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Book Reader using Raspberry Pi

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***Abstract*—** Image-based sequence recognition has been a long-standing research topic in the field of computer science and technology. This project focuses on investigating the problem of text recognition, which is among the most important and challenging tasks in image-based sequence recognition. It mainly focuses on effects of uniform and full height map correction methods for dwarfing book spread images in an automated book reader design for individuals with visual impairment and blindness. The accuracy of the book spread images is quantified and measured by introducing the corrected images to an Optical Character Recognition engine. Based on character recongnization algorithm one can achieve the text to speech conversion and accuracy of speech is more. Camera-based assistive text reading framework and audio output along with Raspberry Pi is used in this project. Robotic assistive based page rotation is used to turn the pages of the book. It is working based on deep learning system especially applied to address the challenging process of book digitization.

***Keywords*—** Image-based sequence recognition, text recognition, Optical Character Recognition, Assistive reading

I. INTRODUCTION

In the digital world, reading a normal book remains as a big challenge for visually challenged people. This can be solved by converting the image or text into audio format which is user friendly. This conversion can be done by extracting text from an image. This remains as a challenging problem with many practical applications. Text recognition would provide a useful solution for this problem. This extraction is useful in translation purpose, robotics, research, wearable devices and numerous technologies.

Different types of reading assistants have been designed specifically for the visually impaired, but so far no existing reading assistant can read text from challenging patterns and backgrounds found on many commercial products [1]. It can be done by using the camera to capture the image of the page using a camera. In order to make sure that the hand-held object appears in the camera view, we use a camera with sufficiently wide angle to accommodate users with only approximate aim. This method will be used to assist the blind persons to read text from any hand-held devices. It also ensures the elimination of the background is done appropriately.

Several Assistive technologies are being developed for visually impaired people in order to live with confidence and to think positively. A camera-based assistive text reading framework is used in text recognition to track the object and extract print text format from the object [2]. Locating a position of the interested object remains as a challenge for users. Many technologies have been developed for localizing text in images. This technique is of two types rule-based and learning-based. Rule based techniques uses pixel-level image processing to extract text information from predefined text. This type of algorithm tries to define a universal feature descriptor of text. Learning-based algorithms uses model text structure and extract representative text features to build text classifiers.

II. LITERATURE SURVEY

Many surveys have been done to ensure the existing feature of the system for visually impaired. An embodied perspective on the development of multimodal and perceptual replacement technologies for Individuals with Blindness or Severe Visual Impairment (IBSVI) [1]. Difficulties comes from the fact that our cultural world and means of information exchange and design are inextricably associated with the capabilities of embodied humans endowed with spatial vision. The system is developed using computer vision and haptic technology. A fast and effective pruning algorithm is designed to extract Maximally Stable Extremely Regions (MSERs) as character candidates using the strategy of minimizing regularized variations, Text detection in natural scene

images is an important prerequisite for many content-based image analysis tasks [2]. This paper proposes an accurate and robust method for detecting texts in natural scene images Character candidates are grouped into text candidates by the single-link clustering algorithm, where distance weights and clustering threshold are learned automatically by a novel self-training distance metric learning algorithm.

The last decades a variety of portable or wearable navigation systems have been developed to assist visually impaired people during navigation in known or unknown, indoor or outdoor environments [3]. There are three main categories of these systems: electronic travel aids (ETAs), electronic orientation aids (EOAs), and position locator devices (PLDs). This paper presents a comparative survey among portable/wearable obstacle detection/avoidance systems (a subcategory of ETAs) in an effort to inform the research community and users about the capabilities of these systems and about the progress in assistive technology for visually impaired people.

In this paper, a Smart Assistive Navigation System for Blind and Visually Impaired Individuals is designed and implemented to secure a safe and low-cost navigation [4]. Blind navigation systems are many, but very few are those that are completely successful in addressing the requirements of blind individuals to navigate safely, comfortably, and independently.

An end-to-end real-time text localization and recognition method is presented [5]. Its real-time performance is achieved by posing the character detection and segmentation problem as an efficient sequential selection from the set of Extremal Regions. The ER detector is robust against blur, low contrast and illumination, colour and texture variation. In the first stage, the probability of each ER being a character is estimated using features calculated by a novel algorithm in constant time and only ERs with locally maximal probability are selected for the second stage, where the classification accuracy is improved using computationally more expensive features.
This paper presents a new label layout technique for projection-based augmented reality (AR) that determines the placement of each label directly projected onto an associated physical object with a surface that is normally inappropriate for projection (i.e., no planar and textured) [6]. Central to our technique is a new legibility estimation method that evaluates how easily people can read projected characters from arbitrary viewpoints

III. EXISTING SYSTEM

There are vast amounts of historical, technical, economic and most confidential data are present only in printed format. The objective is to help the visually impaired to read and understand all the printed documents. This can be done by Optical Character Recognition (OCR) technique. It is an important pre-processing technique applied in digitization of historic and mechanic printed documents. Character Recognition is difficult due to variability in writing style of the users.

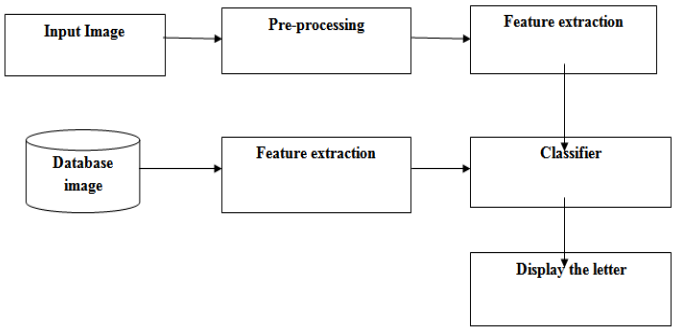

Figure 1. OCR

Figure 1 consists of the steps such as:

- image acquisition – a color, gray level or binary image is acquired;
- pre-processing – image processing techniques are applied to improve image quality;
- layout analysis – the text structure is understood to facilitate text interpretation; word segmentation in characters; classification – pattern recognition is employed for character recognition
- **Post-processing** – gather the recognized characters to obtain the original words.

A neural network model which is the branch of artificial intelligence is generally referred to as artificial neural networks (ANNs). ANN teaches the system to execute task, instead of programming computational system to do definite tasks. To perform such tasks, Artificial Intelligence System (AI) is generated. It is a pragmatic model which can quickly and precisely find the patterns buried in data that replicate useful knowledge.

This type of reading assistant that separates the background image has been developed using Mat Lab programming. It was difficult to particularly extract a text from the image. Performance is relatively slow in certain cases of extracting.

IV. PROPOSED SYSTEM

A book reader has been proposed using Raspberry-pi which is user friendly. This system consists of a camera and a speaker attached to Raspberry Pi. The purpose of the camera is to capture the image of the book that is placed under it. Once the image has been captured it has been sent for processing. The processing steps involve the separation of the text from the background. The text after separated is forwarded to conversion process. The Conversion process involves converting the RGB colour into black and white matrix that separates the words into single character in order to recognize the text correctly. This matrix formation is suitable to improve the efficiency of the system. After the recognition of the text the final output is sent to the user in the form of audio. The main advantage of the system is the conversion and the output is sent in the form of audio.

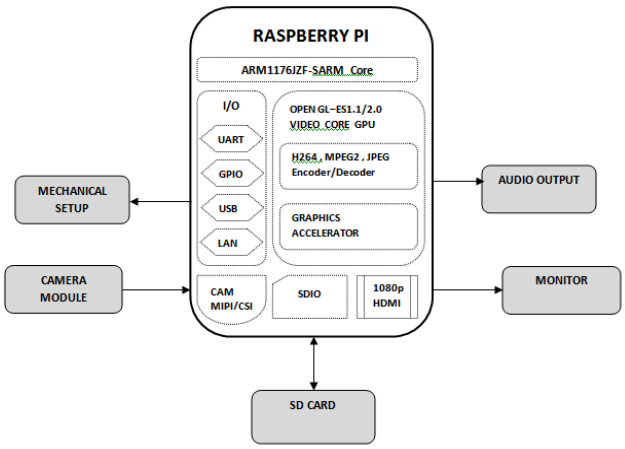

Figure 2. Book Reader Block Diagram

In figure 2, there are many components that are interrelated with each other Raspberry Pi is the key element in connecting all those components. The first processing step is the **Character Detection.** Character candidates are specifically detected as Extremal Regions. Each and every single character is extracted from the text and are compared with the database for recognition.

A. Raspberry Pi

Micro controller board is a miniature marvel, packing considerable computing power into a footprint no larger than a credit card.

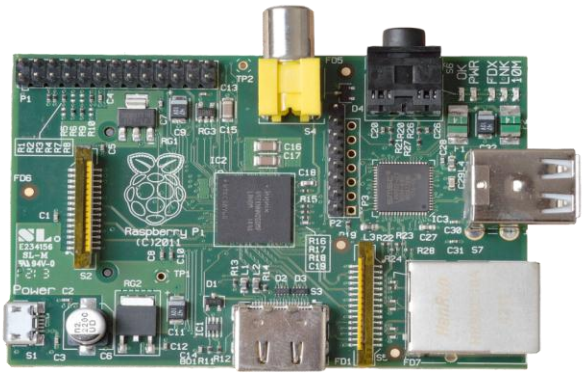

Figure 3. Raspberry Pi Kit

1) Processor

The heart of the Raspberry Pi system is a Broadcom BCM2835 system-on-chip (SoC) multimedia processor. This means that the vast majority of the system's components, including its central and graphics processing units along with the audio and communications hardware, are built onto that single component hidden beneath the 256 MB memory chip at the centre of the board. ARMv6 is a lightweight and powerful architecture, but has a rival in the more advanced ARMv7 architecture used by the ARM Cortex family of processors. Software developed for ARMv7, like software developed for x86, is sadly not compatible with the Raspberry Pi's BCM2835—although developers can usually convert the software to make it suitable. That's not to say you're going to be restricted in your choices.

2) Operating System

The other distinct feature of Raspberry Pi is the operating system that the system uses. Now-a-days most of the computer or Laptops runs on dual OS either windows or Apple Operating System which are closed source. But Raspberry Pi uses a separate OS namely GNU/Linux. It is open source operating system that can be installed from anywhere and has the ability to modify the code on the basis of user need.

3) Connecting Power

The Raspberry Pi is powered by the small micro-USB connector found on the lower left side of the circuit board. This connector is the same as found on the majority of smart phones and some tablet devices. Many chargers designed for smart phones will work with the Raspberry Pi. The Pi is more power-hungry than most micro-USB devices, and requires up to 700mA in order to operate. Only connect the micro-USB power supply when you are ready to start using the Pi.

4) Wireless Networking

Current Raspberry Pi's do not support any form of wireless network onboard. But by adding an Ethernet to the device can support wifi model. Two USB wireless adapters, suitable for use with the Raspberry Pi Using such a device, the Pi can connect to a wide range of wireless networks, including those running on the latest 802.11n high speed standard.

5) Wired Networking

To get your Raspberry Pi on the network, you'll need to connect an RJ45 Ethernet patch cable between the Pi and a switch, router or hub. If you don't have a router or hub, you can get your desktop or laptop talking to the Pi by connecting the two directly together with a patch cable. Usually, connecting two network clients together in this way requires a special cable, known as a crossover cable. In a crossover cable, the receiver and transmit pairs are swapped so that the two devices are prevented from talking over each other—a task usually handled by a network switch or hub. The Raspberry Pi is cleverer than that, however.

The features of Raspberry Pi include high performance, low cost, low power and user friendly. It also has advantage that it can also be connected with SD card, speaker, USB Port etc.

6) Raspberry Pi Computing Model

The Raspberry Pi Compute Module (CM1), Compute Module 3 (CM3) and Compute Module 3 Lite (CM3L) are DDR2-SODIMM-mechanically-compatible System on Modules (SoMs) containing processor, memory, eMMC Flash (for CM1 and CM3) and supporting power circuitry. These modules allow a designer to leverage the Raspberry Pi hardware and software stack in their own custom systems and form factors. In addition these module have extra IO interfaces over and above what is available on the Raspberry Pi model A/B boards opening up more options for the designer.

The CM1 contains a BCM2835 processor (as used on the original Raspberry Pi and Raspberry Pi B+ models), 512MByte LPDDR2 RAM and 4Gbytes eMMC Flash. The CM3 contains a BCM2837 processor (as used on the Raspberry Pi 3), 1Gbyte LPDDR2 RAM and 4Gbytes eMMC Flash. Finally the CM3L product is the same as CM3 except the eMMC Flash is not fitted, and the SD/eMMC interface pins are available for the user to connect their own SD/eMMC device.

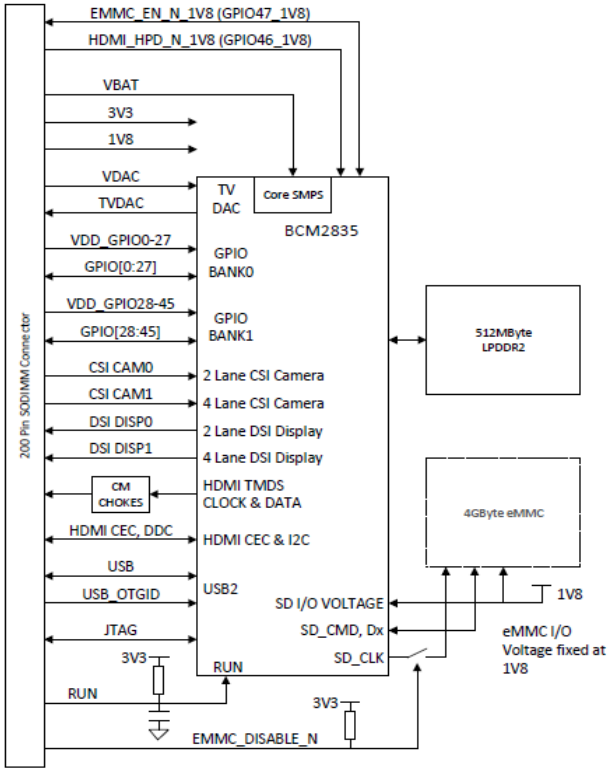

Figure 4. CM1 Block Diagram

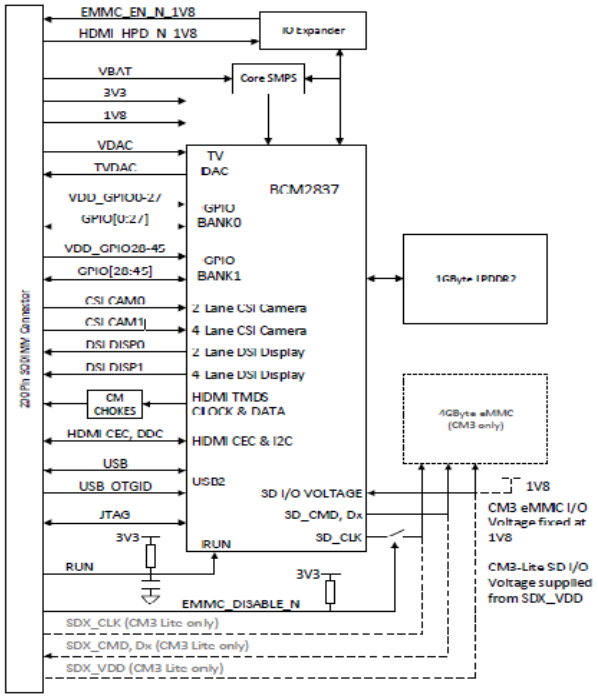

Figure 5. CM3/CM3L Block Diagram

a) Features:

University of Cambridge's Computer Laboratory, Decline in skill level, Designed for education, A credit card sized PC, Plugs into a TV or monitor, Inexpensive(ish) ~$35 each

b) Capability: Programming, Electronic Projects, Office, Play HD Videos.

c) Software and Indtruction set

- ARMv6 (CM1) or ARMv7 (CM3, CM3L)
- Mature and stable Linux software stack
- Latest Linux Kernel support
- Many drivers upstreamed
- Stable and well supported userland
- Full availability of GPU functions using standard API

d) Pin Diagramof Raspberry Pi

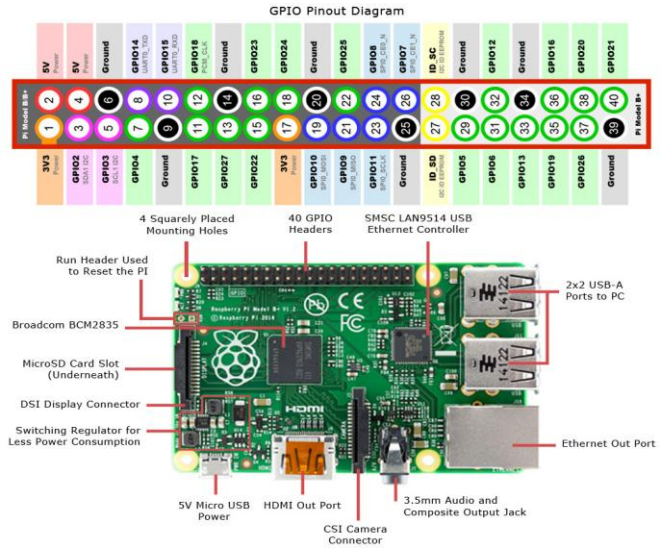

Figure 6. Raspberry Pi Pin Diagram

e) Mechanical Specification

The Compute Modules conform to JEDEC MO-224 mechanical specification for 200 pin DDR2 (1.8V) SODIMM modules (with the exception that the CM3, CM3L modules are 31mm in height rather than 30mm of CM1) and therefore should work with the many DDR2 SODIMM sockets available on the market.

f) Pin Assignment

Raspberry Pi totally consists of totally 40 pins which is used for different purposes are explained in the figure 7.

Pin Name	DIR	Voltage Ref	PDN[a] State	If Unused	Description/Notes
RUN and Boot Control (see text for usage guide)					
RUN	I	3V3[b]	Pull High	Leave open	Has internal 10k pull up
EMMC_DISABLE_N	I	3V3[b]	Pull High	Leave open	Has internal 10k pull up
EMMC_EN_N_1V8	O	1V8	Pull High	Leave open	Has internal 2k2 pull up
GPIO					
GPIO[27:0]	I/O	GPIO0-27_VDD	Pull or Hi-Z[c]	Leave open	GPIO Bank 0
GPIO[45:28]	I/O	GPIO28-45_VDD	Pull or Hi-Z[c]	Leave open	GPIO Bank 1
Primary SD Interface[d,e]					
SDX_CLK	O	SDX_VDD	Pull High	Leave open	Primary SD interface CLK
SDX_CMD	I/O	SDX_VDD	Pull High	Leave open	Primary SD interface CMD
SDX_Dx	I/O	SDX_VDD	Pull High	Leave open	Primary SD interface DATA
USB Interface					
USB_Dx	I/O	-	Z	Leave open	Serial interface
USB_OTGID	I	3V3		Tie to GND	OTG pin detect
HDMI Interface					
HDMI_SCL	I/O	3V3[b]	Z[f]	Leave open	DDC Clock (5.5V tolerant)
HDMI_SDA	I/O	3V3[b]	Z[f]	Leave open	DDC Data (5.5V tolerant)
HDMI_CEC	I/O	3V3	Z	Leave open	CEC (has internal 27k pull up)
HDMI_CLKx	O	-	Z	Leave open	HDMI serial clock
HDMI_Dx	O	-	Z	Leave open	HDMI serial data
HDMI_HPD_N_1V8	I	1V8	Pull High	Leave open	HDMI hotplug detect
CAM0 (CSI0) 2-lane Interface					
CAM0_Cx	I	-	Z	Leave open	Serial clock
CAM0_Dx	I	-	Z	Leave open	Serial data
CAM1 (CSI1) 4-lane Interface					
CAM1_Cx	I	-	Z	Leave open	Serial clock
CAM1_Dx	I	-	Z	Leave open	Serial data
DSI0 (Display 0) 2-lane Interface					
DSI0_Cx	O	-	Z	Leave open	Serial clock
DSI0_Dx	O	-	Z	Leave open	Serial data
DSI1 (Display 1) 4-lane Interface					
DSI1_Cx	O	-	Z	Leave open	Serial clock
DSI1_Dx	O	-	Z	Leave open	Serial data
TV Out					
TVDAC	O	-	Z	Leave open	Composite video DAC output
JTAG Interface					
TMS	I	3V3	Z	Leave open	Has internal 50k pull up
TRST_N	I	3V3	Z	Leave open	Has internal 50k pull up
TCK	I	3V3	Z	Leave open	Has internal 50k pull up
TDI	I	3V3	Z	Leave open	Has internal 50k pull up
TDO	O	3V3	O	Leave open	Has internal 50k pull up

[a] The PDN column indicates power-down state (when RUN pin LOW)
[b] Must be driven by an open-collector driver
[c] GPIO have software enabled pulls which keep state over power-down
[d] Only available on Lite variants
[e] The CM will always try to boot from this interface first
[f] Requires external pull-up resistor to 5V as per HDMI spec

Figure 7. Pin assignment in Raspberry Pi

g) Power Supply

Raspberry Pi consists of totally 40 pins which is used for various purposes. The connections are given to enable various connections. The power supply is given through the pin numbers 1,2,4,17 as given in figure 6. There are 2 different volt conditions specified for Raspberry Pi. They are 3V and 5V. The minimum percentage for that power description is explained in the following table. Different descriptions are explained in figure 8.

Supply	Description	Minimum	Typical	Maximum	Unit
VBAT	Core SMPS Supply	2.5	-	5.0 + 5%	V
3V3	3V3 Supply Voltage	3.3 - 5%	3.3	3.3 + 5%	V
1V8	1V8 Supply Voltage	1.8 - 5%	1.8	1.8 + 5%	V
VDAC	TV DAC Supply[a]	2.5 - 5%	2.8	3.3 + 5%	V
GPIO0-27_VDD	GPIO0-27 I/O Supply Voltage	1.8 - 5%	-	3.3 + 5%	V
GPIO28-45_VDD	GPIO28-27 I/O Supply Voltage	1.8 - 5%	-	3.3 + 5%	V
SDX_VDD	Primary SD/eMMC Supply Voltage	1.8 - 5%	-	3.3 + 5%	V

Figure 8. Power supply for Raspberry Pi

h) Electrical Specification

Symbol	Parameter	Minimum	Maximum	Unit
VBAT	Core SMPS Supply	-0.5	6.0	V
3V3	3V3 Supply Voltage	-0.5	4.10	V
1V8	1V8 Supply Voltage	-0.5	2.10	V
VDAC	TV DAC Supply	-0.5	4.10	V
GPIO0-27_VDD	GPIO0-27 I/O Supply Voltage	-0.5	4.10	V
GPIO28-45_VDD	GPIO28-27 I/O Supply Voltage	-0.5	4.10	V
SDX_VDD	Primary SD/eMMC Supply Voltage	-0.5	4.10	V

Table 4: Absolute Maximum Ratings

DC Characteristics are defined in Table 5

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
V_{IL}	Input low voltage[a]	VDD_IO = 1.8V VDD_IO = 2.7V	- -	- -	0.6 0.8	V V
V_{IH}	Input high voltage[a]	VDD_IO = 1.8V VDD_IO = 2.7V	1.0 1.3	- -	- -	V V
I_{IL}	Input leakage current	TA = +85°C	-	-	5	μA
C_{IN}	Input capacitance	-	-	5	-	pF
V_{OL}	Output low voltage[b]	VDD_IO = 1.8V, IOL = -2mA VDD_IO = 2.7V, IOL = -2mA	- -	- -	0.2 0.15	V V
V_{OH}	Output high voltage[b]	VDD_IO = 1.8V, IOH = 2mA VDD_IO = 2.7V, IOH = 2mA	1.6 2.5	- -	- -	V V
I_{OL}	Output low current[c]	VDD_IO = 1.8V, VO = 0.4V VDD_IO = 2.7V, VO = 0.4V	12 17	- -	- -	mA mA
I_{OH}	Output high current[c]	VDD_IO = 1.8V, VO = 1.4V VDD_IO = 2.7V, VO = 2.3V	10 16	- -	- -	mA mA
R_{PU}	Pullup resistor	-	50	-	65	kΩ
R_{PD}	Pulldown resistor	-	50	-	65	kΩ

[a] Hysteresis enabled
[b] Default drive strength (8mA)
[c] Maximum drive strength (16mA)

Figure 9. Electrical Specifications of Raspberry Pi

B. Optical Character Recognition

It is an algorithm used to recognize the text patterns and to separate the text from the background of the image.
It is the mechanical conversion of handwritten or printed text into machine code whether from a scanned document or plain document and even from images. It is a field of research in pattern recognition, artificial intelligence and computer vision.

OCR has been used in many areas such as data entry, research purposes, automatic technologies such as automatic number plate recognition, insurance documents, key capture.

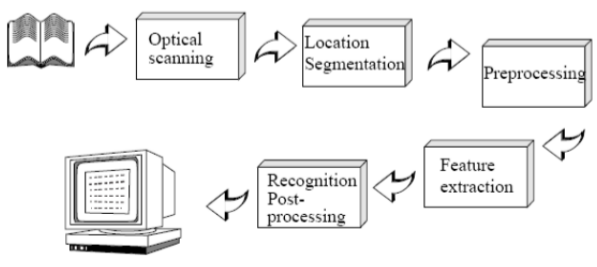

Figure 10. OCR

OCR Algorithm:

Step 1: Captures the image

Step 2: Performs optical Scanning in order to recognize the text in the image.

Step 3: Location segmentation is to locate the position of the text in the stored database to produce the output.

Step 4: Pre-processing is to produce the black and white matrix to make the recognition easier.

Step 5: Additional Feature such as image or background is extracted from the image.

Step 6: After the processing steps are over the text is recognized and the output is sent to the user.

V. COMPARISON

Various Book reader has been evolved for using various technologies. The Book reader has been developed using neural technologies and machine learning has a disadvantage of recognizing the hand written style. It was difficult to understand the pattern of a character or number. But using Raspberry Pi it was easy to recognize the correct format.

Pic Micro controller has been used to develop book reader which was unable to tune the sound, recognize the shape used in the image. It has been solved by Raspberry Pi Micro controller with its inbuilt feature of sound tuning.

The figure 11 explains the comparison between the our microcontroller Raspberry Pi with the other controllers and existing system such as PIC, Machine learning with various features such as processing, Character recognition, Performance, Output.

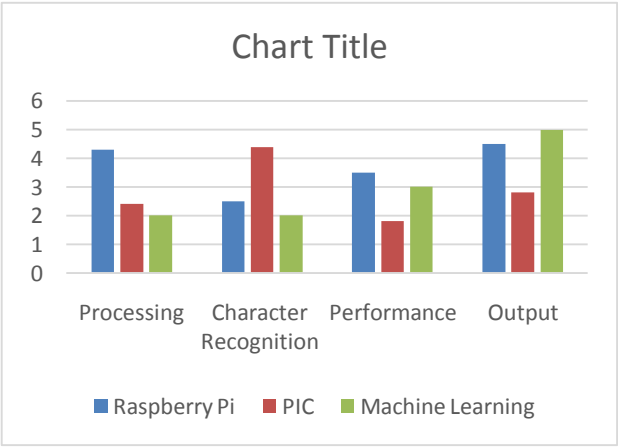

Figure 11. Performance analysis

VI. CONCLUSION

A text detection and recognition with Audio output system was successfully demonstrated on Open CV platform .This platform is more portable than PC platform. Thus the system mainly focuses on visually impaired to overcome their disability of reading book or any text in the printed document. This system uses dynamic set of images but the common format is stored already in SD card which is used for comparison in identifying the text. The output is produced in audio format. It can be enhanced in the future by identifying even the pictures and the various colors used in the image .It can also be identifying by not converting into black and white matrix. This disadvantage of converting into black and white matrix can be resolved using an appropriate recognition algorithm.

REFERENCES

[1] X. Chen, J. Yang, J. Zhang, and A. Waibel, "Automatic detection and recognition of signs from natural scenes," IEEE Trans. Image Process., Vol. 13, Issue 1, pp. 87–99, Jan. 2004.

[2] D. Dakopoulos and N. G. Bourbakis, "Wearable obstacle avoidance electronic travel aids for blind: A survey," IEEE Trans. Syst., Man, Cybern., Vol. 40, Issue. 1, pp. 25–35, Jan. 2010.

[3] B. Epshtein, E. Ofek, and Y. Wexler, "Detecting text in natural scenes with stroke width transform," in Proc. Comput. Vision Pattern Recognit., 2010, pp. 2963–2970.

[4] Y. Freund and R. Schapire, "Experiments with a new boosting algorithm," in Proc. Int. Conf. Machine Learning, 1996, pp. 148–156.

[5] N. Giudice and G. Legge, "Blind navigation and the role of technology," in The Engineering Handbook of Smart Technology for Aging, Disability,and Independence, A. A. Helal, M. Mokhtari, and B. Abdulrazak, Eds. Hoboken, NJ, USA: Wiley, 2008.

[6] A. Shahab, F. Shafait, and A. Dengel, "ICDAR 2011 robust reading competition: ICDAR Robust Reading Competition Challenge 2: Reading text in scene images," in Proc. Int. Conf. Document Anal. Recognit., 2011, pp. 1491–1496.

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