Math Report

Linear Algebra in Facial Recognition

E -22

Done by –

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1.INTRODUCTION

1.1 Linear Algebra

A branch of mathematics that is concerned with mathematical structures closed under the operations of addition and scalar multiplication and that includes the theory of systems of linear equations, matrices, determinants, vector spaces, and linear transformations.

Applications of Linear Algebra:

- Traffic Signals
- Face Recognition
- Genetics
- Image Processing
- Google Search
- Cryptography
- Computer Graphics

1.2 Facial Recognition

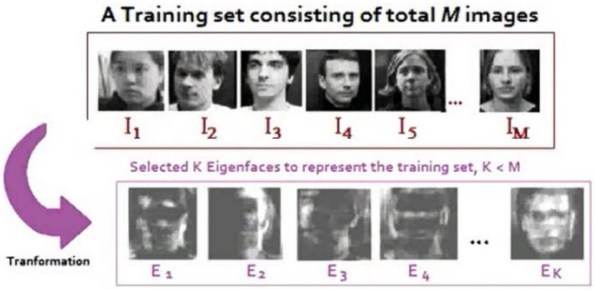
Face recognition is a technology capable of identifying or verifying a subject through an image, video or any audiovisual element of his face. It is a method of biometric identification that uses that body measures to verify the identity of a person through its facial biometric pattern and data. The technology collects a set of unique biometric data of each person associated with their face and facial expression to identify, verify and/or authenticate a person.

1.2.1 Working

Face recognition systems work by capturing an incoming image from a camera device. These ones compare the relevant information of the incoming image signal in real-time in photo or video in a database. In this comparison of faces, it analyses mathematically the incoming image without any margin of error and it verifies that the biometric data matches the person. The use of artificial intelligence (AI) and machine learning technologies, face recognition systems can operate with the highest safety and reliability standards.

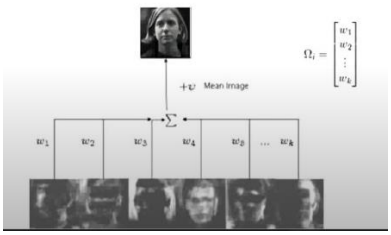
2.Facial Recognition using PCA

PCA is a mathematical procedure that uses orthogonal transformation to convert a set of values of possibly corelated M variables into a set of values of K uncorrelated variables called the Principle Components. The number of principle components is always less than or equal to the number of original variables i.e. K<M.



The transformation is defined in such a way that the first principal component shows the most dominant "direction"/" features" of the data set and each succeeding component in turn shows the next most possible dominant "direction"/ "features" under the constraint that it be uncorrelated the proceeding components.

Therefore, each variable in the original dataset can be represented in terms of these k principle components.

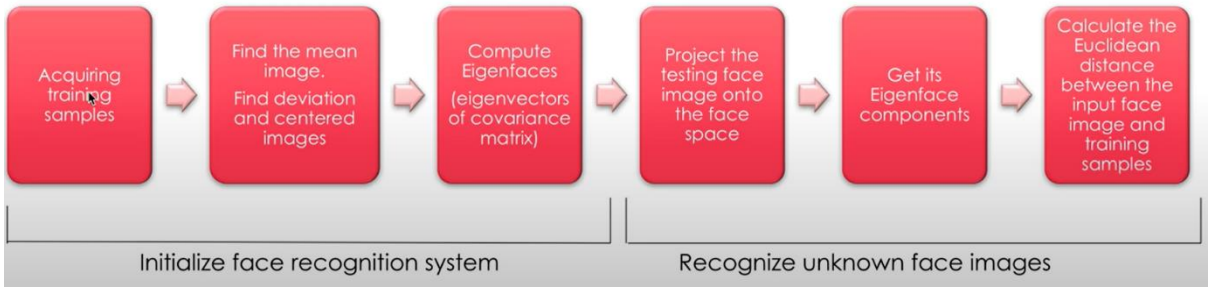


Representing a data point this way reduces the no. of values needed to recognize it.

2.1 Eigenface Approach

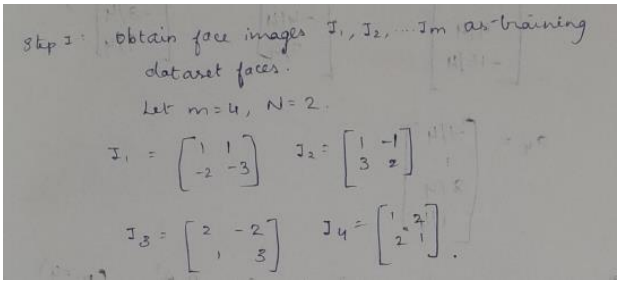
Eigenfaces are the eigenvectors of the covariance matrix of the dataset. Eigenfaces are also referred to as Ghostly Images.Prime reason – To represent the input data efficiently, each individual faces are be represented in terms of linear combination of eigenfaces. Need to reduce dimensionality – PCA.

2.2 Recognition Process

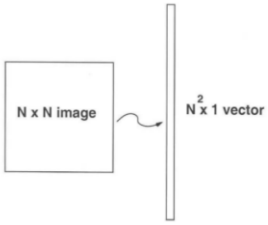


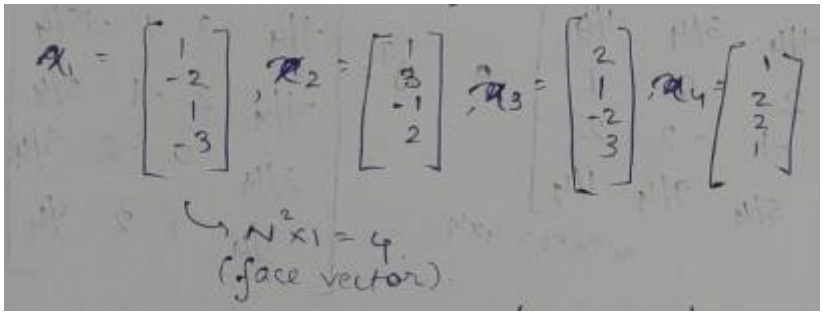
2.2.1 Step 1 – Obtain Data

Obtain a set of images which forms a data set and will be considered for the face recognition process.



2.2.2 Step 2 – Convert the image into vectors

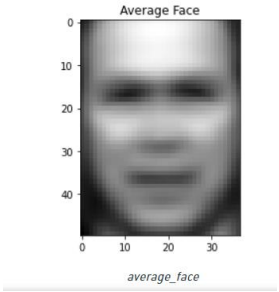


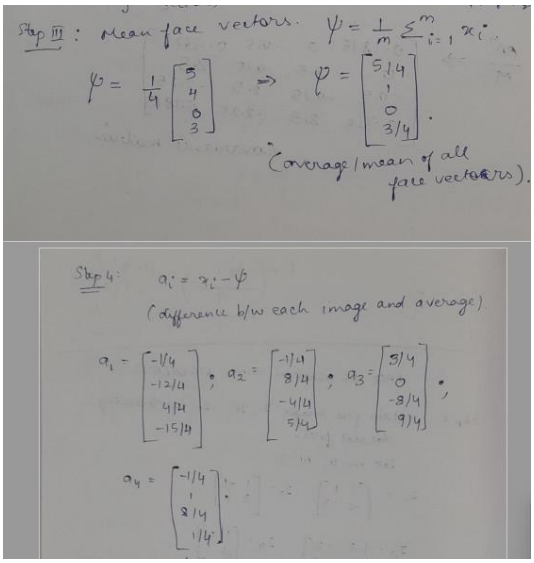


2.2.3 Step 3 - Calculate the average of all these face vectors and subtract it from each vector.

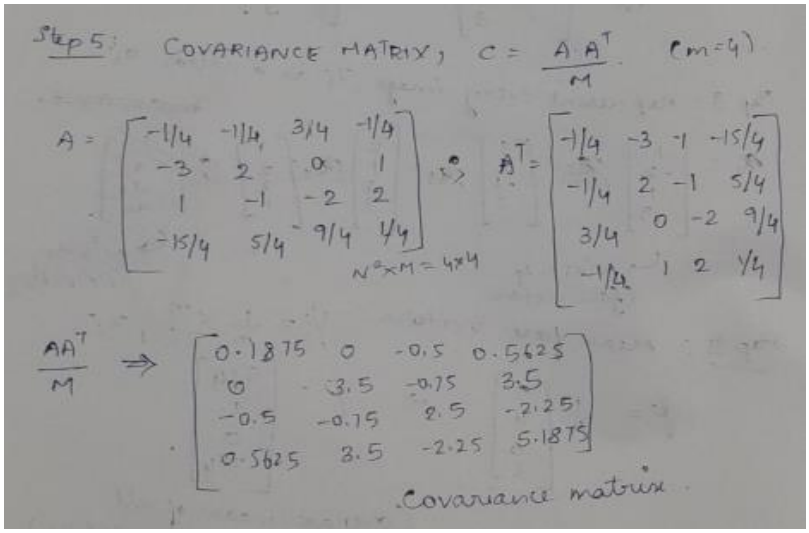
$$\psi = \frac{1}{m}\sum_{i=1}^{m} x_i$$

$$\mathrm{a}_i = x_i - \psi$$

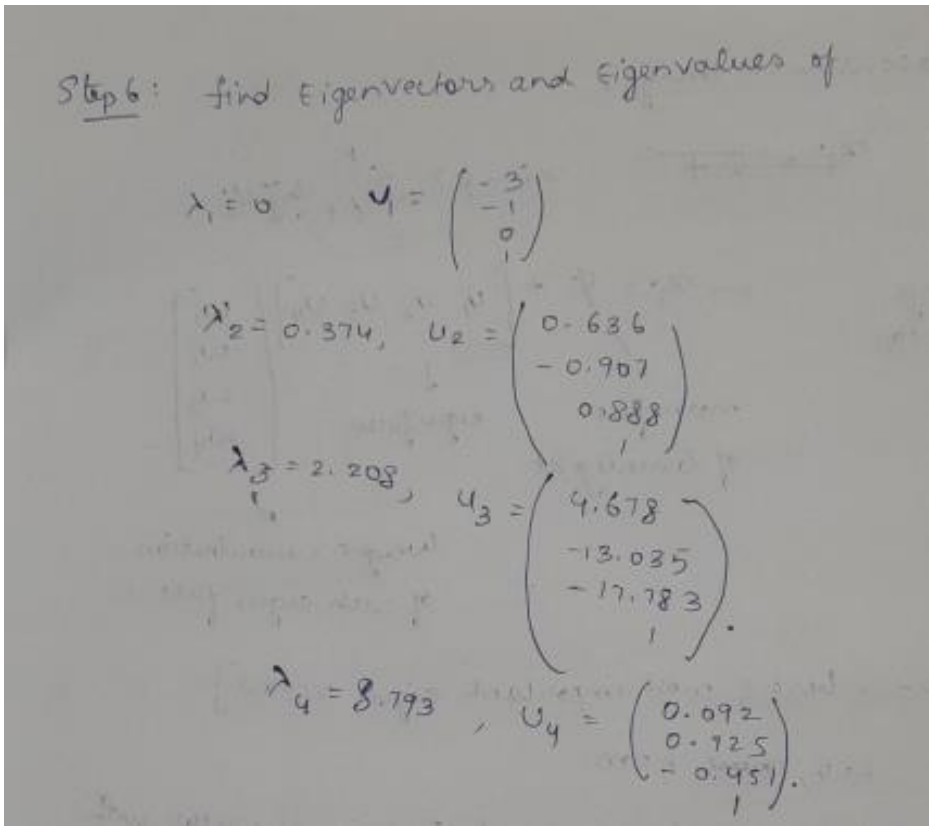




2.2.4 Step 4 – Find the Covariance Matrix

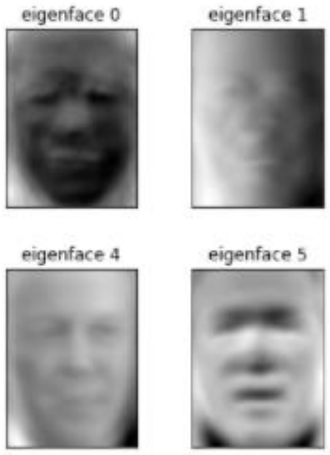


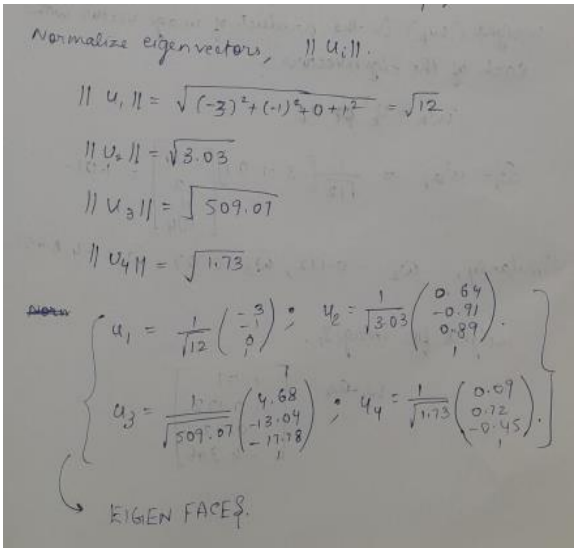
2.2.5 Step 5 – Find the eigenvalues and eigenvectors of covariance matrix



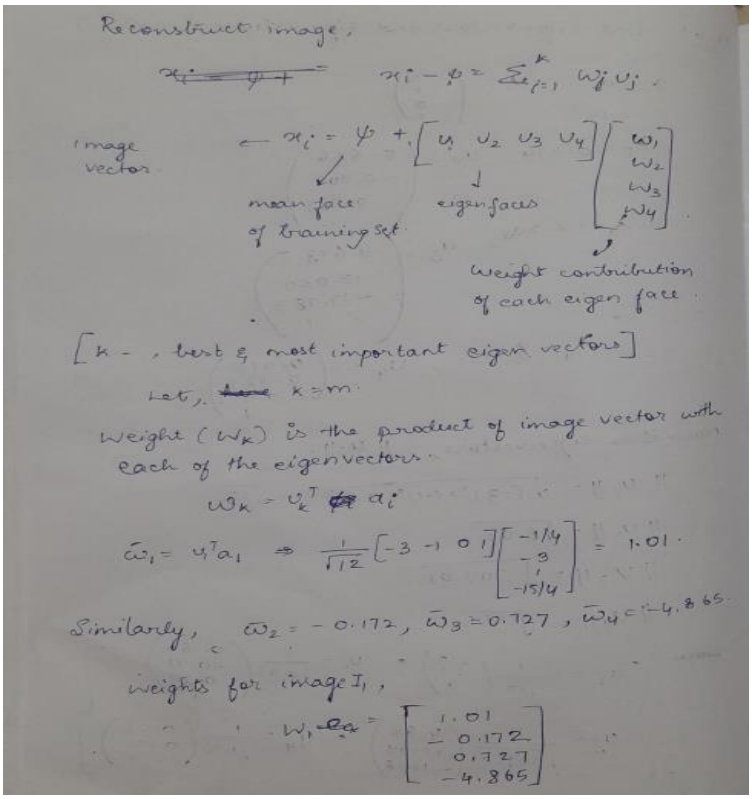
2.2.6 Step 6 – Find Eigen faces

$$x_i - \psi = \sum_{j=1}^{K} w_j u_j$$

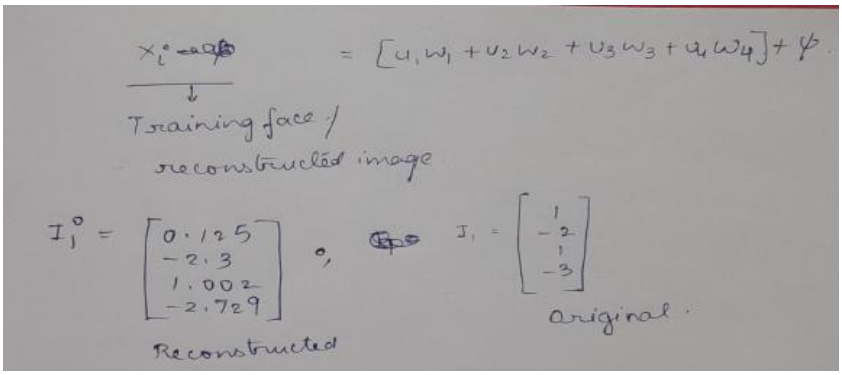




2.2.7 Step 7 - Reconstruct the image and find the training image

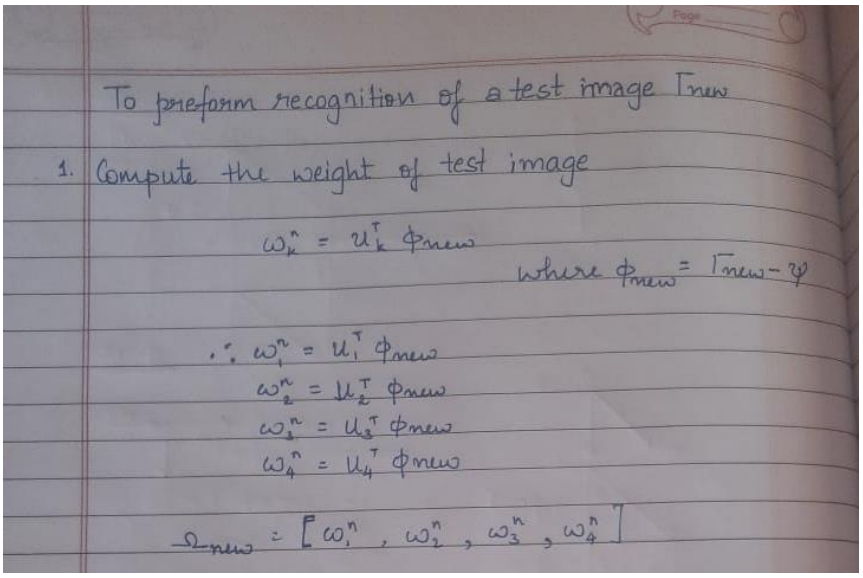


$$x_i - \psi = \sum_{j=1}^{K} w_j u_j$$



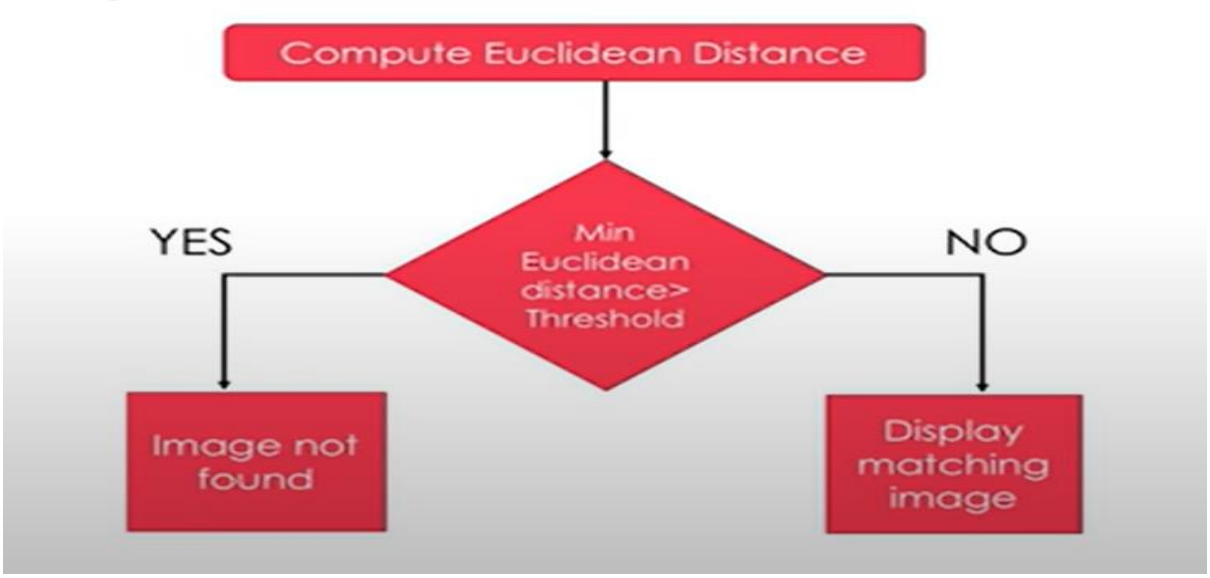
2.2.8 Recognize an image

Image that needs to be recognized is fed into the program. By the previous steps the eigen components of the image are obtained.



2.2.9 Compute the Euclidean Distance

Euclidean distances between the eigen face of the test image and previous computed eigen faces are evaluated.



Euclidean distance e_d between weight matrix Ω_{new} & each face class Ω_k

$$\|\Omega_{new} - \Omega_k\| = \sum_{i=1}^{m} (\omega_i^n - \omega_i^k)^2$$

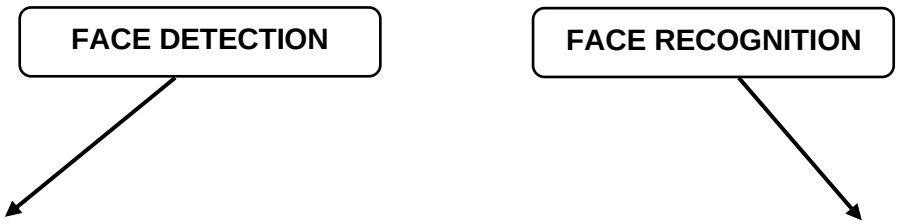
When minimum e_d < Threshold (T), the new face or test face is classified as belonging to the class k. otherwise the test face is classified as UNKNOWN

Threshold (T) is usually taken as half the largest distance blw any two face images in the training set

$$T = \frac{1}{2} \max_{j,k} \|\Omega_j - \Omega_k\| \cdot \quad j, k = 1, 2, 3 \ldots m$$

3. MATLAB Simulation

3.1 Face Detection vs Face Recognition



Face Verification

(Face or No Face Decision)

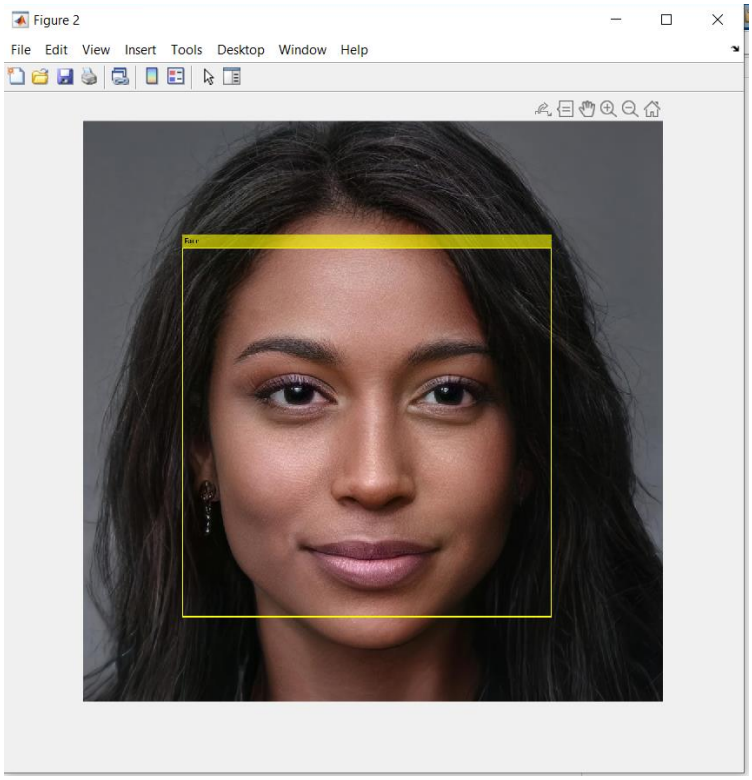
Face Identification

(Identification of whose image among all images)

3.2 MATLAB Code

```
%% face detect
[file,path]=uigetfile('*.*','Select image')
loc=strcat(path,file)
pic=imread(loc);
pic2=rgb2gray(pic);
%face
ff=vision.CascadeObjectDetector();
bbox=step(ff,pic2)
dd=insertObjectAnnotation(pic,'Rectangle',bbox,'Face','LineWidth',2);
pts=detectMinEigenFeatures(pic2,'ROI',bbox)
imshow(dd);
hold on
```

3.3 MATLAB Output



4.ANIMATION OF A LINE

4.1 Srinidhi Kannan (BL.EN.U4AIE21121)

4.1.1 MATLAB Code

```
%body
A1=[3;1.3];B1=[5;1.3];C1=[3;4];D1=[5;4];E1=[3;1.29];
for lamda=0:0.01:1
    x=(1-lamda)*A1+lamda*B1;
    plot(x(1,1),x(2,1),'r.','MarkerSize',12);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*B1+lamda*C1;
    plot(x(1,1),x(2,1),'r.','MarkerSize',12);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*C1+lamda*D1;
    plot(x(1,1),x(2,1),'r.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*D1+lamda*E1;
    plot(x(1,1),x(2,1),'r.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
%legs
A2=[3.5;1.2];B2=[3.5;0];
for lamda=0:0.01:1
    x=(1-lamda)*A2+lamda*B2;
    plot(x(1,1),x(2,1),'k.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
A3=[4.5;1.2];B3=[4.5;0];
for lamda=0:0.01:1
    x=(1-lamda)*A3+lamda*B3;
    plot(x(1,1),x(2,1),'k.','MarkerSize',12);
```

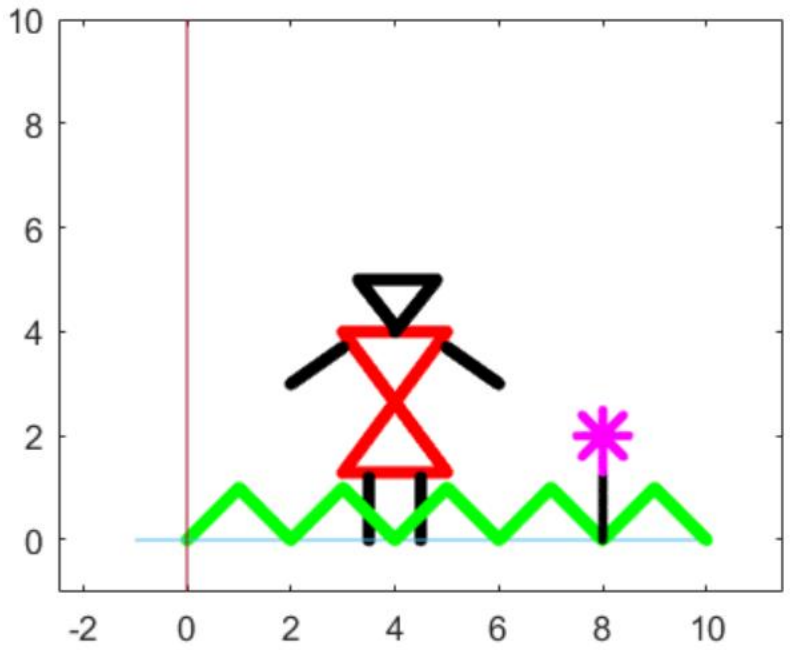
```
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
%hands
A4=[3;3.7];B4=[2;3];
for lamda=0:0.01:1
    x=(1-lamda)*A4+lamda*B4;
    plot(x(1,1),x(2,1),'k.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
A5=[5;3.7];B5=[6;3];
for lamda=0:0.01:1
    x=(1-lamda)*A5+lamda*B5;
    plot(x(1,1),x(2,1),'k.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
%face
A6=[4;4.1];B6=[3.3;5];C6=[4.8;5];D6=[4;4];
for lamda=0:0.01:1
    x=(1-lamda)*A6+lamda*B6;
    plot(x(1,1),x(2,1),'k.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*B6+lamda*C6;
    plot(x(1,1),x(2,1),'k.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*C6+lamda*D6;
    plot(x(1,1),x(2,1),'k.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
%grass
A=[0;0];B=[1;1];C=[2;0];D=[3;1];E=[4;0];F=[5;1];G=[6;0];H=[7;1];I=[8;0];J=[9;1
];K=[10;0];
```

```
for lamda=0:0.01:1
    x=(1-lamda)*A+lamda*B;
    plot(x(1,1),x(2,1),'g.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    plot([-1,10],[0,0])
    plot([0,0],[-1,10])
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*B+lamda*C;
    plot(x(1,1),x(2,1),'g.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*C+lamda*D;
    plot(x(1,1),x(2,1),'g.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*D+lamda*E;
    plot(x(1,1),x(2,1),'g.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*E+lamda*F;
    plot(x(1,1),x(2,1),'g.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*F+lamda*G;
    plot(x(1,1),x(2,1),'g.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*G+lamda*H;
    plot(x(1,1),x(2,1),'g.','MarkerSize',12);
```

```
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*H+lamda*I;
    plot(x(1,1),x(2,1),'g.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*I+lamda*J;
    plot(x(1,1),x(2,1),'g.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
for lamda=0:0.01:1
    x=(1-lamda)*J+lamda*K;
    plot(x(1,1),x(2,1),'g.','MarkerSize',12);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
%flower
A6=[8;0];B6=[8;1.5];
for lamda=0:0.01:1
    x=(1-lamda)*A6+lamda*B6;
    plot(x(1,1),x(2,1),'k.','MarkerSize',8);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
A7=[8;1.3];B7=[8;2.5];
for lamda=0:0.01:1
    x=(1-lamda)*A7+lamda*B7;
    plot(x(1,1),x(2,1),'m.','MarkerSize',8);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
A8=[7.5;2];B8=[8.5;2];
for lamda=0:0.01:1
    x=(1-lamda)*A8+lamda*B8;
    plot(x(1,1),x(2,1),'m.','MarkerSize',8);
    pause(0.01);
```

```
    hold on
    axis('equal')
    drawnow
end
A9=[8.4;2.4];B9=[7.6;1.6];
for lamda=0:0.01:1
    x=(1-lamda)*A9+lamda*B9;
    plot(x(1,1),x(2,1),'m.','MarkerSize',8);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
A10=[7.6;2.4];B10=[8.4;1.6];
for lamda=0:0.01:1
    x=(1-lamda)*A10+lamda*B10;
    plot(x(1,1),x(2,1),'m.','MarkerSize',8);
    pause(0.01);
    hold on
    axis('equal')
    drawnow
end
```

4.1.2 MATLAB Output



4.2 Suryamritha M (BL.EN.U4AIE21126)

4.2.1 MATLAB Code

```
clf
XA=[2;0];XB=[8;0];XC=[2;10];XD=[8;10];XE=[4;10];XF=[6;10];XG=[6;12];XH=[4;12];
XI=[2;12];XJ=[8;12];XK=[2;16];XL=[8;16];XM=[0;8.5];XN=[1;8];XO=[9;8];XP=[10;8.
5]
XQ=[-4;6];XR=[-
3;6];XS=[13;6];XT=[14;6];XU=[3.5;16];XV=[6.5;16];XW=[1.5;17.5],XX=[2.5;18.5]
XY=[7.5;18.5];XZ=[8.5;17.5];XAA=[2;-3];XBB=[4;-3];XCC=[4;0];XDD=[6;0];XEE=[6;-
3];XFF=[8;-3];
XGG=[1.5;-5];XHH=[4.5;-5];XII=[5.5;-5];XJJ=[8.5;-
5];XKK=[4;13.5];XLL=[6;13.5];XMM=[4;13];
XNN=[6;13];XOO=[2;15.5];XQQ=[1.5;15.5];XRR=[1.5;13.5];XPP=[2;13.5];XSS=[8;15.5
];XTT=[8.5;15.5];
XVV=[8.5;13.5];XUU=[8;13.5];XYY=[4;15];XWW=[3.5;14.5];XXX=[4.5;14.5];XZZ=[6;15
];
XA3=[5.5;14.5];XB3=[6.5;14.5];XC3=[5;1];XD3=[7;5];XE3=[5;9];XF3=[3;5];
XG3=[11;10];XH3=[11;13];XI3=[13;13];XJ3=[13;10];XK3=[11;12];XL3=[13;12];
XM3=[14;13];XN3=[14;10]
for lamda=-0:0.05:1
    x=(1-lamda)*XA+lamda*XB;
    plot(x(1,1),x(2,1),'black.','MarkerSize',20)
    pause(0.05);
    hold on
    axis('equal')
    plot([0,20],[0,0])
    plot([0,0],[-5,10])
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XB+lamda*XD;
    plot(x(1,1),x(2,1),'black.','MarkerSize',20)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XD+lamda*XC;
    plot(x(1,1),x(2,1),'b.','MarkerSize',20)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XC+lamda*XA;
    plot(x(1,1),x(2,1),'black.','MarkerSize',20)
    pause(0.0001);
    hold on
    drawnow
end
for lamda=0:0.05:1
```

```
    x=(1-lamda)*XE+lamda*XF;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XF+lamda*XG;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XG+lamda*XH;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XH+lamda*XE;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XH+lamda*XI;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XH+lamda*XJ;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XH+lamda*XJ;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XJ+lamda*XL;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
```

```
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XL+lamda*XK;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XK+lamda*XI;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XU+lamda*XX;
    plot(x(1,1),x(2,1),'c.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XX+lamda*XW;
    plot(x(1,1),x(2,1),'c.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XW+lamda*XU;
    plot(x(1,1),x(2,1),'c.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XV+lamda*XY;
    plot(x(1,1),x(2,1),'c.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XY+lamda*XZ;
    plot(x(1,1),x(2,1),'c.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XZ+lamda*XV;
```

```
    plot(x(1,1),x(2,1),'c.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XC+lamda*XM;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XM+lamda*XN;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XN+lamda*XC;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XD+lamda*XP;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XP+lamda*XO;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XO+lamda*XD;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XM+lamda*XQ;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
```

```
end
for lamda=0:0.05:1
    x=(1-lamda)*XN+lamda*XR;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XR+lamda*XQ;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XP+lamda*XT;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XT+lamda*XS;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end


for lamda=0:0.05:1
    x=(1-lamda)*XS+lamda*XO;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XA+lamda*XAA;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XAA+lamda*XBB;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
```

```
    x=(1-lamda)*XBB+lamda*XCC;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XB+lamda*XFF;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XFF+lamda*XEE;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XEE+lamda*XDD;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XEE+lamda*XII;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XII+lamda*XJJ;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XJJ+lamda*XFF;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XAA+lamda*XGG;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
```

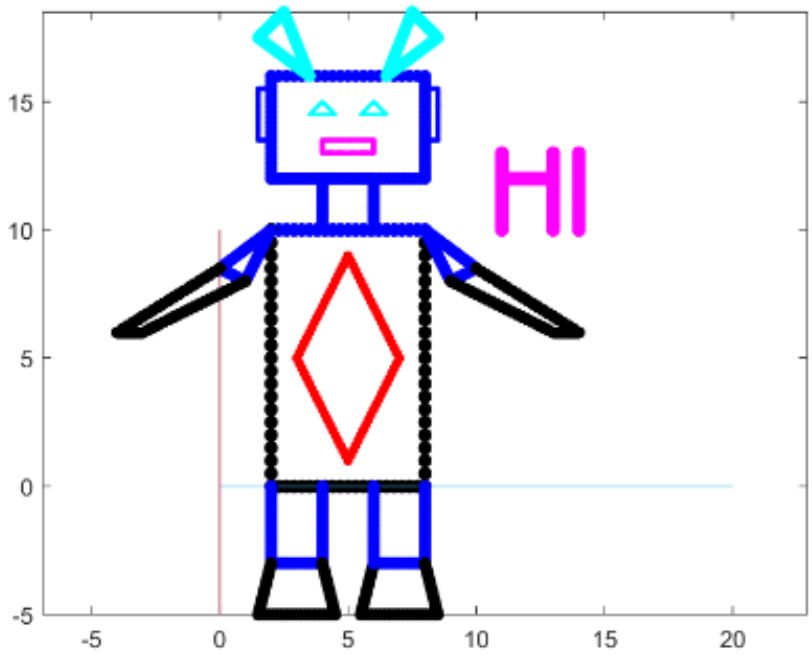
```
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XGG+lamda*XHH;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XHH+lamda*XBB;
    plot(x(1,1),x(2,1),'black.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XEE+lamda*XDD;
    plot(x(1,1),x(2,1),'b.','MarkerSize',18)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XKK+lamda*XLL;
    plot(x(1,1),x(2,1),'m.','MarkerSize',8)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XLL+lamda*XNN;
    plot(x(1,1),x(2,1),'m.','MarkerSize',8)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XNN+lamda*XMM;
    plot(x(1,1),x(2,1),'m.','MarkerSize',8)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XMM+lamda*XKK;
    plot(x(1,1),x(2,1),'m.','MarkerSize',8)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XOO+lamda*XQQ;
```

```
    plot(x(1,1),x(2,1),'b.','MarkerSize',8)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XQQ+lamda*XRR;
    plot(x(1,1),x(2,1),'b.','MarkerSize',8)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XRR+lamda*XPP;
    plot(x(1,1),x(2,1),'b.','MarkerSize',8)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XSS+lamda*XTT;
    plot(x(1,1),x(2,1),'b.','MarkerSize',8)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XTT+lamda*XVV;
    plot(x(1,1),x(2,1),'b.','MarkerSize',8)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XVV+lamda*XUU;
    plot(x(1,1),x(2,1),'b.','MarkerSize',8)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XYY+lamda*XWW;
    plot(x(1,1),x(2,1),'c.','MarkerSize',6)
    pause(0.000001);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XWW+lamda*XXX;
    plot(x(1,1),x(2,1),'c.','MarkerSize',6)
    pause(0.05);
    hold on
    drawnow
```

```
end
for lamda=0:0.05:1
    x=(1-lamda)*XXX+lamda*XYY;
    plot(x(1,1),x(2,1),'c.','MarkerSize',6)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XZZ+lamda*XA3;
    plot(x(1,1),x(2,1),'c.','MarkerSize',6)
    pause(0.000001);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XA3+lamda*XB3;
    plot(x(1,1),x(2,1),'c.','MarkerSize',6)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XB3+lamda*XZZ;
    plot(x(1,1),x(2,1),'c.','MarkerSize',6)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XC3+lamda*XD3;
    plot(x(1,1),x(2,1),'red.','MarkerSize',14)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XD3+lamda*XE3;
    plot(x(1,1),x(2,1),'red.','MarkerSize',14)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XE3+lamda*XF3;
    plot(x(1,1),x(2,1),'red.','MarkerSize',14)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XF3+lamda*XC3;
    plot(x(1,1),x(2,1),'red.','MarkerSize',14)
```

```
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XK3+lamda*XL3;
    plot(x(1,1),x(2,1),'m.','MarkerSize',20)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XH3+lamda*XG3;
    plot(x(1,1),x(2,1),'m.','MarkerSize',20)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XI3+lamda*XJ3;
    plot(x(1,1),x(2,1),'m.','MarkerSize',20)
    pause(0.05);
    hold on
    drawnow
end
for lamda=0:0.05:1
    x=(1-lamda)*XM3+lamda*XN3;
    plot(x(1,1),x(2,1),'m.','MarkerSize',20)
    pause(0.05);
    hold on
    drawnow
end
```

4.2.2 MATLAB Output



4.3 Varshini Balaji (BL.EN.U4AIE21139)

4.3.1 MATLAB Code

```
clf;
hold off;
fill([-15 -15 15 15],[-15 10 10 -15],'k');
hold on;
%% 1
g=[-3.5;0];h=[-3;1];i=[-2;0];
for lambda=0:0.05:1
    x=(1-lambda)*g+lambda*h;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    hold on
    axis('equal')
    plot([-15,15],[0,0],'k')
    plot([0,0],[-15,10],'k')
    drawnow
end
hold on
for lambda=0:0.05:1
    x=(1-lambda)*i+lambda*h;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.00001);
    drawnow
end
plot(-3, 2, '.c', 'MarkerSize',30)
%% 2
d=[-2;0];e=[-1;2.5];f=[0;0];
for lambda=0:0.05:1
    x=(1-lambda)*e+lambda*d;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.00001);
    drawnow
end
hold on
for lambda=0:0.05:1
    x=(1-lambda)*f+lambda*e;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.00001);
    drawnow
end
plot(-1, 3.5, '.c', 'MarkerSize',32)
%% 3
a=[0;0];b=[2;5];c=[4;0];
for lambda=0:0.05:1
    x=(1-lambda)*a+lambda*b;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.005);
    drawnow
end
hold on
```

```
for lambda=0:0.05:1
    x=(1-lambda)*c+lambda*b;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.005);
    drawnow
end
plot(2, 6, '.c', 'MarkerSize',35)
%% 4
j=[4;0];k=[5;2];l=[6;0];
for lambda=0:0.05:1
    x=(1-lambda)*j+lambda*k;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
for lambda=0:0.05:1
    x=(1-lambda)*l+lambda*k;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
plot(5, 3, '.c', 'MarkerSize',32)
%% 5
m=[6;0];n=[7;1];o=[7.5;0];
for lambda=0:0.05:1
    x=(1-lambda)*m+lambda*n;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
for lambda=0:0.05:1
    x=(1-lambda)*o+lambda*n;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
plot(7, 2, '.c', 'MarkerSize',30)
% base
hold on
p=[-3.5;0];q=[-2;-4];
for lambda=0:0.05:1
    x=(1-lambda)*q+lambda*p;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
r=[6;-4];s=[7.5;0];
for lambda=0:0.05:1
    x=(1-lambda)*r+lambda*s;
    plot(x(1,1),x(2,1),'w.','markersize',25)
```

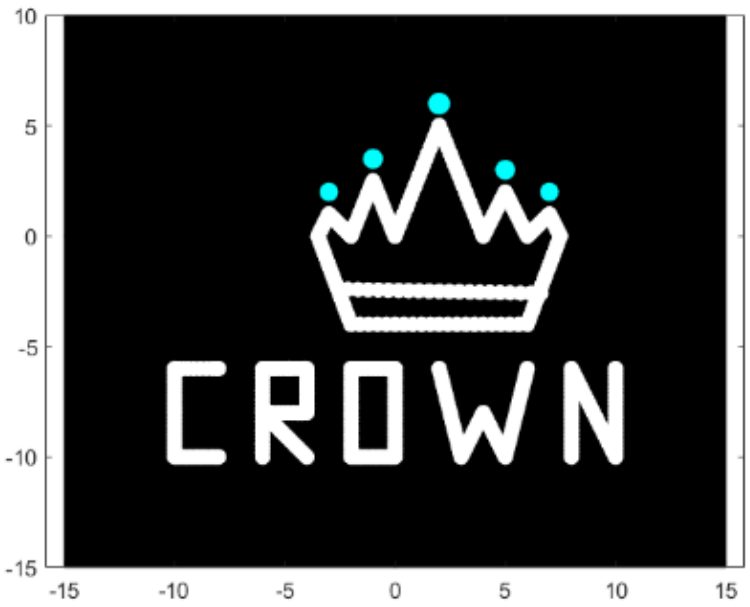
```
    pause(0.05);
    drawnow
end
hold on
t=[-2;-4];u=[6;-4];
for lambda=0:0.05:1
    x=(1-lambda)*t+lambda*u;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
v=[-2.6;-2.4];w=[6.6;-2.6];
for lambda=0:0.05:1
    x=(1-lambda)*v+lambda*w;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
% WORDINGS
x=[-8;-6];y=[-10;-6];
for lambda=0:0.05:1
    x=(1-lambda)*x+lambda*y;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
z=[-10;-6];aa=[-10;-10];
for lambda=0:0.05:1
    x=(1-lambda)*z+lambda*aa;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
bb=[-10;-10];cc=[-8;-10];
for lambda=0:0.05:1
    x=(1-lambda)*bb+lambda*cc;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
dd=[-6;-6];ee=[-6;-10];
for lambda=0:0.05:1
    x=(1-lambda)*dd+lambda*ee;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
```

```
ff=[-6;-6];gg=[-4;-6];
for lambda=0:0.05:1
    x=(1-lambda)*ff+lambda*gg;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
hh=[-4;-6];ii=[-4;-8];
for lambda=0:0.05:1
    x=(1-lambda)*hh+lambda*ii;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
jj=[-4;-8];kk=[-6;-8];
for lambda=0:0.05:1
    x=(1-lambda)*jj+lambda*kk;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
ll=[-6;-8];mm=[-4;-10];
for lambda=0:0.05:1
    x=(1-lambda)*mm+lambda*ll;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
nn=[-2;-6];oo=[-2;-10];
for lambda=0:0.05:1
    x=(1-lambda)*nn+lambda*oo;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
pp=[-2;-10];qq=[0;-10];
for lambda=0:0.05:1
    x=(1-lambda)*pp+lambda*qq;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
rr=[0;-10];ss=[0;-6];
for lambda=0:0.05:1
    x=(1-lambda)*rr+lambda*ss;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
```

```
    drawnow
end
hold on
tt=[0;-6];uu=[-2;-6];
for lambda=0:0.05:1
    x=(1-lambda)*tt+lambda*uu;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
vv=[2;-6];ww=[3;-10];
for lambda=0:0.05:1
    x=(1-lambda)*ww+lambda*vv;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
xx=[3;-10];yy=[4;-8];
for lambda=0:0.05:1
    x=(1-lambda)*xx+lambda*yy;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
zz=[4;-8];a1=[5;-10];
for lambda=0:0.05:1
    x=(1-lambda)*a1+lambda*zz;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
a2=[5;-10];a3=[6;-6];
for lambda=0:0.05:1
    x=(1-lambda)*a2+lambda*a3;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
a4=[8;-10];a5=[8;-6];
for lambda=0:0.05:1
    x=(1-lambda)*a4+lambda*a5;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
a6=[8;-6];a7=[10;-10];
for lambda=0:0.05:1
```

```
    x=(1-lambda)*a7+lambda*a6;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
hold on
a8=[10;-10];a9=[10;-6];
for lambda=0:0.05:1
    x=(1-lambda)*a8+lambda*a9;
    plot(x(1,1),x(2,1),'w.','markersize',25)
    pause(0.05);
    drawnow
end
```

4.3.2 MATLAB Output



5.REFERENCES

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- **https://youtu.be/61NuFlK5VdU**
- **https://youtu.be/R0Cm7zKIJI8**
- **https://www.geeksforgeeks.org/ml-face-recognition-using-eigenfaces-pca-algorithm/**