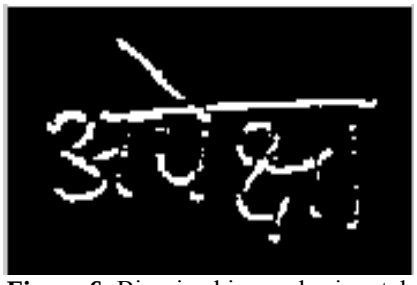

Figure 6: Binarized image horizontal

2.4 Image dilation

Dilation operation is one of the operations of morphological operations. Morphology is a set of image processing operations that process images based on shapes. To an input image, morphological operations apply a structuring element, creating the same size output image. In the output image the value of each pixel is based on a comparison of the corresponding pixel in the input image with its neighbors. Dilation adds pixels to the boundaries of objects in an image. The number of pixels added to the object in an image depends on the size and shape of the structuring element used to process the image. Dilation can be apply in both vertically and horizontally.

Figure 7: Dilated vertical image

Figure 8: Dilated horizontal image

2.5 Segmentation

Segmentation subdivides an image into its constituent objects. In segmentation, basic constituent of the word extract, which are characters. Segmentation phase is also crucial in contributing to this error due to touching characters, which cannot properly tackle by a classifier. Segmentation is the process of sub-diving the image into useful segments or components. We categorize the existing segmentation algorithm into region-based, data clustering, and edge-base segmentation. Region-based segmentation includes the seeded and unseeded region growing algorithms, and the fast scanning algorithm. All of them expand each region pixel by pixel based on their pixel value or quantized value so that each cluster has high positional relation. For data clustering, the concept of them is based on the whole image and considers the distance between each data.

Figure 9: Segmented image

2.6 Feature Extraction

A feature is an interesting part of an image, such as a corner, edge or line. Feature extraction enables to drive a set of feature vectors from a set of detected features. Feature extraction is most important step in developing a classification system. From the fig 9, I cropped a character which is the first character of the image.

Figure 10: Cropped character.

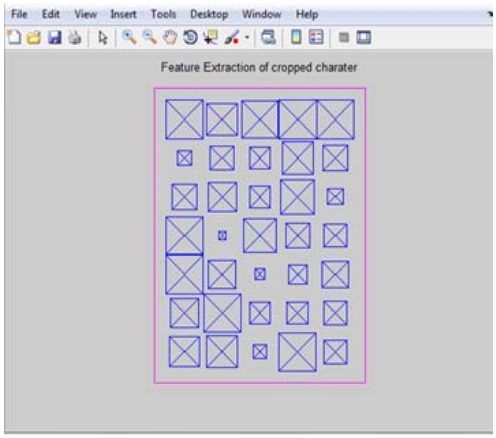

Figure 11: Feature extraction of cropped character

The feature extraction of a character is shown in 7x5 matrixes. The box contains pixels of the image and divided into the matrixes. The value of the character can be find by the matching the character with the ASCII value of character which is stored in the class library.

```
>> disp(char(2309:2350))
अआइईउऊऋऌऍऐऎऑओऒऔकखगघङचछजझञटठडढणतथदधनऩपफबभम
```

Figure 12: ASCII values of the Hindi characters.

Therefore we can find the value of 'a' from the ASCII value, so the value of 'a' is 2309. This value is stored in database for further processing for the same character in the different shape and the other characters were also recognize by the same procedure.

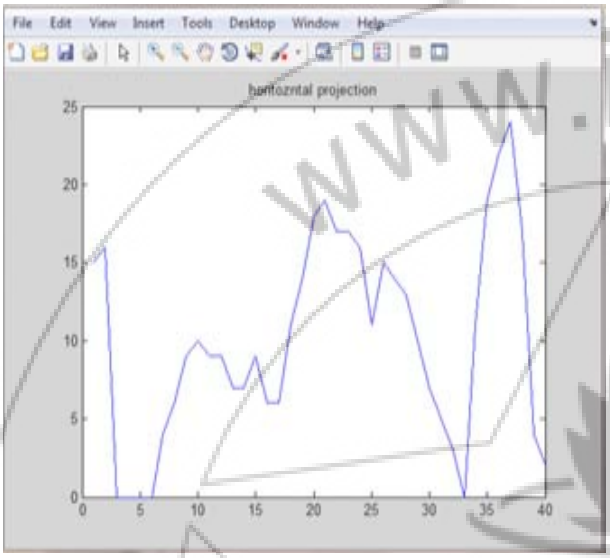

Figure 13: The horizontal projection of the character 'a'.

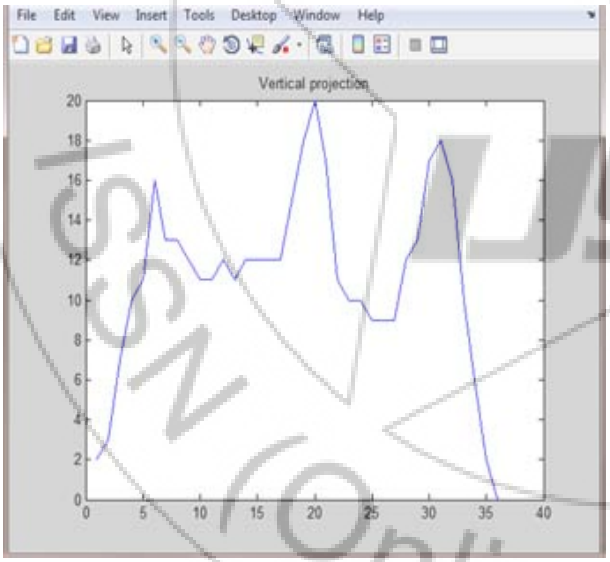

Figure 14: Vertical projection of the character 'a'.

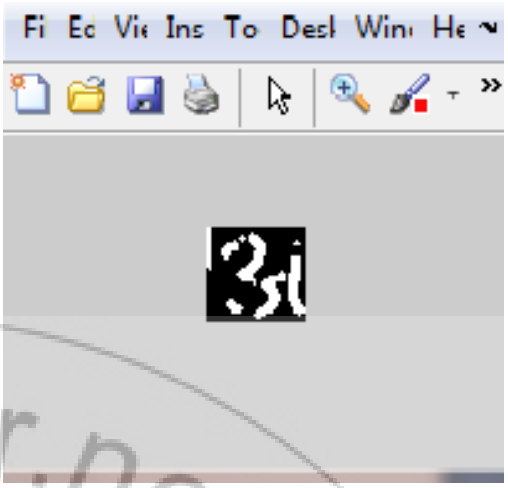

Figure 15: The final image of recognize character.

2.7 Classification

Classification of the Hindi characters is performed by the Euclidean distance method. Where for this type of algorithm we estimate the future vectors for the each and every train data and store it in a data base. The Euclidean method is a simple method but powerful enough for the detection of the characters. For the case of test data we estimate the vectors and then these vectors are separated from the train data. In classification k-means are used. K-mean algorithm is one of the simplest unsupervised learning algorithms that solve the well known problem of clustering. It follows a easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori.

The main idea is to define centroids of k numbers, one for each cluster. These centroids should be placed in a cunning way because of different location causes different result. So, the better way is to place them as much as possible far away from each other. The next step is to take each point which belong to a given set of data and associate it to the nearest centroid. When no point is remaining, the first step is completed. At this point k numbers of new centroids will be recalculated as bary centers of the clusters resulting from the previous step.

After we have these k numbers of new centroids, again a new binding has to be done between the same data set points and the nearest new centroid. Finally, the aim of this algorithm is to minimizing an objective function that is a squared error function.

3. Experimental Result and Discussion

The result obtained from this experiment is we can recognize Hindi characters with their four most similar shapes. The characters are recognized if they match 75% to the some other character it will consider as the same as other character by their horizontal and vertical projections. There are many shapes of a single character we can process as many shape of same character as possible. I work on another four more different shape of the same character.

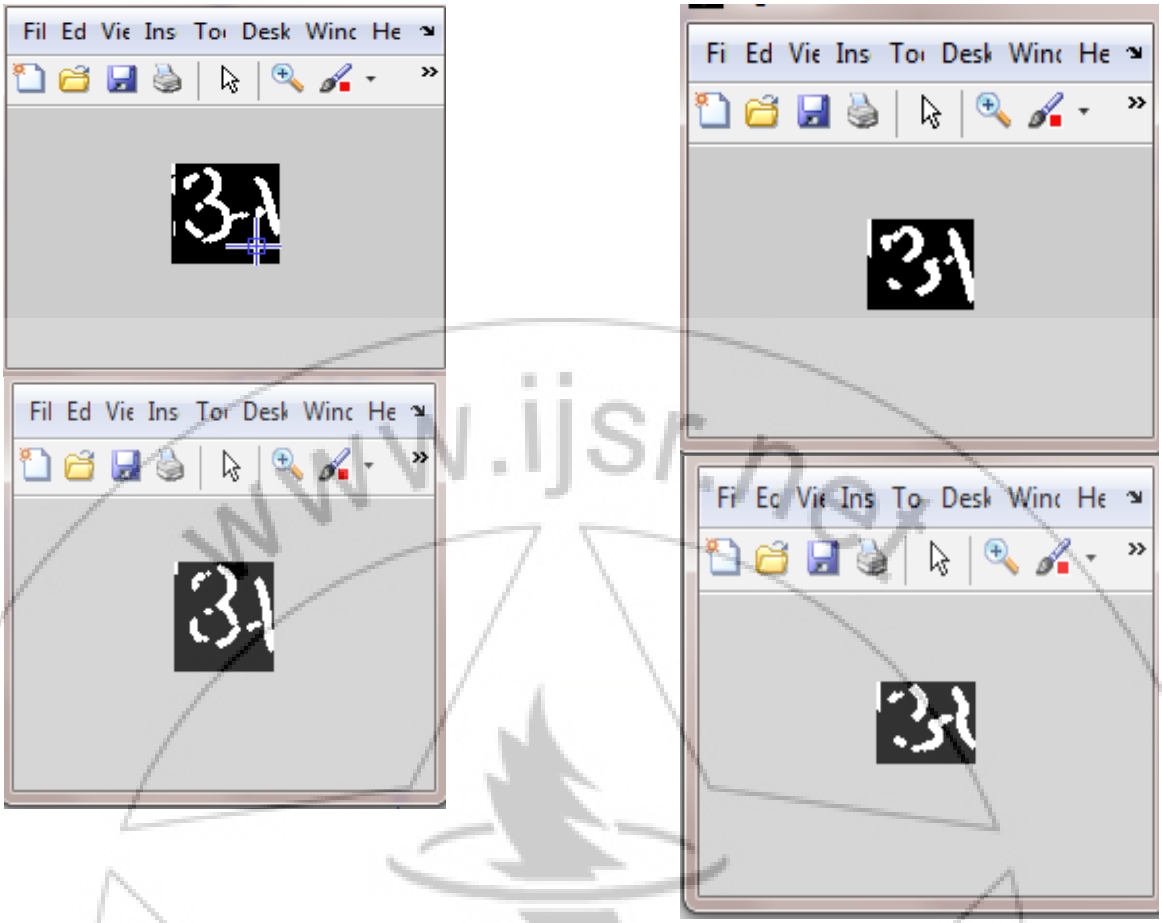

Figure 16: Outputs of different shapes of the same character

The classification values of the characters are stored in database. The database used in this work was trained with the four most standard fonts, and the accuracy brings by the k-means clustering. K-means clustering is an algorithm to cluster n data points specified in m dimensions or attributes into k clusters, considering that the point form a vector space. Each cluster is represented by a centroid of the data points in the cluster.

```
TA1=[0.770000000000000;0.590000000000000;0.480000000000000;1;0.860000000000000;0.280000000000000;0.970000000000000;0.340000000000000;1;1;0.950000000000000;
    0.700000000000000;0.490000000000000;1;0.400000000000000;1;0.200000000000000;0.760000000000000;0.440000000000000;0.340000000000000;1;0.950000000000000;
    0.420000000000000;0.570000000000000;0.400000000000000;0.750000000000000;0.970000000000000;0.810000000000000;0.480000000000000;0.370000000000000;
    0.770000000000000;0.800000000000000;0.220000000000000;0.860000000000000;0.460000000000000];
TA2=[0.640000000000000;0.450000000000000;1;0.890000000000000;0.950000000000000;0.720000000000000;0.580000000000000;1;0.930000000000000;0.590000000000000;
    0.960000000000000;0.350000000000000;0.960000000000000;1;0.520000000000000;0.850000000000000;0.860000000000000;0.480000000000000;0.680000000000000;
    0.330000000000000;0.720000000000000;1;0.430000000000000;0.970000000000000;0.520000000000000;0.640000000000000;0.500000000000000;0.710000000000000;
    1;0.830000000000000;1;0.900000000000000;1;1;1];
TA3=[0.860000000000000;0.790000000000000;0.570000000000000;1;1;0.530000000000000;0.990000000000000;0.400000000000000;0.970000000000000;0.570000000000000;
    1;0.960000000000000;0.490000000000000;1;0.420000000000000;1;0.700000000000000;0.430000000000000;1;0.430000000000000;0.570000000000000;1;0.580000000000000;
    0.720000000000000;0.350000000000000;0.530000000000000;0.800000000000000;0.410000000000000;0.970000000000000;0.450000000000000;1;0.930000000000000;
    0.910000000000000;1;0.800000000000000];
TA4=[0.790000000000000;0.270000000000000;0.850000000000000;0.750000000000000;0.900000000000000;0.330000000000000;0.760000000000000;0.620000000000000;
    0.800000000000000;0.660000000000000;0.930000000000000;0.550000000000000;0.800000000000000;0.870000000000000;0.480000000000000;1;0.880000000000000;
    0.470000000000000;0.610000000000000;0.390000000000000;0.910000000000000;1;0.660000000000000;0.740000000000000;0.410000000000000;0.680000000000000;
    0.880000000000000;0.310000000000000;0.920000000000000;0.470000000000000;1;1;0.850000000000000;1;0.700000000000000];
```

Figure 17: Classification values of the characters

4. Conclusion and Future Scope

The result of the experiment show that the problem of Hindi character recognition solves successfully with the use of K-means. By the use of OCR we can recognize all the Hindi characters and their matras which are use in the Hindi words. From the result we can see that by the segmentation method we can separate the touching characters and remove the shrirorekha from the word. We conclude the horizontal and vertical gradient for edge detection using manual canny edge detector and take the vertical and horizontal projection of each character for matching with other character and their classification. Therefore this experiment illustrate that we recognize all the Hindi character and classify them successfully.

Future scope of this experiment is we can recognize a full Hindi word or text instead of a character, we can recognize the Hindi numbers. Another scope is speech recognition of the Hindi character using OCR for blind people.

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