4.4 Recognition

In this character recognizer we are using two algorithms in order to recognize a character. The two algorithms that are used here in order to recognize a character are nearest neighbor and dynamic time wrapping, where the nearest neighbor algorithms is used to form the clusters and dynamic time wrapping is used to measure the distance between the stored samples and written letter.

4.5 Nearest neighbor algorithm

During the training phase all the similar characters are grouped as a cluster. After completing of the cluster formation then whenever the letter has been written in the writing area in order to recognize, it initially compares to which 5 clusters the letter closely belongs to and identifies those clusters. After completion of the identification of 5 nearest neighbors then nearest distance is calculated using DTW algorithm.

4.6 DTW Classifier

After finding of the nearest neighbors using the above algorithm then based upon the DTW distance achieved for each of the neighbors the appropriate character will be chosen. All the distances will be arranged in the ascending order and whichever character has the minimum or lowest distance will be chosen as the appropriate letter. Distance to a class is defined as the minimum distance computed using Dynamic Time Warping (DTW) of the test sample to all the optimal deformations and free samples of the class.

$$D(i,j) = min\begin{cases} D(i,j-1) \\ D(i-1,j) \\ D(i-1,j-1) \end{cases} + d(x_i, y_i).$$

Based upon the recognition rate that each letter has achieved compared to the training data, the letter or character which has the highest recognition rate will be displayed as output in the text file.

The recognition rate generally depends upon both the quality and quantity of the training samples available to the Character Recognizer. For more accuracy more number of samples should be trained. The flow of system is explained in the Figure 4.

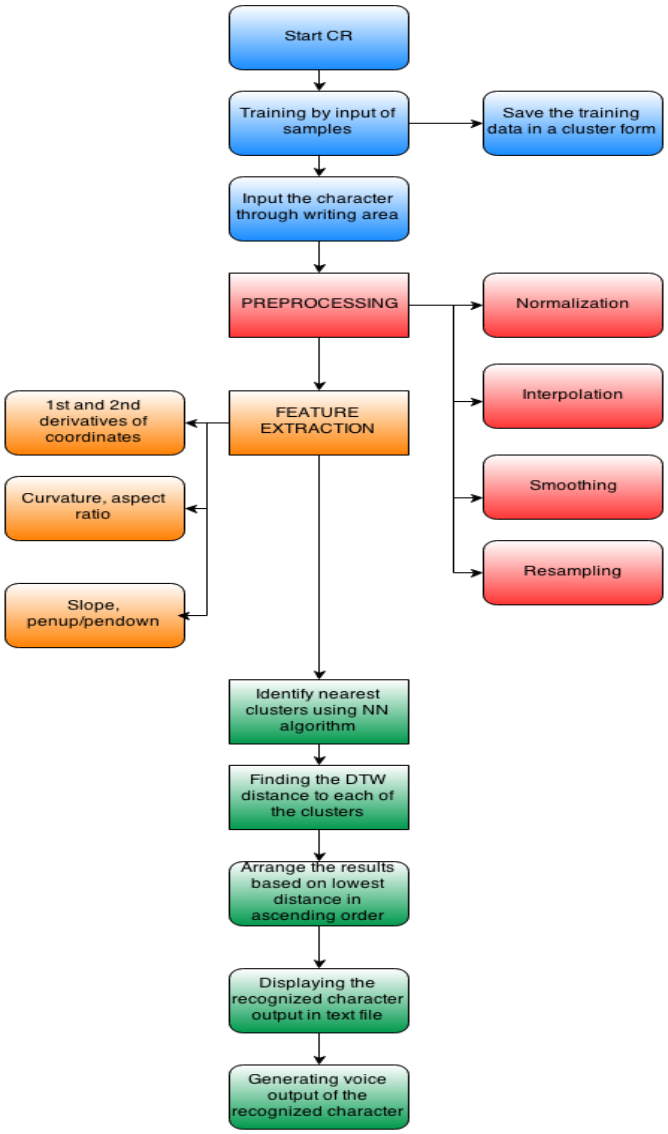

Figure 4: Flow of the system

5. Software

Character Recognizer (CR) is implemented by using Raspbian operating systems (Debian which is one of the Linux distributions). Before implementing CR on embedded development boards some of the GUI requirements need to be installed on the board:

Steps for Porting Raspbian OS:

1) Download the Raspbian wheezy image which is a ZIP file.
2) Then extract the Raspbian wheezy image.
3) Download the image writer software and open the image writer.
4) Select the Raspbian file in write image block
5) Then to multiflash reader.
6) Click on write to device.

Necessary changes should be done in the config .txt file like resolution settings, HDMI settings.

6. Performance Evaluation

CR performance depends largely on the quality and quantity

of the training samples and the ability of the writer to produce consistent handwriting.

7. Results

CR is implemented on embedded development board by using Raspbian operating systems. Setup of the character recognizer is shown in Figure 5.

Figure 5: Setup of CR

Before usage of Character Recognizer user needs to train all the Telugu letters that are used for the purpose of recognition. Here for each letter three different samples or variations from three different users have been recorded during the training phase.

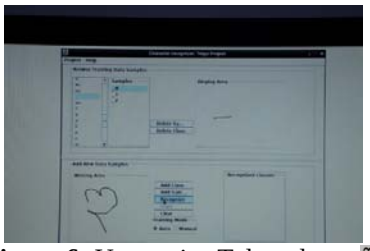

Figure 6: User trains Telugu letter ఇ

When the user writes a letter in the writing area for recognition, the letter that has highest recognition rate is recognized and the output is displayed in a text file .This is shown in the Figure 7.

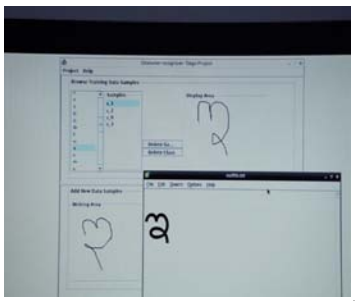

Figure 7: CR recognizes the letter ఇ

The output that has been displayed in text file will be linked to the text to speech engine and produces the sound output through the speakers connected to the Raspberry Pi board.

8. Future Scope

The existing user interface can be designed to be more user friendly. The probability of recognition can be increased by building bigger database of samples. The recognition capability can be extended to recognize multiple words separated by space, so that more words can be recognized at single instance. Character recognizer which is currently designed using mouse interface canbe further extended to touch screens for ease of interaction.

9. Conclusion

Character recognition tools are becoming hugely popular these days, as cost of mobile devices like tablets are decreasing dramatically. As a result of this more students and corporates are using these low cost mobile devices to get their work done more effectively.

This character recognition tool, is one step forward in the journey to make devices more accessible to people who wish to interact with mobile devices in their local languages. Even letters which, different users write completely different from the other users, are recognized with high efficiency. We are making continuous efforts to improve the recognition accuracy and usability of handwriting interfaces.

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