International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Real Time Implementation of Telugu Character Recognition using Raspberry Pi

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Abstract: ***The market for small hand-held devices like mobiles devices and tablet computers is constantly growing. User interfaces designed in native languages of the users, can increase the reach and usability of these devices to wider population. Till now there are many tools available for English language but there are only few for Telugu language. This paper describes the implementation of Telugu character recognizer (CR) using Raspberry pi board. The hardware which is used here in order to develop online character recognition system is Raspberry Pi which has ARM11 processor. Users try to write the letters using mouse and it is displayed on the LCD screen. Two algorithms K-NN (nearest neighbor) and DTW (dynamic time wrapping) are used to recognize the letter. By using these algorithms and based on the hardware used, the text output and the voice output for the particular letters are generated. For Disabled people who can't speak and hear, the only way of communication for them is through Writing. Using these type of character recognizer tools helps them to communicate easily with the devices. This paper develops an user interface in native languages, like Telugu Language which helps elder people who are more familiar with their native languages to interact with devices in a more effective and easy manner and also kids can make use of this character recognizer tool to learn native languages easily.***

Keywords: Online telugu character recognition, Raspberry Pi, Raspbian operating systems, User interface, Mobile Devices

1. Introduction

Interest in online character recognition has increased because of the rapid addiction to smart phones and tablet PCs. Writing is one of the easiest ways to exchange information between human and any hand held devices. Disabled people generally have the problem to convey their message to other people. In order to communicate with people using hand held devices in native languages, character recognizer tools are helpful. The basic objective of character recognition is to interpret the character written by the user and then compare it with an existing database which contains different variations of the same character written by different users. Character recognition has been classified in to two types as online character recognition and offline character recognition. Character recognition is in research for many decades.

This paper focusses on development of character recognizer custom made for Telugu Characters. In this paper, it is clearly explained about character recognizer developed on ARM11 processor using Raspbian operating system which is used to recognize individual characters. Embedded hand held device consists of one electronic board which consists of Broadcom BCM 2835 system on chip (SOC) which has ARM11 processor. LCD screen acts as an input and output device.

2. Theoretical Background

2.1 Areas of Character Recognition

Character recognition can be subdivided into two categories namely offline and online and can be further classified into write dependent and writer independent.

This paper has been implemented for both writer dependent and writer independent. Some of the tools work only for single user and those are called as writer dependent. Tools working for multiple users are called as writer independent. The detailed description of online and offline recognition has been explained in the further sections.

The important feature of any Character Recognition tool is the time it takes to recognize user written character. The lesser the time and higher the accuracy, the more effective is the tool.

2.2 Offline Character Recognition

In offline character recognition, text is not recognized simultaneously as the user writes. Here text is originally written on a surface such as paper and from there it involves scanning of that document and there on it is recognized by the computer.In case of offline character recognition, the handwritten character is typically scanned in form of a paper document and made available in the form of a binary or gray scale image to the recognition algorithm and then further preprocessing and feature extraction steps are done for the purpose of recognition. This type of recognition is also sometimes known as “Optical Character Recognition”.

2.3 Online Character Recognition

In contrast to the offline, there is real time recognition of characters in online character recognition systems. Online systems have better information for doing recognition since

they have timing information and since they avoid the initial search step of locating the character as in the case of their offline character recognition. Online system uses the position of the pen as a function of time directly from the interface.In general in online handwriting recognition stylus is used, to write the letter but here “mouse” is used in order to write the letter on the LCD screen.

3. Hardware System Design

Character Recognizer (CR) is implemented on Raspberry Pi board by porting Raspbian operating systems.

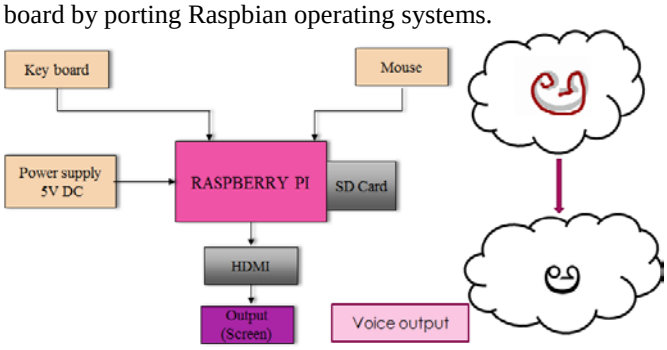

Figure 1: Block diagram for Character recognition

3.1 LCD Screen

LCD screen is interfaced to the Raspberry Pi board using HDMI port which is on the Raspberry pi board. The resolution has been set to 1024x768 pixels in the config file of the Raspbian OS for proper output.

3.2 Raspberry Pi Board

The Raspberry Pi is an open source, single-board computer built on ARM 11 processor.The Raspberry Pi is cheap, it’s powerful, and it does not consume a lot of power. It is pocket sized or credit card sized board. In contrast to a typical PC architecture, theSOC integrates a processor (CPU), a graphics processing unit (GPU), and some memory into a single unit. The BCM2835 SOC contains an ARM1176JZ-F processor running at 700MHz, 256MB of RAM, and a GPU named Video Core IV.

The Raspbian OS distribution of Debian is designed to provide embedded software programmers with a familiar and fully functional interface to custom hardware development.

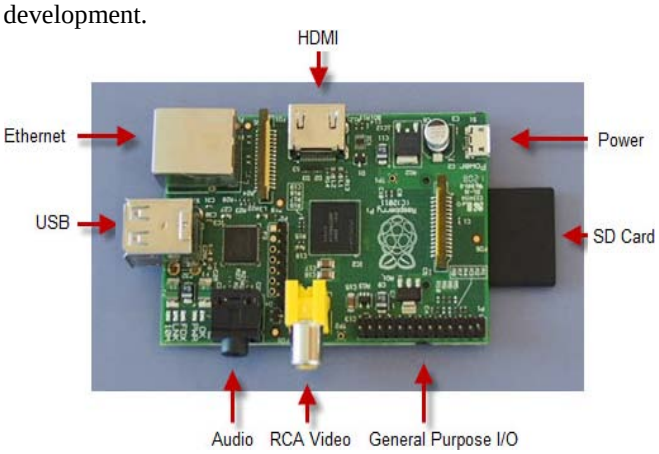

Figure 2: Raspberry pi board (model b)

3.3 Other Inputs

Keyboard, mouse and the power supply are connected to the Raspberry Pi board using a USB hub. Mouse is used in order to write the letters on the writing area provided in the character recognizer. Keyboard is used in order to type the commands for setting of the environment path.

3.4 Experimental Observations

The Character Recognizer generates two types of outputs. Text output is obtained on LCD screen which is connected to the Raspberry Pi board which is saved as .txt file. Voice output for the particular recognized letter is obtained from speakers which are connected to the raspberry pi board.

4. System Flow

4.1 Training

Initially the user should create a new project and train the Character Recognizer. During training phase, user should create a database of different variations of the Telugu Language characters written by different users. This training is done in the writing area where the letters should be written in the writing area. If some user was unable to write a character similar to the original character then he can train the character to the desired manner in the training mode and name that character to the original letter. This helps the user to write the character as per their ability in training and name them to the original character.

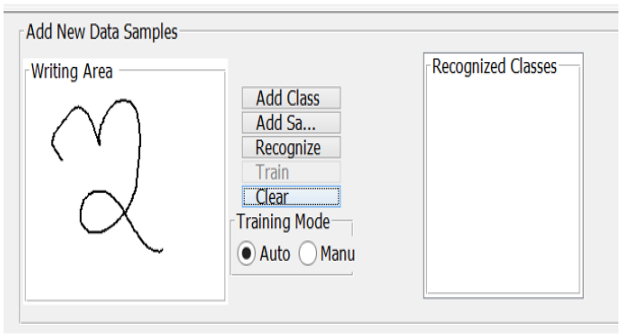

Figure 3: Telugu character written in writing area

4.2 Preprocessing

The main purpose of preprocessing phase in handwriting recognition is to remove noise or distortions present in input characterdue to hardware and software limitations and convert it into a smooth handwriting.

4.3 Feature extraction

After preprocessing, feature extraction is carried, where some of the distinguishing features are extracted from a letter. Some of the Preprocessed x-y features are Shape context (SC),Tangent angle (TA),Generalized shape context (GSC), Preprocessed x-y features, normalized 1st and 2nd derivatives,Sub stroke shape extractor.

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.

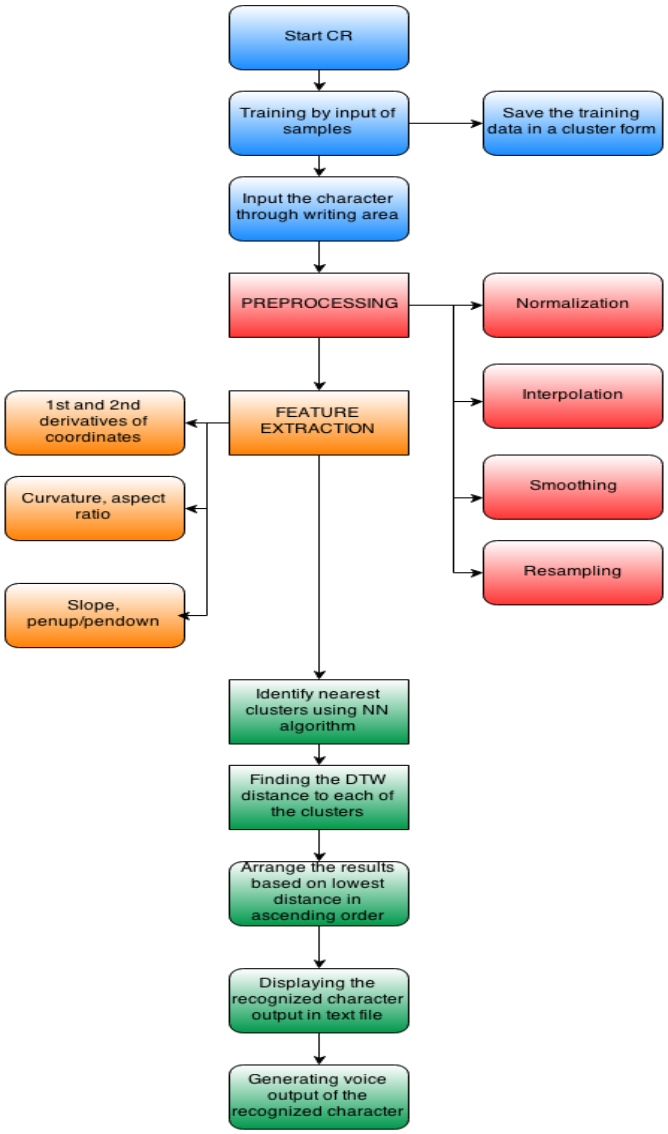

Figure 4: Flow of the system

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.

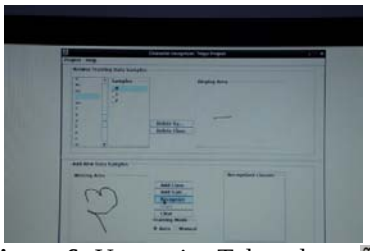

Figure 6: User trains Telugu letter ఇ

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.

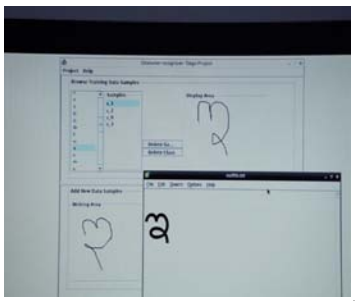

Figure 7: CR recognizes the letter ఇ

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.

References

[1] Vandana Roy, Sriganesh Madhvanath, Anand S., Ragunath R. Sharma, "A Framework for Adaptation of the Active-DTW Classifier for Online Handwritten Character Recognition," International Conference on Document Analysis and Recognition, pp. 401-405, 2009.

[2] Jagadeesh Babu V, Prasanth L, Raghunath Sharma R, Prabhakara RaoG.V., Bharath A., HMM-based Online Handwriting Recognition Systemfor Telugu Symbols, ICDAR'2007, 23-26 September2007, Curitiba,Brazil.

[3] H.Swethalakshmi, A.Jayaraman, V.S.Chakravarth, C. ChandraSekhar, "Online Handwritten Character Recognition of Devanagari and Telugu Characters using Support Vector Machines", 10th InternationalWorkshop on Frontiers in Handwriting Recognition, La Baule, France,October 23-26, 2006.

[4] Jayaraman, A., Chandra Sekhar, C., Chakravarthy, V. S., "Modularapproach to recognition of strokes in Telugu script", Proceedings of theNinth International Conference on Document Analysis and Recognition, September 23-26, 2007, pp 501-505.

[5] Rajkumar.J, Mariraja K., Kanakapriya, K., Nishanthini, S.,Chakravarthy, A system for Online Character Recognition of Telugu script based on Support Vector Machines, International Conference on Frontiers in Handwriting Recognition (ICFHR 2012),Bari, Italy, September 18-20,2012.

[6] Muralikrishna Sridhar, Dinesh Mandalapu, Mehul Patel, "Active-DTW A Generative classifier that combines Elastic Matching with Active Shape Modeling for Online Handwritten Character Recognition," International Workshop on Frontiers in Handwriting Recognition, 2006.

[7] Kumar, A. and Bhattacharya, S., 2010. Online Devanagari Isolated Character Recognition for the iPhone using Hidden Markov Model. Proceedings of the IEEE Students' Technology Symposium, pp. 300-304.

[8] G.Mori, S.Belongie, and J.Malik, "Efficient Shape Matching Using Shape Contexts", IEEE Trans. Pattern Analysis and Machine Intelligence, Vol. 27, No.11, November 2005, pp. 1832-1837.

[9] M.Pastor, A. Toselli, and E.Vidal, "Writing Speed Normalization for On-Line Handwritten Text Recognition",Proc. of ICDAR'05, Seoul, 2005, pp. 1131-1136.

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