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The Methods Used in Text to Braille Conversion and Vice Versa

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ABSTRACT: The visually impaired form an integral part of our society. The National Census of India has estimated around 21.9 Million disabled people in the country. Out of them, more than 15 million people in India are blind. This is the highest among all other disabilities. Three out of every five disabled children in the age group of 0-9 years, have been reported to be visually impaired in India. Due to their disability, visually impaired people face difficulties in gaining full advantage of computers. With the rapid evolution of technology, researchers have proposed to give the blind an ability to take advantage of these advancements. Accordingly, designers and engineers have started working on projects that relate input and output devices to computers for the visually challenged individual to have full control of the machines. The project's objective is to design and develop a Braille System and output devices for the visually impaired individuals that enable them to interact and communicate. This study proposes an algorithm which enables the user to convert the text that we normally have in our day to day usage into a Braille Script and thus facilitate the visually impaired. The Product that has been created is an intuitive and simplistic design that will enable the end user to comfortably read.

KEYWORDS: Braille, Technology for the visually impaired, Braille System

I. INTRODUCTION

Braille was originally developed as a means for soldiers to read communications at night without the need for lighting which could expose their position Braille has now been adopted as the standard form of written communication for visually impaired people.**[3]** First developed in nineteenth century, it is a system of writing that uses patterns of raised dots to inscribe characters on paper. It therefore allows visually – impaired people to read and write using touch instead of vision. All over the world, persons who are visually impaired have used Braille as the primary means of accessing information. A text to Braille converter is intended to aid the blind to interact with others at workplaces and homes. Facilities for the sightless have been organized in various places for providing reading facilities to the blind in the form of Braille coded texts**. [2]** The invention of the Braille traces backs to the year 1809 when Louis Braille (4 January 1809 – 6 January 1852) who was a French educator invented this system of reading and writing for use by the visually impaired. His system remains known worldwide simply as Braille. Braille consists of a system of six or eight possible dot combinations that are arranged in a fixed matrix, called a cell. Every dot can be set or cleared, giving 61 combinations in six-dot & 256combinations in eight-dot Braille. All dots of a Braille page should fall on the intersections of an orthogonal grid. When texts are printed double-side (recto-verso), the grid of the verso text is shifted so that its dots fall in between the recto dots. Braille has a low information density. An average page of 25x 29 cm, can have 32 characters on a line & 27 lines in a page. A typical dot has a diameter of 1.8 mm. This project presents a solution to such a problem, making learning process for an unsighted person easy. Since all text-books are not be available as Braille script or as Audio recordings, developing this system will address this problem. An image of the content in the textbook will be taken and converted into a Braille script. **[1]**In 1918, Braille was accepted as a standardized tactile writing for the blind.**[5]**

II. RELATED WORK

A sight-blessed person can interact with the computer via different Input/output devices, while a visually impaired person, on the other hand, is somehow forced to use specially designed devices or programs to interact with computers**.**

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[4]. The visually impaired person uses a variety of equipment and programs that enable him/her to enter data into computers or control them. Among these input devices are Braille keyboards and Braille/Character scanners. In this research work, image capture and extraction method is used for the conversion of Braille into normal text**. [5]** The first part contains the capturing of image of Braille text and the other deals with its processing. For the conversion from text to Braille, the system is not efficient because errors occurred in the conversion of the captured image into Braille. In this methodology, suggested six micro vibration motors were placed on various parts of the body similar to the six dots of a Braille cell and then according to the Braille text inputted to the system, the specific motor vibrated and the text was converted into Braille [2]. This proposed methodology changed drastically and the need for a device which was a Unicelled refreshable Braille display that would convert digital text into Braille output, became essential. [3] In this method, at the input stage, the text data was sent from the mobile device by a Bluetooth Transmitter and at the output part the data was received by a Bluetooth Receiver. The existing modules are far away from the fundamental problems of blind and the blind could not acquire self-dependence in the field of reading knowledge available in the form of digital data. Keeping this in mind, we have studied and proposed a few methods which would prove extremely beneficial in the conversion of text to Braille.

III. BASIC BRAILLE CELL

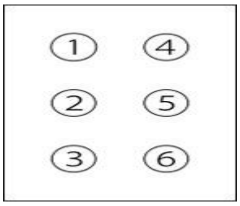

Fig. 1. The Braille Cell

A Braille Cell is made up of six dots that fit under the fingertips, arranged in two columns of three dots each. Each cell represents a letter, a word, a combination of letters, a numeral or a punctuation mark. In Braille, an alphabet is made up by a combination of six dots. Each character in Braille consists of one or more (to a maximum of six) raised dots. The position of the different dots represents the different letters of the alphabet. The first ten letters of the alphabet are formed using the top four dots (1, 2, 4, 5). Adding a dot 3 makes the next ten letters and adding a dot 6 to that makes the last six letters. **[2]**

IV. GRADE 1 BRAILLE

A Braille letter is by default taken to be in lower case. To indicate an uppercase alphabet, the capital sign is put in front of the Braille letter**.[1**].Dot height is 2 approx. 0.02 inches (0.5 mm); the horizontal and vertical spacing between dot centres within a Braille cell is approx. 0.1 inches (2.5 mm); the blank space between dots on adjacent cells is approx. 0.15 inches (4mm) horizontally and 0.2 inches (0.5mm) vertically. A standard Braille page is 11 inches by 11.5 inches and typically has a maximum of 40 to 43 Braille per line and 25 lines are there in a Braille sheet. **[1].**

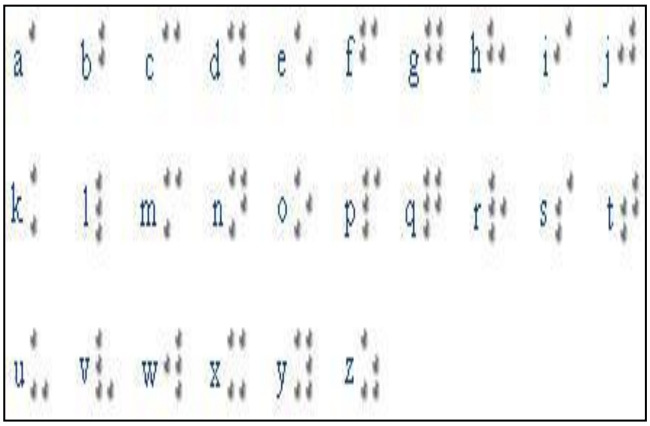

Fig. 2. Basic Braille Script

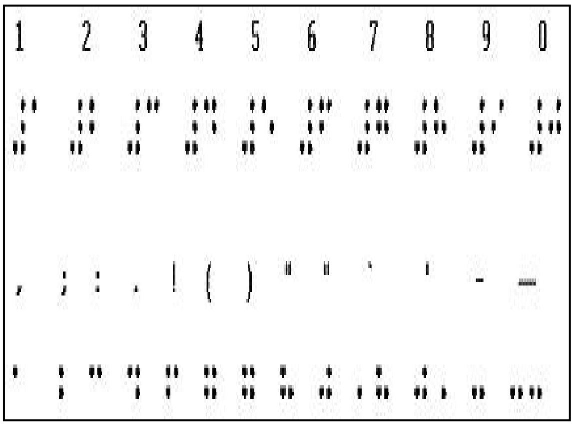

Fig.3. Braille for numbers and punctuation marks

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V. SCOPE OF THE WORK

There are a lot of translation software available for conversion of English text to Braille, but some lack certain features such as the ability to change the translation grade and are also very expensive. Their license costs anywhere between three hundred to thirteen hundred dollars**. [3]**There are free translation software packages which are available, but they also possess a limiting factor, they do not allow the user to format the Braille text or have multiple grade translations within the text itself. The software does not allow the user to have multiple languages for translation within a document. Most of the Indian languages like Devanagari, are not available. Translation for special symbols and diagrams are also not possible. In our project, we are emphasizing on a specific Font and size. We take the input as any font, size or character and then compare it with the features already stored in the database. Latter part can be feature extraction, which will compare all the features of input with the database and if the feature matches, then the corresponding object in the database is the required output of the system. All these functions are performed by Pi Tesseract an optical Character Recognizer and then as per the signal allotted to the object, the signal will flow through GPIO pins and get popped accordingly **[1]**. Taking this study to the next level, this project can be implemented in various languages too. Here, the inputs will be in a different language and per the letters of these languages, buttons will be popped up. As Indian languages are phonetic in nature, implementing it further for other languages will not be a big problem.

VI. USING RASPBERRY PI

A. The Block Schematic

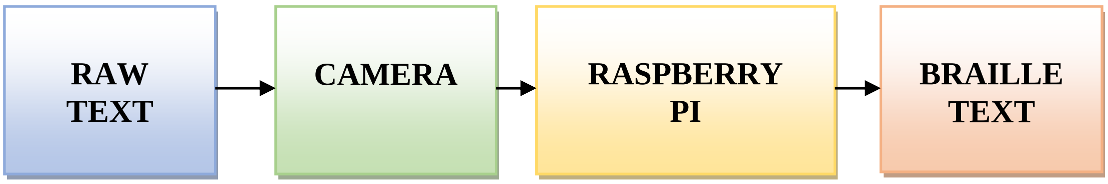

Fig. 4. Block Schematic

The raw text is captured by the camera. The camera then sends the Captured Image to the Micro-Controller (Raspberry Pi) which in turn converts it into Braille Text.

B. Design Flow

The blocks which perform Image Acquisition, enhancement, character segmentation, Edge detection, filtering and the comparison with the database to finally recognize the character optically, is done by Pi-Tesseract.

Image acquisition - Acquiring the image in other terms is known as Image acquisition. We acquire our Image using Mag –Picamera directly Interfaced with Raspberry Pi.

Image Enhancement - This is improvement of digital image quality. Contrast adjustment is made by histogram acquisition. It also increases the visibility of the Image.

Filtering - The technique of median filtering is used in the filtering section. A median filter operates over a window by selecting the median intensity in the window in which it is supposed to operate. Median filter is an example of Non-linear filtering, it is often used to remove noise

Edge Detection - At first the edges in the image is determined with the help of edge detection methods, hence finding the boundaries.

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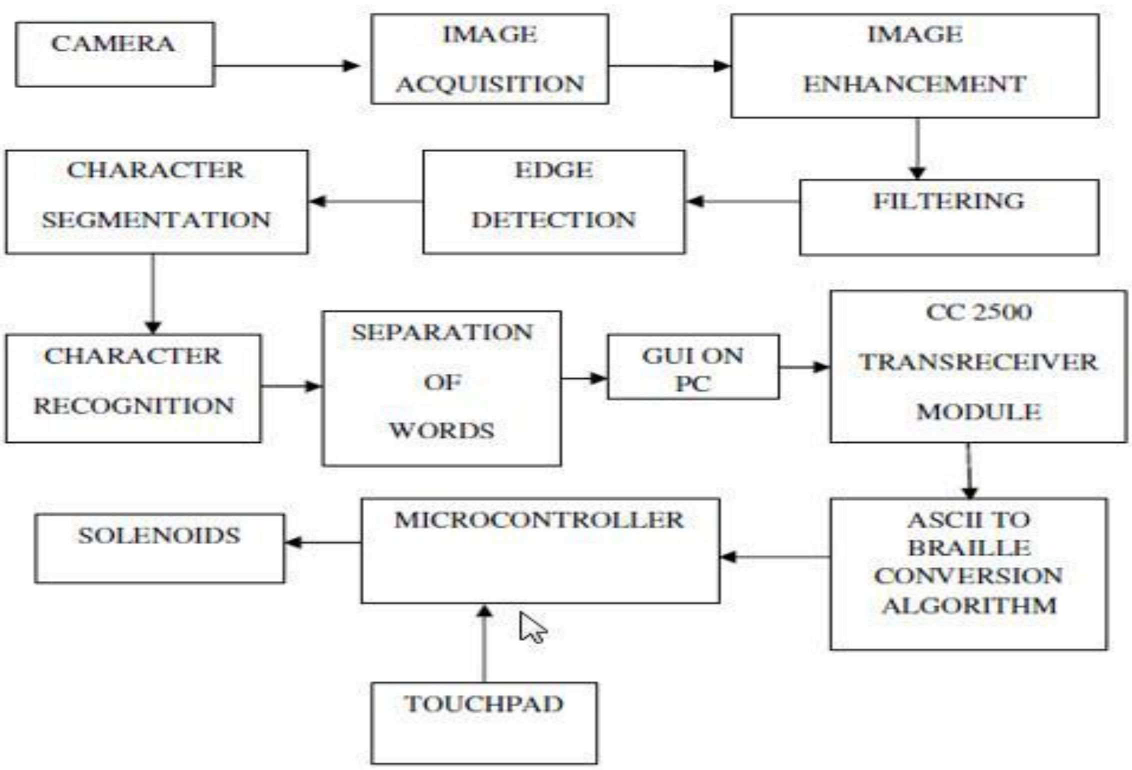

Fig. 5. Design Flow

Character Segmentation - Partition of image into several components. Segmentation is an important part of any image recognition system, one extracts the objects for further processing such as description or recognition of a character.

Character Recognition - The captured image is compared with the images early stored in the system for character recognition.

Separation of words - Here the letters obtained are separated to words. We set a threshold value for space, if the value obtained is greater than the threshold value, it is considered as letter else space. Thus, separation of words takes place.

C. Optical Recognition

The techniques involved in Optical character recognition are:

Adaptive Thresholding - It is a technique Used in Pi Tesseract, where in the spatial and Luminous (i.e. the variations in the intensity of light) variations are considered.

Connected Component Analysis - It is an algorithmic application of Graph theory where subsets of connected components (i.e. the components with very high correlation) are uniquely *labelled*, based on a given heuristic (i.e. a set of parameters).

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Find Text Lines and Words - It finds various break points, page ends and words in a line.

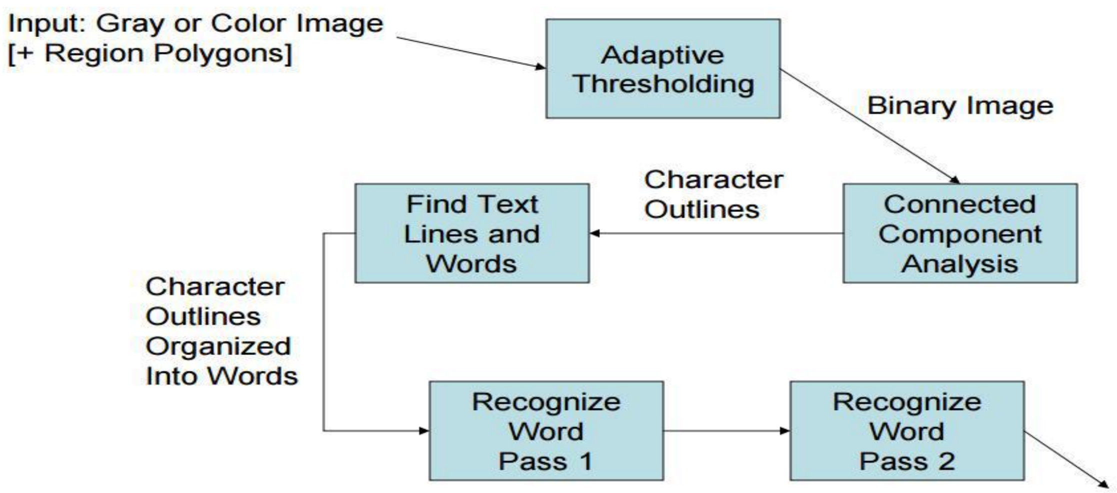

Figure 6: Optical Recognition

Recognize Word Pass 1 - Out of the 2 passes to recognize the word, the first pass detects the word in context and passes it further to pass 2.

Recognize Word Pass 2 - This Pass confirms whether the word recognised in pass 1 is correct or not. That is used for confirmation purpose.

D. Components Used

Camera - The camera used in this project is a high-resolution camera that usually suits our need (MAG PI – Compatible with Raspberry Pi). A webcam will also work with our project, but for better quality and better results, we will be using high resolution camera. MAG-PI is the camera that we are using in our project.

Raspberry Pi - Raspberry Pi is a very widely used Micro-Controller, especially for Image Processing Purposes, as it makes the task very easy.

Push Button Switches - These are used to pop up the Braille script that we are going to output. In all there are 6 such switches. Basic connection between switches and Raspberry Pi is given.

E. Implementation of the system

Suppose the input sentence is “I ENJOY READING.” Now, this sentence will be broken down into tokens by Pi Tesseract OCR, which will be in the form of letters as given: I, E, N,J,O,Y,R,E,A,D,I,N,G. In grade 1 braille, all these characters are matched from the lookup table which will be a part of our Database. For grade 1 Braille, the tokenized text will be matched with the lookup table. If any match exists, the corresponding signal will be sent according to the values.**[1]**

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VII. USING MICROCONTROLLER PIC16F877A

A. Microcontroller PIC16F877A

The PIC16F877A is a low-power, high performance CMOS 8-bit microcomputer, with 8K words of Flash Programmable and Erasable Read Only Memory (PEROM).

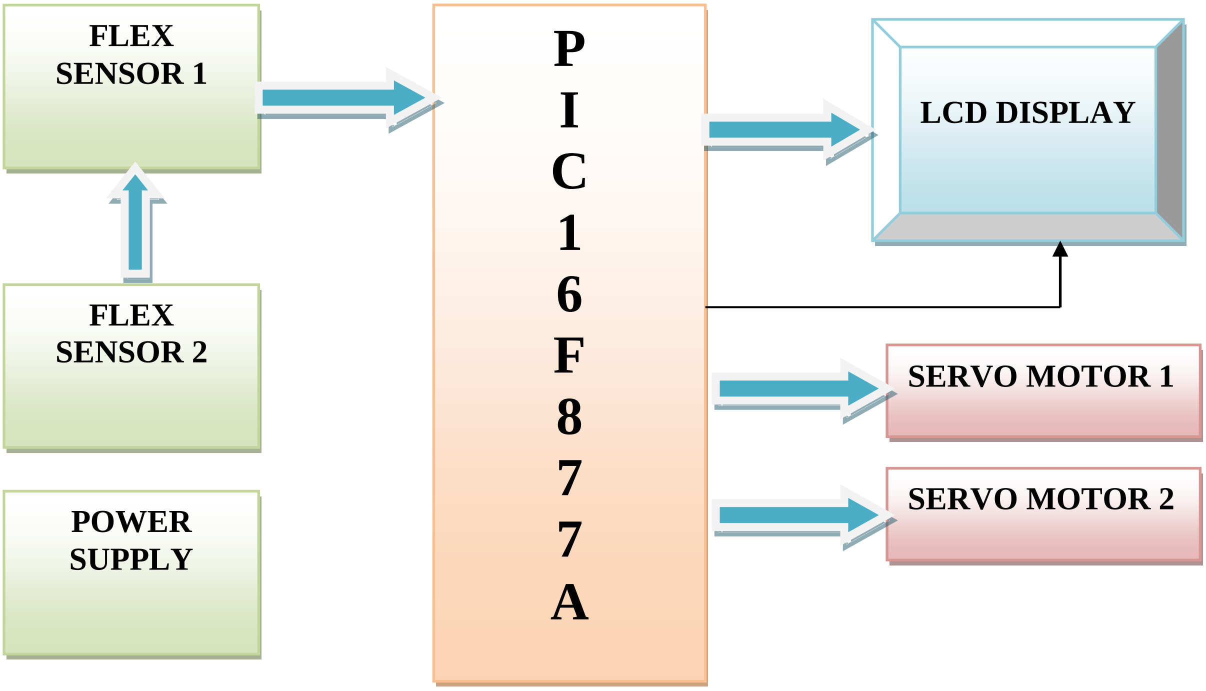

Fig. 7. Block Diagram

B. LCD Display:

The LCD display unit helps users to manage this operation very easily. It is a 16X2 lines alpha numeric display unit which displays all events.

C. Flex Sensor

Flex sensor is a resistor which helps in Angle Displacement Measurement. Some of its uses include Robotics, Gaming (Virtual Motion), Medical Devices, Computer Peripherals and Musical Instruments

D. Servo Motor

The Servo Motor uses error sensing negative feedback to control the precise angular position. Servos are used for precise positioning in robotic arms, legs, RC Aero planes, Helicopters etc. Hobby Servo Motors have three wires, two of them (RED and BLACK) are used to give power and the third one is used for control signals. Servos can be easily controlled by microcontrollers using Pulse Width Modulated (PWM) signals on the control wire. Here we are using a servo whose angular rotation varies from 0 to 180 degrees. **[2]**

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E. Power Supply

The power supply is the most indispensable part of any project. IC regulators are versatile, relatively inexpensive and are available with features such as current/voltage boosting, internal short circuit current limiting, thermal shutdown and floating operation for high voltage applications. The regulated circuit is used to maintain a constant output level. The integrated circuit regulator, sometimes called the three-terminal regulator contains the circuitry for reference source error amplitude control device and overload protection, all summed up in a single IC chip. **[2]**

VIII. USING FPGA

A. Design of the proposed system

The crux of this Design Implementation is the conversion from the basic "Braille" language to English using FPGA. The Spartan-3 family of Field-Programmable Gate Arrays is specifically designed to meet the needs of high volume, cost sensitive consumer electronic applications. Braille Keyboard (I/P device), LCD (O/P device) and speaker (O/P device) are all interfaced to the FPGA. Software will take the combination of all the six cells from I/P hardware, decode it and give the appropriate O/P on hardware. Whenever the user provides Braille input, the same will be accepted and displayed on the screen and accordingly speech output of the character will be output. After accepting few characters, the user will press play button. The device must search for that word from the look up table and accordingly output it to the speech device. The system consists of a Braille Keyboard (I/P device), an LCD (O/P device) and a speaker (O/P device) all of which are interfaced to the FPGA. The software will take a combination of all the six cells from the I/P hardware, decode it and give the appropriate O/P to the hardware. The system block diagram is shown in fig.3.

B. Architectural overview

The Spartan-3 family architecture consists of five functional elements:
- Configurable Logic Blocks (CLBs).
- Input/output Blocks (IOBs).
- Block RAM.
- Multiplier blocks.
- Digital Clock Manager (DCM)

These components are shown in Fig.11.

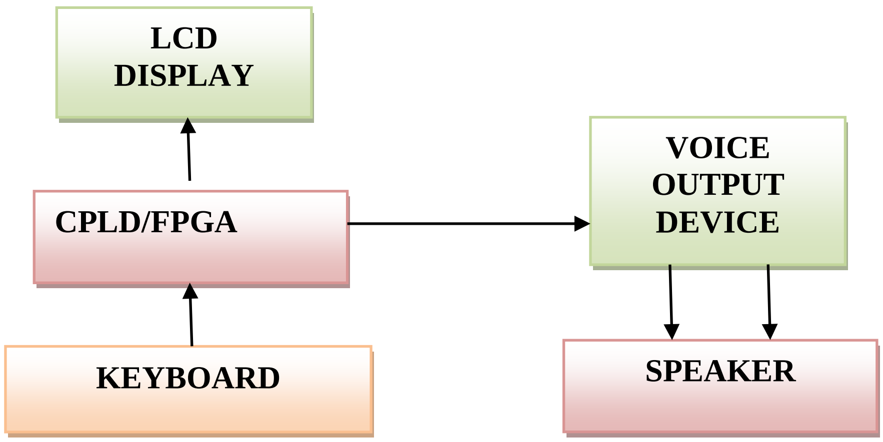

Fig. 10. System Block Diagram

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Configurable Logic Blocks (CLBs):The CLBs contain RAM-based Look-Up Tables (LUTs) to implement logic and storage elements that can be used as input/outputs or latches. CLBs can be programmed to perform a wide variety of logical functions.

Input/output Blocks (IOBs): Control the Flow of data between the I/O pins and internal logic of the device. Each IOB supports bidirectional data flow plus 3-state operation. Twenty-six different signal standards, including eight high-performance differential standards, are available.

Block RAM: Provides data storage in the form of 18-Kbit dual-port blocks. It has up to 3.5 Mb of RAM in 18-kb blocks, and synchronous read and writes. True dual-port memory and each port has synchronous read and write capability, Different clocks for each port.

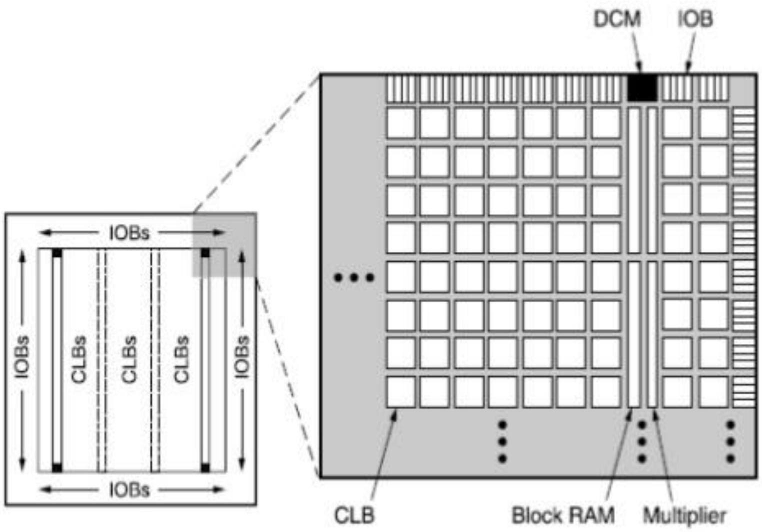

Fig. 11. Architecture of Spartan-3 Family

Digital Clock Manager (DCM):Multiplier blocks accept two 18-bit binary numbers as inputs and calculate the product. Digital Clock Manager (DCM) blocks provide self-calibrating, fully digital solutions for distributing, delaying, multiplying, dividing, and phase shifting clock signals. **[4]** The static Memory Programming Technology is one of the most efficient programming technologies and has basic steps Involved in designing which are shown in following flowchart. Fig. 12 & Fig 13 gives the flowchart for the designed system. The steps are as follows:

- Design description
- Behavioural simulation (Source code interpretation)
- Synthesis
- Functional or Gate level simulation
- Implementation and fitting
- Place and Route
- Timing or Post layout simulation
- Programming, Test and Debug

The Following steps are followed during programming:

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- The HSWAPEN input pin defines whether the I/O pins that are not actively used during configuration have pull-up resistors during configuration.
- The dedicated configuration pins (CCLK, DONE, PROGB, M2, M1, M0, HSWAPEN) and the JTAG pins (TDI, TMS, TCK, and TDO) always have a pull-up resistor to VC-CAUX during configuration, regardless of the value on the HSWAPEN pin.
- Depending on the chosen configuration mode, the FPGA either generates a CCLK output, or CCLK is an input accepting an externally generated clock. A persist option is available which can be used to force the configuration pins to retain their configuration function even after device configuration is complete. If the persist option is not selected then the configuration pins with the exception of CCLK, PROGB, and DONE can be used as user I/O in normal operation. The maximum bitstream length that Spartan-3 FPGAs support in serial daisy-chains is 4,294,967,264 bits (4 GBits), roughly equivalent to a daisy-chain with 323XC3S5000 FPGA.

Configuration Mode Pins						
Configura-tion Mode(1)	M0	M1	M2	Synchro-nization clock	Data Width	Serial D out
Master Serial	0	0	0	CCLK Output	1	Yes
Slave serial	1	1	1	CCLK Input	1	Yes
Master Parallel	1	1	0	CCLK Output	8	No
Slave par-allel	0	1	1	CCLK Input	8	No
JTAG	1	0	1	TCK Input	1	No

Table 1: Details about the configuration of FPGA

The flowchart of the slave serial mode is as shown in the figure 12 below:

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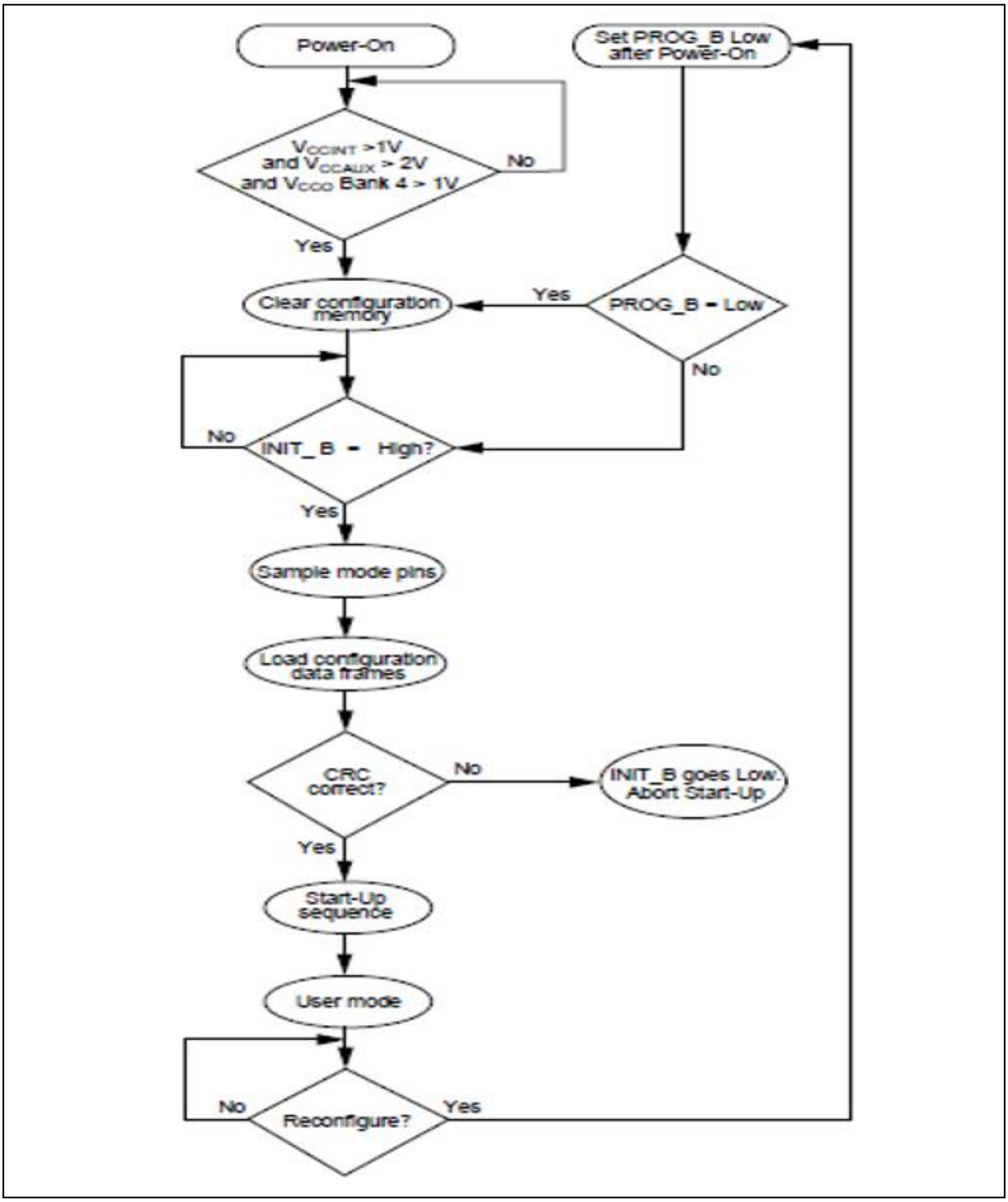

Fig. 12. Flowchart for slave serial mode

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C. Inference and output

Apart from the one discussed above, it can also be used for typing. Taking an example, if a blind person wants to write or type, then the Braille equivalent that has been given as input will be converted to English and the person who is typing can also get a conformation about what is being typed. Say if "hello" is being typed, then this system will pronounce h, e, l, l, o every time the character is being pressed and prevents the occurrence of mistakes. The above method is reliable for the visually impaired and blind people where in when the input is given to the FPGA through Xilinx Impact software and the corresponding text output is displayed on the LCD screen. We simulated the program, and downloaded it on the FPGA kit. FPGA Spartan 3 IC XC3S400 is a very fast, low power consuming and efficient IC.

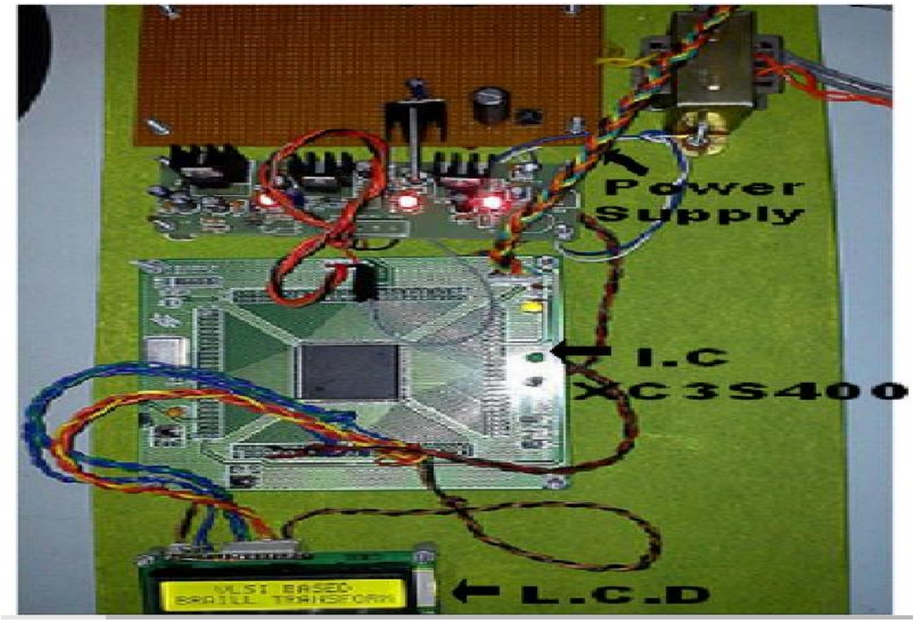

Fig. 13. Implemented circuit for the designed system

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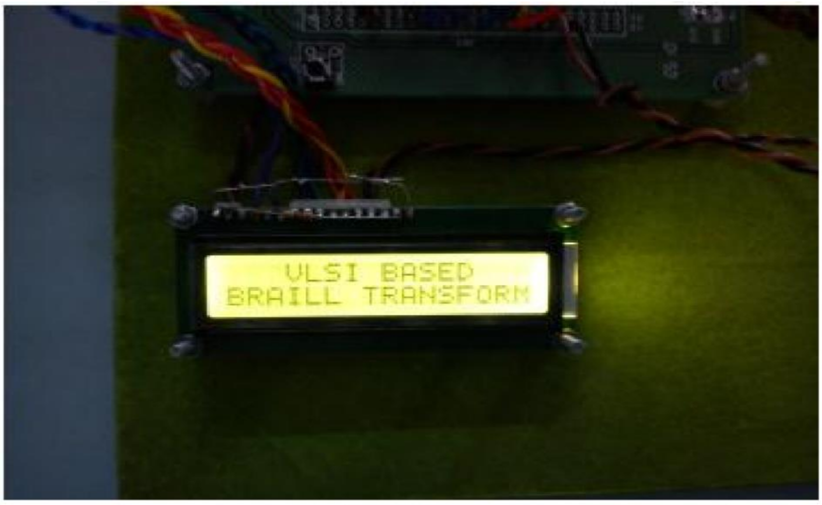

Fig. 14. Output of the system

IX. CONCLUSION AND FUTURE WORK

The method using the microcontroller PIC16F877A, uses fewer components, is light weight and flexible, requires less power and is easy to operate. Many languages can be used in it. This device can be further modified to improve the vocabulary, by using more number of flex sensors and by making the servomotor arrangement capable of producing all the Braille characters. By using the digital signal processor, we can also provide speech to Braille conversion and vice versa. The method which uses Raspberry Pi is a Low-Cost Text to Braille Converter. It also has a functionality of Text to Audio conversion to help the visually impaired in either reading books or listening to it. The low power consuming FPGA board is implemented to convert Braille to text very efficiently. One main advantage of the FPGA of Spartan 3 IC is that we can adjust the internal hardware circuitry according to the software coding.

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