# REAL TIME CHARACTER RECOGNITION ON FPGA FOR BRAILLE DEVICES

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**Abstract -** ***Blind and visually impaired people are challenged in their daily lives by living in a sighted world. The resources available for them to get educated are limited and localized. To overcome such limitations, devices employing Optical Character Recognition (OCR) are used. There is a need for a device that is inexpensive, portable, reliable and yet powerful enough to grant access to all the resources that are available to a normal sighted person. Such advanced devices are in the R & D phase and they include single character presentation with real time OCR.***

***This paper aims to implement OCR in real time on an FPGA for the purpose of recognizing stream of characters obtained form a video camera. This forms the image recognition part of an advanced Braille device. Selected frames from the video feed are processes to identify the character. We have designed and analyzed an OCR system employing an Artificial Neural Network (ANN) on MATLAB. The weights of the neural network generated by MATLAB are hardcoded into the FPGA for classification.***

***Key Words:*** *Blind and visually impaired, Optical character recognition, Artificial neural network, Matlab*

## 1. INTRODUCTION

285 million people are visually impaired worldwide: 39 million are blind and 246 million have low vision about 90% of the worlds visually impaired live in developing countries. Blind and Visually impaired people are challenged in their daily lives by living in a sighted world. To shift blindness from a problem to an inconvenience access to information and fluency in technology is vital. The resources available to achieve this purpose are in the form of Braille or speech (audio)

Audio tools are useful, but listening is not literacy. Everyone, blind or sighted must be able to read and write. Thus, Braille remains relevant and access to Braille materials is the key to literacy for the visually impaired. Through advances in technology, a number of devices that assist the visually impaired have been development refreshable Braille displays, Braille computers – the Note taker and software's that convert text to speech (JAWS). The cost of such devices is inherently high. Also, such devices require regular maintenance noise and inconvenient when in a group.

Hence there is need for a device that is inexpensive, portable reliable and yet powerful enough to grant access to all the resources that are available to a normal sighted person. Our project tries to address this problem. Our conceptual device can drastically increase the amount of text available to Braille reader without any intermediate costs.

## 2. LITERATURE SURVEY:

The survey was a study on OCR techniques, artificial neural networks, FPGAs, and their application in image processing. Few of the modern Braille devices and utilities are described here.

### 2.1 Braille Devices

**Braille translation software:** The fastest Braille embosser available cannot produce even one dot of material unless a Braille translation program is installed on the computer. Three titles are most prevalent today, the Duxbury Braille Translator, Braille 2000, and Mega Dots.

**Embossers:** A Braille embosser, also referred as a Braille printer, is a piece of very specialized computer hardware. The embosser allows Braille files that have been created on the personal computer to produce in hard-copy Braille.

**Note takers:** First introduced by Blazie Engineering in the mid-1980's these easy-to-use personal organizers allow a person knowledgeable in Braille to create documents, read text, keep addresses and appointments, access a list of special utilities and do so almost a decade before the sighted found similar convenience in the Palm Pilot and Pocket Pc.

**Refreshable Braille displays**: These devices allow the user to interact with his or her computer using Braille. They are called refreshable because the unit is made up of a line of pins that move up and down to display the Braille dots. Braille displays also have navigation keys that allow the user to move around the computer screen without taking his or her hands from the display to perform tasks.

**Optical Character Recognition:** Optical character recognition, usually abbreviated to OCR, is the mechanical or electronic conversion of scanned images of handwritten, typewritten or printed text into machine-encoded text. It is widely used as form of data entry from some sort of original paper data source, whether documents, sales receipts, mail, or any number of printed records. It is a common method of digitizing printed texts so that they can be electronically searched, stored more compactly, displayed on –line, and used in machine processes such as machine translation, text-to-speech and text mining. OCR is field of research in pattern recognition, artificial intelligence and computer vision.

Early optical character recognition could be traced to activity around two issues: expanding telegraphy and creating reading devices for the blind. In 1914, Emanuel Goldberg developed a machine that read characters and converted them into std telegraph code. Around the same time, Edmund Fournier d'Albe developed the Optophone, a handheld scanner that when moved across a printed page, produced tones that corresponded to specific letters or characters.

## 3. PROPOSED METHODOLOGY

### 3.1 Image Processing System

The image processing systems prepares the acquired image for subsequent classification by neural network. It consists of the following stages: image acquisition, pre-processing, segmentation and classification.

**Image acquisition:** The printed or displayed text is obtained a CMOS sensor/camera as a video. The camera is scrolled over the text to be recognized. As the reading speed will be slow when compared to the frame rate of the camera, only a few frames of the video input are selected, periodically, for recognition. The raw pixel data output of the CMOS sensor is converted to an RGB or grayscale format.

**Pre-processing:** Printed documents usually consist of black print on a back print on a white background. Hence, when performing OCR, it is common practice to convert the multilevel image(RGB or Grayscale) into a bi-level image of black and white. This process is known as thresholding. The image resulting from the scanning process may contain a certain amount of noise.

**Segmentation:** Segmentation is a process that determines the constituents of an image. Applied to text, segmentation is the isolation of characters or words. The majority of optical character recognition algorithms segment the words into isolated characters which are recognized individually. Usually this segmentation is performed by isolating each connected component.

## 4. IMPLEMENTATION

The research about the ways to implement an ANN on a FPGA and decided to hardcode a trained neural network onto the FPGA due its ease of implementation. The following section describes the complete implemented system and the tools used to build.

Some of the hard ware provided on the DE2 board are listed below:

- Altera Cyclone II 2C35 FPGA device
- Altera Serial Configuration device – EPCS16
- USB Blaster (on board) for programming 512-Kbyte SRAM
- 8-Mbyte SDRAM
- 4-Mbyte Flash memory

### 4.1 System Implementation

Altera DE2 FPGA development board and Verilog HDL are used to describe the system. Quartus II IDE was used to build the design files and program the FPGA. The Mega function wizard utility was used to create floating point operation blocks required by the floating point ALU.

#### MATLAB

The stored video captured from the mobile phone was used initially in the image processing stages. Video is read using 'VideoReader' function and 'read' function. The individual frames areas are separated and stored

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individually in the system as .jpg images using 'imsave' and strcat' option.

ABCDEFGH IJKLMNOPQRSTUVWXYZ

Abcdefghijklmnopqrstuvwxyz

1234567890

**Fig -1**: Arial round MT bold character set.

Fig. 1 shows one of the tested neural networks. It describes an ANN with a 48 element input vector, 25 neurons in the hidden layer and 62 neurons in the output layer.

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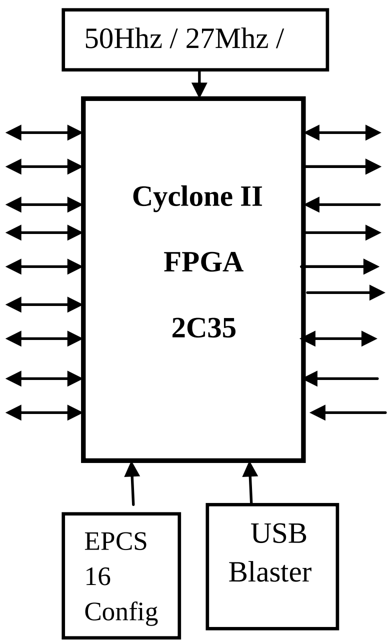


**Fig -2**: Altera DE2 board

1. USB 2.0 Host/Device
2. 10/100 Ethernet Phy/MAC
3. SD Card
4. Ir DA Transceiver
5. Flash (1Mbyte)
6. SDRAM(8 by)
7. SRAM(512 Kbytes)
8. 7-Segment Display(8)
9. Expansion Headers (2)
10. Pushbutton Switches
11. Toggle Switches
12. PS2 & RS-232 Ports
13. 16*2 LCD Module
14. User Red LED
15. USER Green
16. Tv Decoder
17. VGA 10bit Video DAC
18. 16bit Audio CODEC

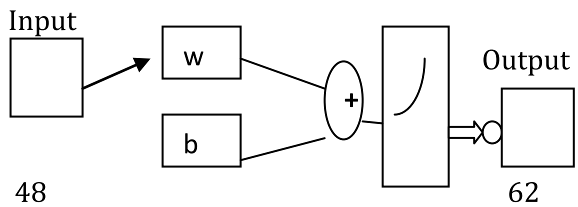


**Fig -3**: Tested Neural Network.

### 4.2 Result

The proposed OCR system using Artificial Neural Network was successfully implemented on MATLAB. Three English font styles containing 62 unique symbols (26 capital letters, 26 small letters and numbers 0-9) were tested on the implemented system and successful recognition was achieved.

## 5. CONCLUSIONS

The end result of this paper focuses on developing a real time character recognition system on an FPGA. An advantage of developing this system on FPGA was the ability to update the functionalities or correct any error by re-programming the FPGA with a systems new version.

Hardware development was done using an Altera DE2 development board with a Cyclone II FPGA which was found to be appropriate for multimedia projects. The CMOS sensor from TERASIC (TRDB-D5M) with 5 megapixel resolution is form the same vendor. This development kit include Verilog HDL demonstration codes for the image acquisition, conversion and image storage. Some of them were used with few changes and additions to meet project's needs.

Neural network developed on Matlab was very successful in identifying characters form a set of unique symbols of the same font style. Due to time constraint, we could only implement a part of the neural network on the FPGA. The code to implement that network is generic and it can be extended to any desired size.

A method for real time character recognition was explored. We have proposed a novel method to implement such a system which could be used in advanced Braille devices that help the visually challenged gain access to all the text that is available to a normal sighted person. We gained deep insight on implementation image processing algorithms on an FPGA. We also learnt a lot about artificial neural networks and its use in the field of character recognition.

### 5.1 Future Enhancement

This system can be used for any optical character recognition purpose, but it is optimized to be used with a Braille device. It can become the OCR front end for advanced wearable Braille devices.

Characters of many different font styles and size of many languages can be recognized by just changing the weights of the neural networks appropriately. The biases and weights for different target symbol sets could be generated on a PC using training software such as Neural Network Toolbox of Matlab and stored in a header or list. file. This file alone is enough to reconfigure the system to identify the desired character set of the language of the user's choice.

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