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Research Article

Refreshable Braille Display using Raspberry Pi and Arduino

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Abstract

The aim of this project is to create a refreshable electronic braille display using Raspberry Pi 2 and Arduino Mega2560 board. This aims at creating a refreshable braille display that is capable of converting Normal text file as well as printed image files to braille. To achieve the functionality of converting image files to text we have used tesseract-ocr engine of Google which the best available OCR engine available right now and is highly accurate. The Raspberry pi does the image processing and the Arduino drives the display. The display is made of 6 servo motors, which can be controlled by the PWM. The servo motor acts as an actuator in this project..

Keywords: *Braille, OCR, servo motor, PWM, Arduino, Raspberry Pi*

1. Introduction

Braille is a writing cum reading method used by blind or visually impaired people. In braille script, each character is represented by a unique combination of 6 dots, which form one cell . It has always been a challenge to make braille books for blind people. On an average a page of normal text takes around 4 pages(A. Domale, B. Padalkar, R. Parekh and M. A. Joshi *et al*, 2013) in braille which often makes braille books quite bulkier which involve a higher production cost. So, to work around this problem we have come up with a solution to make a braille display which can take text as well as image input and convert that into braille. There are currently many refreshable braille displays available in the market but all of them face a major problem i.e. high cost, so we propose a design in order to tackle this challenge.

In the past there was a paper that proposes a design of braille display using microprocessors but that device aimed at converting the braille text to a display which is having a mechanical piezoelectric display (S. M. Elster, B. L. Zuber and J. L. Trimble *et al*, 1985). The main challenge there was that, we don't have many books/reading materials in braille. At Annual IEEE conference INDICON 2012, A device named DRISHTI (Vineeth Kartha; Dheeraj S. Nair; S. Sreekant; P. Pranoy; P. Jayaprakash *et al*,2012) was proposed which discussed about a gesture based Braille device, the device was implemented using solenoid as actuators. Arduino IDE and Processing IDE was used along with Atmega 328 Microcontroller. The principle of dot matrix was used to represent braille dots using Solenoids, although the design was quite good, but it faced some problems such as high power consumption and noise, since solenoids were involved. Kentaro Noda, Kiyoshi Matsumoto, Isao Shimoyama (Noda, Kentaro, Kiyoshi Matsumoto, and Isao Shimoyama, *et al*,2008) proposed and fabricated a skin type structure based tactile sensor to detect the object surface by scanning. The proposed sensor had different layers of elastomers as epidermis-dermis, piezo resistive cantilevers were placed behind the ridge which were responsible for unique deformation of the sensor. The proposed sensor was quite efficient but needed a lot of precision for scanning the exact angle. Increasing Braille Literacy: Voice-Assisted Electronic Braille Books (Mahmoud Al-Qudsi *et al*,2013) (eBraille eBook) for the Visually Impaired this paper aims at making eBooks to braille through a braille display plus an additional voice assistance this is similar to out text input, where direct text can be given as input to the file. So, here we propose a design that that solves the above challenges. The text to braille display that we have designed uses a SBC (Raspberry Pi) and an Arduino board which can convert any text or image to braille.

A raspberry pi is a SBC, with great computational power. Raspberry Pi is a credit card sized single board computer designed by Raspberry Pi Foundation, which can be plugged into a monitor or TV. It was primarily designed for teaching coding to kids of elementary school, but overtime pi has built its reputation as a Multitasking Board which is widely used by various hobbyists and makers for their projects. The board is capable of functioning as a full desktop and is capable of processing high quality video. It even has the ability to interact with the outside world and control the

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music systems, Television etc. Here we are using Raspberry Pi 2 Model B, which is having 1GB RAM and 32 bit ARMv7 Processor.

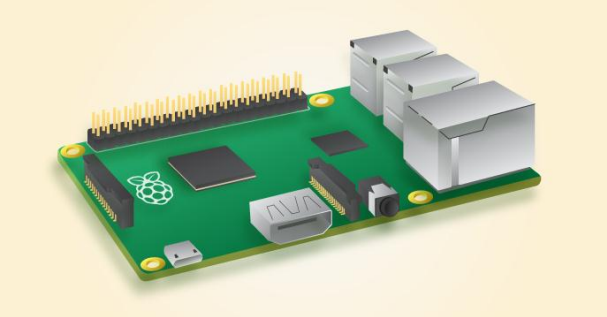


Fig.1 Raspberry pi

Arduino is an open source mother board that is intended to design interactive hardware projects which can sense and control the external world through sensors and actuators. Arduino is a mother board, which works on an 8 bit Atmega microcontroller. For our project we are using Arduino mega2560 is a microcontroller board on ATmega2560. The board has many digital pins and a few analog pins, which have an inbuilt analog to digital convertor on the board. The board is generally programmed through the Arduino IDE, based on the processing project, which supports C, C++ and Java languages for programming it. The board has only a few KB of RAM, which make it not suitable for high computational power activities. The board is driven by a 16 MHz clock pulse but without any Operating System on it. It can be programmed only through serial communication, either through UART or USB cable. It supports power input from 5 V to 20 V, in which, for our project, 9 V is optimal. The Arduino Mega board used in this project has 54 digital input/output pins of which 15 pins can be used as PWM outputs.

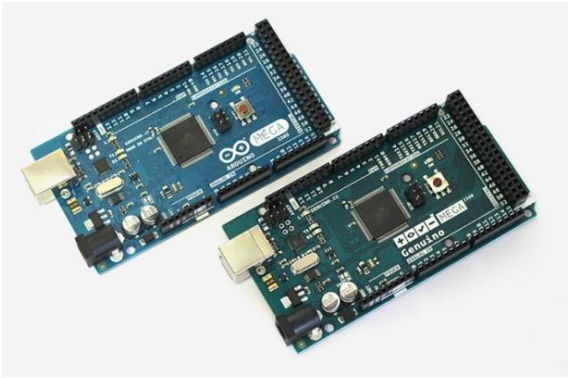


Fig.2 Arduino Mega

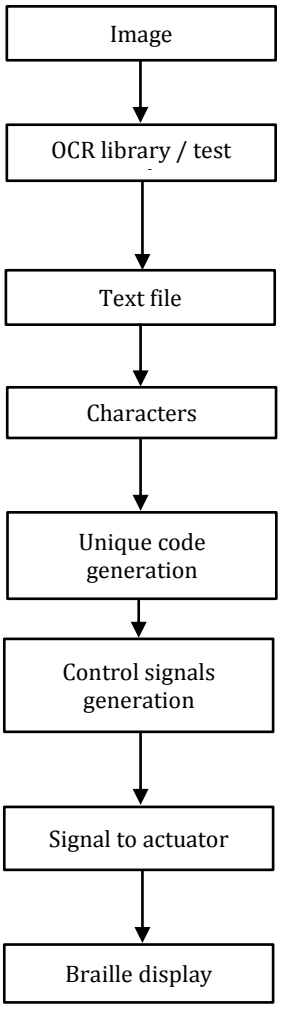
Proposed Refreshable braille system

Hardware Stage

We are going to use the following components

1) Raspberry Pi
2) Arduino Board
3) Servo Motors

Flow chart:



Flow chart

We have operated the pi in headless mode for this project, where pi is not connected to a monitor. The raspberry pi 2 used here has 4 USB ports, in which one is used for serial communication with Arduino. This minicomputer works at a huge machine clock of 900 MHz, which can be overclocked till 1 GHz and has a quad core processor. The device works on a 5 V power supply. We have worked on Raspbian OS, which is based on debian Linux. This OS is specifically designed for raspberry pi and is most widely used on this board. This OS comes with python pre-installed, which does the job of image processing and Arduino controls. The whole system runs on the micro SD card, which has the OS and files in it.

It is used for processing the image and split the image into characters using OCR (optical character recognition) techniques. OCR is a system which allows us to convert the hand written notes or printed material into a computer editable file, which can be used in future. So, using these OCR techniques, the pi converts the image and then each character is assigned

by a unique code. The code is sent to Arduino, which will control the display.

Arduino is controlled serially by the raspberry pi, using the nanpy Libraries. The nanpy libraries are designed in python, which can be used to control Arduino through serial port. The nanpy libraries control the Arduino at a baud rate of 115200 bps and with the nanpy firmware installed on Arduino . So, in this process the pi acts as a master and controls Arduino as a slave. After the image being processed and the characters being converted to unique code, it obtains the information about the pins of the servo motor and notifies the Arduino about the functions which it has to do. Then the Arduino produces PWM pulses to control the actuators.

For displaying the output we are going to use combination of six servo motors as all the braille combinations are formed by various combination of six dots.

The servo motor is different from a normal DC motor as it can only rotate in 180 degrees. The servo motor is widely used in Robotics related projects. The servo motors need a 5 V DC supply, and a control signal based on pulse width modulation to control the position. Pulse width modulation is a technique where the on time of a signal is controlled w.r.t the total signal time. Here the signal used has a total time (time on plus time off) of 20ms. So the time for which the high pulse is given determines the location the servo motor should go to.

- For a 0.5ms duration of a 5V pulse, the servo motor needs to go to 0 degree position.
- For a 1.5ms duration of a 5V pulse, the servo motor needs to go to 90 degree position.
- For a 2.5ms duration of a 5V pulse, the servo motor needs to go to 180 degree position.

After receiving the input pulse, the servo motor gets the current position of the motor and hence decides the direction and time period for which the wheel attached must rotate, hence sending the wheel or the pointer (in this case) to the desired position.

We have kept these six motors aligned in a box with a slit made so that for ON condition of these motors, the tip of the pointer will touch the finger of a blind person and by the pattern formed by the tips, he can sense which character is being displayed.

Software Stage

For coding we have used the python programming language which is a high level, easy to understand and code language. The python script will make use of the Google's Tesseract-OCR libraries for processing the image file. Tesseract-OCR libraries are one of the best libraries available to read the printed text, with a least error rate. So, the OCR libraries produce the output as a text file, which is the output of the image in the form of simple text (Patel, Chirag, Atul Patel, and Dharmendra Patel *et al*,2012).

The text obtained from the Tesseract-OCR libraries is then split into individual characters and then assigned with a unique code of zeros and ones, which indicate the position of servo motors. Then the unique code is sent serially to the Arduino, which controls the servo motor using the PWM output. For this purpose, we are using the nanpy libraries. The nanpy library uses python to control the control the serial data sent to the Arduino and the actions the Arduino does. For this purpose, Arduino has nanpy firmware installed on it, which would give the complete control of Arduino to raspberry pi. So, the python script after converting the image to characters, will send the control signals to appropriate servos connected to the Arduino board to get the servo motors to position required.

In addition to Nanpy and Tesseract-ocr, we use also use Pyserial which helps to transfer data serially to the Arduino Board.

Working

There are 2 working modes

1) Text input based
2) Image input based

In the Text input based method, we enter the desired text to be displayed in a text file, which is read by the python script and then the text is broken into characters and is sent serially to the Arduino for display.

In the Image based input we give the desired image as the input and the Tesseract-Ocr converts the Image to a text file with the required text in it.

- The text file is given as an input to the python code.
- The script reads the text file, character by character.
- For every unique character we generate a unique code.
- The unique code is converted to control signal.
- These control signals are transmitted serially to the Arduino.
- As per the control signals , the servo motors change their position and touch the fingers of the person

We can also modify the speed of operation of the servo motors as per the need of different persons by increasing or decreasing the time delay between the consecutive characters.

Circuit:

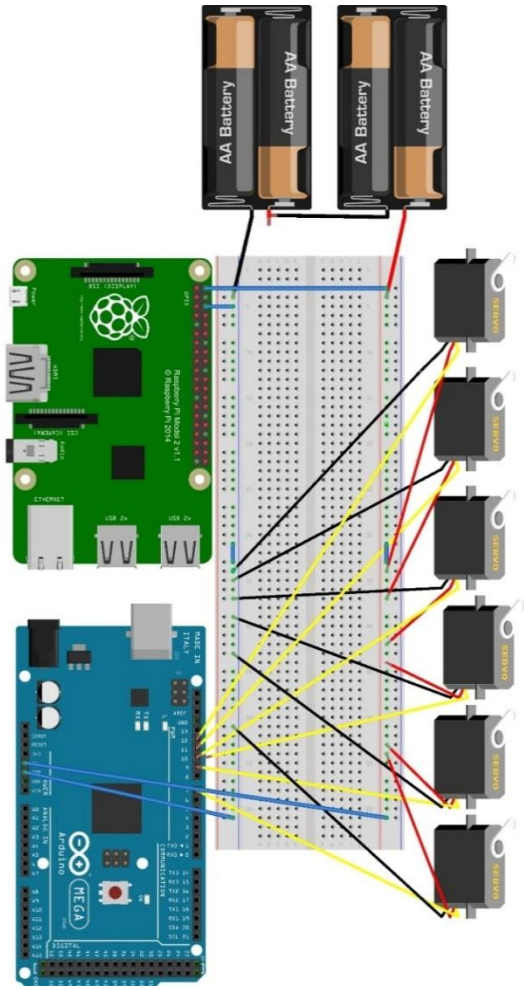


Fig.3 Circuit Diagram

Fig.4 Braille Display

Conclusion

This image to braille convertor can be added with a camera module and hence the images can be captured in a regular time interval and then the images can be represented as text on the refreshable display, allowing the blind people to read normal books and journals comfortably. Moreover they need not wait for the braille version of the book or journal to come out. Our model of the refreshable display has a speed of representing the braille characters at a huge rate of 12 character in 2.5 seconds and on an average 290 characters in 60 seconds.

Our complete system works on just a power supply of 15.4 Watts. The raspberry pi here is powered by a 5 V, 2 A charger in which pi is performing the processing and 2 servo motors are powered through pi. The Arduino is connected with a 9 V, 0.6 A charger, which helps Arduino produce PWM signals and 4 servo motors are powered from the Arduino board.

References

A.Domale, B.Padalkar , R.Parekh and M.A.Joshi(2013), “Printed Book to Audio Book Converter for Visually Impaired”, India Educators Conference(TIIEC) Texas Instruments, Bangalore doi:10.1109/TIEC.2013.27 , pp. 114-120

S. M. Elster, B. L. Zuber and J. L. Trimble(1985), "A Research Prototype of an Inkbraille Reading Aid," in IEEE Transactions on Biomedical Engineering, vol. BME-32, no. 8, pp. 633-636

Vineeth Kartha; Dheeraj S. Nair; S. Sreekant; P. Pranoy; P. Jayaprakash(2012) , “DRISHTI – A gesture controlled text to braille converter”, India Conference(INDICON),2012 Annual IEEE , pp. 335-339

Noda,Kentaro,Kiyoshi Matsumoto and Isao Shimoyama(2008),"Tactile sensor with standing piezoresistive cantilevers, covered with 2-layer skin type structures for texture detection of object surface.", Intelligent Robots and Systems, 2008. IROS 2008. IEEE/RSJ International Conference

“Refreshable braille display” Patent US 20130203022 A1. Aug 8, 2013

Patel, Chirag, Atul Patel, and Dharmendra Patel(2012) "Optical character recognition by open source OCR tool tesseract: A case study." International Journal of Computer Applications 55.10 (2012)

https://en.wikipedia.org/wiki/Braille

http://www.pyroelectro.com/tutorials/servo_motor/schematic.html