

Barcode Recognition System

N. M. Z. Hashim¹, N. A. Ibrahim², N. M. Saad³, F. Sakaguchi⁴, Z. Zakaria⁵

^{1, 2, 3, 5} Faculty of Electronics & Computer Engineering, Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

nikzarifie@utem.edu.my¹
adila.ibrahim@hotmail.com²
norhashimah@utem.edu.my³
zahriladha@utem.edu.my⁵

⁴ Faculty of Engineering, University of Fukui,
3-9-1 Bunkyo, Fukui City, Fukui Prefecture, Japan. 910-8507.
saka@dignet.fuee.fukui-u.ac.jp⁴

Abstract: *Barcode became essential elements in sales and products services due to importance of keeping records of all items in on place. For this purpose, there are many methods implemented to make the barcode reading process became easier to users. This project is to develop a barcode recognition system by using image processing. The system will be able to read barcode through an image and the system capable to capture the image by using a webcam. This project will be using MATLAB software program to develop the system and it will integrate with webcam or digital camera. System will analyse the image and then display on the Graphical User Interface (GUI) the barcode type, data and size of the image. System is designed to recognize different types of barcode and display the data once the barcode image is captured. System also is to provide convenience way of observing data from the barcode with lower costing compared by using the electronic barcode scanners. This system can be used anytime and anywhere by the user who likes to observe the data represented by the barcode numbers without going any places providing the barcode scanner services. As the result, the project has been developed smoothly and perfectly. For the future system development, it is suggested that the system also should consist a slider so that the user would able to control the brightness of the image which captured by webcam.*

Keywords: Acquisition, Barcode, Grayscale MATLAB, Image Threshold

1. INTRODUCTION

Barcode is a visual representation of information in the form of bars and spaces on a surface. The bars and spaces are designed with different widths and consist of numbers, characters and symbols such as dot, colon and others. Different combinations of these alphanumeric characters are used to represent information. There are various types of barcodes in use today e.g. Code 128, Code 39, EAN etc. (Brain, 2000) [1]. The successful of barcode technology has been constantly improving in order to accommodate more information in the minimum possible space. Today barcodes are widely used on books and at retail stores in order to keep track of the products available and easy checkout of the products. The barcodes are normally read using scanners using laser beams or cameras [2].

Generally, barcodes are symbols shaped in the form of rectangles which consist of thin or thick parallel lines parallel to each other. Barcodes provide means for

automatic rapid data input into the computer. Since the last decade, barcodes are being used in many areas such as market products and electronic devices. The lines on barcodes contain the reference number of the product. This information should be recorded in computers to store each product separately for counting company sales and purchase quantities. When reading barcodes on products using some laser scanning device, a signal is generated by the system and processed in the computer by software. Then this information is used to determine which product is selected. This process provides rapid and reliable sales opportunities to companies for selling their products. There are several types of barcode that being used within the industrial field nowadays. A barcode symbology defines the technical details of a particular type of barcode includes width of bars, character set, method of encoding and checksum specifications. Barcode types can be classified into four type of category and those categories are numeric-only barcodes, alpha-numeric barcodes, 2D barcode and industry standard for barcode and labels.

As in image processing, the thresholding is the one of element to be consider as a way to describe an image. Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. During the thresholding process, individual pixels in an image are marked as object pixels if the value is greater than some threshold value (assuming an object to be brighter than the background) and as the background pixels otherwise. This convention is known as threshold above. Variants include threshold below, which is opposite of threshold above; threshold inside, where a pixel is labelled "object" if its value is between two thresholds; and threshold outside, which is the opposite of threshold inside. Typically, an object pixel is given a value of "1" while a background pixel is given a value of "0." Finally, a binary image is created by colouring each pixel white or black, depending on a pixel's label.



Figure 1: (a) Different between Original Image and (b) Thresholding Effect Image

W. N. W. Shuhaimi reported in Real Time Barcode Reader for Laboratory Attendance (software) that the project was developed to create and develop database system for laboratory attendance based on real time barcode reader. System was able able to read and display barcode and then save the data into a database system for recording purpose. Microsoft Visual Basic 6 is used as the main software to create Microsoft Access [3].

M. E. H A. Azizi developed a mobile barcode scanner to be used for laboratory attendance which it can save data in PIC16F877A Microcontroller and monitor using LCD module interface. Project consists of the combination of hardware such as barcode scanner, PIC16F877A microcontroller and LCD module to produce system that have input output signal. The barcode scanner is device that transmits data to microcontroller and the result show up instantly to the LCD by using serial communication. Project used Protues Isis 6 Professional and the MPLab IDE as a compiler for the microcontroller [4].

From the literature review from those projects, a barcode system which uses other software which MATLAB programming is designed and proposed. Apart from that, the system that has been developed before used an infrared sensor to decode the barcode and similar to the two projects which has been done by two researchers. This proposed project is to create another alternative way to read the barcode not by using infrared sensor yet by using image processing and MATLAB toolboxes.

The objectives project is to develop an algorithm of barcode recognition system by using web camera, digital camera or image chosen from any folder then it will display the barcode information for the user instantly.

Nowadays most of the barcode scanners are using infrared methods to scan a barcode. This may lead to the costing issue where those scanners are expensive to be purchased and unaffordable to the user. To overcome this problem, the camera based system for barcode reading is applied to develop a barcode recognition system.

2. METHODOLOGY

2.1. Overall Project

The project presented the methodology as shown in Figure 2 above. Firstly, image that contains the barcode information is acquired either by using a camera or selected image from any file from computer.

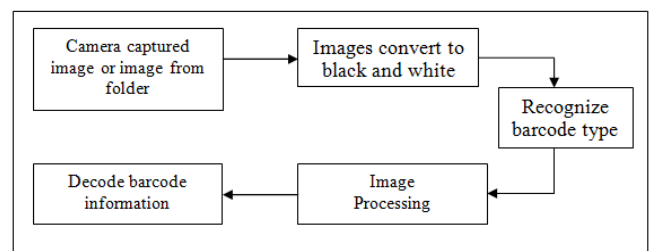


Figure 2: Project Block Diagram

The colour image contains in fact the full usable information. The image is then being converted to grayscale format. The image is transformed into a pre-processed grayscale image for reducing noise and enhancing the image contrast between bars and spaces.

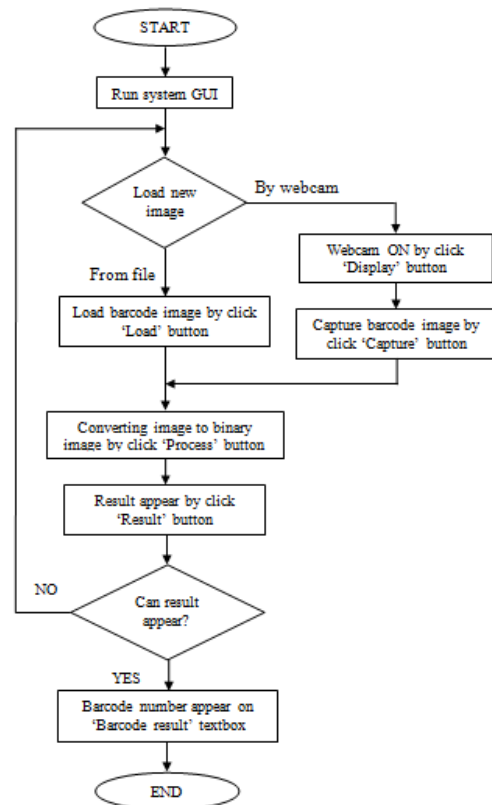


Figure 3: System Flowchart

A barcode orientation is identified that is parallel to bars in the pre-processed image. A projected sequence is generated by projecting pixels of the pre-processed image along the barcode orientation. Because the acquired image will typically contain an area larger than the barcode, it is initially required to crop the barcode area as the rest of the image is unnecessary. Since the barcode region is required, the borders of the barcode line coordinates must be determined. An edge detection algorithm was used to determine the borders. The binarized sequence is generated by applying a threshold to detected peaks and valleys of the projected sequence. A barcode-encoding sequence then is generated from the binarized sequence, in which each barcode bar module and each barcode space module are represented by a single respective bit in the barcode-encoding sequence. The barcode encoded information is extracted from the barcode-encoding sequence.

2.2. MATLAB Toolbox

Inside MATLAB, there are toolboxes with different functions and features which being provided for the users. For this project, it only used two of MATLAB toolboxes and those are Image Processing Toolbox and Image Acquisition Toolbox. These two toolboxes were created to provide a function which related with image processing and image acquisition task. Here the other list of toolboxes besides image processing and image acquisition that available in MATLAB [5].

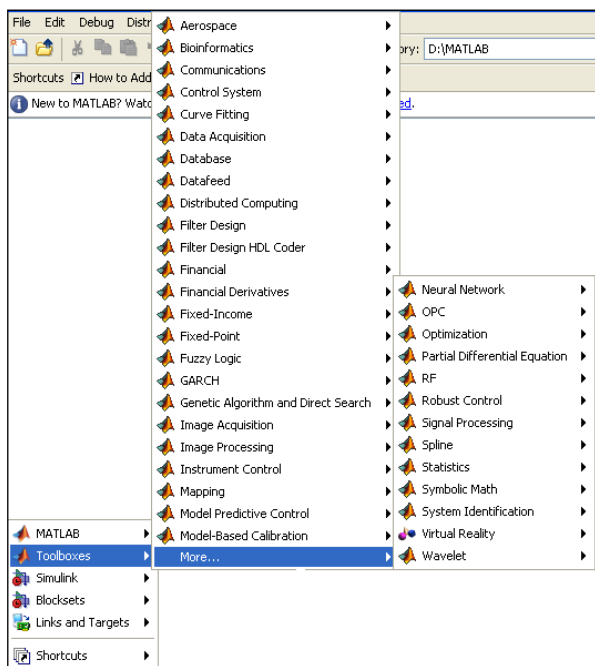


Figure 4: MATLAB Toolboxes

2.3. Image Processing Toolbox

The Image Processing Toolbox is a collection of functions that extend the capability of the MATLAB numeric computing environment. The toolbox supports a

wide range of image processing operations, including spatial image transformations, morphological operations, neighbourhood and block operations, linear filtering and filter design, transforms, image analysis and enhancement, image registration, de-blurring and region of interest operations [6].

The image processing toolbox is used when it comes to the image processing process on the barcode. Here some of the MATLAB command which were used inside project system.

Table 1: Image Processing Commands and Descriptions

Image Processing Command	Description
imread	Read image for graphic file.
imshow	Display image in handle graphic figure.
im2bw	Convert image to binary image by thresholding.
medfilt2	2-D median filtering
imerode	Erode image
imdilate	Dilate image
rgb2gray	Convert RGB image or colormap to grayscale.

2.4. Image Acquisition Toolbox

With this toolbox, it is able to help to connect and configure hardware, preview the acquisition and acquire and visualize image data. The hardware in this project would be the webcam. Image acquisition toolbox also was needed in order to capture and show the webcam by default. With the correct MATLAB command, the webcam was able to set to the default state and the image also can be captured. By using image acquisition toolbox and image processing toolbox, MATLAB would able to provide a complete environment for developing customized imaging applications.

Table 2: Image Acquisition Command and Description

Image Acquisition Command	Description
clear	Clear image acquisition object from memory
getsnapshot	Immediately return single image frame
imaqreset	Disconnect and delete all image acquisition objects.
videoinput	Create video input object.
get	Image acquisition object properties
imaqwinf	Information about available image acquisition hardware

2.5. System GUI Design

The GUI for this project as shown in Figure 5 below and was executed by MATLAB [7]-[11].

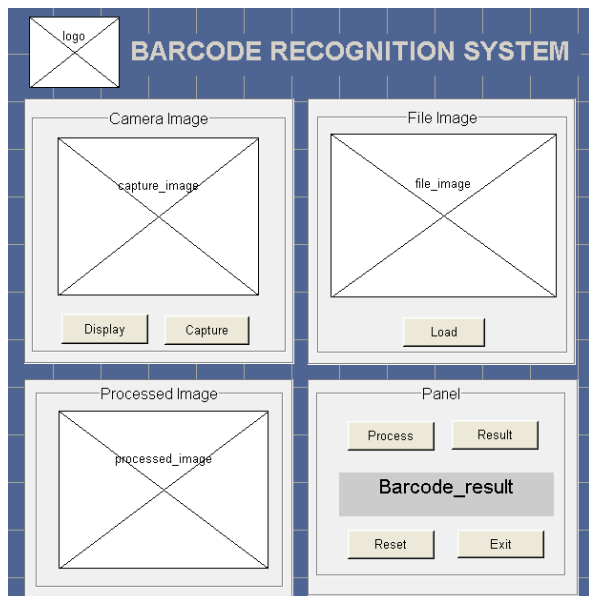
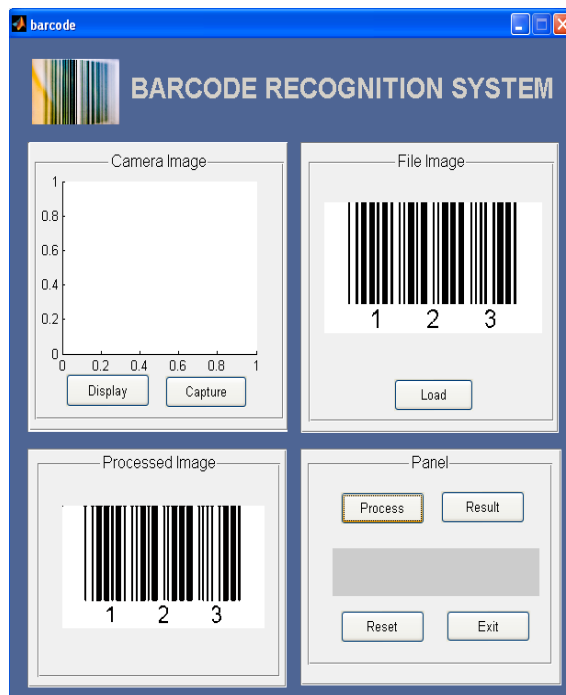


Figure 5: System GUI Design

3 RESULTS

A Barcode is simply a simple way of encoding characters in a simple machine readable format of black bars, normally printed onto a white background. There were certain problems that have to be countered in order to develop this barcode recognition system. Finding the suitable barcode algorithm was the first task that to be fulfilled since finding the algorithm was the main objectives for the project. The difficulties were due to there were many types of barcodes and not all of the encoding barcode information was able to be used. Finally, there were three barcodes that have been selected to be read by the system and those barcode was the EAN 13, Code 39 and Code 128 [12].



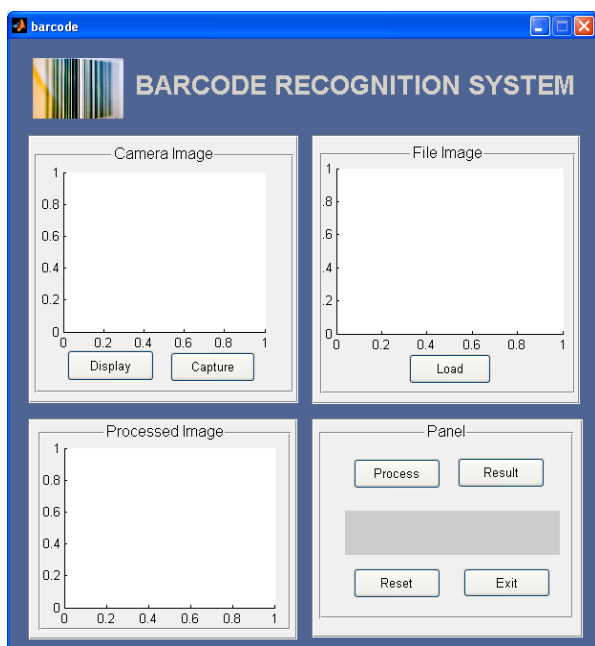
(b)

Figure 10: (a) System GUI (b) Image Selected and Processed Image

At the end of this project session, the programme coding were successfully wrote until the GUI was able to display barcode image on the frame and also convert the coloured image into black and white together with the thresholding in the out GUI [13]-[18].

Conclusions

At the end of this session, it can be conclude that the project has been developed smoothly and perfectly. The project objective that to carry out the system GUI by using MATLAB coding were successfully achieved where the GUI was working as targeted in the objectives, even one of the button system failed to function until end of this session. The only non-functional button was the final step for the system development and it is recommended this project will be continued until the system is fully functioning together with additional function that able to help this system in the future. In order to get more efficiency for this project, the following suggestion will be applied for future project progress. Firstly, barcode recognition system should be able to analyze any images from any perspectives. System should be able to rotate the image either automatically or manually by the user before the data from barcode is being extracted. This will be able the system to be read easily and perfectly. For the future system development, it is suggested that the system also should consist a slider so that the user would able to control the brightness of the image which captured by webcam. This was due to the unsuitable brightness level makes the captured barcode image was quite hard to be decoded. Beside 1D types of barcode, there are 2D



(a)

barcode such as QR code, PDF417 and Data Matrix code which exist within the industry nowadays. During the research session, it was noticed that the usage of 2D barcode nowadays are increase day by day. So, it is recommended that for future system development, system should be able to decode and read 2D types of barcode. With the capability of read and decode these two type of barcode, the system was able to publish and ready to be used by other users or any industry field.

Acknowledgment

We are grateful to Universiti Teknikal Malaysia Melaka (UTeM) for their kind help for giving their laboratory facility as the place to do research and experimental works in order to complete this study. Thank you to all the supports given from our Centre of Telecommunication Research and Innovation (CeTRI) especially the knowledge and supplying the components which related to this project.

References

- [1] Brain M., 2000 'How UPC Barcodes Work?', <http://electronics.howstuffworks.com/upc.htm>, last viewed 7th November 2008.
- [2] Seideman T., 1993, 'Barcodes Sweep the World', Vol. 8 Issue 4, http://www.americanheritage.com/articles/magazine/it/1993/4/1993_4_56.shtml, last viewed 7th November 2008.
- [3] W. N. W. Shuhaimi, "Real Time Barcode Reader for Laboratory Attendance (Software Part), Bachelor Thesis, 2007.
- [4] M. E. H. A. Aziz, "Real Time Barcode Reader for Laboratory Attendance (Hardware Part), Bachelor Thesis, 2007.
- [5] Stephen J. Chapman, "MATLAB Programming for Engineers", 2nd Edition, Bookware Company Series, 391-449; 2002
- [6] Rafael C. Gonzales, Richard E. Woods, Digital Image Processing, 2nd Edition, Prentice-Hall, Inc, Upper Saddle River, New Jersey 07458.
- [7] N. M. Z. Hashim, N. A. Ali, A. S. Jaafar, N. R. Mohamad, L. Salahuddin, N. A. Ishak, "Smart Ordering System via Bluetooth", International Journal of Computer Trends and Technology (IJCTT) Volume 4 Issue 7, pp. 2253-2256, 2013.
- [8] N. M. Z. Hashim, S. N. K. S. Mohamed, "Development of Student Information System", International Journal of Science and Research (IJSR) Volume 2 Issue 8, pp. 256-260, 2013.
- [9] N. M. Z. Hashim, N. A. M. M. Arifin, "Laboratory Inventory System", International Journal of Science and Research (IJSR) Volume 2 Issue 8, pp. 261-264, 2013.
- [10] N. M. Z. Hashim, S. H. Husin, A. S. Ja'afar, N. A. A. Hamid, "Smart Wiper Control System", International Journal of Application or Innovation in Engineering & Management (IJAIEM) Volume 2 Issue 7, pp. 409-415, 2013.
- [11] N. M. Z. Hashim, A. S. Jaafar, N. A. Ali, L. Salahuddin, N. R. Mohamad, "Traffic Light Control System for Emergency Vehicles Using Radio Frequency", IOSR Journal of Engineering (IOSRJEN) Volume 3 Issue 7, pp. 43-52, 2013.
- [12] Semicron Systems, "Learn how to select a barcode scanner or bar code reader for your POS applications!", Copyright 2000 Semicron Systems <http://www.makebarcode.com/info/info.html>, last viewed on 6th November, 2008.
- [13] N. M. Z. Hashim, M. S. Sizali, "Wireless Patient Monitoring System", International Journal of Science and Research (IJSR) Volume 2 Issue 8, pp. 250-255, 2013.
- [14] N. M. Z. Hashim, N. A. Ali, A. Salleh, A. S. Ja'afar, N. A. Z. Abidin, "Development of Optimal Photosensors Based Heart Pulse Detector", International Journal of Engineering and Technology (IJET) Volume 5 No 4, pp. 3601-3607, 2013.
- [15] N. M. Z. Hashim, A. F. Jaafar, Z. Zakaria, A. Salleh, R. A. Hamzah, "Smart Casing for Desktop Personal Computer", International Journal Of Engineering And Computer Science (IJECS) Volume 2 Issue 8, pp. 2337-2342, 2013.
- [16] N. M. Z. Hashim, N. B. Hamdan, Z. Zakaria, R. A. Hamzah, A. Salleh, "Flood Detector Emergency Warning System", International Journal Of Engineering And Computer Science (IJECS) Volume 2 Issue 8, pp. 2332-2336, 2013.
- [17] N. M. Z. Hashim, N. H. Mohamad, Z. Zakaria, H. Bakri, F. Sakaguchi, "Development of Tomato Inspection and Grading System using Image Processing", International Journal Of Engineering And Computer Science (IJECS) Volume 2 Issue 8, pp. 2319-2326, 2013.
- [18] N. M. Z. Hashim, N. M. T. N. Ibrahim, Z. Zakaria, Fadli Syahrial, H. Bakri, "Development New Press Machine using Programmable Logic Controller", International Journal Of Engineering And Computer Science (IJECS) Volume 2 Issue 8, pp. 2310-2314, 2013.

AUTHOR



N. M. Z. Hashim received the B.Eng. and M.Eng. degree in Electrical and Electronics Engineering from University of Fukui, Japan in 2006 and 2008, respectively. From 2008, he worked as Lecturer in Faculty of Electronics and Computer Engineering, Universiti Teknikal Malaysia Melaka (UTeM), Malaysia. He is acting the Head of Department of Computer Engineering

Department. His works are in Signal and Image Processing, Wavelet Transformation, Communication and Electronic Engineering. He joined Institute of Electrical and Electronic Engineers (IEEE), Board of Engineering Malaysia (BEM), Institute of Engineering Malaysia (IEM), Society of Photo-Optical Instrumentation Engineers (SPIE), International

Association of Computer Science and Information Technology (IACSIT) and International Association of Engineers (IAENG) as member.

N. A. Ibrahim received his B. Eng in Electronic Engineering (Computer Engineering) from Universiti Teknikal Malaysia Melaka, Malaysia.



N. M. Saad earned her M. Eng. in Electronics and Telecommunication from Universiti Teknologi Malaysia (UTM) in 2004 and B. Eng. in Medical Electronics from the same university in 2001. Her research interests are Digital Signal Processing (DSP), Digital Image Processing and Biomedical Engineering. She is currently doing her PhD research in Brain MRI image detection and classification system with UTM. She is a lecturer under the Department of Computer Engineering, Faculty of Electronics and Computer Engineering, Universiti Teknikal Malaysia Melaka (UTeM). She has been teaching DSP for several years.



F. Sakaguchi graduated in 1983 from the Faculty of Science, Kyoto University, where he obtained an M.S. in Geophysics in 1985. In 1988, he became a Lecturer at Mie University (Faculty of Humanity). He also has a Dr. of Eng. degree and, in 1992, became an Associate Professor of Electronic Engineering, Fukui University. He has been engaged in research on statistical signal processing and information theory. He is a member of the Institute of Information Theory and Its Applications.



Z. Zakaria, PhD, MIEEE, BEM, Grad IEM - was born in Malaysia in 1975. He received the B. Eng. and M. Eng. in Electrical and Electronic Engineering from the Universiti Teknologi Malaysia in 1998 and 2004 respectively. He obtained his Doctorate from The University of Leeds in 2010 in the field of Microwave Engineering. From 1998 to 2002, he was with STMicroelectronics, based in Malaysia where he worked as Product Engineer. He is currently a Senior Lecturer and also the Deputy Dean (Academic) at the Faculty of Electronic and Computer Engineering, University Teknikal Malaysia Melaka, where he teaches Electronics, Microwave Engineering and Signal Processing. His research interests include a variety of microwave device developments such as planar and non-planar microwave filters, amplifiers and antennas. He also investigates radio wave propagation as well as energy harvesting for wireless sensor networks and signal processing.