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BIOMETRIC SYSTEMS (SWE1015)

CRIMINAL INFORMATION BASED FACE RECOGNITION SYSTEM

FINAL REVIEW (FALL 2019-20)

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1.ABSTRACT

This project implements a face recognition system which first detects the face and then identifies the particular person by comparing the detected face with image database. It will help to maintain a strong security in that environment. Firstly the data sets are created and trained them with the help of algorithms which undergoes feature extraction, normalization and then pre processed.The trained data sets are compared with the input facial image, it first detects and recognises the person and displays the name of the personnel.

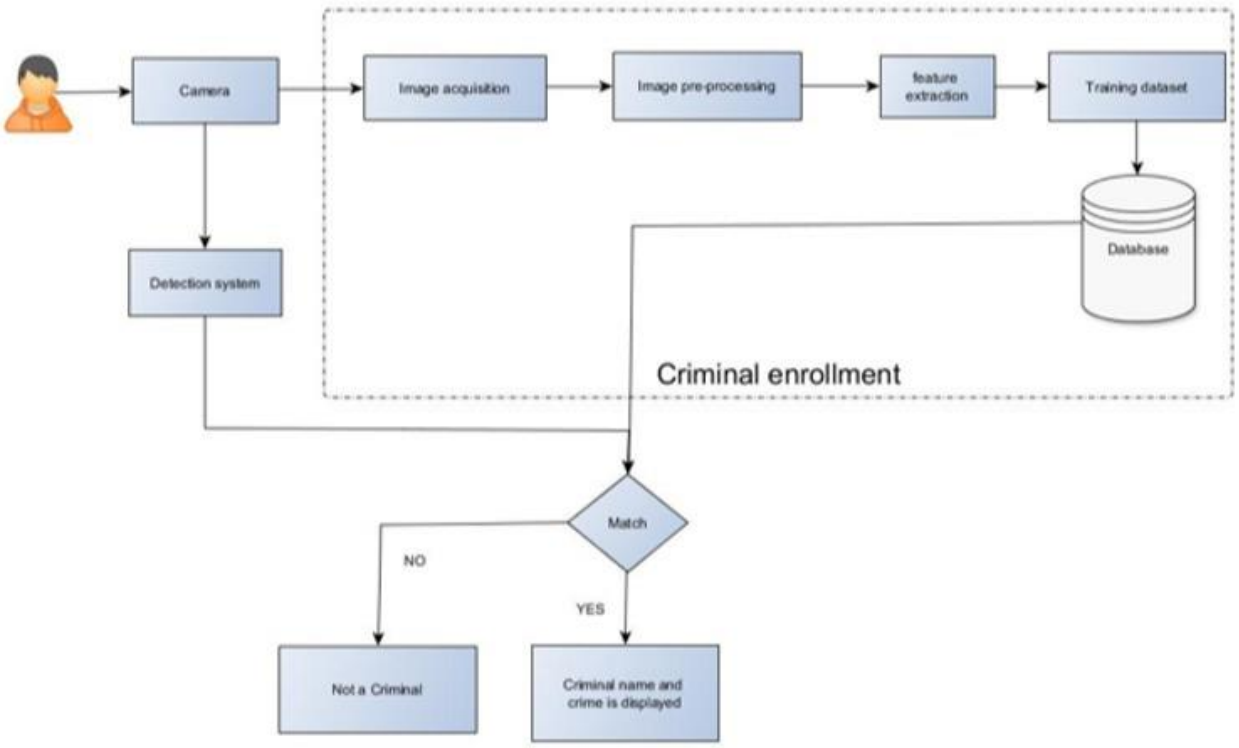
2. KEY WORDS

LBPH RECOGNISER, FACE DATASETS, HISTOGRAM, HAAR CASCADE ALGORITHM.

3. INTRODUCTION

A facial recognition system is a technology capable of identifying or verifying a person from a digital image or a video frame from a video source. There are multiple methods in which facial recognition systems work, but in general, they work by comparing selected facial features from given image with faces within a database. It is also described as a Biometric Artificial Intelligence based application that can uniquely identify a person by analysing patterns based on the person's facial textures and shape[better source needed] While initially a form of computer application, it has seen wider uses in recent times on mobile platforms and in other forms of technology, such as robotics. It is typically used as access control in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems. Although the accuracy of facial recognition system as a biometric technology is lower than iris recognition and fingerprint recognition, it is widely adopted due to its contactless and non-invasive process. Recently, it has also become popular as a commercial identification and marketing tool. Other applications include advanced human-computer interaction, video surveillance, automatic indexing of images, and video database, among others.

4. ARCHITECTURE



5 LITERATURE SURVEY

S.No	Article	Summary
1.	Face Recognition from video sequences; Author:Qianqian Zhao ,Hualong Cai	Since one of the major applications of face recognition is surveillance for security purposes, which involves realtime recognition of faces from an image sequence captured by a video camera. A videobased face recognition system typically consists of three modules: one for detecting the face; a second one for tracking it; and a third one for recognizing it.

2.	Human face recognition application using pca and eigenface approach;Author: Anissa Lintang Ramadhani, purnawarman musa,Eri Prasetyo Wibomo	Based on Principal Component Analysis (PCA reduces the dimension of the data)Create an image subspace (face space) which best discriminates between faces like faces occupy near points in face space. It Compare two faces by projecting the images into faces speed and measuring the distance between them.
3.	Invariant Feature Method; Authors: Imad Mohamed Ouloul, Karim Afdel, Abdellah Amghar, Zakaria Moutakki	Feature-invariant methods that try to find invariant features of a face despite its angle or position. Facial recognition utilizes distinctive features of the face including: distinct micro elements like: Mouth, Nose, Eye, Cheekbones, Chin, Lips, Forehead, Ears,Upper outlines of the eye sockets, the areas surrounding the cheekbones, the sides of the mouth, and the location of the nose and eyes. The distance between the eyes, the length of the nose and the angle of the jaw.
4.	Holistic Approach for face recognition; Authors: Soumya Kanti Das , and Lutfa Akte.	Holistic approaches attempt to identify faces using global representations, i.e., descriptions based on the entire image rather than on local features of the face. These schemes can be subdivided into two groups: statistical and AI approaches. In the simplest version of the holistic approaches, the image is represented as a 2D array of intensity values and recognition is performed by direct correlation comparisons between the input face and all the other faces in the database.
5.	OpenFace; Authors: Brandon Amos, Bartosz Ludwiczuk, Mahadev Satyanarayanan	Algorithm : OpenFace.
6.	Eigenfaces for Recognition; Authors: Matthewe Turk and Alex Pentland	This paper provides the information for a real time face system that locates the head and then recognise the person by comparing characteristic of the face. This system works with the 2D image converted from a three dimensional image. The 2D image representation helps the image processing process. This increases the efficiency of the face recognition.

7.	Multi-task Pose-Invariant Face Recognition;Authors: Changxing Ding, Student Member, IEEE, Chang Xu, and Dacheng Tao, Fellow, IEEE	Face images captured in unconstrained environments usually contain significant pose variation, which dramatically degrades the performance of algorithms designed to recognize frontal faces. This paper proposes a novel face identification framework capable of handling the full range of pose variations within 90 degrees of yaw. The proposed framework first transforms the original poseinvariant face recognition problem into a partial frontal face recognition problem Techniques used: Face Pose Normalization Facial Texture Detection Patch based Face representation Feature Translation Training Iterative Optimization Algorithm .
8.	Face Recognition-based Lecture Attendance System;Authors: Yohei KAWAGUCHI Tetsuo SHOJI Weijane LIN Koh KAKUSHO Michihiko MINOH.	Department of Intelligence Science and Technology, Graduate School of Informatics, Kyoto University Academic Center for Computing and Media Studies, Kyoto University In this paper, in order to obtain the attendance, positions and face images in classroom lecture, we proposed the attendance management system based on face recognition in the classroom lecture. The system estimates the attendance and the position of each student by continuous observation and recording. The result of our preliminary experiment shows continuous observation improved the performance for estimation of the attendance.
9.	Face Recognition/Detection by Probabilistic Decision-Based Neural Network,Authors: Shang-Hung Lin, Sun-Yuan Kung, Fellow, IEEE, and Long-Ji Lin.	This paper proposes a face recognition system based on probabilistic decision-based neural networks (PDBNN). The PDBNN face recognition system consists of three modules: First, a face detector finds the location of a human face in an image. Then an eye localizer determines the positions of both eyes in order to generate meaningful feature vectors. The facial region proposed contains eyebrows, eyes, and nose, but excluding mouth. (Eye-glasses will be allowed.) Lastly, the third module is a face recognizer. It is more effective Algorithm : Probability decision based neural network .

10.	Infra red based Techinque.Authors: Jinwoo kang, amol borkar; angelique yeung, nancy nong, mark smith, monson hayes.	The thermal infra-red imagery is insensitive to variations in lighting which makes such image to be used for detecting and recognizing faces. When using infra-red the images vein and tissues structure which are unique in each individual yield a good results when applied to these images.
11.	Deep Face Recognition Authors: Omkar M. Parkhi, Andrea Vedaldi, Andrew Zisserman.	The goal of this paper is face recognition from either a single photograph or from a set of faces tracked in a video. Recent progress in this area has been due to two factors: end to end learning for the task using a convolutional neural network (CNN) The availability of very large scale training datasets Algorithm : Convolution Neural Network.
12.	Single Sample Face Recognition via Learning Deep Supervised Auto-Encoders ,Authors: Shenghua Gao, Yuting Zhang, Kui Jia, Jiwen Lu, Yingying Zhang.	This paper targets learning robust image representation for single training sample per person face recognition. Motivated by the success of deep learning in image representation, we propose a supervised auto-encoder, which is a new type of building block for deep architectures. Algorithm : Supervised Auto Encoders
13.	Face Description with Local Binary Patterns: Application to Face Recognition Timo Ahonen, Student Member, IEEE,Abdenour Hadid, and Matti Pietikainen, Senior Member, IEEE.	This paper presents a novel and efficient facial image representation based on local binary pattern (LBP) texture features. The face image is divided into several regions from which the LBP feature distributions are extracted and concatenated into an enhanced feature vector to be used as a face descriptor. Algorithm : Local Binary Pattern .
14.	Facial recognition 20 times more accurate with advances in convolutional neural networks, NIST finds.	Facial recognition algorithms can identify matches with error rates as low as 0.2 percent given good quality photos, 20 times better than the top 4 percent error rate recorded only five years ago, according to the latest report from NISTs Ongoing Facial Recognition Vendor Test (FRVT).
15.	Implementation of classroom attendance system based on face recognition in class Ajinkya patil, mrudang shukla	For security reasons, we can use detection and recognition system. To identify culprits on bus stations, railway stations 7 other public places, we can use this system. This will be helping hand to the police. In this system, we will use GSM module. Suppose if culprit is detected, then detected signal can be transmitted using GSM module to the central control room of police station. With the help of ISDN number of GSM, culprit surviving area will be recognized.

16.	RFID-Based Students Attendance Management System Arulogun O. T., Olatunbosun, A., Fakolujo O. A., and Olaniyi, O. M.	By incorporating a facial recognition application that would serve to further increase the biometric security of the system against impersonation by erring students. Usage of High Frequency (HF) active RFID tags against passive Low frequency (LF) RFID tags for better performance and flexibility of users Performance evaluation of combination of thumbprint, facial recognition and RFID technology to students attendance monitoring problem.
17.	Algorithm for Efficient Attendance Management: Face Recognition based approach Naveed Khan Balcoh, M. Haroon Yousaf, Waqar Ahmad and M. Iram Baig.	This paper introduces the efficient and accurate method of attendance in the classroom environment that can replace the old manual methods. This method is secure enough, reliable and available for use. No need for specialized hardware for installing the system in the classroom. It can be constructed using a camera and computer. There is a need to use some algorithms that can recognize the faces in veil to improve the system performance.
18.	A Review Paper on Face Recognition Techniques Sujata G. Bhele1 and V. H. Mankar.	Face recognition has been a fast growing, challenging and interesting area in real time applications. A large number of face recognition algorithms have been developed in last decades. In this paper an attempt is made to review a wide range of methods used for face recognition comprehensively. This include PCA, LDA, ICA, SVM, Gabor wavelet soft computing tool like ANN for recognition and various hybrid combination of this techniques. This review investigates all these methods with parameters that challenges face recognition like illumination, pose variation, facial expressions.
19.	Generic Training Set based Multimanifold Discriminant Learning for Single Sample Face Recognition College of Automation, Nanjing University of Posts and Telecommunications Nanjing 210003, China. Received April 11, 2016; revised July 2, 2017; accepted September 5, 2017; published January 31, 2017.	In this paper they proposed a virtual sample generating algorithm called k nearest neighbors based virtual sample generating (kNNVSG) to enrich intra-class variation information for training samples. They proposed image set based multimanifold discriminant learning (ISMMDL) algorithm. For ISMMDL algorithm, it learns a projection matrix for each manifold modeled by the local patches of the images of each class, which aims to minimize the margins of intra-manifold and maximize the margins of inter-manifold simultaneously in lowdimensional feature space.

20.	Deep Neural Network for Human Face Recognition Dr. Priya Guptaa, Nidhi Saxenaa, Meetika Sharmaa	Here, the process of identifying people through facial images, has numerous practical applications in the area of biometrics, information security, access control, law enforcement, smart cards and surveillance system. The paper proposes a new way of using a deep neural network (another type of deep network) for face recognition. In this approach, instead of providing raw pixel values as input, only the extracted facial features are provided.
21.	Face Detection and Recognition using Viola-Jones algorithm and Fusion of PCA and ANN Narayan T. Deshpande Associate professor, Dr. S. Ravishankar Professor.	The major challenge encountered in multidimensional visual model analysis. Here, the proposed methodology is implemented in two stages. The first stage detects the human face in an image using violaJones algorithm. In the next stage the detected face in the image is recognized using a fusion of Principle Component Analysis and Feed Forward Neural Network. The performance of the proposed method is compared with existing methods. Better accuracy in recognition is realized with the proposed method. The proposed methodology uses Bio ID-Face-Database as standard image database.
22.	GPU Based Face Recognition System for Authentication Bhumika Agrawal, Chelsi Gupta, Meghna Mandloi, Divya Dwivedi, Jayesh Surana Information Technology, SVITS Gram Baroli, Sanwer road, Indore, MP, India.	The significant role in identifying a person for authentication purpose in public places such as airport security. The the most successful template based techniques for face recognition is Principal Component Analysis (PCA) which is generally known as Eigen face approach. Graphics Processing Unit (GPU) is the solution for fast and efficient computation.
23.	Built-in Face Recognition for Smart Phone Devices Aesha Shah, Kavin Shah, Vidhi Shah, Chintan Shah 123 Student, Dept Of Information Technology , Vidyalankar Institute Of Technology ,Maharashtra, India.	This paper presents the deployment of face recognition on mobile phones. Face recognition is a computation-intensive process and requires resources beyond the capacity of modern mobile devices. It describes about a prototype of Auto Face Tagger on Android Phones.

24.	A Literature review on Facial Expression Recognition Techniques Ms.Aswathy.R Post Graduate Scholar, Computer Science Department, Nehru college of Engineering , India.	Automatic facial expression recognition has become a progressive research area since it plays a major role in human-computer-interaction. The facial expression recognition finds major application in areas like social interaction and social intelligence. A review of various techniques used in facial expression recognition like principal component analysis (PCA), linear discriminant analysis (LDA) etc is done in this paper. The survey is represented in tabular form for quick reference.
25.	Automatic Locking Door Using Face Recognition. Ishaan Sathe, Chiman Patel, Prasad Mahajan, Tanmay Telang, Sejal Shah Electronics Department, Mumbai University.	This paper is to help people for improvement of the door security of sensitive locations by using face detection and recognition. . This paper comprises of three subsystems: namely face detection, face recognition and automatic door access control. Image acquisition is the process of capturing an image. The face is detected by using the Viola Jones method and face recognition is implemented by using the Principal Component Analysis (PCA). Face Recognition based on PCA is generally referred to as the use of Eigen faces.

6. MODULES

- IMAGE ACQUISITION [TRAINING]
- PRE PROCESSING
- EXTRACTION
- ENROLLMENT
- DATABASE
- DETECTION
- RECOGNITION
- DISPLAY NAME

6.1 IMAGE ACQUISITION

The first stage of any vision that is the colored image is the image acquisition stage. Captures the images for the datasets and stores it in the database for future inference. The stored datasets are well-trained.

6.2 PREPROCESSING

Clean up the raw data so that it is in the best possible state to make recognition. Data sets acquired are processed in order to normalize in similar ranges. Specify the fixed size for all the images so that it is easy for acquiring accurate features for recognition.

6.3 EXTRACTION

The most important features for recognition from the pre-processed biometric data is extracted. That is in this module we select some nodal points such as : length between eyes, face color, nose length, chin length, distance between chin and neck etc.,.

6.4 ENROLLMENT

The extracted features and information of the faces are enrolled to the system so that it is used when detecting and recognising the face when it appears. Image archive is stored that is the sample faces are stored in the database as a TEMPLATE.

6.5 DATABASE

In biometric, the database is housed for both enrollment and verification templates of the end users. Used in client-server topology.

6.6 DETECTION

The objective of finding the faces(location anf size) in an image and probably extract them to be used by the face recognition algorithm.

6.7. RECOGNITION

With the facial images already extracted, pre-processed i.e cropped, resized and usually converted to greyscale, the face recognition algorithm is responsible for finding characteristics which best describe the image. Can basically operate on two modes: Verification or authentication of a facial image: compares template with the input facial image of the user which is requiring authentication.(1*1) Identification or facial recognition:compares i/p facial image with dataset to find the user that matches the face.(1*N)

6.8. DISPLAY NAME

Finally after performing all the above processes, it gives the output i.e, it displays the name of the person when placed under the camera.

7. CODE IMPLEMENTATION

7.1. DATASET GENERATOR

```
import cv2
import sqlite3

camera = cv2.VideoCapture(0)
classifier = cv2.CascadeClassifier('haarcascade_frontalface_default.xml')


def insertOrUpdate(cid,cname,ccomited):
   db = sqlite3.connect('facedb.db')
   cursor = db.cursor()
   cursor.execute('''CREATE TABLE IF NOT EXISTS
                criminaldata(ID TEXT, Name TEXT,relationship TEXT)''')
   cursor.execute('''INSERT INTO criminaldata
             VALUES(?,?,?)''', (cid,cname,ccomited))
   #print('User inserted')
   db.commit()
   db.close()

cid = input("Enter the Criminal ID no : ");
cname=input("Enter the Criminal name : ");
ccomited=input("Enter the Crime commited : ");
insertOrUpdate(cid,cname,ccomited)

i=0

while True:
    ret, frame = camera.read()
    gray_frame = cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY)#gray scale image
    face = classifier.detectMultiScale(gray_frame,1.3,10)
    for x,y,w,h in face:
        cv2.rectangle(frame,(x,y),(x+w,y+h),(0,0,245),4)#rectangle frame
        cv2.imshow("Face Detect", frame)
        cv2.imwrite("facedata/criminal."+str(cid)+"."+str(i)+".jpg",gray_frame[y:y+h,x:x+w])
        i = i+1
    if cv2.waitKey(1) & 0xFF == ord('q'):#waiting time
        break
    elif i>49:#number of images
        break
```

```
print('User inserted')
camera.release()
cv2.destroyAllWindows()
```

7.2 TRAINNER

```
import os
import cv2
import numpy as np
from PIL import Image

recognizer=cv2.createLBPHFaceRecognizer();
path='facedata'

def getImagesWithID(path):
  imagePaths=[os.path.join(path,f) for f in os.listdir(path)]
  faces=[]
  IDs=[]
  for imagePath in imagePaths:
     faceImg=Image.open(imagePath).convert('L');
     faceNp=np.array(faceImg,'uint8')
     ID=int(os.path.split(imagePath)[-1].split('.')[1])

     faces.append(faceNp)
     print str(ID)

     IDs.append(ID)
     cv2.imshow("training",faceNp)
     cv2.waitKey(10)
  return IDs, faces

IDs,faces=getImagesWithID(path)
recognizer.train(faces,np.array(IDs))
recognizer.save('trained.yml')
cv2.destroyAllWindows()
```

7.3 DETECTOR

```
import cv2
import numpy as np
import pickle
import sqlite3
```

```
faceDetect=cv2.CascadeClassifier('haarcascade_frontalface_default.xml');
cam=cv2.VideoCapture(0);
rec=cv2.createLBPHFaceRecognizer();
rec.load("trained.yml")
def getProfile(id):
    conn=sqlite3.connect("facedb.db")
    cmd="SELECT * FROM criminaldata WHERE ID="+str(id)
    cursor=conn.execute(cmd)
    profile=None
    for row in cursor:
        profile=row
    conn.close()
    return profile
font=cv2.cv.InitFont(cv2.cv.CV_FONT_HERSHEY_COMPLEX_SMALL,2,1,0,2)
while(True):
    ret,img=cam.read();
    gray=cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)
    faces=faceDetect.detectMultiScale(gray,1.3,5);
    for(x,y,w,h)in faces:
        cv2.rectangle(img,(x,y),(x+w,y+h),(0,0,255),2)
        id,conf=rec.predict(gray[y:y+h,x:x+w])
        profile=getProfile(id)
        if(profile!=None):
            cv2.cv.PutText(cv2.cv.fromarray(img),"ID:"+str(profile[0]),(x,y+h+30),font, 255)
            cv2.cv.PutText(cv2.cv.fromarray(img),"Name:"+str(profile[1]),(x,y+h+60),font, 255)
            cv2.cv.PutText(cv2.cv.fromarray(img),"Crime:"+str(profile[2]),(x,y+h+90),font, 255)

    cv2.imshow("Face",img);
    if(cv2.waitKey(1)==ord('q')):
      break;
cam.release()
cv2.destroyAllwindows()
```

8 SCREENCHOTS

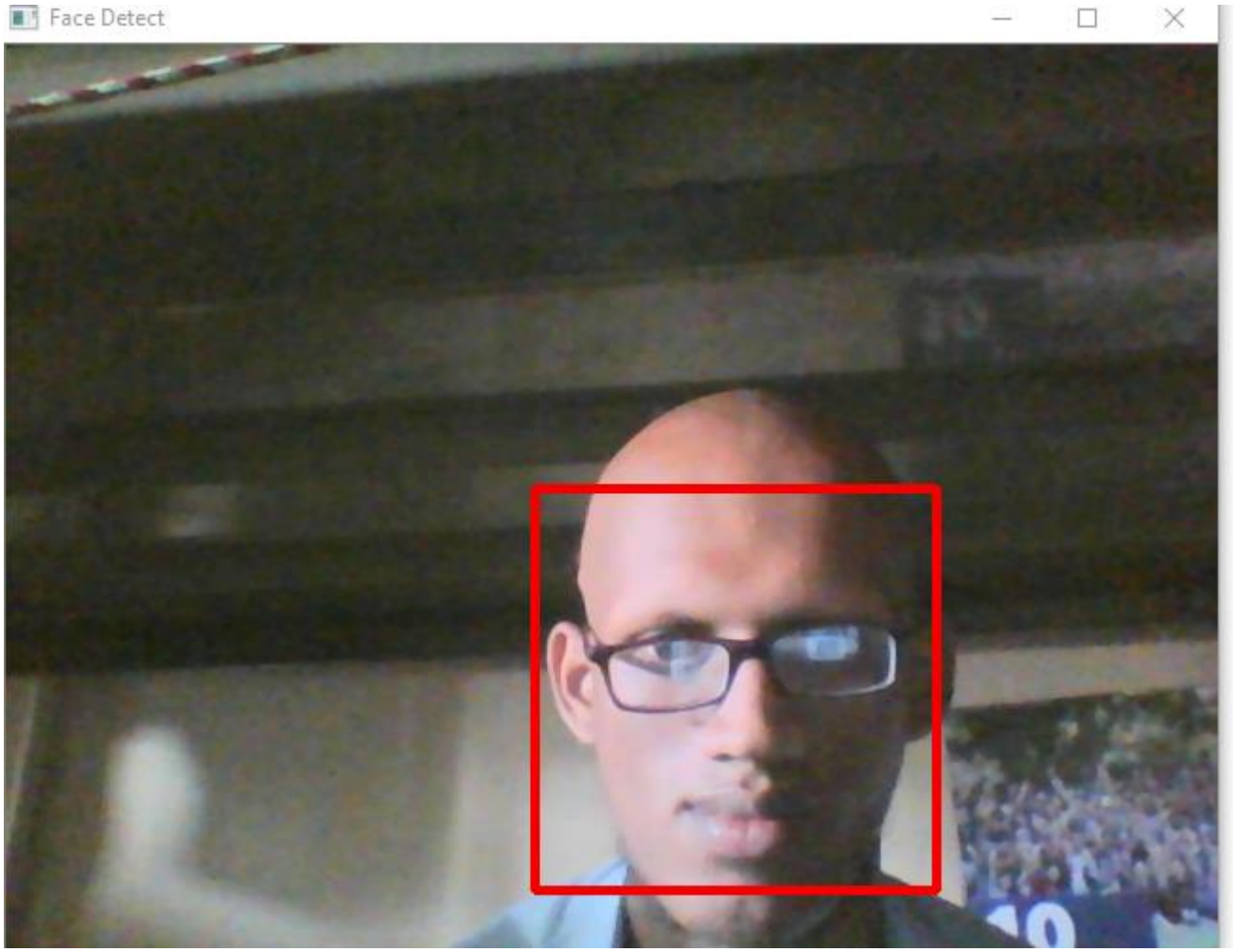
8.1 PROCESS 1

8.1.1 IMAGE ACQUISTION

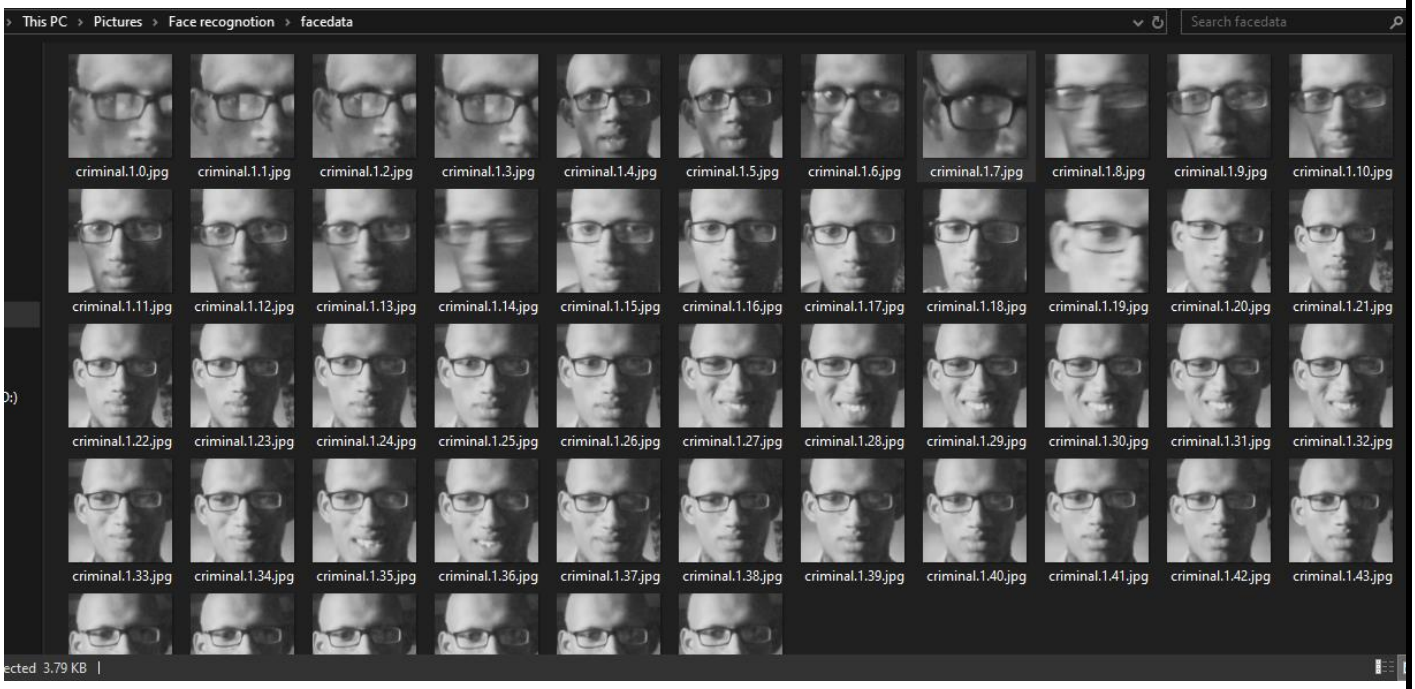
Enter id and name to capture img for matching process.

```
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:\Users\dhiva\Pictures\Face recognotion\data_creator.py =====
Enter the Criminal ID no : 1
Enter the Criminal name : "dhiva"
Enter the Crime commited : "reth"
User inserted
>>>
```

8.1.2 CAPTURING IMAGE

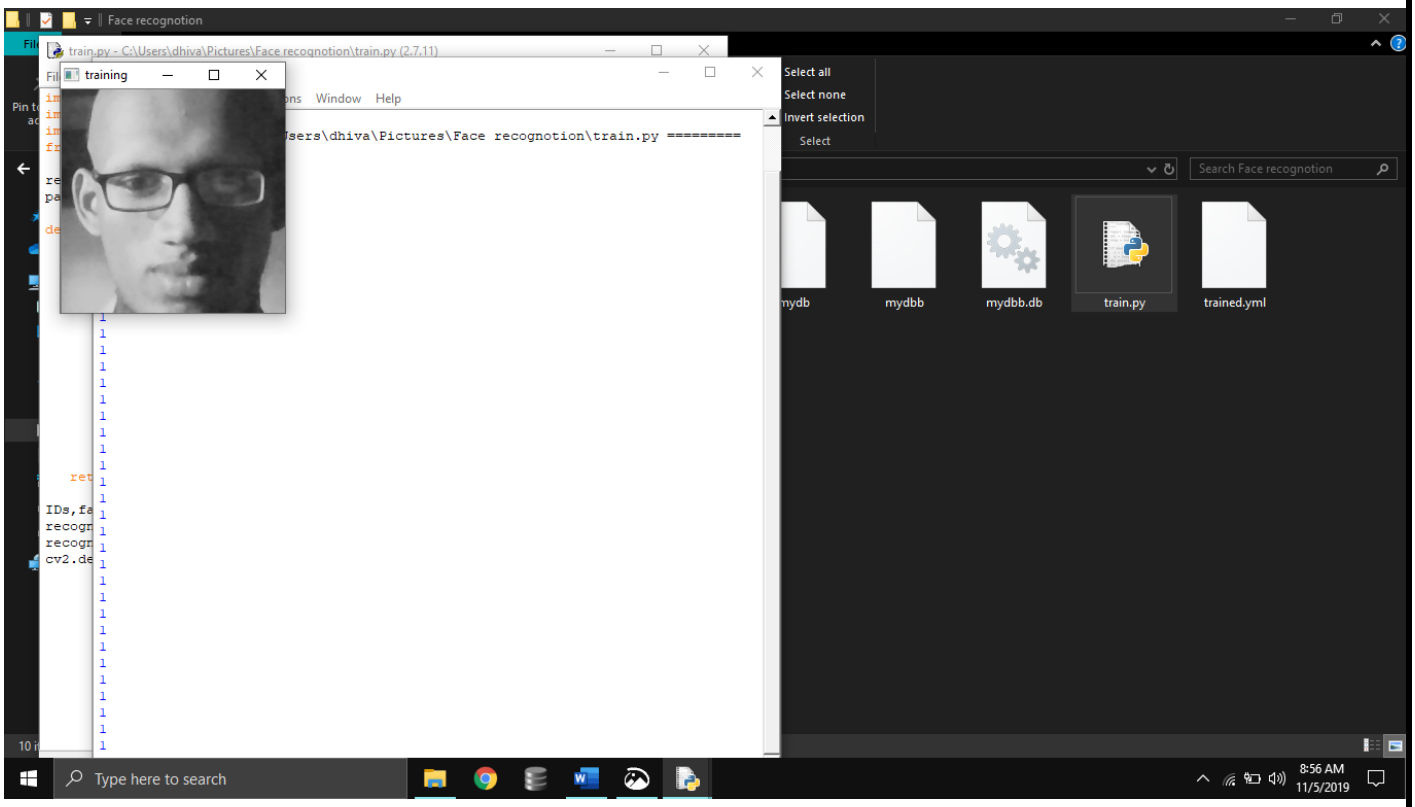


8.1.3 IMAGE DATASET



8.2 PROCESS 2

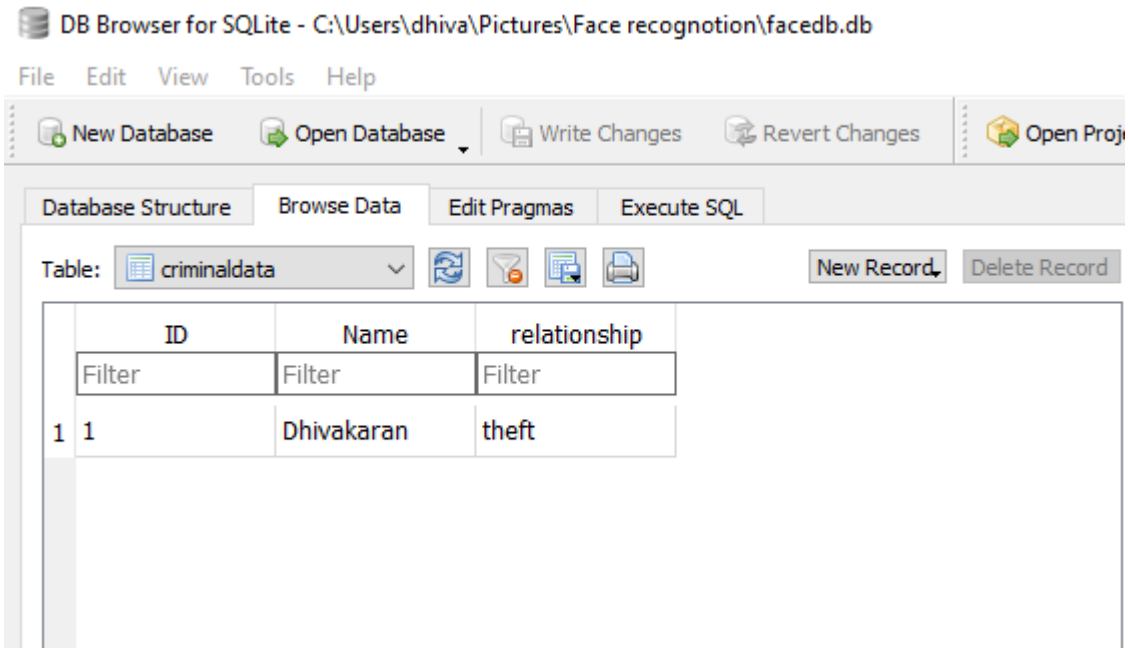
8.2.1 TRAINING DATASET



8.3 PROCESS 3

8.3.1 VERIFICATION AND VALIDATION

8.4 DATABASE



9. FACIAL RECOGNITION SYSTEM IN AIRPORT

Someday all youll need to identify yourself at an airport is your shining face and that day is not in some distant, sci-fi future. Test runs of facial-recognition technology (also known as biometrics) are popping up at airports around the country.

The goal of the system is to simplify and speed up the process of presenting documents to get on a flight.

After the first check-in, passengers can also use face recognition to pass through security and to get on the plane. The system prevents the need for travelers to present their passport up to four times during the usual check-in process.Travelers look into a camera that scans their face. This image is then compared against a collection of pictures kept by the Airlines. The agency collects face scans from passports and visas.The system, however, has raised concerns about privacy.

9.1. HOW IT WORKS

At the check-in desk or self-service kiosk, you can choose the biometric option and have your photo taken. The photo will then be matched with others in the Airline database, such as those for passports or visas. If there are no red flags, a green check mark will flash on the screen and you will be able to go directly to the security checkpoint (where your face will be scanned again), then to the gate (scanned again) and finally to your seat on the airplane.

Thats all without having to fish in your pocket for an ID. You'll still need to have your passport with you so you can display it, for example, when you arrive at your overseas destination.

10. ALGORITHMS

10.1. NEURAL NETWORKS WITH GABOR FILTERS

Bhuiyan et al. proposed in 2007 a neural network method combined with Gabor filter. Their algorithm achieves face recognition by implementing a multilayer perceptron with back-propagation algorithm. Firstly, there is a pre-processing step. Every image is normalized in terms of contrast and illumination. Noise is reduce by a fuzzily skewed filter. It works by applying fuzzy membership to the neighbor pixels of the target pixel. It uses the median value as the 1 value membership, and reduces the extreme values, taking advantage from median filter and average filter. Then, each image is processed through a Gabor filter. The filter is represented as a complex sinusoidal signal modulated by a Gaussian kernel function. The Gabor filter has five orientation parameters and three spatial frequencies, so there are 15 Gabor wavelets. The architecture of the neural network is illustrated in figure 1.10. To each face image, the outputs are 15 Gabor-images which record the variations measured by the Gabor filters. The first layer receives the Gabor features. The number of nodes is equal to the dimension of the feature vector containing the Gabor features. The output of the network is the number of images the system must recognize. The training of the network, the backpropagation algorithm, follows this procedure: 1. Initialization of the weights and threshold values. 2. Iterative process until termination condition is fulfilled: (a) Activate, applying input and desired outputs. Calculate actual outputs of neurons in hidden and

output layers, using sigmoid activation function. (b) Update wights, propagating backwards the errors. (c) Increase iteration value Although the algorithms main purpose is to face illumination

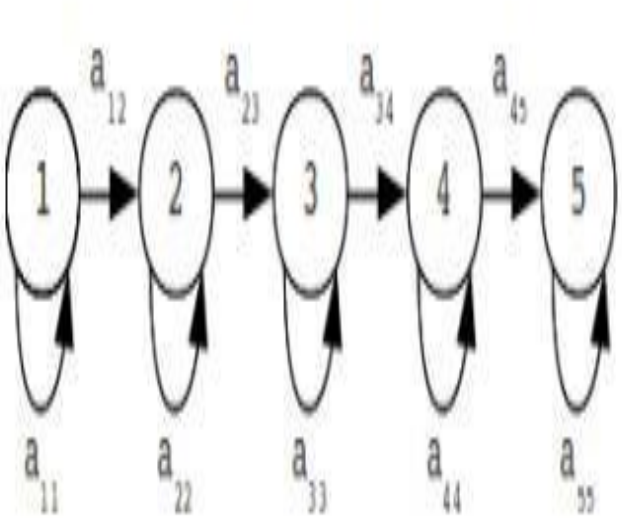


Figure 1: NETWORK LAYER DIAGRAM

variations, it shows a useful neural network application for face recognition. It could be useful with some improvements in order to deal with pose and occlusion problems.

10.1.1 PROCESS

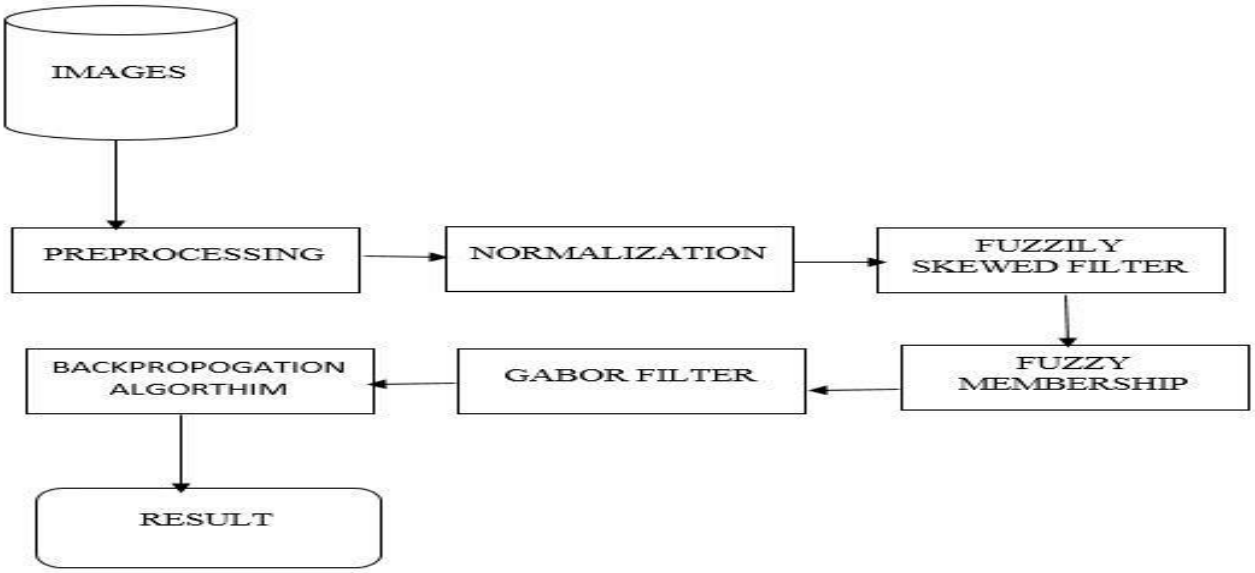


Figure 2: NETWORK LAYER DIAGRAM

10.2 NEURAL NETWORKS AND HIDDEN MARKOV MODELS

Hidden Markov Models (HMM) are a statistical tool used in face recognition. They has been used in conjunction with neural networks. Bevilacqua et. al have developed a neural network that trains pseudo two-dimensional HMM.

HMM can be defined as = (A, B,) :

A o= [aij] is a state transition probability matrix, where aij is the probability that the state i becomesthe state j.

B = [bj (k)] is a state transition probability matrix, where bj (k) is the probability to have the observationk when the state is j.

= 1, . . . , n is the initial state distribution, where i is the probability associated to state i. They propose a pseudo 2D-HMM, defining superstates formed by states, being the 3-6-6-6-3 the most successful configuration.

The input of this 2D-HMM process is the output of the artificial neural network (ANN). The ANN provides the algorithm with the proper dimensionality reduction. So, the input to the 2D-HMM are images compressed into observation vectors of binary elements. The ANN, using error back propagation algorithm, extracts main features and stores them in a 50 bit. sequence. The input face image is divided into 103 segments of 920 pixels, and each segment is divided into four 230 pixel features. So, the first and last layers are formed by 230 neurons each. The hidden layer is formed by 50 nodes. So a section of 920 pixels is compressed in four sub windows of 50 binary values each. The training function is iterated 200 times for each photo. Finally, the ANN is tested with images similar to the input image, doing this process for each image. This method showed promising results, achieving a 100 percent accuracy with ORL database.

10.3 FUZZY NEURAL NETWORKS

The introduction of fuzzy mathematics in neural networks for face recognition is another approach. Bhattacharjee et al. developed in 2009 a face recognition system using a fuzzy multilayer perceptron (MLP). The idea behind this approach is to capture decision surfaces in non-linear manifolds, a task that a simple MLP can hardly complete.

The feature vectors are obtained using Gabor wavelet transforms. The method used is similar to the one presented in point 10.1. Then, the output vectors obtained from that step must be fuzzified. This process is simple: The more a feature vector approaches towards the class mean vector, the higher is the fuzzy value. When the difference between both vectors increases,the fuzzy value approaches towards 0.

The selected neural network is a MLP using back-propagation. There is a network for each class. The examples of this class are class-one, and the examples of the other classes form the class two. Thus, is a two-class classification problem. The fuzzification of the neural network is based on the following idea: The patterns whose class is less certain should have lesser role in wight adjustment. So, for a two-class (i and j) fuzzy partition i(xk) k = 1, .. . , p of a set of p input vectors,

where di is the distance of the vector from the mean of class i. The constant c controls the rate at which fuzzy membership decreases towards 0.5. The contribution of xk in weight update is given by —1(xk) 2(xk)— m , where m is a constant, and the rest of the process follows a usual MLP procedure.
The results of the algorithm show a 2.125 error rate using ORL database.

$$\varphi i = 0.5 + \frac{e^{c(dj-di)/d} - e^{-c}}{2(e^{c} - e^{-c})}$$

$$\varphi j = 1 - \varphi i(x_k)$$

10.4 VIOLA JONES ALGORITHM

The Viola-Jones algorithm is a widely used mechanism for object detection. The main property of this algorithm is that training is slow, but detection is fast. This algorithm uses Haar basis feature filters, so it does not use multiplications.
The efficiency of the Viola-Jones algorithm can be significantly increased by first generating the integral image.
Detection happens inside a detection window. A minimum and maximum window size is chosen, and for each size a sliding step size is chosen. Then the detection window is moved across the image as follows: 1.Set the minimum window size, and sliding step corresponding to that size.

2.For the chosen window size, slide the window vertically and horizontally with the same step. At each step, a set ofNface recognition filters is applied. If one filter gives a positive answer, the face is detected in the current widow.
3.If the size of the window is the maximum size stop the procedure. Otherwise increase the size of the window and corresponding sliding step to the next chosen size and go to the step 2.
Each face recognition filter (from the set ofNfilters) contains a set of cascade-connected classifiers. Each classifier looks at a rectangular subset of the detection window and determines if it looks like a face. If it does, the next classifier is applied. If all classifiers give a positive answer, the filter gives a positive answer and the face is recognized. Otherwise the next filter in the set ofNfilters is run.

10.5 MEMTIC ALGORITHM APPROACH

The use of multi-label classification, i.e., assigning unseen patterns to multiple categories, has emerged in modern applications. A genetic-algorithm based multi-label feature selection method has been considered useful because it successfully improves the accuracy of multi-label classification. However, genetic algorithms are limited to identify fine-tuned feature subsets that are close to the global optimum, which results in a long runtime. In this paper, we present a memetic feature selection algorithm for multi-label classification that prevents premature convergence and improves the efficiency. The proposed method employs memetic procedures to refine the feature subsets found through a genetic search, resulting in an improvement in multi-label classification.

10.6 PSEUDO CODE FOR MEMTIC ALGORITHM APPROACH

```
Procedure MA
begin
 generate random population of P solutions (chromosomes);
 for each individual i∈P: calculate fitness(i);
    for j=1 to #generations
       for each individual i∈P: do i=Local-Search(i);
          for crossover
             select two parents i_a, i_b∈P randomly;
             generate offspring i_c=Crossover(i_a, i_b);
             i_c=Local-Search(i_c);
             add individual i_c to P;
          end for
          for mutation
             select an individual i∈P randomly;
             generate offspring i_c=Mutate(i);
             i_c=Local-Search(i_c);
             add individual i_c to P;
          end for
          P=select(P);
          j=j+1;
    end for
 end
```

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