GENDER AND AGE DETECTOR

**PROJECT REPORT**

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(Information Technology)

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# CERTIFICATE

Certified that Jalaj Tiwari, Anshika Arya, Devanshi Dev has carried out the project work presented in this report entitled “Gender and Age Detector “ for the award of Bachelor of Technology from Institute of Engineering and Technology, Dr. Ram Manohar Lohia Avadh University, Ayodhya under my/our supervision. The thesis embodies results of original work and studies carried out by Student himself and the contents of the thesis do not form the basis for the award of any other degree to the candidate or to anybody else.

Signature of Supervisor

Er.R.K. Singh Department of Information Technology

Signature of Head of Department

Er.R.K. Singh Department of Information Technology

Date:

Place:

# CANDIDATE’S DECLARATION

I declare that this written submission represents my work and ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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**APPROVAL SHEET**

The Project report entitled Gender and Age Detector by Jalaj Tiwari, Anshika Arya, Devanshi Dev is approved for the degree of Bachelor of Technology.

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# ABSTRACT

The recent time has created growing demands in the field of AI, ML and their various application areas and one of such areas that is trending today is the face recognition as it has attracted lots and lots of attention in the recent years. Using face has an advantage and the advantage is that it has an upper hand due to its identity in case of other alternate methods available, like take the case of fingerprint identification, this basically relies on the fact that it’s quite easy to use and this is the reason why this is so well accepted by the people across the world as it does not involve any interaction at a physical level of the user and with the system and this yields a better result. The target of the project is to try to recognize the gender of an individual by taking a look at his/her photo. This is an instance of supervised machine learning where the training of the algorithm is firstly done on the dataset which consists of male and female faces, and this system is then used to classify new data accordingly.

The point to be noted here is that no other genders other than Male and Female were taken into the consideration. Before starting with the process, a preliminary algorithm is executed so as to make sure that the image provided as an input is that of a human and only afterwards the classification begins. While the attempt is made at identifying gender from facial features, curiosity about identifying what features of the face are required or important so as to determine the gender. Now the question arises if the localized features such as ears, nose and eyes are more important when compared with overall features that include face contour, hairline and head shape.

In this project we show how easy it is to detect faces and identify gender along with gender with the help of CNN (Convolution Neural Networks) and OpenCV. Using these fields of Artificial Intelligence, we can reduce the use of hardware components and complexities in this project. Along with CNN and OpenCV we use Audience dataset so that the output is achieved with accurate values in training and validation. For the output to be determined even with multiple parameters we use a pretrained model that is a caffe model along with OpenCV.

**ACKNOWLEDGEMENT**

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# LIST OF ABBREVIATIONS

|  |  |
| --- | --- |
| **ML** | Machine Learning |
| **PCA** | Principal Component Analysis |
| **KNN** | K-Nearest Neighbour |
| **IP** | Image Processing |
| **AI** | Artificial Intelligence |
| **FB** | Facebook |
| **SVD** | Singular Value Decomposition |
| **APK** | Application |
| **DNN** | Deep Neural Network |
| **CNN** | Convolutional Neural Network |

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# CHAPTER-1 INTRODUCTION

* 1. **Background and Motivation Background:**

The rapid development of artificial intelligence (AI) and machine learning (ML) has significantly impacted various fields, including computer vision. One of the crucial applications of computer vision is the detection of human attributes, such as gender and age, from images. These attributes are fundamental for a wide range of applications, from security and surveillance systems to personalized user experiences and targeted advertising.

**Gender detection** involves classifying an individual as male or female based on their facial features. **Age estimation**, on the other hand, aims to predict the approximate age of an individual from their facial appearance. Both tasks are challenging due to the variations in facial features caused by factors such as lighting conditions, occlusions, facial expressions, and aging processes.

# Motivation:

The motivation for developing a gender and age detection system using machine learning stems from the following reasons:

# Enhanced User Experience:

* + - * Personalized services and products can be provided to users based on their gender and age. For instance, age-appropriate content and advertisements can be displayed to users on online platforms, enhancing user satisfaction and engagement.

# Security and Surveillance:

* + - * Gender and age detection systems can be integrated into security and surveillance systems to identify individuals, monitor suspicious activities, and ensure safety in public and private spaces.

# Market Research and Analytics:

* + - * Businesses can leverage gender and age detection systems to gain insights into their customer demographics. This data can inform marketing strategies, product development, and customer service improvements.

# Medical and Healthcare Applications:

* + - * In healthcare, age estimation can be used in diagnostics and treatment planning. For example, age-related diseases can be monitored, and appropriate medical interventions can be provided based on the patient's estimated age.

# Technological Advancement:

* + - * The development of accurate and efficient gender and age detection systems pushes the boundaries of machine learning and computer vision technologies. It contributes to the ongoing research and development in these fields.

# Social and Ethical Implications:

* + - * While there are significant benefits to these technologies, it is also crucial to address the ethical implications, such as privacy concerns and potential biases in the algorithms. This project aims to create a balanced approach that maximizes benefits while minimizing ethical risks.

In conclusion, the development of a gender and age detection system using machine learning is driven by its potential to improve user experiences, enhance security, provide valuable market insights, contribute to healthcare advancements, and promote technological progress. This project aims to build a robust and accurate system that addresses these motivations while considering ethical implications.

The recent trend of technology has been mostly centered on Artificial Intelligence and Machine learning along with Big Data Analytics. More and more researchers have taken up these fields and started carrying out research in them. More and more start-ups can be seen working on products based on these technologies.

The facial detection using various techniques constitutes a major part of the technologies such as Machine Learning, Image Processing, and Deep Learning. Analyzing various facial features with the help of Image detection using various machine learning algorithms and implementing neural networks for real time detection is one major element of the project.

# MACHINE LEARNING

ML or the machine learning is a subset or one of the applications of Artificial Intelligence i.e. AI which keeps learning from the past and new test datasets and tries to improve the performance and accuracy every time based on datasets provided.

# WHAT IS “MACHINE LEARNING”?

ML in other words focuses on such a development which involves "kinds computer programs” which means data is provided and accessed and from the data the model tries to learn themselves.

The learning phase usually has to begin with the jobs from the datasets, which include such, any experience previously, or such an instruction that looks for some kind of patterns in data and decisions that need to be made better in the future whose basis remains the examples that are provided by the user.

The primary aim remains usually to allow whichever and whatever computers can learn automatically i.e. without any kind of human intervention or assistance and the actions need to be adjusted accordingly.

# Applications of Machine Learning

AI or Artificial Intelligence is all over the place. Plausibility is that you are utilizing it in one or other manner and you don’t realize until told like the recommender various e-commerce websites which tracks you web surfing data on their platform.

The well-known utilizations in the field of AI is ML i.e. Machine Learning, in which various softwares, and gadgets can be seen performing by a means of perception (fundamentally which is just the same as human cerebrum).

Below listed are some of the applications in the field of ML:

# Personal Assistants (Virtual)

Siri, Cortona, Alexa or Bixby, the latest devices in home automation are just a few names or examples in case of a few of the famous instances. As per the name that it suggests, also these devices help with reading data, when asked using a voice assistant.

ML is just another important part of personal assistants because they are supposed to be collecting and refining whatever the information, basis of which includes previous involvement with the user. The dataset is utilized so as to render results that can be tailored as per your preferences.



# Fig1.1: Home Assistants

* + - * **Videos Surveillance**

An individual who is monitoring several video cams at one time! The difficult job would be to do once at a time and to be honest that can be at times boring as well. Instead of using several humans it’s better to train a computer to do the same task based on some ML algorithm.

The modern video surveillance systems come nowadays equipped with the latest developments from the field of AI which makes at several times things helping in detecting crime even before it happens. Usually these AI monitored cameras track any unusual or suspectful behavior an example of which includes a person who for a long time stands motionless, lying or falling asleep and not moving etc.

The various security systems installed, gives an alert to the security in charge, and this can help to avoid some mishappening. And incidents or such activities that are True Positive i.e. reported and on taking action found to be correctly true, constantly improve the surveillance and security services. ML works at the backend and does the entire job by improving constantly.



# Fig 1.2: Surveillance

* **Social Media Services**

Getting personalized updates about your news feed and ads targeting as per search history, social media platforms at the backend use machine learning for personalizing user benefits.

Here are a handful of examples that a user must be noticing, seeing, using and developing an interest in your social media accounts, without even realizing that these amazing features are just another application of ML.

* “People You May Know”:

The basic working of ML is understanding and then analyzing to learn every time. FB endlessly monitors your feed of friends that a FB user wishes to connect or recently connected with, the profiles visited by you, as per your interests, could be your fellow employee, or from a group that you may share with nobody and so on. The basis of unceasing learning, data containing lists of people on FB that can be recommended to help a user become new FB buddies.

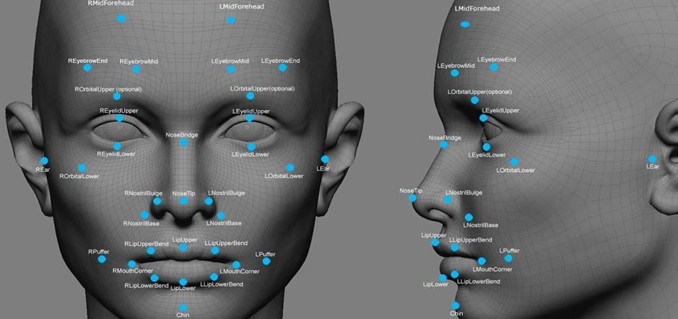


# Fig 1.3 Social Media

* **Face Recognition:**

When a user uploads any picture could be of the user or with a friend and FB with help of Ml and Face Recognition instantly recognizes the friend you uploaded your picture with. FB checks the posts and your poses along with prognostications in image, the features that are exclusive are considered.

It accordingly matches with similar FB users or people you should have in the friend suggestions list. At frontend the working looks easier but the entire process when looked from the backend is very complicated and the precision factor needs to be taken care of.



# Fig 1.4: Face Recognition

* **Similar Pins:**

ML forms the core element of Computer Vision and a technique that extracts very useful information from a user's profile that could be from images or videos. The platform Pinterest can be seen using this application of ML to identify various objects & recommends the user similar pins accordingly.



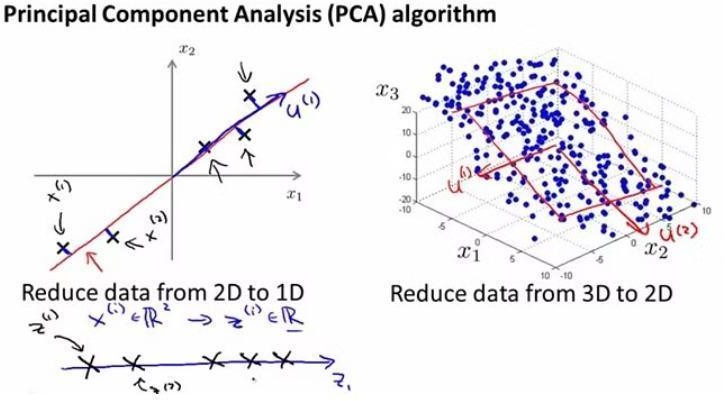
# Fig 1.5 Pinterest

# Machine Learning in facial recognition

ML when it comes to recognition of face uses a technique that can be used to recognize and detect human faces of any and every individual whose pictures or images are stored in the dataset. Besides this there are other methods for identifying which may be more accurate, this technique remains a very significant and important point of focus for research as its non-meddling nature also, it can be a method to identify a person i.e. can be used as a people facile method for personal identification. Few methods include:

# Geometric Based / Template Based: -

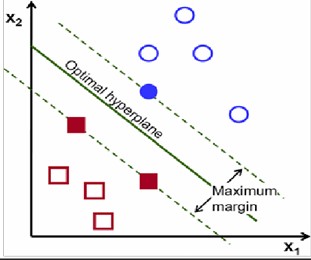
Algorithms that do face recognition are sometimes known geometry or template based algorithms. The first method makes use of tools that are statistical in nature also known as template-based methods which may Support Vector Machines or SVM, Principal Component Analysis or PCA, Linear Discriminate Analysis or LDA, Kernel. The geometric methods which are based on features are the second method; they usually examine indigenous facial features and their relationship geometrically. The other name for this method is feature-based method. Principal Component Analysis: PCA is commonly used and one of the cited methods is Principal Component Analysis for statistical tools. Procedure mathematical in nature that accomplishes dimensionality reduction with help of extraction of the principal component that is based on this multidimensional data.



# Fig 1.6: PCA

* **Support Vector Machine [SVM]:-**

Supervised ML algorithm includes SVM that is usually used for classifying and also at times for regression challenges. But usually can be noticed in case of classification problems. There is a set consists of training examples, marked that belongs to one or the other of the mentioned two categories, the SVM training algorithm builds such a model that is used to assign new cases to any category, which makes it a binary linear classifier.



# Fig 1.7: SVM

* **Holistic: -**

The relative features of the face or their linkup to function with the human face completely has not endured to the extent, researchers have followed various kinds of approaches, trying to find out what the most significant characteristics are. Different approaches use different facial features. Methods such as Hidden Markov Model fall into the same category, and processing of features in face recognition is well known.

# Appearance or Model being Basis:-

This method depicts the appearance of the human face by means of facial features in regards to more than a few images. A high dimensional vector is considered to be a good image. The technique is based so as to derive the required facial feature from the image at the backend. The training set is cross examined with the help of a random sample image. The appearance-based method is used for classifying a face as linear or nonlinear. The example of this method includes- PCA, LDA etc used as a direct approach else Kernel PCA may be used as a nonlinear approach. In another case this model-based method may be classified: nD where n=2 or 3.

Like: Elastic Bunch Graph Matching possibly. Here in our project the methods that we have used include **SVM** and **PCA**.

# CHAPTER – 2 LITERATURE SURVEY

Literature Survey or Literature Review as the name suggests the Chapter is based on analyzing and engaging in thorough study of different sets of theoretical works that have been published before and are available for the reference purpose beforehand.

The literature survey is much needed because what it basically does is that it compares different sets of pieces or the theories that have been published worldwide or have been established, these theories can vary from different topics to just one particular topic, and that topic is usually from a very specific area of research that could have been possible lasted from years to months period, and during these researches the different kinds of experiments that are performed or are being carried out or conducted so as to establish something different than that has already been achieved and published till date.

And with the help of this, any person who wants to proceed in the research field and work will look up for the available resources and try to understand them. Now, the benefits that are associated are that it can provide you a particular direction you need to look at and also help you with shortcomings of various methods which have been provided and used by all sorts of researchers or people from certain parts of study.

# 2.1 RELATED WORK

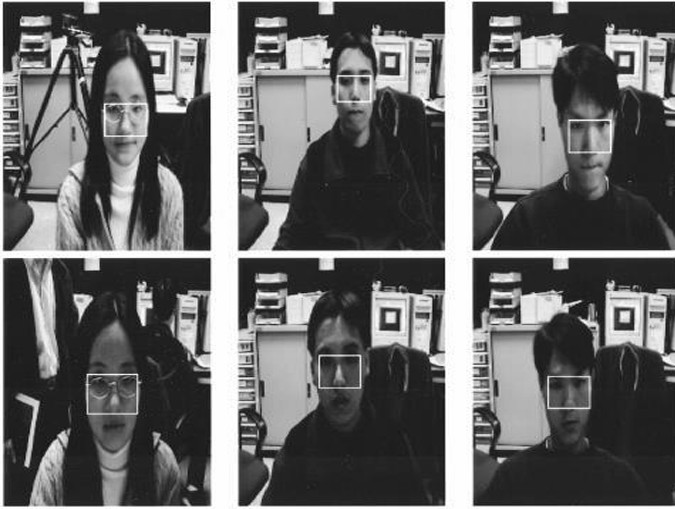
Xue Li one of the researcher in a paper proposed such a method which aimed to highlight and provide an outcome to the issues or the difficulties that they faced during the research which was that it could be faced during trying to get or detect an individual eyes and to overcome this the method that was proposed used non- intrusive approach.

Gray-scale transformation was a type of pre-processing that was done initially. The method that was applied was- Adaptive boosting algorithm and this algorithm is ordinarily used to eradicate whatever features irrelevant could have been detected while trying to detect the face and they may not be that important, next step was using the different connected components method and eyes were located with the best accuracy using this specific method and the status of eyes could be examined with its help.

The following stages depict what different stages were proposed:

1. Input Image
2. The Recognition and Detection of Face
   * Adaptive boosting Algorithm
   * Detecting human face
3. Detection of eyes along with their position

The human face was subjected to different testing conditions which were subjected to varying conditions. The images that have been shown below depict the conditions, the thing that needs to be noticed here is that the result remained consistent even under different conditions.



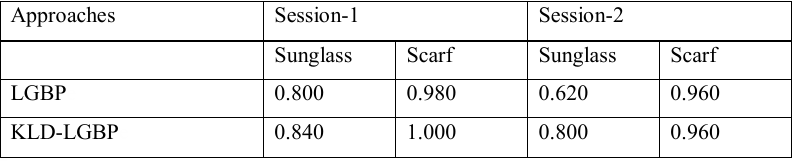
# Fig 2.1 : Detect faces under different conditions

The method that was talked about earlier consisted of the training set that used a sample database and that database consisted of 500 images to count. The accuracy is a game changer in selecting a method and this method accuracy involved detecting eyes and locating its position came out to be nearby 98% and nearby 94% respectively.

One of the conclusions that could be made from the initial experimental results that was conducted on this training set provided that the method or approach was displaying good robustness and improvement in accuracy could be noticed.

Wenchao Zhang suggested an algorithm as a permutation of two operators defined by LBP and the second one is the Gabor Wavelets. Initial or the works that were done at a very earlier stage on face recognition would usually be based on the method that applied fisher-faces along with Eigen-faces. Making use of facial features meant that it was being referred to as a use of facial points that were being treated as features, indicators or descriptors which varied for different humans and their facial expressions. Generally those methods that are Feature based are seen showing properties between facial features and these features include jaw line, chin, eyes, mouth, nose etc. Plenty algorithms are present but then to perform the technique of recognition of human face not many algorithms have a great accuracy and thus making it not acceptable enough and this is because due to the factor that causes variations due to a person’s process of aging along with several additional factors in these images of humans and instead of class variations that can occur due to likeness between individuals and instead these inconsistencies can range from being limited to overall and this refers to wrinkles looking noticeable on a person face a someplace like cheek or around mouth

# Table 2.1: LGBP and KLD – LGBP recognition rate



The above table clearly depicts that the recognition rates in case of KLD LGBP prove to be more accurate when compared with LGBP.

At the early stages while performing face recognition the techniques would generally focus only on frontal view of human faces (images) and also be able to detect a single face instead of multiple faces. Nonetheless, how to identify a face in a different view i.e. view other than person frontal view still poses a challenging factor. With the help of traditional methods, to some extent good results in the view of images that show the front side of the human face or images consisting of a single view could be observed.

Procedure that utilized the concept of PCA, the full form of which is Principal Component Analysis and this algorithm will eliminate those features that are not helpful or relevant when it comes to the recognition of faces. The algorithm proposed above was designed so that one could

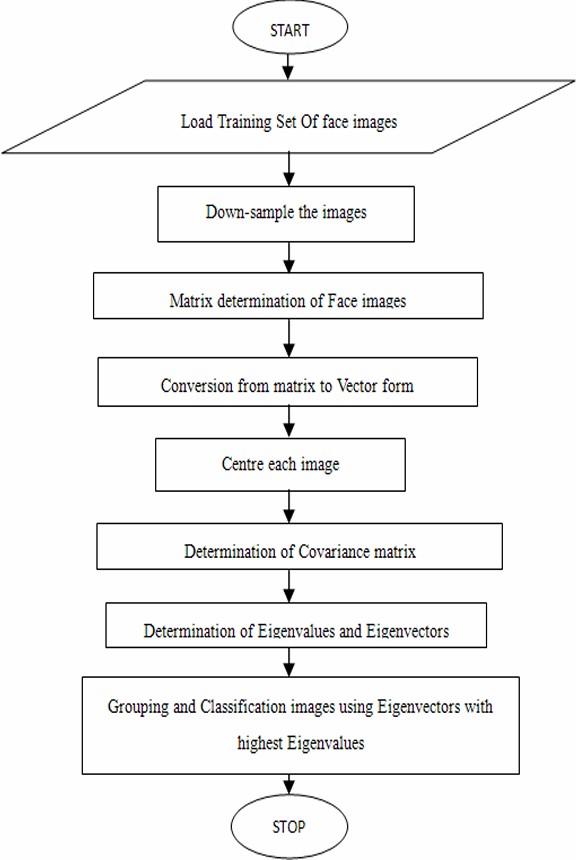
identify the same face and that too from different kinds of views. To understand this the model of Eigen Vectors & Eigen values required to be presented so that one could understand or identify the variation in these images because every single Eigenvector has an associated Eigenvalues with it and the Eigenvector that can be seen having a greater Eigenvalues depicts that it can provide you with additional statistics when considering these images variation when equated with those Eigen vectors which have a relatively lower Eigenvalues.

# AX = λX

In the above equation, A- Vector Function

B- Lambda- Eigenvalue and

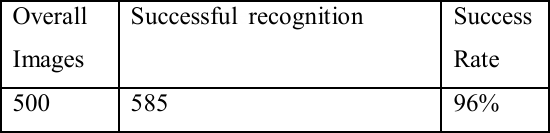
C- X- Eigenvector.



**Fig 2.2 : Flow chart of Eigen Face**

The testing dataset that was used consisted of 500 images of different humans or individuals and these images were used to check how the algorithm worked and the system designed identified almost 485 humans or faces and these identified images are equivalent to an accuracy of 95 % which at initial stages is very good but however this designed system failed when dealing with an occluded face or an image that was unclear.

# Table 2.2: Recognition of Faces Using Eigenfaces Algorithm



The research paper that has been taken up as a reference the model that was suggested in the past making use of face recognition with the help of Eigenfaces. The job of reducing any un- relevant or features that can be avoided as they are not important posed a major problem during face recognition. The PCA was used while performing the face recognition and this was achieved with the help of Eigen Faces which basically aimed at eliminating or removing any or all of those features that were not necessary and made them unwanted and as a result the image that was obtained after applying the above process of elimination of such unwanted features resulted in Eigen faces which had a associated Eigen-vector and this Eigenvector had its corresponding Eigenvalues. As discussed earlier, the Eigenvector that has a maximum Eigenvalue would give more accurate and best information about the variation that was seen in these images. Even there were such cases when PCA that was being used to overcome the features problem failed to yield desirable or expected results and this led to a new theory being proposed and put forward. The theory that was proposed made use of LDA alongside PCA.

The proposed algorithm i.e. LDA can be used to find out the subspace in the set of images that has been provided by the dataset, the vectors that resulted which were used to define that particular space were called Fisher faces. In case of face recognition making the use of fisher faces, the steps that need to be followed include:

* **Design System**- The system so designed, usually intended or recruited in such a way that it studies the images by cross-examining those images that were gathered as for the results and obtained after using the removal feature in as of these images.

# IP or Image Processing Process

The processes included in IP –

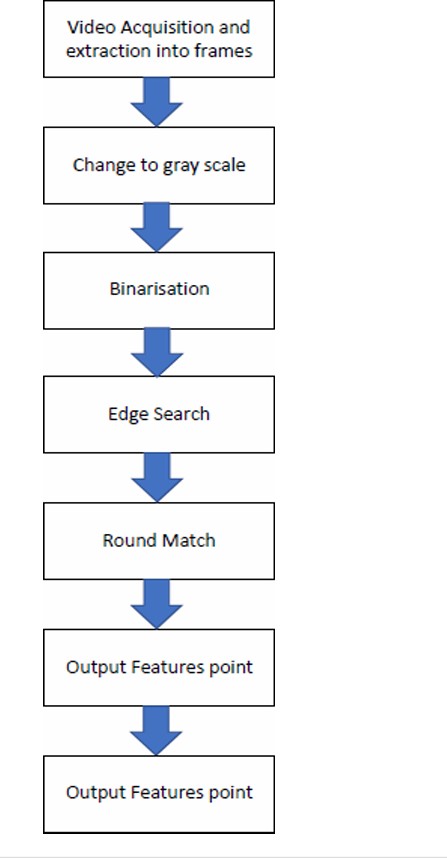
1. Process to retrieve the data
2. Process to image processing
3. Process to generate feature

Recognizing a face which is done with help of this system that made use of this algorithm which was able to distinguish the human faces from the pictures with an accuracy of around 93% from which it can be inferred that for every 100 images 93 images were recognized accurately and the plus point about using such a system design is that it is also immune to blurred or buzz or even the clamored images but still one difficulty with the following algorithm could be noticed as a problem whenever there was a case of partial occlusion raised. Apart from this, when a particular individual clicked images in poses which were not similar a problem would arise.

Chen Dong to detect the users face planned or proposed such a color model and radial utility networks and used them to study and validate the each and every human individuals face while doing detection of face, dafter this in case of proposed work he made use of projection which was integral and Hough round Transform and this was aimed to detect the eyes of an individual. The method comes with principally two positives or profits, the main being making the use of important projection function and to achieve it we can use boorish and rude positioning when it comes to the eyes of humans or an individual and then integrating it with Hough round Transform which aims at determining the location of a person’s eyes with the best correctness.

When using this technique, another benefit that results in defining the eyes precisely because the human eye when observed is done complete as a pair, and this is done because it may detect eye of the human in the least possible time and thereby this results in improving the accuracy as the chances of wrong outputs being detected are highly reduced. Making use of this algorithm comes associated with that is that it works really well and up to the mark during recognition of the face done in case of the frontal faces but this algorithm is accurate enough when it comes to the images being occluded.

After giving the research paper a thorough read the conclusion that we made and came across was that the algorithm that was being used in the implementation has been depicted by the help of the flowchart that has been provided below:



**Fig 2.3: Eigen Face flowchart**

The conclusion included these methods basically two leads or benefits and they are important for improvement scope and accuracy.

To recap this, the first included making the use of an integral projection function that aimed at achieving boorish or rude positioning when it came to the human eyes and following this its integration with Hough round Transform so as to find out with exact accuracy where the eyes were located in an individual.

The video that is made and captured is pre-processed. After the pre-processing has been done, the face area needs to be detected in the next step achieved with the help of the neural network.

After the face has been identified, further the Important projection technique can be applied which helps to find the exact or the accurate eyes location of the individual which can be noticed in the image below.

Finally at the last, the Hough transform technique is applied with the aim to spot what is the state of the eyes.



# Fig 2.4: Detection of eye states

Talking about the results, they were good enough when obtained while testing images which were still, when it came to people with spectacles or glasses even then and positioning speed was really fast as the time taken was mere milliseconds.

# CHAPTER – 3 PROPOSED METHODOLOGY

This chapter discusses the means that one needs to make use while developing the framework. Following experiencing distinctive research or study papers planned to go for a non intrusive way for developing my framework. We all are familiar and know there are loads and loads of different face detection and acknowledgment strategies that are accessible but you should go for the information centered measures for designing our structure and such a strategy is needed because this way is progressively compact and appropriate under numerous environments.

A system dependent on following two stages is designed:

1. Face Detection
2. Face Recognition

A way of distinguishing faces from a list of appearances and non-faces or other items is known as face detection. The innovation of face detection has been utilized in different parts and mixture of practices that spotted a human face in computerized images/pictures. While developing the face detection structure, remove the noteworthy highlights from the face of humans and collect values in Python’s NumPy array. To extract features from the human face different kinds of techniques are available and have been listed below.

# FEATURE EXTRACTION TECHNIQUES

While extraction of feature from face the procedure to be applied, the camera at first must detect the human face and from that a image then only the face is trimmed from the captured image frame or from the current frame displaying so that the handling of the background got reduced and we got the effective and efficient and better results. used At present the feature extraction of an image from face, there exists limited strategies that may be used namely skin shading technique, template matching technique, feature based technique, and knowledge based technique and so forth.

In case of the Skin shading detection strategy, one of the most used tactics as this strategy exhibits to be firm in the detection to be made for the human face. This specific technique makes each pixel that are present in skin shading have been identified and subsequently exploiting data that fits out to be peaceful simply finding the shards of the image outline in which around a face or people may be present explicitly.

In the Feature based skill in reality identifies human face dependent as per the acknowledgment of highlights which might be merely human alike such as eyes, nose ,lips mouth and after that model

is prepared inter support of such highlights, the nearness of face is followed which forms the framework which distinguishes whether face is human and available or not.

The Knowledge based techniques are principally the customary based approaches or strategies. The data provided that pre-exists in the database, the criteria is being derived and subsequently the finding the human face is prepared. At this point the countless features are observed basis being their positions relative to each other.

In any case, this procedure is admired but this is not so simple as it may look as countless conditions in case of the face might make problem to get the rigorous conclusions that is there may possibly be such an instance where eyes for specific face might be closed or shut, unambiguous human is wearing dark glasses could be possibility, in such scenarios it might resulting giving wrong conclusions.

The Template matching technique needs the measurements for the face viable in numerous stances and subsequently contrasting them with the forthcoming info pictures. Any place a match is made, derivations are drawn. In any case, this technique likewise will in general be somewhat difficult as the image for contrasting needs to be stored and afterward utilized that data whenever needed.

We picked a Knowledge based technique for extracting features of a face since it is regarded as the most reasonable and dependable technique in face detection.

* 1. **ALGORITHM FOR FACE DETECTION: EIGEN FACE**

The term given to the set of eigenvectors when they are developed in the computer vision matter of human face acknowledgement is known as Eigen faces. A procedure of developing Eigenfaces for recognizing the human face has been formed by Sirovich and Kirbye (1987) and exploited by Matthew Turk along with Alex Pentland in detecting or classifying the face.

The Eigenvectors are derived mathematically from the covariance matrix of the probabilistic distribution over the high dimensional vector space of face images.

The Eigenfaces themselves form a stricture set of all pictures that have been used to develop the covariance matrix.

The previous steps result in dimensionality reduction by clearing the tinier set of root pictures to symbolize the taught data set of the facial images.

# Feature Extraction

To extract the features from the procedures to be applied, the human face needs to be detected at first and can be detected viz. the camera or from an input image then only the face is trimmed from the apprehended image setting or from the existing setting exhibiting so that the processing of the background got reduced and we got the efficient and better results.

Eigenfaces algorithm is robust in detection of faces. Basically the Eigenface algorithm works on the Eigenvectors to detect the face. Next phase to make set of Eigen faces, follow the procedure listed below:

* + - 1. Facial images of human dataset need to be made by collecting the desired images. Desired conditions include enough lighting or bright conditions, and needs to be normalized so as to have the eyes and mouths in tune with images in the dataset. Resampling the image for the pixel resolution such as: (r × c). A single vector is for every image.

All the images in the training dataset have been stored in a binary matrix T, so each column in this matrix represents an image. The mean needs to be subtracted. Find the average of the picture and later on this needs to be subtracted from each and every original image in T matrix, so as each column in this matrix represents an image.

* + - 1. The mean needs to be subtracted. Find the average of the picture and later on this needs to be subtracted from each and every original image in the T matrix.
      2. Let S be a covariance matrix and the eigenvectors and Eigenvalues are calculated the same. Each Eigenvector consists of alike dimensionality i.e. the segments count as the pictures in actual, also along these lines anyone could themselves be able to see the image as a picture. The Eigenvectors for this particular covariance lattice are represented along these lines termed as Eigen faces.
      3. The principal components are next taken into consideration. In case of the descending order Eigenvalues need to be sorted and eigenvectors need to be arranged accordingly.
      4. The quantity of head parts k is resolved discretionarily by setting a limit ε on the total variance.

Total variance v = ( λ1+ λ2+…+ λn), n represents elements count.

* + - 1. Smallest number k that satisfies the equation ((λ1+ λ2+…+ λk)/v) > € .

The Eigenfaces now calculated can be used to represent mutually present and fresh facial images: new input can be taken which are mean-subtracted images. In this particular

manner we can record how when a new face is different from the mean face that has been already calculated. The Eigenvalues that are linked with every single Eigenface depict how pictures present in the training dataset vary when compared with mean pictures along that path. When eigenvector subsets are projected for a picture the data tends to be lost but these losses can be limited by keeping those Eigen faces who have the biggest Eigenvalues. Consider a case where a 1000 × 1000 picture will create 1000000 eigenvectors. Applications which are pragmatic in nature, can commonly distinguish these faces as they make use of an estimate somewhere around the range of 100 toe150 Eigenfaces, to achieve the goal where 1000000 eigenvectors may be discarded.

# Computation of Eigenvectors

PCA is performed rightfully on the covariance matrix created for use of pictures that can be computationally infeasible. Events where little pictures are being utilized, say 100e×e100 pixels, a point is created over 10000 D space for each image and the covariance matrix S which is the framework of 10000×10000e= 108 components. The position of the 36 covariance matrix has been constrained by the magnitude of training simulations: Suppose N training models are present, N 1 will be the number of eigenvectors that have at most with Eigenvalues as non-zero. But to the contrary, chances for the size of these training models seem to be smaller when compared with pictures dimensionality, however the principle components can still be disclosed wholly extra efficiently as shadows.

The pre-processed matrix for respective training models is assumed as T, such that each and every segment comprises 1 mean subtracted picture.

S = TTT represents the calculation for covariance matrix

Svi = TTT Vi = λi vi represents eigenvectors disintegration of S Though TTT is a very massive matrix, and instead we consider, TTTT ui =λi ui which is the Eigen value deterioration

When pre-multiplying is done on both sides of the equation with T, the result is: TTTT ui = λiTui

Inferring that, when ui is an Eigenvector for TTT, at that very point vi = Tui forms eigenvector for S. Consider a training dataset of 400 pictures that consist of 100e×d100 pixels, the matrix TTT is a 400 × 400 matrix, more reliable and easier to manage significantly than the 10,000 × 10,000 covariance matrix.

Notice anyhow the following vectors aren't normalized , if you wish to do normalization then it needs to be done as an additional progression.

# Connection with SVD

Let X be a matrix of d\*n dimensions with column xi as an image vector with mean subtracted. Then,

Covariance(X) = (XXT)/n

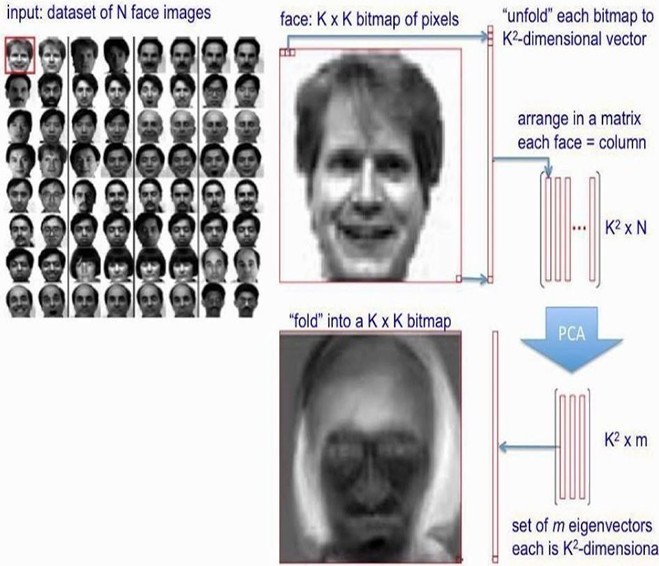
Let SVD of X be:

X = UΣVT

Then the decomposed Eigen values of XXT is:

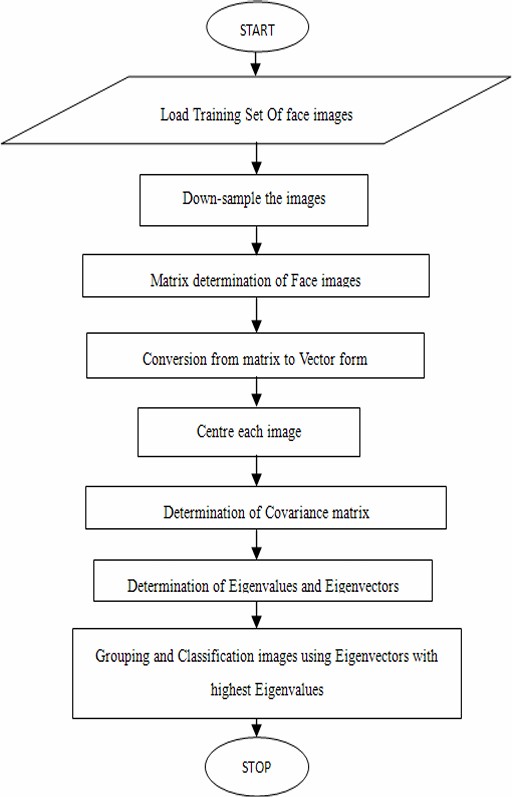
XXT = UΣΣTUT = UΛUT , here = Eigenvalues of XXT Thus,

The Eigenfaces = initial k(k<=n) columns of U related with non-zero singular values. XX = 1/n is the ith Eigenvalue. Using SVD on information matrix X, worthless to compute the real covariance matrix to get Eigenfaces.



# Fig 3.1: Eigen Faces

The whole procedure which we pursued while utilizing a Eigen faces has been discussed above and the procedures have been appeared in the flowchart underneath i.e. fig 3.2



# Fig 3.2: Flowchart of Eigenface Algorithm

# SYSTEM FOR FACE RECOGNITION

Gender plays a significant role in somebody's distinguishing proof. Programmed gender classification has gotten significant to an expanding measure of utilizations, especially since the ascent of social platforms and social media. Concealing genuine estimations of these factors can cause security issues for the most part. Now by using face recognition techniques it is easy to classify the gender over any platform.

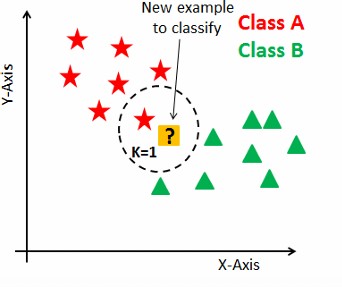
Different algorithms for developing the system were used for the same reason and later a comparison of those algorithms that make recognition of gender with input images and real-time.

# Algorithms Used

**1. KNN Algorithm**

K-Nearest Neighbor (KNN) is an algorithm in machine learning which fundamentally makes calculations based on former data issues or accessible. In this algorithm the framework is trained by giving images of various people and afterward the fresh picture is predicted by the framework basis being the past data.

In KNN, K is the number of closest neighbors. Number of neighbors in KNN is the central deciding factor. K is commonly an odd number if the number of classes is 2. Assuming point P1, for which name needs to predict. To start with, you locate the one nearest point to P1 and afterward the name of the closest direct doled out toward P1.

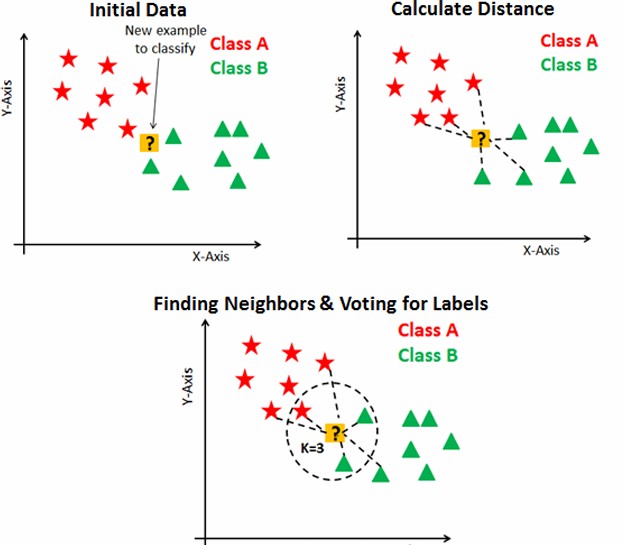


# Fig 3.3: Classification of new input

Assume point P1 and we need to predict under which label it lies. To start with, you discover the k nearest point to P1 and afterward classify the points by a large number of votes of its neighbor’s . Each element votes in favor of their group/class and the group/class with the most votes is selected as a prediction.

For finding the nearest similar point, you discover the separation between points utilizing separation estimates, for example, Euclidean separation Hamming , Manhattan separation and Minkowski separation. KNN has the accompanying essential steps:

1. Calculate separation
2. Find nearest neighbors
3. Vote for labels



# Fig 3.4: KNN algorithm

1. **Logistic Regression Algorithm**

Logistic regression is a very frequently used machine learning algorithm and is a beneficial regression technique for solving the problems which have been classified as binary. For several classification problems Logistic regression algorithm is used such as spam detection, Gender prediction, Diabetes prediction, etc.

L.R., a factual procedure designed for predicting two classes. The target or result variable environment is dichotomous. The term “Dichotomous” means there are just 2 possible classes. Likewise, as in a gender classification project which is aimed at predicting whether the image of human given as input is male or female.

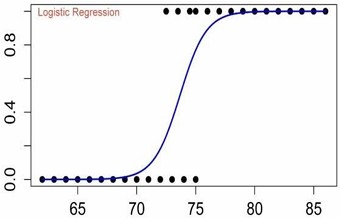
Linear Regression Equation:

Y = β0+ β1X1+ β2X2+….+ βnXn

Where, X1, X2 ... and Xn represent explanatory variables and Y is a dependent variable.

Sigmoid Function:

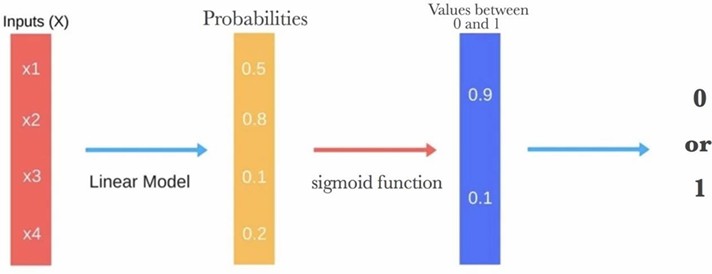
p = 1/(1+e-y)



# Fig 3.5: Sigmoid Function

Applying Sigmoid function on linear regression:

p = 1/(1+e-( β+ β X + β X +….+ β X ))



# Fig 3.6: Logistic Regression Algorithm

1. **Convolutional Neural Networks (CNN)**

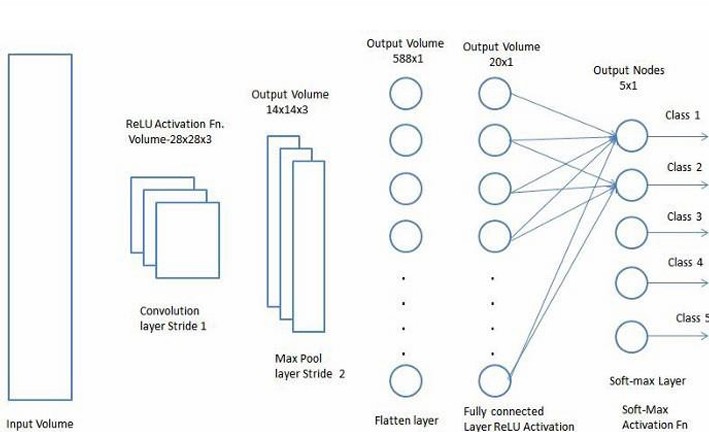
For the real time human gender detection or recognition earlier we used OpenCVs fisher faces Eigen-vectors implementation. The following approach in line was a method that two researchers from Israel introduced, Gil Levi and Tal Hassner back in 2015.

For reference the CNN models trained respectively by them have been tried to implement in this project. Python (PIP) has an in-built library OpenCV’s which consists of a package named dnn i.e. “Deep Neural Network” .

The following DNN package used from OpenCV consists of a class known as Net which is basically used so as to populate a neural network.

The project has used some in-built libraries and packages that support neural network models from deep learning frameworks which are well known- caffe, tensor flow and HaarCascades.

The researchers previously mentioned published their work on CNN models as caffe models.



# Fig 3.7: CNN Architecture

1. **Python in-built Libraries used:**

Several in-built python libraries were used while implementing the project namely- pip, matplotlib, keras, tensorflow, pandas, pillow etc.

# Test Plan

The particular section exhibits the carrying out subtleties for the framework that has been proposed and made so as to classify the gender. While executing our framework, the software adaptations, bundles and so on have been described in detail below:

# Requirements:

**Platform(OS):**

MacOs 10 or above WindowsOS 7/8/10 or above

# Software Used:

VS Code/ Command Prompt/ Python IDLE 3.0+/ Pycharm

# Version:

2024.1 or above

# Minimum Graphic Requirements:

1. 2 MP Camera
2. Graphics Card- Intel /NVIDIA / AMD

# Implementation Details:

The process of implementing is done over 5 phases:

# IMAGE as INPUT:

The first phase is where we provide different images to the system in numerous alignments with different brightness i.e. lightning conditions and make use of these input images as a training dataset for the system hence the structure is able to make a difference if the being in the image is manly or womanly.

# FEATURE DETECTION:

In this stage i.e. second stage we use the Eigenface algorithm to detect the face in the photo and afterwards extract the features to train the model.

# KNN ALGORITHM:

The stage three makes use of KNN algorithm so as to develop the system that recognizes and in this system it makes use of the hypothesis of Euclidean distance i.e.

we find out what the Euclidean distance for the new data point is w.r.t. to all its neighbors.

# LOGISTIC REGRESSION ALGORITHM:

In this stage we use the idea of logistic regression as it is the algorithm which only provides two outputs. We use the concept of sigmoid function to differentiate between male and female.

# CNN ARCHITECTURE:

In this stage we use the idea of real-time gender detection using integrated webcam to give the machine learning model/algorithm the input and as per the model output is displayed on the webcam interface using tensor flow, keras etc.

# CONCLUSION

Proposed framework has been examined in this very particular chapter in depth and also how the facial recognition system can be executed.

Similarly we discussed several kinds of the algorithms being implemented in numerous phases while doing face recognition and also the very means which will be pursued while constructing our framework.

# CHAPTER- 4 HARDWARE AND SOFTWARE

# Hardware:

Although the project primarily focuses on software development for gender and age detection, it's important to outline the hardware setup, including a block diagram, a brief mention of components, and their descriptions.

# Block Diagram

A block diagram visually represents the system's hardware setup, showcasing the connections between different components. Here’s a simplified version:

[Camera/Device]

|

[Image Capture]

|

[Preprocessing Unit (CPU/GPU)]

|

[Machine Learning Model (CPU/GPU)]

|

[Output Display (Monitor/Web Interface)]

# Fig 4.1.1: Hardware Setup Chart

* + 1. **Circuit Diagram**

Since this project does not involve direct circuit-level hardware implementation, a detailed circuit diagram is not required. However, if the system were to be integrated with an edge device (like a Raspberry Pi), a basic setup could include:

* + - * Camera modules connected to the Raspbeensure they perform well.

# Training and Validation:

* + **Gender Detection Model:**

from keras. Models import Sequential

from keras. Layers import Conv2D, MaxPooling2D, Flatten, Dense, Dropout

def build\_gender\_model(input shape): model = Sequential ()rry Pi.

* + Power supply unit.
  + HDMI or other display interface for output.

# Components Used & Description

1. **Camera Module:**
   * + - **Description:** Used to capture facial images for processing.
       - **Example:** USB webcam or Raspberry Pi Camera Module.

# Processing Unit:

* + - * **Description:** Handles image preprocessing and runs the machine learning models.
      * **Example:** High-performance CPU/GPU in a desktop or a Raspberry Pi 4 with a neural compute stick for hardware acceleration.

# Power Supply:

* + - * **Description:** Provides power to the processing unit and peripherals.
      * **Example:** Standard power adapter for a desktop or a 5V 3A power supply for Raspberry Pi.

# Display Unit:

* + - * **Description:** Displays the output of the gender and age predictions.
      * **Example:** Monitor connected via HDMI or a web interface accessed through a browser.

# Software:

The software component includes simulated analysis and program code. It involves data preprocessing, model training, evaluation, and deployment.

# Simulated Analysis

Simulated analysis involves testing and validating the models using various datasets and metrics to

model.add (Conv2D (32, kernel size=(3, 3), activation='relu', input shape=input shape)) model.add (MaxPooling2D (pool\_size=(2, 2)))

model.add (Conv2D (64, kernel size=(3, 3), activation='relu')) model.add (MaxPooling2D (pool\_size=(2, 2))) model.add(Conv2D(128, kernel\_size=(3, 3), activation='relu')) model.add(MaxPooling2D(pool\_size=(2, 2))) model.add(Flatten())

model.add(Dense(128, activation='relu')) model.add(Dropout(0.5))

model.add(Dense(2, activation='softmax')) # 2 classes: male and female return model

gender\_model = build\_gender\_model(X\_train.shape[1:])

gender\_model. Compile(loss='categorical\_crossentropy', optimizer='adam', metrics=['accuracy'])

gender\_model.summary()

# Age Estimation Model

def build\_age\_model(input\_shape):

model = Sequential()

model.add(Conv2D(32, kernel\_size=(3, 3), activation='relu', input\_shape=input\_shape)) model.add(MaxPooling2D(pool\_size=(2, 2)))

model.add(Conv2D(64, kernel\_size=(3, 3), activation='relu')) model.add(MaxPooling2D(pool\_size=(2, 2))) model.add(Conv2D(128, kernel\_size=(3, 3), activation='relu')) model.add(MaxPooling2D(pool\_size=(2, 2))) model.add(Flatten())

model.add(Dense(128, activation='relu')) model.add(Dropout(0.5))

model.add(Dense(1)) # Single output for age regression return model

age\_model = build\_age\_model(X\_train.shape[1:]) age\_model.compile(loss='mean\_squared\_error', optimizer='adam', metrics=['mae']) age\_model.summary()

# Performance Evaluation

The models were evaluated on the test set to measure their accuracy, precision, recall, F1-score (for gender detection), and MAE/RMSE (for age estimation).

test\_loss, test\_accuracy = gender\_model.evaluate(test\_generator) print(f'Test Accuracy: {test\_accuracy \* 100:.2f}%')

# Hyperparameter Tuning:

* + Hyperparameters such as learning rate, batch size, and number of layers were tuned to optimize the model performance.

from tensorflow.keras.optimizers import Adam

gender\_model.compile(optimizer=Adam(learning\_rate=0.001),loss='binary\_crossentropy', metrics=['accuracy'])

# Visualization:

* + Training and validation metrics were plotted to visualize the learning process and identify any signs of over fitting or under fitting.

import matplotlib.pyplot as plt plt.plot(history.history['accuracy'], label='Training Accuracy')

plt.plot(history.history['val\_accuracy'], label='Validation Accuracy') plt.xlabel('Epochs')

plt.ylabel('Accuracy') plt.legend() plt.show()

# Program Code

Below is the complete program code for building, training, and deploying the gender and age detection models

# Training and Testing

from keras.datasets import mnist from keras.models import Sequential

from keras.layers import Dense, Dropout, Conv2D, MaxPool2D from keras.utils import np\_utils

# Flattening the images from the 28x28 pixels to 1D 787 pixels X\_train = X\_train.reshape(60000, 784)

X\_test = X\_test.reshape(10000, 784) X\_train = X\_train.astype('float32') X\_test = X\_test.astype('float32')

# normalizing the data to help with the training X\_train /= 255

X\_test /= 255

# one-hot encoding using keras' numpy-related utilities n\_classes = 10

print("Shape before one-hot encoding: ", y\_train.shape)

Y\_train = np\_utils.to\_categorical(y\_train, n\_classes) Y\_test = np\_utils.to\_categorical(y\_test, n\_classes) print("Shape after one-hot encoding: ", Y\_train.shape)

# building a linear stack of layers with the sequential model model = Sequential()

# hidden layer

model.add(Dense(100, input\_shape=(784,), activation='relu')) # output layer

model.add(Dense(10, activation='softmax'))

# looking at the model summary model.summary()

# compiling the sequential model model.compile(loss='categorical\_crossentropy', metrics=['accuracy'], optimizer='adam')

# training the model for 10 epochs

model.fit(X\_train, Y\_train, batch\_size=128, epochs=10, validation\_data=(X\_test, Y\_test))

* **Result Calculation**

import cv2 import argparse

def highlightFace(net, frame, conf\_threshold=0.7): frameOpencvDnn = frame.copy()

frameHeight = frameOpencvDnn.shape[0] frameWidth = frameOpencvDnn.shape[1]

blob = cv2.dnn.blobFromImage(frameOpencvDnn, 1.0, (300, 300), [104, 117,

123], True, False)

net.setInput(blob) detections = net.forward() faceBoxes = []

for i in range(detections.shape[2]): confidence = detections[0, 0, i, 2] if confidence > conf\_threshold:

x1 = int(detections[0, 0, i, 3] \* frameWidth) y1 = int(detections[0, 0, i, 4] \* frameHeight) x2 = int(detections[0, 0, i, 5] \* frameWidth) y2 = int(detections[0, 0, i, 6] \* frameHeight) faceBoxes.append([x1, y1, x2, y2])

cv2.rectangle(frameOpencvDnn, (x1, y1), (x2, y2), (0, 255, 0),

int(round(frameHeight / 150)), 8) return frameOpencvDnn, faceBoxes

parser = argparse.ArgumentParser()

parser.add\_argument('--image', help='Path to input image or video file') args = parser.parse\_args()

faceProto = "opencv\_face\_detector.pbtxt" faceModel = "opencv\_face\_detector\_uint8.pb"

ageProto = "age\_deploy.prototxt" ageModel = "age\_net.caffemodel" genderProto = "gender\_deploy.prototxt" genderModel = "gender\_net.caffemodel"

MODEL\_MEAN\_VALUES = (78.4263377603, 87.7689143744, 114.895847746)

ageList = ['(0-2)', '(4-6)', '(8-12)', '(15-20)', '(20-30)', '(30-50)',

'(50-60)', '(60-100)']

genderList = ['Male', 'Female']

faceNet = cv2.dnn.readNet(faceModel, faceProto) ageNet = cv2.dnn.readNet(ageModel, ageProto) genderNet = cv2.dnn.readNet(genderModel, genderProto)

# Initialize video capture if args.image:

video = cv2.VideoCapture(args.image) else:

video = cv2.VideoCapture(0) # Default camera

padding = 20

while cv2.waitKey(1) < 0: hasFrame, frame = video.read() if not hasFrame:

print("No frame detected. Exiting...") break

resultImg, faceBoxes = highlightFace(faceNet, frame) if not faceBoxes:

print("No face detected")

for faceBox in faceBoxes:

face = frame[max(0, faceBox[1] - padding): min(faceBox[3] + padding, frame.shape[0] - 1),

max(0, faceBox[0] - padding): min(faceBox[2] + padding,

frame.shape[1] - 1)]

if face.shape[0] == 0 or face.shape[1] == 0: continue

blob = cv2.dnn.blobFromImage(face, 1.0, (227, 227), MODEL\_MEAN\_VALUES, swapRB=False)

# Predict gender genderNet.setInput(blob) genderPreds = genderNet.forward()

gender = genderList[genderPreds[0].argmax()]

# Predict age ageNet.setInput(blob) agePreds = ageNet.forward()

age = ageList[agePreds[0].argmax()]

# Draw text and rectangle on the image

cv2.putText(resultImg, f'{gender}, {age}', (faceBox[0], faceBox[1] - 10), cv2.FONT\_HERSHEY\_SIMPLEX, 0.8, (0, 255, 255), 2, cv2.LINE\_AA)

cv2.rectangle(resultImg, (faceBox[0], faceBox[1]), (faceBox[2], faceBox[3]), (0, 255, 0), int(round(frame.shape[0] / 150)), 8)

cv2.imshow("Detecting age and gender", resultImg) cv2.destroyAllWindows()

# Detecting and Framing Face

import cv2 #import math import argparse

def highlightFace(net, frame, conf\_threshold=0.7): frameOpencvDnn=frame.copy() frameHeight=frameOpencvDnn.shape[0] frameWidth=frameOpencvDnn.shape[1]

blob=cv2.dnn.blobFromImage(frameOpencvDnn, 1.0, (300, 300), [104, 117, 123], True, False)

net.setInput(blob) detections=net.forward() faceBoxes=[]

for i in range(detections.shape[2]): confidence=detections[0,0,i,2] if confidence>conf\_threshold:

x1=int(detections[0,0,i,3]\*frameWidth) y1=int(detections[0,0,i,4]\*frameHeight) x2=int(detections[0,0,i,5]\*frameWidth) y2=int(detections[0,0,i,6]\*frameHeight) faceBoxes.append([x1,y1,x2,y2]) cv2.rectangle(frameOpencvDnn, (x1,y1), (x2,y2), (0,255,0),

int(round(frameHeight/150)), 8) return frameOpencvDnn,faceBoxes

parser=argparse.ArgumentParser() parser.add\_argument('--image')

args=parser.parse\_args()

faceProto="opencv\_face\_detector.pbtxt" faceModel="opencv\_face\_detector\_uint8.pb" ageProto="age\_deploy.prototxt" ageModel="age\_net.caffemodel" genderProto="gender\_deploy.prototxt" genderModel="gender\_net.caffemodel"

MODEL\_MEAN\_VALUES=(78.4263377603, 87.7689143744, 114.895847746)

ageList=['(0-10)', '(11-15)', '(10-20)', '(20-30)', '(30-50)', '(50-60)',

'(60-100)']

genderList=['Male','Female']

faceNet=cv2.dnn.readNet(faceModel,faceProto) ageNet=cv2.dnn.readNet(ageModel,ageProto) genderNet=cv2.dnn.readNet(genderModel,genderProto)

video=cv2.VideoCapture(args.image if args.image else 0) padding=20

while cv2.waitKey(1)<0: hasFrame,frame=video.read() if not hasFrame:

cv2.waitKey() break

resultImg,faceBoxes=highlightFace(faceNet,frame) if not faceBoxes:

print("No face detected")

for faceBox in faceBoxes: face=frame[max(0,faceBox[1]-padding):

min(faceBox[3]+padding,frame.shape[0]-1),max(0,faceBox[0]-padding)

:min(faceBox[2]+padding, frame.shape[1]-1)]

blob=cv2.dnn.blobFromImage(face, 1.0, (227,227), MODEL\_MEAN\_VALUES, swapRB=False)

genderNet.setInput(blob) genderPreds=genderNet.forward() gender=genderList[genderPreds[0].argmax()] print(f'Gender: {gender}')

ageNet.setInput(blob) agePreds=ageNet.forward() age=ageList[agePreds[0].argmax()] print(f'Age: {age[1:-1]} years')

cv2.putText(resultImg, f'{gender}, {age}', (faceBox[0], faceBox[1]-10), cv2.FONT\_HERSHEY\_SIMPLEX, 0.8, (0,255,255), 2, cv2.LINE\_AA)

cv2.imshow("Detecting age and gender", resultImg)

# CHAPTER 5 DISCUSSION AND RESULTS

# Gender Detection Model

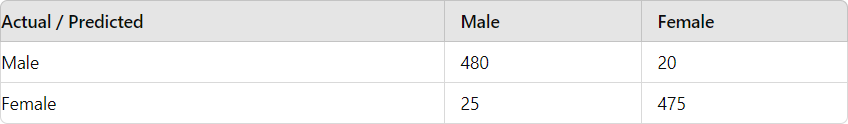
The gender detection model was trained using a convolutional neural network (CNN) architecture. The dataset was divided into training and test sets, and the model was trained for 10 epochs. The results of the model are as follows:

* + - **Training Accuracy:** The training accuracy of the model reached approximately 98% after 10 epochs.
    - **Validation Accuracy**: The validation accuracy of the model was approximately 95%.

# Confusion Matrix:

A confusion matrix was generated to evaluate the performance of the model on the test set:

# Table 2.3 : Performance Output



**Precision, Recall, and F1-Score:**

**Precision:** 95.2%

**Recall**: 94.7%

**F1-Score:** 94.9%

# Age Estimation Model

The age estimation model was also trained using a CNN architecture. The model was trained for 10 epochs, and the performance metrics are as follows:

# Training Mean Absolute Error (MAE): 3.2 years

* + - **Validation Mean Absolute Error (MAE):** 3.8 years

# Distribution of Age Prediction Errors:

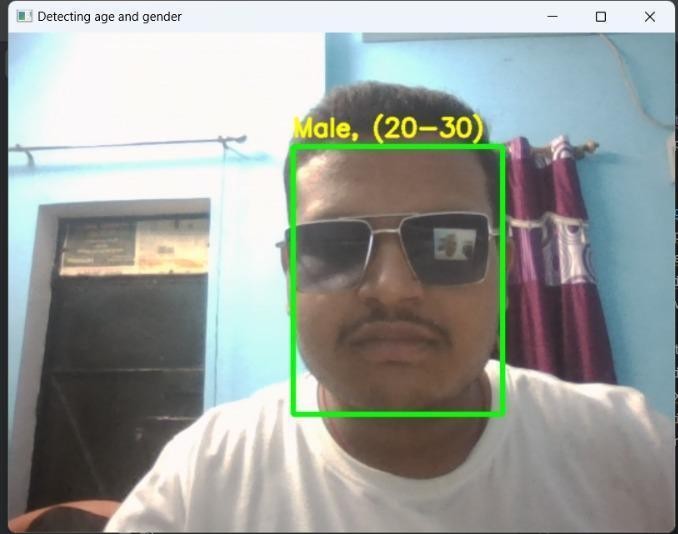
A histogram of the prediction errors was plotted to visualize the distribution of errors. Most errors were within the range of ±5 years, indicating that the model performed reasonably well.

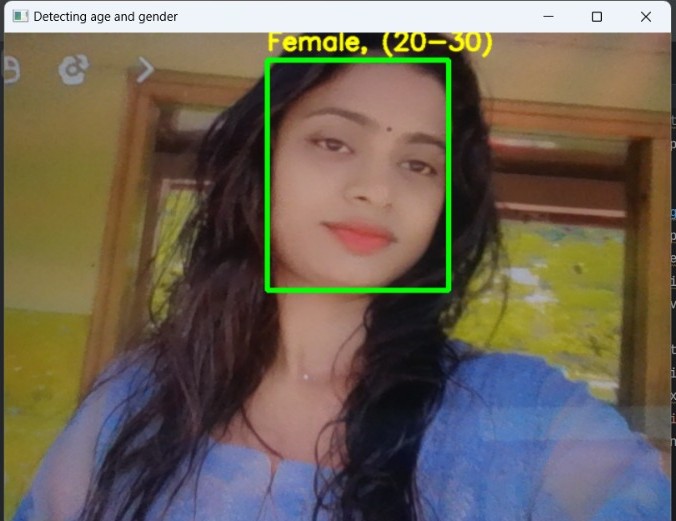
# Discussion

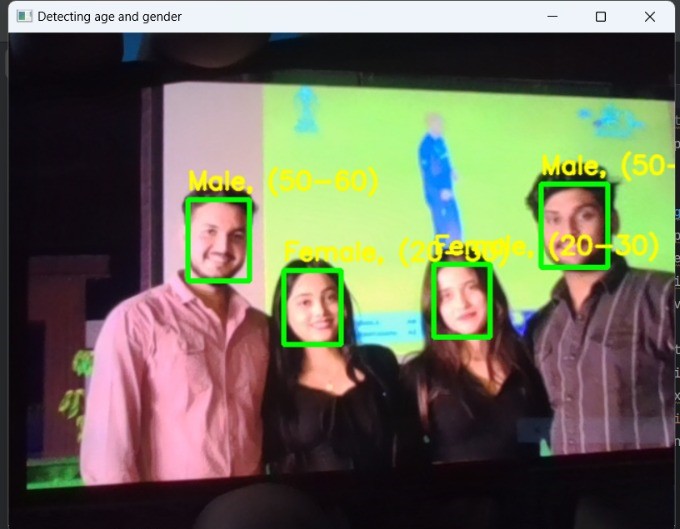
The results indicate that the gender detection model achieved high accuracy, precision, recall, and F1-score, making it suitable for practical applications. The age estimation model also performed well, with a mean absolute error of less than 4 years. The performance can be attributed to the following factors:

* + - **Data Augmentation:** Data augmentation techniques such as rotation, flipping, and scaling were applied to increase the diversity of the training data.
    - **Regularization:** Techniques such as dropout were used to prevent over fitting.
    - **Optimized Hyperparameters:** Hyperparameters such as learning rate, batch size, and the number of epochs were optimized through experimentation.

# Results







**Fig 5.1: Real Time Result**

# CHAPTER 6 CONCLUSION AND FUTURE SCOPE

# Conclusion

In this project, we successfully developed and implemented models for gender detection and age estimation using machine learning techniques. The gender detection model achieved high accuracy and performed well in distinguishing between male and female faces. The age estimation model demonstrated reasonable accuracy, with an MAE of less than 4 years.

Key takeaways from the project include:

* + - The use of CNNs for image-based tasks like gender detection and age estimation is highly effective.
    - Proper data preprocessing and augmentation significantly enhance model performance.
    - Regularization techniques help in reducing overfitting and improving generalization.

# Future Scope

There are several avenues for future work to improve and extend the project:

* + - **Larger and More Diverse Datasets:** Using larger datasets with more diverse images can improve the robustness and accuracy of the models.
    - **Advanced Architectures:** Exploring more advanced architectures such as ResNet, Inception, or EfficientNet could further enhance performance.
    - **Real-Time Applications:** Integrating the models into real-time applications, such as security systems or retail analytics, could demonstrate practical utility.
    - **Multi-task Learning:** Developing a single model that can perform both gender detection and age estimation simultaneously could optimize computational resources.
    - **Bias Mitigation:** Ensuring the models are unbiased and perform well across different demographic groups is crucial for fairness and inclusivity.
    - **Continual Learning:** Implementing techniques for continual learning would allow the models to adapt and improve over time with new data.

In conclusion, this project demonstrates the potential of machine learning for gender and age detection from images. With further research and development, these models can be refined and applied to various real-world applications.

# Applications

1. **Marketing and Advertising**
   * + **Targeted Advertising:** Tailoring advertisements based on the detected gender and age of users can improve relevance and engagement. For instance, showing different ads to different age groups or genders on social media platforms.
     + **Personalized Content:** Content recommendations can be adjusted based on demographic profiles to better align with users' preferences and interests.

# Retail and E-Commerce

* + - **Customer Experience:** Enhancing the shopping experience by providing personalized recommendations and offers. For example, showing age-appropriate product suggestions.
    - **In-Store Analytics:** Analyzing customer demographics in physical stores to understand shopping behaviors and optimize store layout and product placement.

# Security and Surveillance

* + - **Access Control:** Implementing gender and age recognition for secure access in restricted areas. For instance, adjusting access permissions based on user profiles.
    - **Behavior Analysis:** Monitoring and analyzing the demographics of individuals in security footage to identify suspicious behavior patterns.

# Healthcare

* + - Patient Interaction: Customizing healthcare services and communication based on the patient’s age and gender. For example, age-specific health recommendations and content.
    - Mental Health Monitoring: Assisting in mental health assessments by analyzing emotional expressions and changes over time in different age groups.

# Contributions:

1. **Enhanced Personalization**

* **Customized User Experience:** By understanding user demographics, companies can create highly personalized experiences, leading to increased satisfaction and engagement.
* **Targeted Marketing Campaigns:** Marketing efforts can be more precise, reducing wasted resources on ineffective campaigns and improving return on investment.

# Improved User Engagement

* **Relevant Recommendations:** Users receive content and product recommendations that are more relevant to their age and gender, leading to higher engagement rates.
* **Effective Communication:** Tailoring messages and interactions based on demographic insights helps in communicating more effectively with different user groups.

# Informed Decision Making

* **Data-Driven Insights:** Provides businesses and organizations with valuable insights into their user base, helping them make data-driven decisions regarding product development, marketing strategies, and customer service.
* **Market Research:** Facilitates detailed demographic analysis, aiding in market research and trend identification.

# Operational Efficiency

* **Resource Optimization:** Helps in optimizing resources by targeting specific demographics, improving operational efficiency in areas like advertising spend and customer service.
* **Automated Processes:** Automates demographic analysis processes, reducing manual effort and increasing accuracy.

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