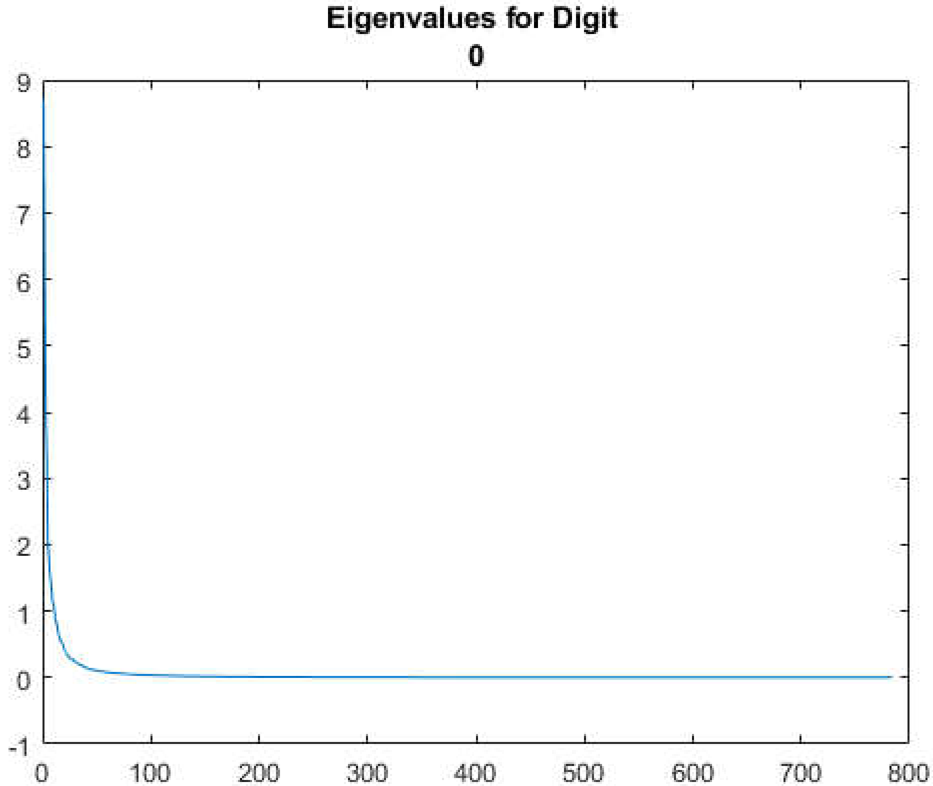
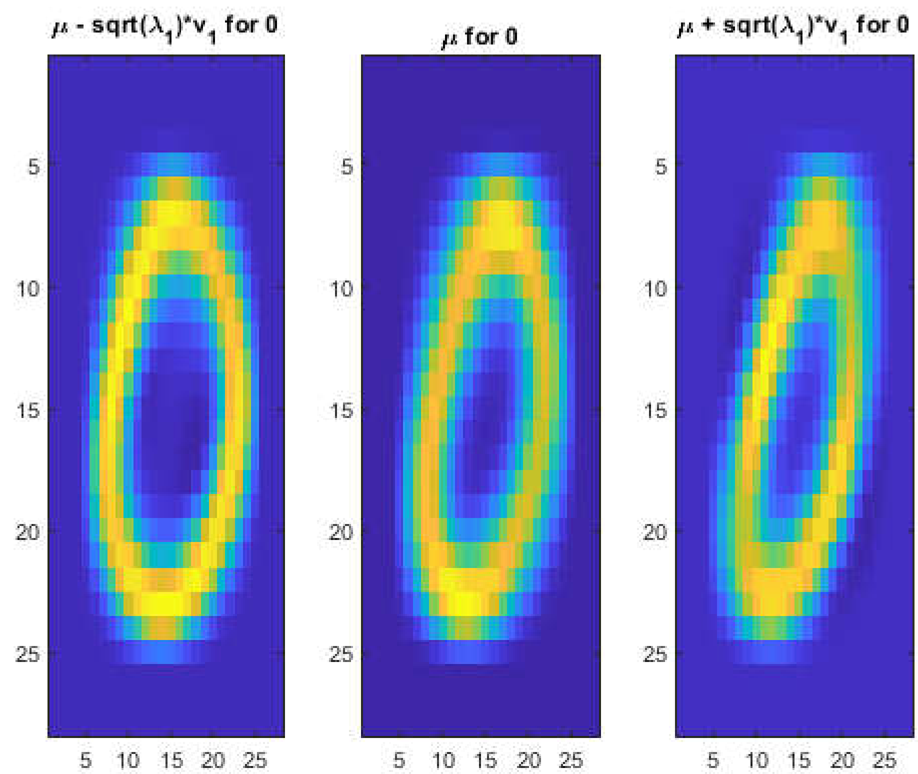
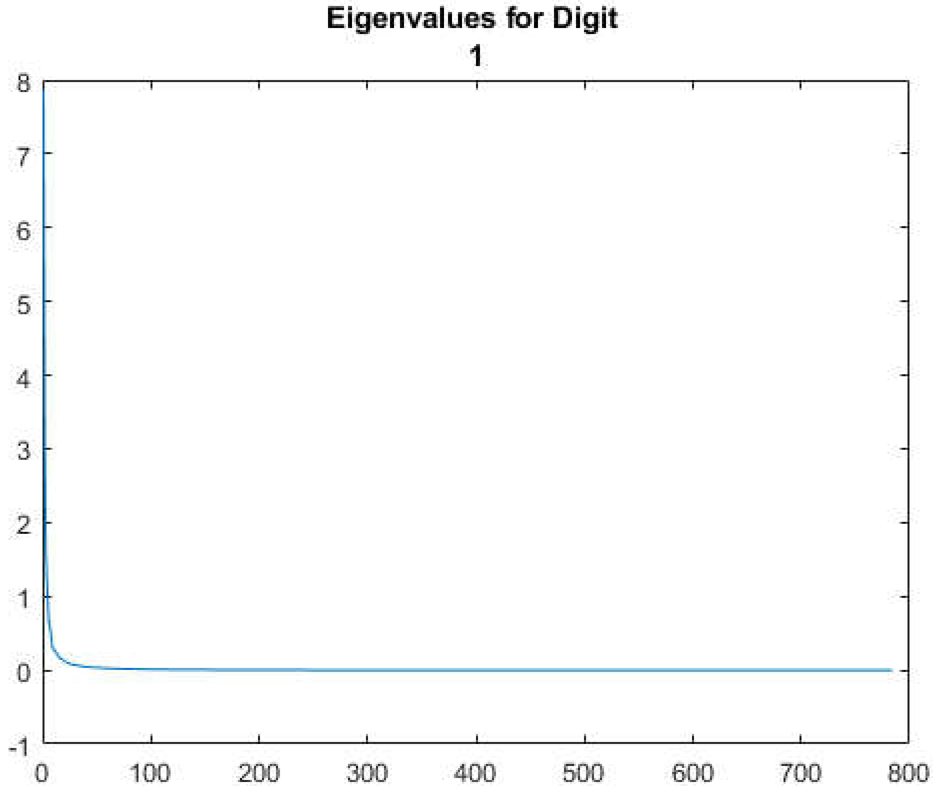
```
load("mnist.mat");
%Iterate through each digit
for d=0:9
   digits = digits_train(:, :, labels_train==d); %get images corresponding to the image
   digits = reshape(im2double(digits), [784 size(digits, 3)]);
   % reshape the images into a vector of size 784.
   % Every column corresponds to one image
   % each row has the pixel intensity for one particular location

   mean_vector = sum(digits, 2)/size(digits, 2);
   %calculate mean = sum/number for each of the 784 component

   digits = digits - mean_vector;
   % subtract mean from data. done to center the image on the mean.
   % Since we have mean, we can retrieve original image by just adding the mean

   cov = digits*digits'/size(digits, 2);
   % calculate the co-variance matrix for the data
   % the MLE estimate is used for the covariance matrix

   [V, D] = eig(cov);
   % Eigen value decomposition for the co variance matrix
   % it returns the eigenvalues in the diagonal matrix D and corresponding
   % unit eigen vectors in V

   [~, i] = sort(diag(D), 'descend');
   % get the index permutation correspoding to decreasing sort of eigen values
   % this is done so that we can sort the eigenvectors acc. to eigenvalues

   V = V(:, i); %sort the eigen vectors
   D = D(i, i); %sort the eigen values

   v1 = V(:, 1); %eigen vector with maximum eigen vector
   lambda1 = D(1, 1); %maximum eigen value. Note D is diagonal matrix

   figure;
   plot(diag(D)); %plot the eigen values
   title(["Eigenvalues for Digit " num2str(d)]);

   %show the three images mu, mu-sqrt(l)v, mu + sqrt(l)v
   figure;
   subplot(1,3,1); imagesc(reshape(mean_vector - sqrt(lambda1)*v1,[28 28]));
   title("\mu - sqrt(\lambda_1)*v_1 for " + string(d))
   subplot(1,3,2); imagesc(reshape(mean_vector,[28 28]));
   title("\mu for " + string(d))
   subplot(1,3,3); imagesc(reshape(mean_vector + sqrt(lambda1)*v1,[28 28]));
   title("\mu + sqrt(\lambda_1)*v_1 for " + string(d))
end
```

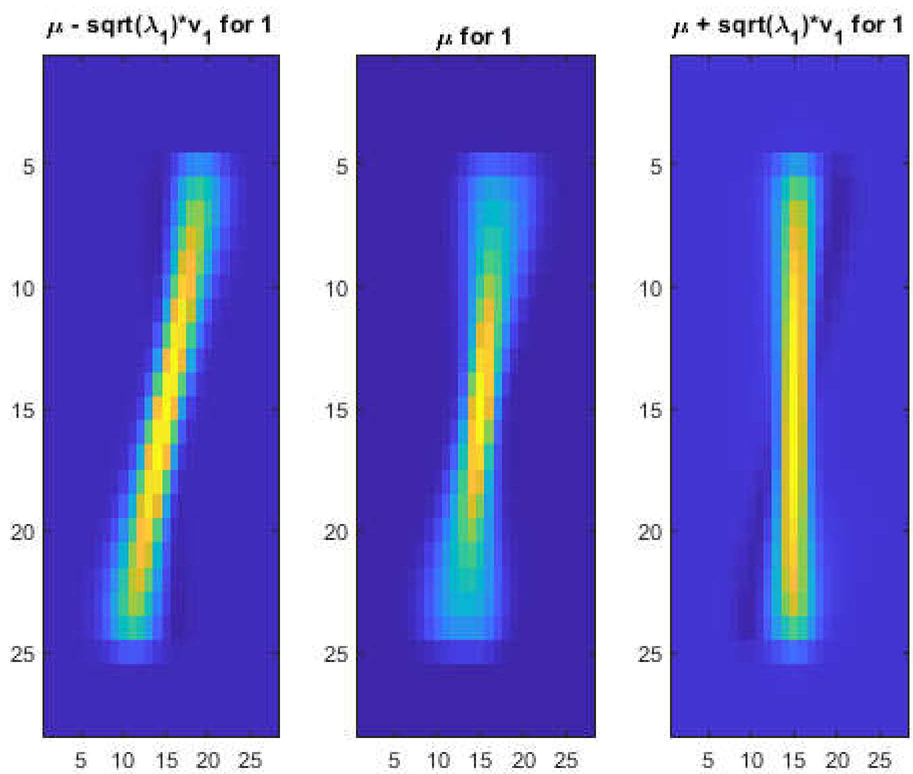


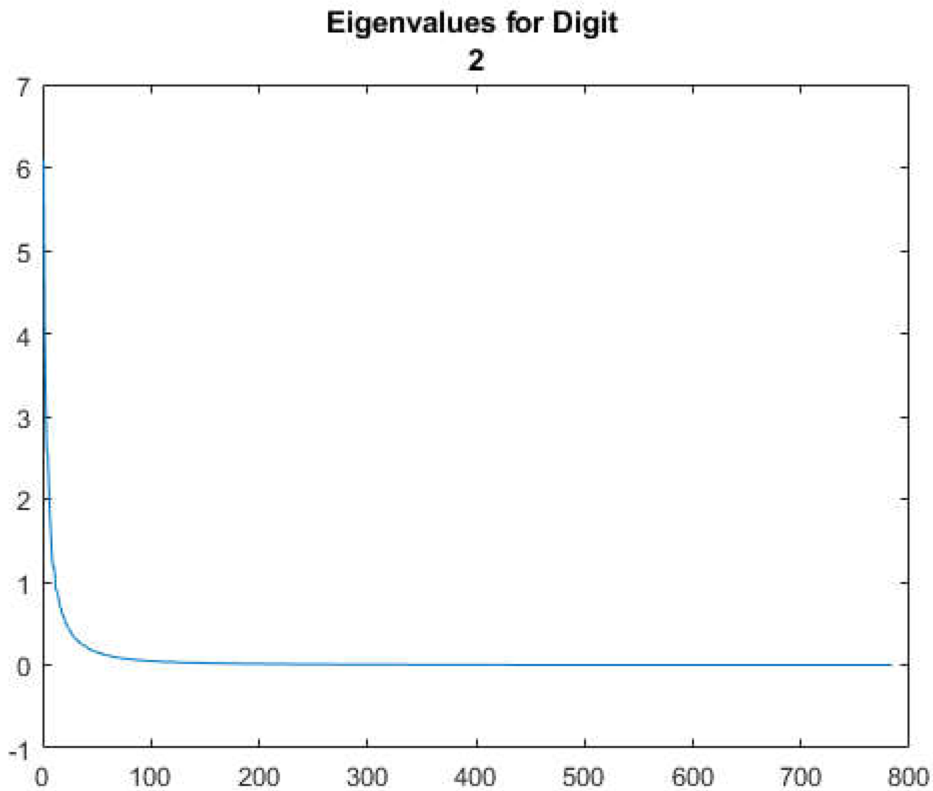
Eigenvalues for Digit
0
9
8
7
6
5
4
3
2
1
0
-1
0
100
200
300
400
500
600
700
800



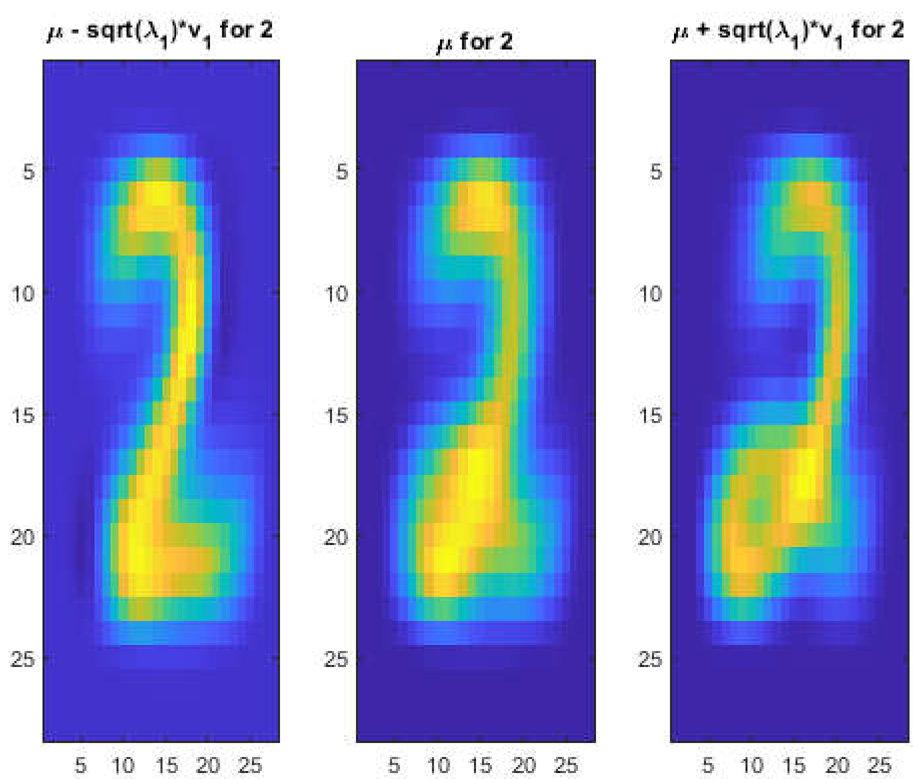
μ - sqrt(λ1)*v1 for 0
μ for 0
μ + sqrt(λ1)*v1 for 0
5
10
15
20
25


Eigenvalues for Digit
1
8
7
6
5
4
3
2
1
0
-1
0
100
200
300
400
500
600
700
800

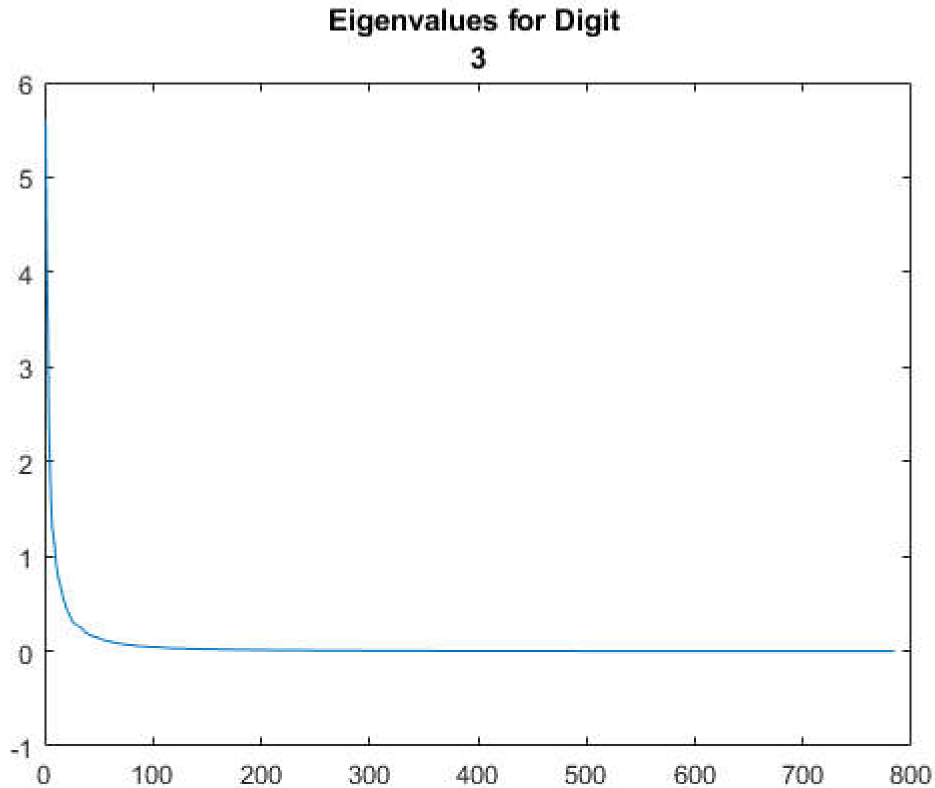

μ - sqrt(λ_1)*v_1 for 1
μ for 1
μ + sqrt(λ_1)*v_1 for 1
5
10
15
20
25
5 10 15 20 25

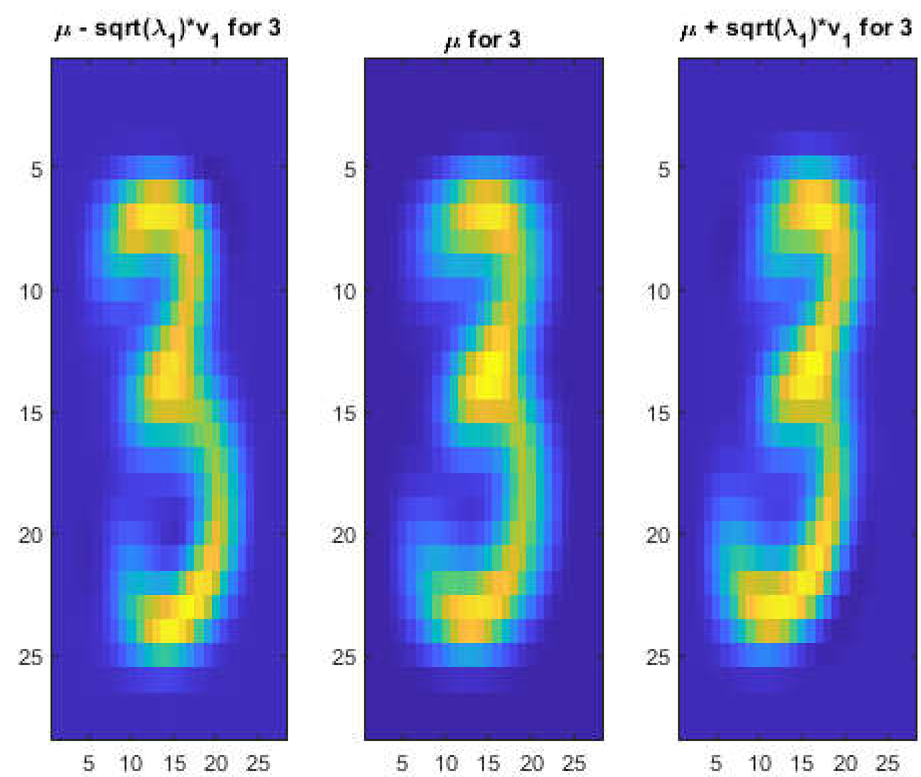


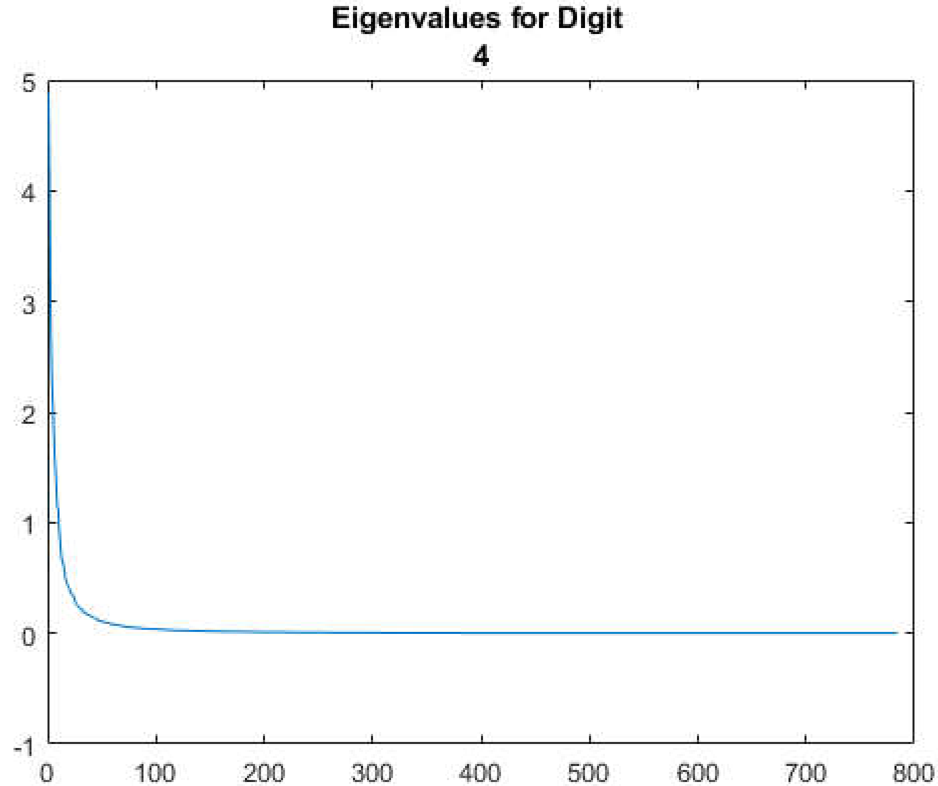
Eigenvalues for Digit 2
7
6
5
4
3
2
1
0
-1
0
100
200
300
400
500
600
700
800

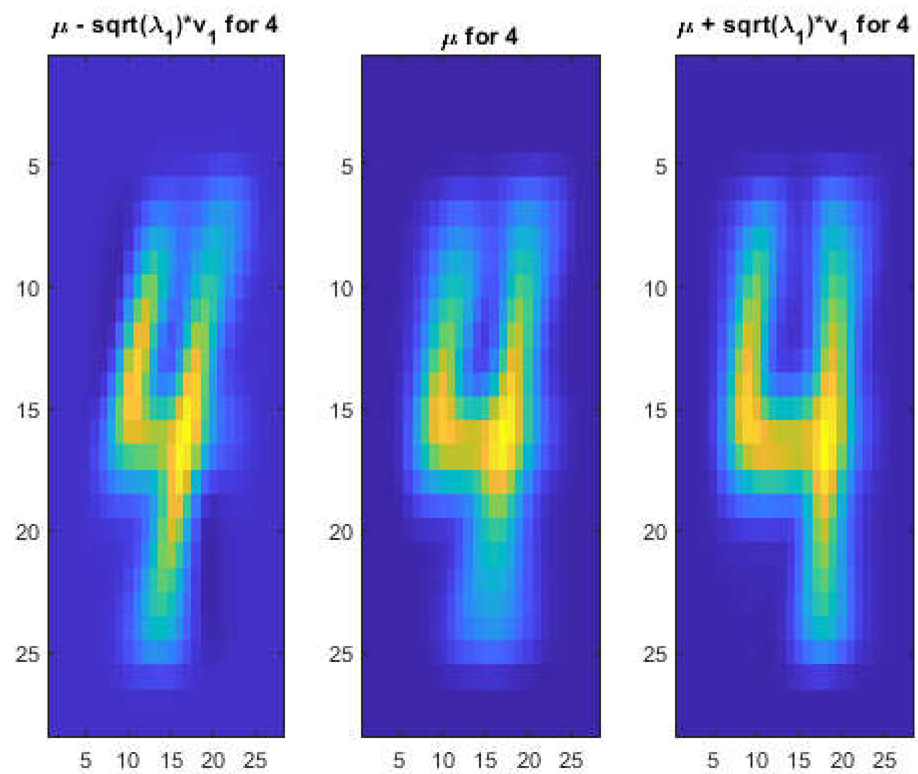


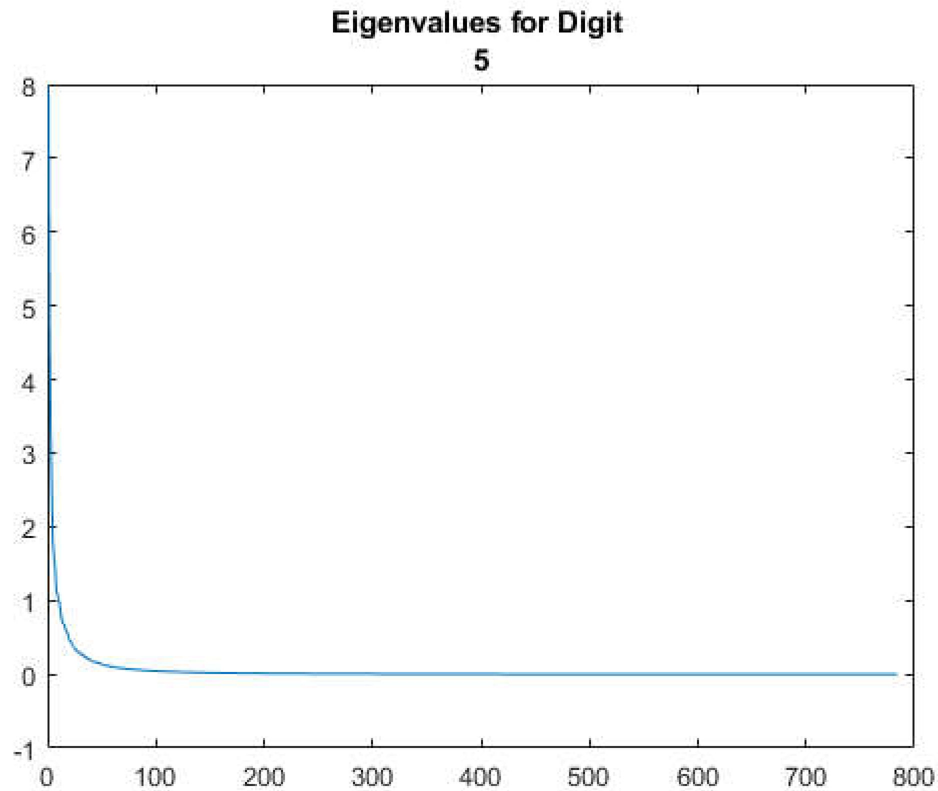
μ - sqrt(λ1)*v1 for 2
μ for 2
μ + sqrt(λ1)*v1 for 2
5
10
15
20
25


Eigenvalues for Digit
3
6
5
4
3
2
1
0
-1
0
100
200
300
400
500
600
700
800

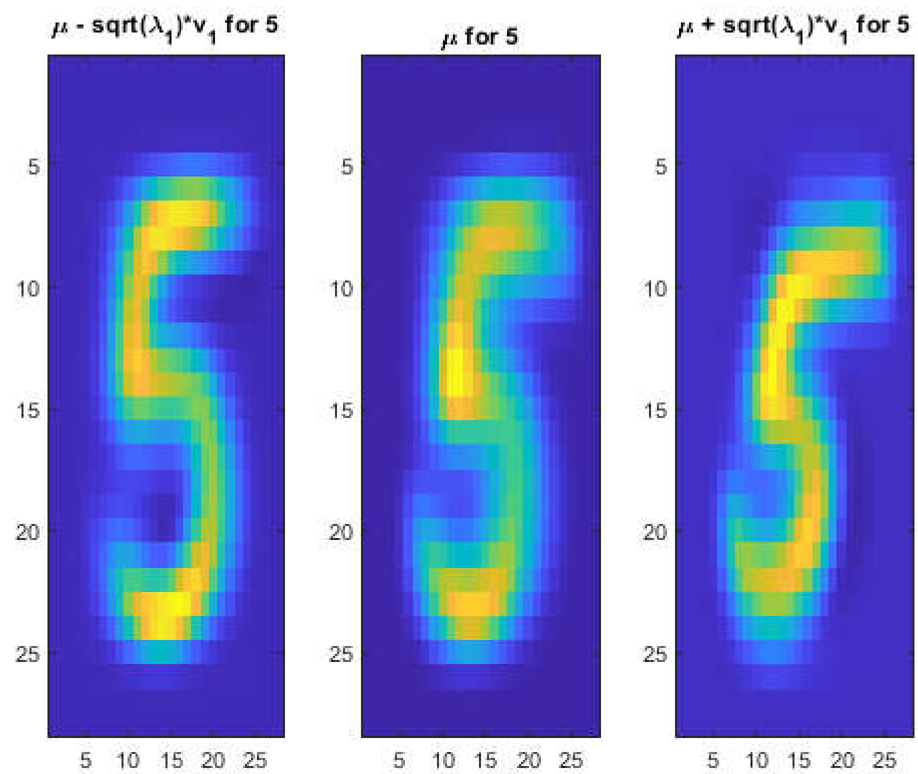

μ - sqrt(λ1)*v1 for 3
μ for 3
μ + sqrt(λ1)*v1 for 3
5
10
15
20
25
5 10 15 20 25


Eigenvalues for Digit
4
5
4
3
2
1
0
-1
0
100
200
300
400
500
600
700
800

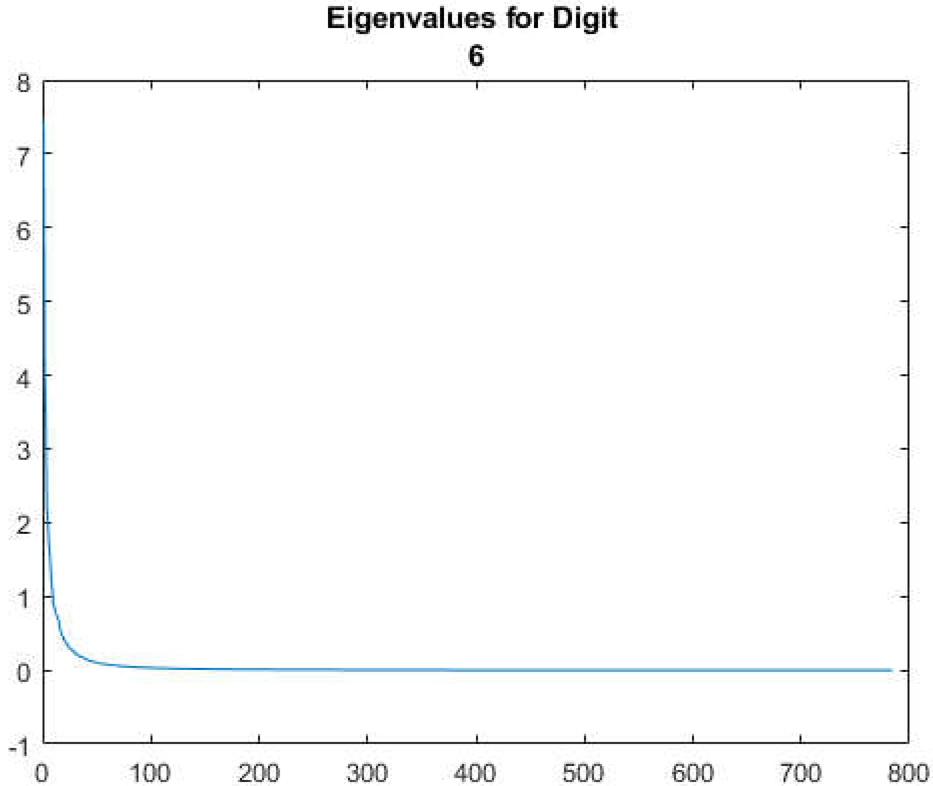

μ - sqrt(λ1)*v1 for 4
μ for 4
μ + sqrt(λ1)*v1 for 4
5
10
15
20
25
5 10 15 20 25

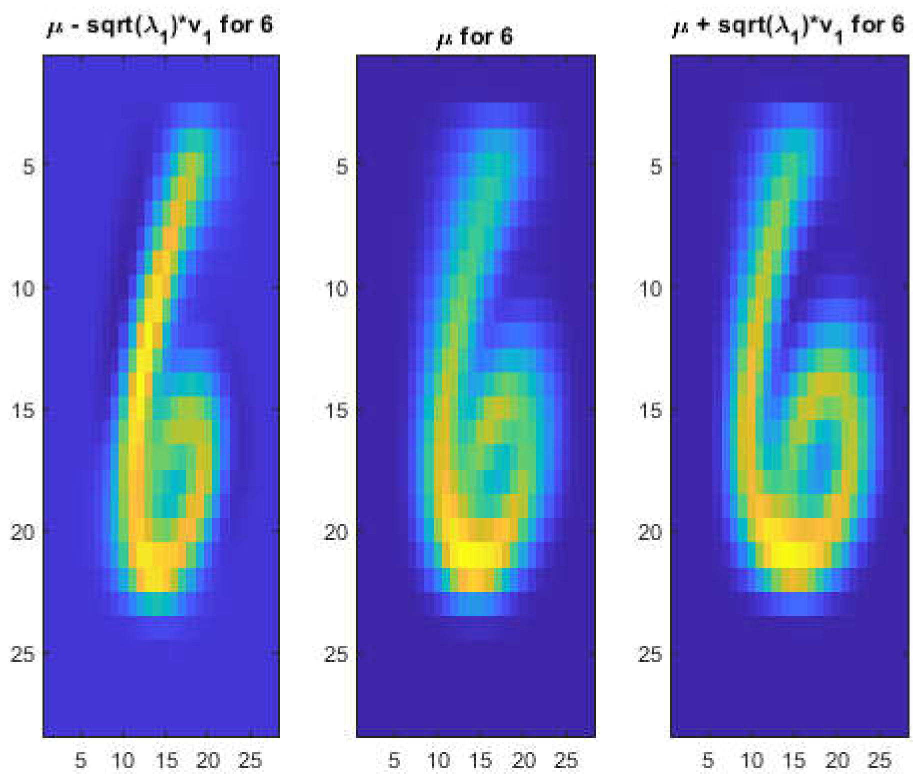


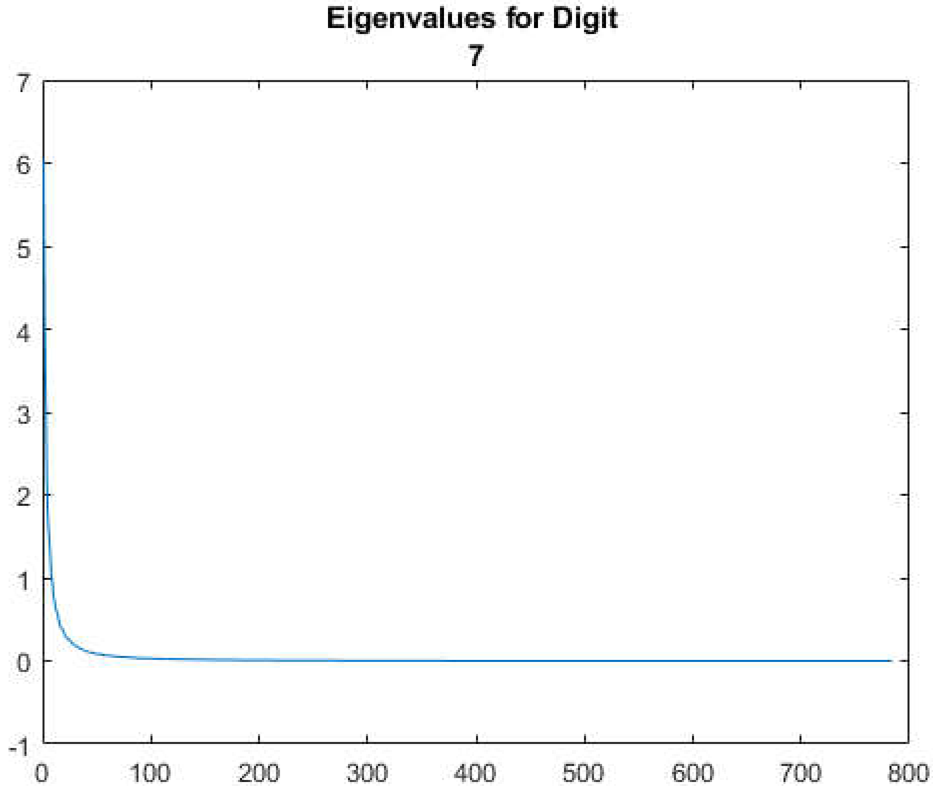
Eigenvalues for Digit
5
8
7
6
5
4
3
2
1
0
-1
0
100
200
300
400
500
600
700
800



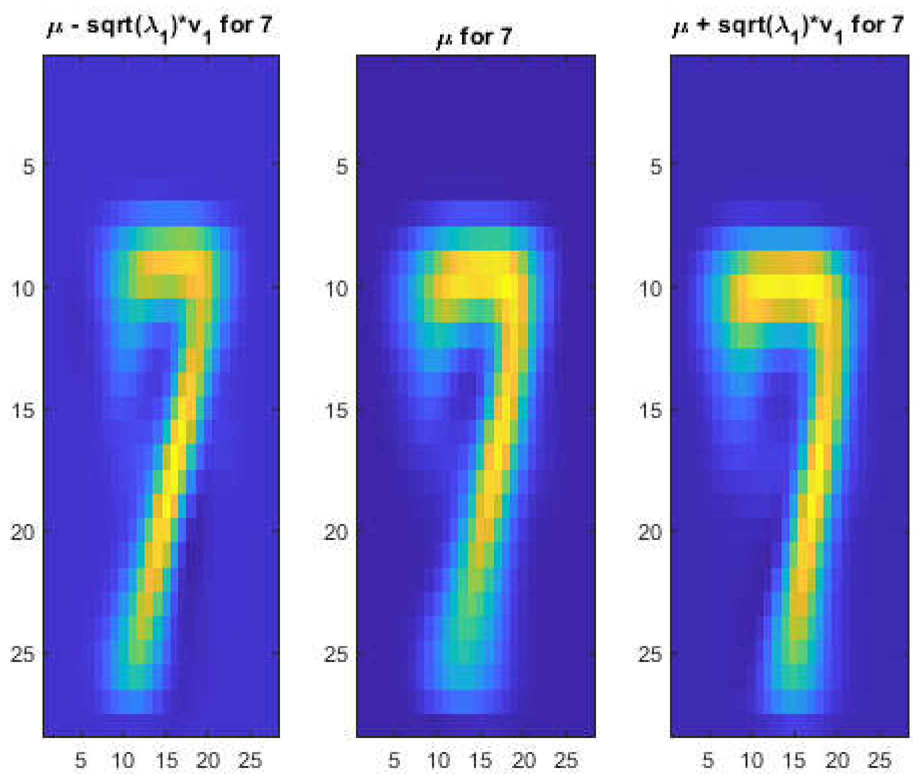
μ - sqrt(λ_1)*v_1 for 5
μ for 5
μ + sqrt(λ_1)*v_1 for 5
5
10
15
20
25
5 10 15 20 25


Eigenvalues for Digit
6
8
7
6
5
4
3
2
1
0
-1
0
100
200
300
400
500
600
700
800

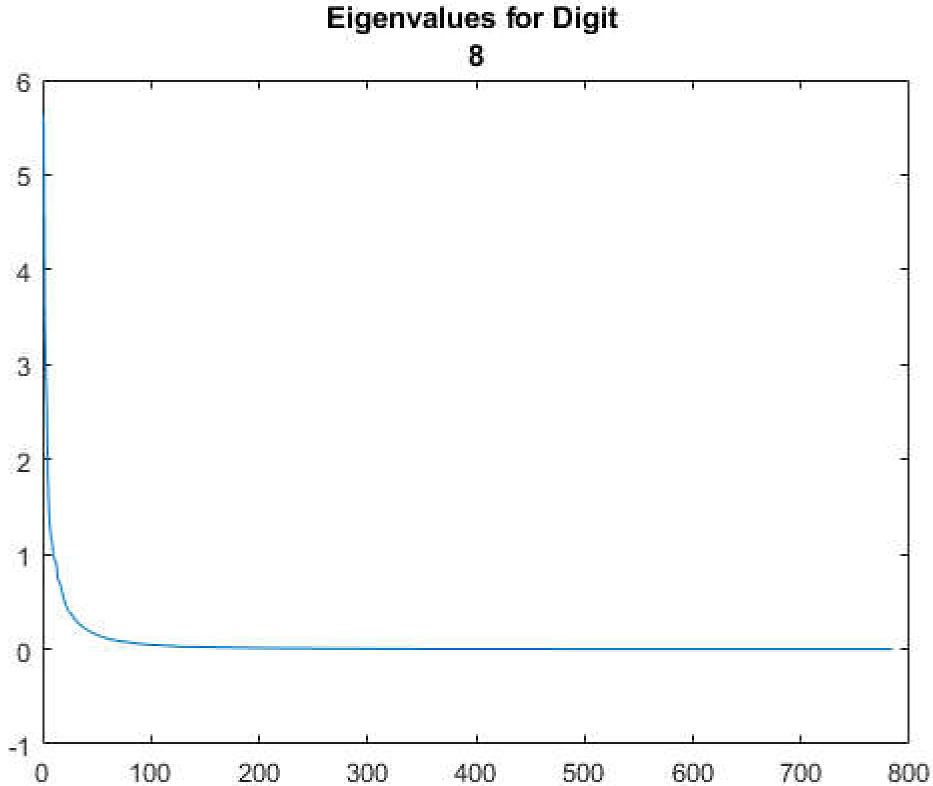

μ - sqrt(λ_1)*v_1 for 6
μ for 6
μ + sqrt(λ_1)*v_1 for 6
5
10
15
20
25
5 10 15 20 25



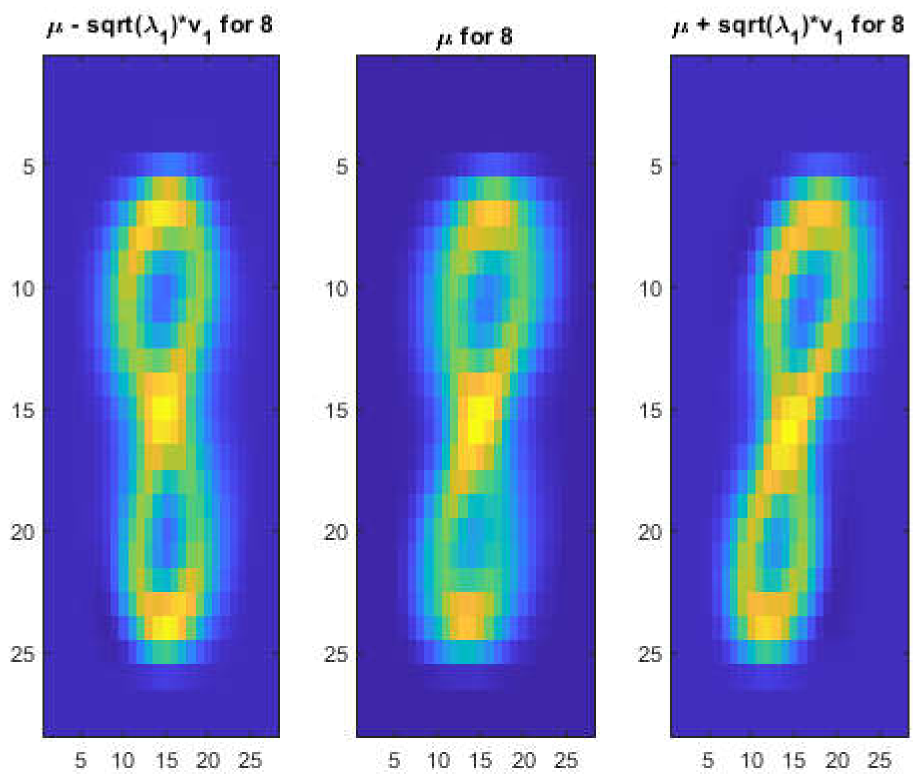
Eigenvalues for Digit
7



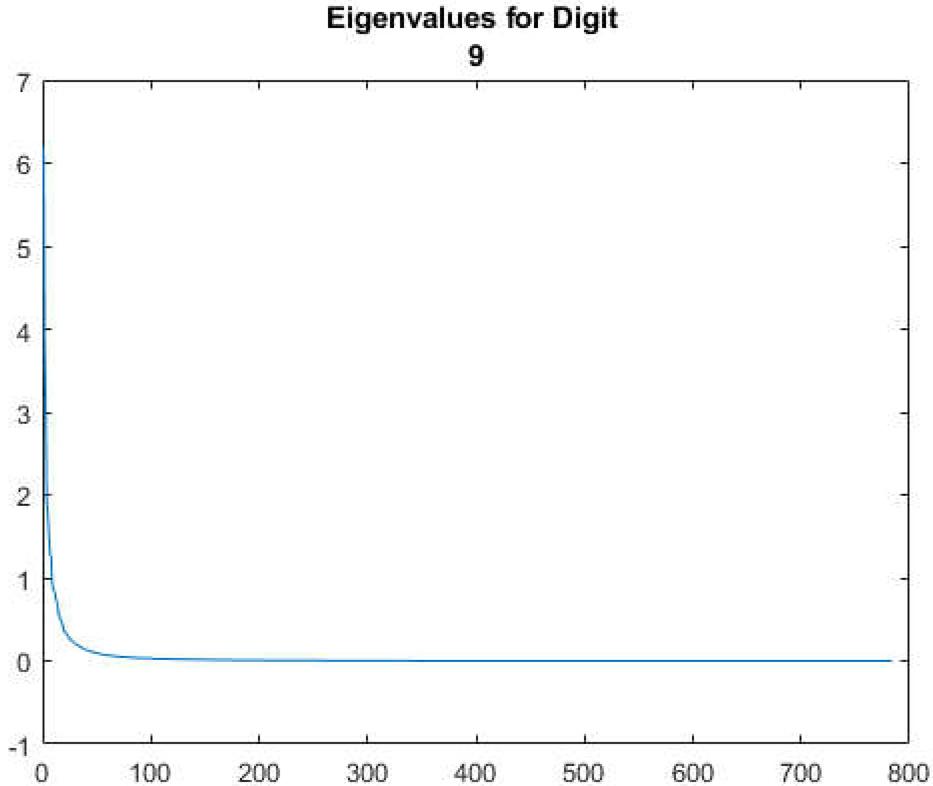
μ - sqrt(λ1)*v1 for 7
μ for 7
μ + sqrt(λ1)*v1 for 7

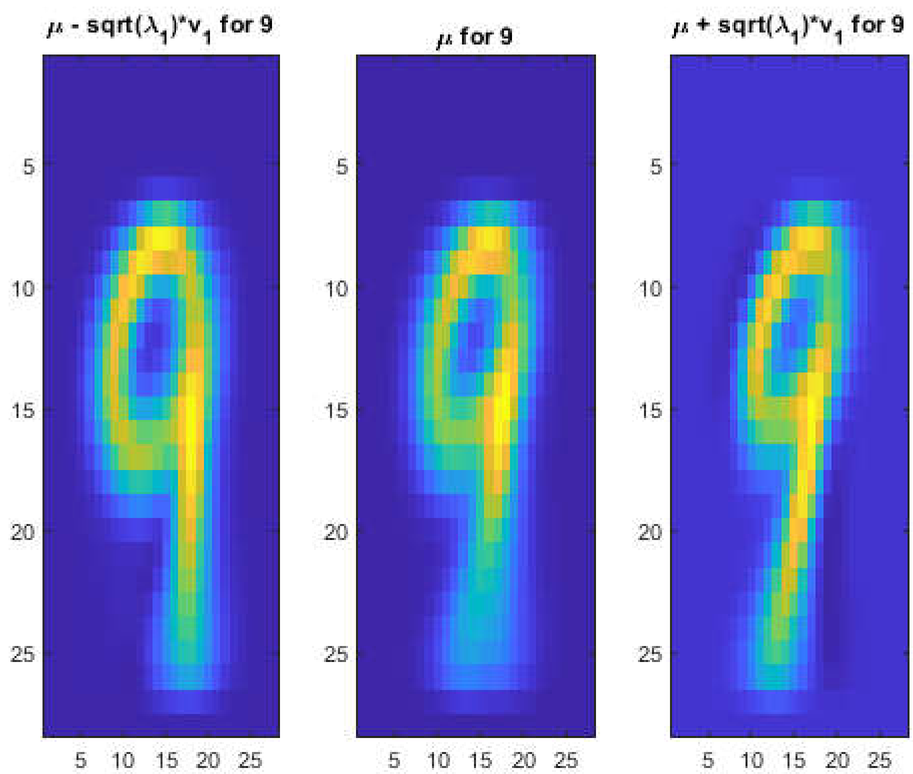


Eigenvalues for Digit
8
6
5
4
3
2
1
0
-1
0
100
200
300
400
500
600
700
800



μ - sqrt(λ_1)*v_1 for 8
μ for 8
μ + sqrt(λ_1)*v_1 for 8
5
10
15
20
25





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