{

Serial.print(" wrong "); digitalWrite(5,HIGH);

}

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Serial.print("Kilogram:"); Serial.print( weight); Serial.print(" Kg");

Serial.print(" calibration\_factor: ");

Serial.print(calibration\_factor);

Serial.println(); if(Serial.available())

{

char temp = Serial.read(); if(temp == '+' || temp == 'a') calibration\_factor += 10;

else if(temp == '-' || temp == 'z') calibration\_factor -= 100;

}

}

## OBSEVATION:

**It was observed that for secured weight of 200GRAMS based on our observation:**

|  |  |  |
| --- | --- | --- |
| **SR NO.** | **WEIGHT** | **RESULT OBSERVED ON LED** |
| 1. | 200GRAMS | LED IS OFF |
| 2. | 210GRAMS | LED IS ON |
| 3. | 000GRAMS | LED IS ON |

LED OFF indicates that there is no change in the weight that to be secured and the weight is safe. LED ON indicates that there is some change in weight that to be secured and someone tries to touch or pick the weight and weight is unsafe.

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# Chapter 5 Conclusion



## CONCLUSION:

It was concluded that, as we put images of any one Bollywood celebrity amongst all. After clicking the classify button of the website we will be able to see the table which contains the highest percentage of that particular celebrity.

## RESULT:

We got 89% of accuracy of the classification with the highest Precision rate of 94% and Recall rate of 90% by using SVM with the best parameter determined by GridSearchCV and Flask as a backend server to connect algorithms to the front end of a website.

**Following is the link to the video of our project:** [**https://drive.google.com/open?id=1AKZ6G0Rf8KcBrAlaxV1uGm6BU4nGkPB7**](https://drive.google.com/open?id=1AKZ6G0Rf8KcBrAlaxV1uGm6BU4nGkPB7)

## FUTURE SCOPE:

* + - It is important in various biomedical applications, such as cancer detection, subtype identification, and protein localization for high content screening.
    - This can be used to boost augmented reality applications and gaming.
    - It can give empowerment to self-driving vehicles.
    - This can be used to create a city guide by using real time information from instagram photos that other tourists have posted.
    - Deep learning–based classification in histology can be used for intraoperative surgical guidance for computationally aided diagnosis in histopathology section.

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