AN APPROACH TO IDENTIFY THE ORIGINALITY OF THE PRODUCT BY MATCHING THE BARCODE WITH THE DATABASE AFTER EXTRACTING THE BARCODE FROM A SUPERIMPOSED MESH

A THESIS

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTERS OF TECHNOLOGY

In

PRINTING ENGINEERING AND GRAPHIC COMMUNICATION

By

AAKASH BAIDYA

Class Roll Number : **001411602003**
Exam Roll Number : **M4PRI1602**
Registration Number : **129437 of 14-15**

Under The Guidance of

Dr. KANAI CHANDRA PAUL

DEPARTMENT OF PRINTING ENGINEERING

JADAVPUR UNIVERSITY

KOLKATA - 700098, INDIA

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DEDIACATION

This thesis is dedicated to my Parent, Beloved Friend, Respected Teachers and Respected Professors who have supported me in many ways when needed.

AAKASH BAIDYA

JADAVPUR UNIVERSITY

Department of Printing Engineering

Certificate of Recommendation

This is to certify that AAKASH BAIDYA (Exam Roll Number : **M4PRI1602** , Registration Number : **129437 of 14-15**) has completed her dissertation entitled, "An Approach To Identify The Originality Of The Product By Matching The Barcode With The Database After Extracting The Barcode From A Superimposed Mesh" under the supervision and guidance of Dr. KANAI CHANDRA PAL, Associate Professor, Printing Engineering Department, Jadavpur University, Kolkata. We are satisfied with his work and dedication which is being presented for the partial fulfillment of the degree of M.Tech in Printing Engineering and Graphic Communication, Jadavpur University, Kolkata – 700098.

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Certificate of Approval

The thesis at instance is hereby approved as a creditable study of Engineering subject carried out and presented in a manner satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is understood that by this approval the undersigned does not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein, but approve the thesis for the purpose for which it is submitted.

Final Examination for Evaluation of Thesis

JADAVPUR UNIVERSITY

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Declaration of Originality and Compliance of Academics Ethics

I hereby declare that this thesis contains literature survey and original research work by undersigned candidate, as part of this Masters in Printing Engineering and Graphic Communication course of study.

All information in this document has been obtained and presented in accordance with academic rules and ethical conduct.

I also declare that, as required by these rules and conduct, I have fully-cited and referenced all materials and result that are not original to this work.

Name: **AAKASH BAIDYA**

Exam Roll Number: **M4PRI1602**

Title: **An Approach To Identify The Originality Of The Product By Matching The Barcode With The Database After Extracting The Barcode From A Superimposed Mesh**

Date:

Signature:

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ABSTRACT

A barcode is "A machine-readable code in the form of numbers and a pattern of parallel lines of varying widths, printed on and identifying a product." But in truth a barcode is so much more. Barcode systems help businesses and organizations track products, prices, and stock levels for centralized management in a computer software system allowing for incredible increases in productivity and efficiency. Testing the barcode is necessary to assure its parameters conform to industry standards and verify the content is correct.

This thesis has been done with 7 barcodes out of which only 5 has been stored in the database. Initially, the matrix of the original 7 barcode values has been extracted and stored in a file. In the database, 5 original barcodes values have been stored. Finally, the matrix of 5 barcode values, after removing the superimposed mesh, has been extracted and matched with the file where the matrix of the original barcode values had been stored. If both the barcodes matrices values have matched then the barcode value stored in the database will be displayed along with the message "Barcode Match Found" otherwise it will display "No Such Barcode Found". Thus, only 5 will be matching and 2 will not.

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CHAPTER 1 : INTRODUCTION

1.1: OBJECTIVE OF BARCODING

A barcode is an optical machine-readable representation of data relating to the object to which it is attached. Originally barcodes systematically represented data by varying the widths and spacing of parallel lines, and may be referred to as linear or one-dimensional (1D). Later two-dimensional (2D) codes were developed, using rectangles, dots, hexagons and other geometric patterns in two dimensions, usually called barcodes although they do not use bars as such. Barcodes originally were scanned by special optical scanners called barcode readers. Later applications software became available for devices that could read images, such as smartphones with cameras.

An early use of one type of barcode in an industrial context was sponsored by the Association of American Railroads in the late 1960s. Developed by General Telephone and Electronics (GTE) and called KarTrak ACI (Automatic Car Identification), this scheme involved placing colored stripes in various combinations on steel plates which were affixed to the sides of railroad rolling stock. Two plates were used per car, one on each side, with the arrangement of the colored stripes encoding information such as ownership, type of equipment, and identification number.[1] The plates were read by a trackside scanner, located for instance, at the entrance to a classification yard, while the car was moving past.[2] The project was abandoned after about ten years because the system proved unreliable after long-term use.[1]

Barcodes became commercially successful when they were used to automate supermarket checkout systems, a task for which they have become almost universal.

Their use has spread to many other tasks that are generically referred to as automatic identification and data capture (AIDC). The very first scanning of the now ubiquitous Universal Product Code (UPC) barcode was on a pack of Wrigley Company chewing gum in June 1974.[3]

Other systems have made inroads in the AIDC market, but the simplicity, universality and low cost of barcodes has limited the role of these other systems until technologies such as radio frequency identification (RFID) became available after 2000.

1.2: IDENTIFYING THE PROBLEM AND PROPOSED APPROACH

Barcodes are normally printed and labeled to the product with some encrypted data.
The data may be consisting of type of product, price of the product, manufacturer of the product, date of manufacture, etc..but these are not available with the consumer, since these are available with the big seller.
The purpose of barcoding and database management, in the proposed work is to identify the originality of the product by extracting the barcode from superimposed mesh and matching the barcode with the database which is open ended so that consumer can check the details of the product with the database after extracting the same with smart devices.

1.3: PURPOSE OF BARCODING

Barcodes are a way to transfer data. The symbols of the barcode represent various factors, such as manufacturer, price and name of a product. Barcodes are scanned to transfer information about a particular item to a computer, cash register or point of sale system. Barcodes are often overlooked as a method for cutting costs and saving time.

A valuable and viable choice for businesses looking to improve efficiency and reduce overhead, barcodes are both cost-effective and reliable.[4][5][6]

1. Barcodes eliminate the possibility of human error and increase the reliability of the product. The occurrence of errors for manually entered data is significantly higher than that of barcodes. A barcode scan is fast and reliable, and takes infinitely less time than entering data by hand.

2. Using a barcode system reduces employee training time. It takes only minutes to master the hand-held scanner for reading barcodes. Furthermore, employees do not have to gain familiarity with an entire inventory or pricing procedure. This also makes employee training less expensive, since they do not have to be paid for extra training time, and another employee does not have to be compensated for training them.

3. Barcodes are inexpensive to design and print. Generally they cost mere pennies, regardless of their purpose, or where they will be affixed. They can be customized economically, in a variety of finishes and materials.

4. Barcodes are extremely versatile. They can be used for any kind of necessary data collection. This could include pricing or inventory information. Additionally, because barcodes can be attached to just about any surface, they can be used to track not only the products themselves, but also outgoing shipments and even equipment.

5. Barcodes improves inventory control. Because barcodes make it possible to track inventory so precisely, inventory levels can be reduced. This translates into a lower overheard. The location of equipment can also be tracked,

reducing the time spent searching for it, and the money spent replacing equipment that is presumed lost.

6. Barcodes provide better data. Since one barcode can be used for inventory and pricing information, it is possible to quickly obtain data on both. Furthermore, barcodes can be customized to contain other relevant information as needed. They provide fast, reliable data for a wide variety of applications.

7. Data obtained through barcodes is available rapidly. Since the information is scanned directly into the central computer, it is ready almost instantaneously. This quick turnaround ensures that time will not be wasted on data entry or retrieval.

8. Barcodes promote better decision making. Since data is obtained rapidly and accurately, it is possible to make more informed decisions. Better decision making ultimately saves both time and money.

Both inexpensive and user-friendly, barcodes provide an indispensable tool for tracking a variety of data, from pricing to inventory. The ultimate result of a comprehensive bar-coding system is reduced overhead cost.[4]

1.4: PURPOSE OFINVENTORY MANAGEMENT SYSTEM

Any organization that carries an inventory of products has a need to maintain accurate information on the movements of all these items to serve better to its customers and run a profitable business. Whether you need to manage one supply closet or a multi-facility warehouse operation, the goal is to cut down on manual data entry costs, minimize your inventory write-offs and overstocks and increase efficiencies in your supply chain.[7][8]

A complete inventory management solution will consist of **management software**, **mobile computers** and **label printers**. These tools will enable your business to track inventory levels and movements in your warehouse or stock room by item, serial number, or lot number. With full visibility into your entire incoming and outbound inventory, you can make better decisions to maintain dynamic stock levels that meet the demands of your customers and usage.[9]

Inventory management systems offer benefits to the operation of all types and sizes of businesses. An inventory management system decreases data entry errors, increases productivity and lowers operational costs. This is achieved by reducing or eliminating the hand-keying of data, manual physical inventories, backorders and lost sales due to inaccurate stock levels, inventory write-offs and shrinkage. With a properly set-up inventory system, you remove any ambiguity as to what is in your warehouse and where it is going.

Inventory management systems typically pay for themselves in less than one year. Most of the return on investment comes through saving on labor costs and reducing losses in sales due to lack of stock. Very few companies understand how inexpensive and simple it is to put an inventory management system in place. The first step in determining an inventory tracking system is to understand whether you are dealing with **inventory** or **assets**.[10][11]

• **Inventory** refers to objects that are sold, distributed, or otherwise consumed by a company. These "temporary" objects include retail items and supplies. In this case, you may have 100 boxes of staples in inventory and when you use one box, the tracked quantity decreases by one. You are not concerned with which specific instance was sold but rather that 1 of 100 was removed. At the end of the day, you want to know how many you have in stock, where it went and when to order more. This detailed visibility into your inventory usage allows you to make adjustments to your ordering and management process to increase efficiency.

• **Assets** are "permanent" objects that a business uses internally, such as computers, tools, or educational material. Although employees may check the object in or out to for a given project, or even use at home, an asset ultimately belongs to the company and must be returned to the company. An asset is always tracked as a unique item. Even though you may have 10 of the same PC or tool, you are managing each instance as an individual item with its own unique **barcode label** or **RFID tag**. The main concern is to have accurate information on each specific item like location, condition, purchase date, value, custodian, last maintenance, etc.

Description	Asset	Inventory
Objects used internally, such as computers, tools, and educational materials	•	
Track depreciation of company property	•	
Track maintenance on company equipment	•	
Objects are for sale or resale		•
Ability to track/monitor reorder levels		•
Objects are "temporary" and/or often replace, such a paper, pens and other consumables		•
Employees may check objects in and out	•	•

Inventory management solutions are driven (and limited by) the software that is used. Basic inventory functions are covered by all software, but depending on your need to have real-time updates to your system, some applications will be a better fit than others. The real strength of any application is how easily and in-depth it provides visibility into your inventory usage. Features like setting a minimum and maximum stock level for each item allows you to run a simple report to see what needs to be re-ordered. Inventory usage reporting is key to keeping your stock levels relevant to what your customers or company is buying/using. Another software concern is support for the number of users you will have. Some applications are geared towards small business with limited user licensing while others are completely open-ended to fit any business size. To have an effective inventory tracking solution, you'll need to make sure the inventory tracking software is the right fit for your business.

All inventory management systems consist of 4 core components:[12][13]

• **Inventory Tracking Software** - The software you use will determine how you track your inventory. Support for real-time vs. batch updates and the depth of reporting will determine which application is most appropriate for yourbusiness.

• **Mobile Computer** - Inventory tracking requires users to be on the move throughout your facility making updates and changes. Depending on your environment and need for wireless communication a range of devices can serve your process.

• **Wireless Infrastructure** - Many businesses need inventory updates to occur in real-time and a wireless network is a required tool to do so. No matter the size of your facility, a network can be scaled to accommodate it.

• **Barcode Printer** - In order to track items quickly and easily, they need to be labeled with a barcode. Printing can be done at fixed units for high volume printing or on the move with mobile printers.

A proper inventory management solution will streamline your business by significantly reducing costs and waste.

• **Accuracy** - Eliminate human error in inventory counting.

• **Speed** - Reduce man hours by using automated data capture.

• **Accountability** - Document shrinkage and loss to identify steps to reduce them.

• **Mobility** - Make adjustments or replace damaged/unreadable labels on-the-spot using mobile computers and printers.

1.5: TYPES OF BARCODES

1.5.1: Linear barcodes

A first generation, "one dimensional" barcode that is made up of lines and spaces of various widths that create specific patterns.

Example	Symbology	Continuous or discrete	Bar widths	Uses
	Australia Post barcode	Discrete	4 bar heights	An Australia Post barcode as used on a business reply paid envelope.[14]
	Codabar	Discrete	Two	Old format used in libraries and blood banks and on airbills (out of date)[15][16]

	Code 25 – Non-interleaved 2 of 5	Continuous	Two	Industrial[17]
	Code 25 – Interleaved 2 of 5	Continuous	Two	Wholesale, libraries International standard ISO/IEC 16390[18]
	Code 11	Discrete	Two	Telephones (out of date)[19]
	Farmacode or Code 32	Discrete	Two	Italian pharmacode – use Code 39 (no international standard available)[20]
	Code 39	Discrete	Two	Various – international standard ISO/IEC 16388[21]
	Code 49	Continuous	Many	Various[22]
	Code 93	Continuous	Many	Various[23]

	Code 128	Continuous	Many	Various – International Standard ISO/IEC 15417[24]
	CPC Binary	Discrete	Two	Various[25]
	DX film edge barcode	Neither	Tall or short	Color print film[26]
	EAN 2	Continuous	Many	Addoncode (magazines), GS1-approved – not an own symbology – to be used only with an EAN/UPC according to ISO/IEC 15420[27]
	EAN 5	Continuous	Many	Addon code (books), GS1-approved – not an own symbology – to be used only with an EAN/UPC according to ISO/IEC 15420[28]
	EAN-8, EAN-13	Continuous	Many	Worldwide retail, GS1-approved – International Standard ISO/IEC 15420[29]

	Facing Identification Mark	Discrete	Two	USPS business reply mail[30]
	GS1-128 (formerly named UCC/EAN-128), incorrectly referenced as EAN 128and UCC 128	Continuous	Many	Various, GS1-approved – just an application of the Code 128 (ISO/IEC 15417) using the ANS MH10.8.2 AI Datastructures. It is not a separate symbology.[31][29]
	GS1 DataBar, formerly Reduced Space Symbology (RSS)	Continuous	Many	Various, GS1-approved[32][29]
	Intelligent Mail barcode	Discrete	4 bar heights	United States Postal Service, replaces both POSTNET and PLANET symbols (formerly named OneCode)[33]
	ITF-14	Continuous	Two	Non-retail packaging levels, GS1-approved – is just an Interleaved 2/5 Code (ISO/IEC 16390) with a few additional

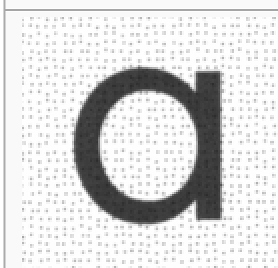
				specifications, according to the GS1 General Specifications[34]
	JAN	Continuous	Many	Used in Japan, similar and compatible with EAN-13 (ISO/IEC 15420)[35]
	Japan Post barcode	Discrete	4 bar heights	Japan Post[36]
	KarTrak ACI	Discrete	Coloured bars	Used in North America on railroad rolling equipment[37]
	MSI	Continuous	Two	Used for warehouse shelves and inventory[38]
	Pharmacode	Discrete	Two	Pharmaceutical packaging (no international standard available)[39]
	PLANET	Continuous	Tall/short	United States Postal Service (no international standard available)[40]

	Plessey	Continuous	Two	Catalogs, store shelves, inventory (no international standard available)[41]
	PostBar	Discrete	4 bar heights	Canadian Post office[42]
	POSTNET	Discrete	Tall/short	United States Postal Service (no international standard available)[43]
	RM4SCC / KIX	Discrete	4 bar heights	Royal Mail / PostNL[44]
	RM Mailmark C	Discrete	4 bar heights	Royal Mail[45]
	RM Mailmark L	Discrete	4 bar heights	Royal Mail[46]
	Telepen	Continuous	Two	Libraries (UK)[47]
	Universal Product Code	Continuous	Many	Worldwide retail, GS1-approved – International Standard ISO/IEC 15420[48]

1.5.2: Matrix (2D) barcodes

A *matrix code*, also termed a *2D barcode* or simply a *2D code*, is a two-dimensional way to represent information. It is similar to a linear (1-dimensional) barcode, but can represent more data per unit area.

Example	Name	Notes
	Aztec Code	Designed by Andrew Longacre at Welch Allyn (now Honeywell Scanning and Mobility). Public domain. – International Standard ISO/IEC 24778[49]
	Code 1	Public domain. Code 1 is currently used in the health care industry for medicine labels and the recycling industry to encode container content for sorting. [50]
	ColorCode	ColorZip[51] developed colour barcodes that can be read by camera phones from TV screens; mainly used in Korea.[52]
	Color Construct Code	Color Construct Code is one of the few barcode symbologies designed to take advantage of multiple colors.[53][54]

	CrontoSign	CrontoSign (also called photoTAN) is a visual cryptogram[55] containing encrypted order data and a one-time-use TAN.[56]
	CyberCode	From Sony.[57]
	d-touch	readable when printed on deformable gloves and stretched and distorted[58][59]
	DataGlyphs	From Palo Alto Research Center (also termed Xerox PARC).[60] Patented.[61] DataGlyphs can be embedded into a half-tone image or background shading pattern in a way that is almost perceptually invisible, similar to steganography.[62][63]
	Data Matrix	From Microscan Systems, formerly RVSI Acuity CiMatrix/Siemens. Public domain. Increasingly used throughout the United States. Single segment Data Matrix is also termed Semacode – Standard: ISO/IEC 16022.[64]
	Datastrip Code	From Datastrip, Inc.[65]
	digital paper	Patterned paper used in conjunction with a digital pen to create handwritten digital documents. The printed dot pattern uniquely identifies the position coordinates on the paper.[66]

	EZcode	Designed for decoding by camera-phones;[67] from ScanLife. [68]
	High Capacity Color Barcode	Developed by Microsoft; licensed by ISAN-IA.[69]
	Han Xin Barcode	Barcode designed to encode Chinese characters introduced by Association for Automatic Identification and Mobility in 2011.[70]
	HueCode	From Robot Design Associates. Uses greyscale or colour.[71]
	InterCode	From Iconlab, Inc. The standard 2D barcode in South Korea. All 3 South Korean mobile carriers put the scanner program of this code into their handsets to access mobile internet, as a default embedded program.[72]
	MaxiCode	Used by United Parcel Service. Now Public Domain[73]
	MMCC	Designed to disseminate high capacity mobile phone content via existing colour print and electronic media, without the need for network connectivity[74]

	NexCode	NexCode is developed and patented by S5 Systems.[75]
	Nintendo e-Reader#Dot code	Developed by Olympus Corporation to store songs, images, and mini-games for Game Boy Advance on Pokémon trading cards.[76]
	PDF417	Originated by Symbol Technologies. Public Domain.[77]
	Qode	American proprietary and patented 2D barcode from NeoMedia Technologies, Inc. [67]
	QR code	Initially developed, patented and owned by Toyota subsidiary Denso Wave for car parts management; they have chosen not to exercise their patent rights. Can encode Japanese Kanji and Kana characters, music, images, URLs, emails. De facto standard for Japanese cell phones. Also used with BlackBerry Messenger to pickup contacts rather than using a PIN code. These codes are also the most frequently used type to scan with smartphones. – International Standard : ISO/IEC 18004[78]
	ShotCode	Circular barcodes for camera phones. Originally from High Energy Magic Ltd in name Spotcode. Before that probably termed TRIPCode.[79]

	SPARQCode	QR code encoding standard from MSKYNET, Inc.[80]
	VOICEYE	Developed and patented by VOICEYE, Inc. in South Korea, it aims to allow blind and visually impaired people to access printed information. It also claims to be the 2D barcode that has the world's largest storage capacity.[81]

1.5.3: Example images

First, Second and Third Generation Barcodes

- GTIN-12 number encoded in UPC-A barcode symbol. First and last digit are always placed outside the symbol to indicate Quiet Zones that are necessary for barcode scanners to work properly

- EAN-13 (GTIN-13) number encoded in EAN-13 barcode symbol. First digit is always placed outside the symbol, additionally right quiet zone indicator (>) is used to indicate Quiet Zones that are necessary for barcode scanners to work properly

"ABCDE12345" encoded inCode 93

"*CSE370*" encoded inCode 39

'A1b2c3D4e5" encoded inCode 128

An example of a *stacked barcode*.Specifically a "Codablock" barcode.

PDF417 sample

Loremipsum boilerplate text as four segmentData Matrix 2D

➢

"This is an example Aztec symbol for Wikipedia" encoded inAztec Code

➢

Text 'EZcode'

➢

High Capacity Color Barcode of the URL for Wikipedia's article onHigh Capacity Color Barcode

➢

"ABCD12345" in several languages encoded inDataGlyphs

➢

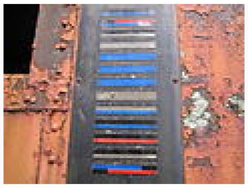
Two different 2D barcodes used in film:Dolby Digital between the sprocket holes with the "Double-D" logo in the middle, and Sony Dynamic Digital Soundin the blue area to the left of the sprocket holes

The QR Code for the Google. "Quick Response", the most popular 2D barcode in Japan, is promoted by Google. It is open in that the specification is disclosed and the patent is not exercised.

MaxiCode example. This encodes the string "ABCD, XYZ"

ShotCode sample

detail of TwibrightOptarscan from laser printed paper, carrying 32 kbit/s OggVorbis digital music (48 seconds per A4 page)

➢ 

A KarTrak railroadAutomatic Equipment Identification label on a caboose in Florida

1.6: EXTRACTIVE TECHNIQUE OF BARCODING FROM THE SUPERIMPOSED MESH

Extraction of barcode from the superimposed mesh was done to match it with the original one. Initially, an image of barcode under superimposed mesh was taken and its lower part has been cropped except the vertical bars. The cropped image was converted to grayscale image which is again converted to binary image. Now removing the mesh by removing all objects containing fewer than 30 pixels. Now labeling the connected components and storing it in a 2D array. Next, measuring the properties of image regions and plotting the bounding box. Now, in a 2d array the nonzero values of rows and columns are stored and then just taking the minimum and maximum values of rows and columns and storing each 2D array in a cell.

1.7: MATCHING TECHNIQUES WITH THE DATABASE

MySQL has been used as database server. A table was created under a database to store the original barcode value and later it will be matched with the barcode value that was extracted from the barcode which was under superimposed mesh and finally appropriate message will be displayed.

CHAPTER 2 : HISTORY& DEVELOPMENT OF BARCODE AND RELATED LITERATURE REVIEW

In 1948, Bernard Silver, a graduate student at Drexel Institute of Technology in Philadelphia, Pennsylvania, US overheard the president of the local food chain, Food Fair, asking one of the deans to research a system to automatically read product information during checkout.[82] Silver told his friend Norman Joseph Woodlandabout the request, and they started working on a variety of systems. Their first working system used ultraviolet ink, but the ink faded too easily and was rather expensive.[83]

Convinced that the system was workable with further development, Woodland left Drexel, moved into his father's apartment in Florida, and continued working on the system. His next inspiration came from Morse code, and he formed his first barcode from sand on the beach. "I just extended the dots and dashes downwards and made narrow lines and wide lines out of them." To read them, he adapted technology from optical soundtracks in movies, using a 500-watt incandescent light bulb shining through the paper onto an RCA935 photomultiplier tube (from a movie projector) on the far side. He later decided that the system would work better if it were printed as a circle instead of a line, allowing it to be scanned in any direction.[83]

On 20 October 1949 Woodland and Silver filed a patent application for "Classifying Apparatus and Method", in which they described both the linear and bullseyeprinting patterns, as well as the mechanical and electronic systems needed to read the code. The patent was issued on 7 October 1952 as US Patent 2,612,994. In 1951, Woodland moved to IBM and continually tried to interest IBM in developing the system. The company eventually commissioned a report on the idea, which concluded that it was both feasible and interesting, but that processing the resulting information would require equipment that was some time off in the future.[83]

IBM offered to buy the patent, but its offer was not high enough. Philco purchased their patent in 1962 and then sold it to RCA sometime later.

During the time of hisundergraduatation, David Collins worked at the Pennsylvania Railroad and became aware of the need to automatically identify railroad cars. Immediately after receiving his master's degree from MIT in 1959, he started work at GTE Sylvania and began addressing the problem. He developed a system called *KarTrak* using blue and red reflective stripes attached to the side of the cars, encoding a six-digit company identifier and a four-digit car number. Light reflected off the stripes was fed into one of two photomultipliers, filtered for blue or red.

The Boston and Maine Railroad tested the KarTrak system on their gravel cars in 1961. The tests continued until 1967, when the Association of American Railroads (AAR) selected it as a standard, Automatic Car Identification, across the entire North American fleet. The installations began on 10 October 1967. However, theeconomic downturn and rash of bankruptcies in the industry in the early 1970s greatly slowed the rollout, and it was not until 1974 that 95% of the fleet was labeled. To add to its woes, the system was found to be easily fooled by dirt in certain applications, which greatly affected accuracy. The AAR abandoned the system in the late 1970s, and it was not until the mid-1980s that they introduced a similar system, this time based on radio tags.[84]

The railway project had failed, but a toll bridge in New Jersey requested a similar system so that it could quickly scan for cars that had purchased a monthly pass. Then the U.S. Post Office requested a system to track trucks entering and leaving their facilities. These applications required special retroreflector labels.

Finally, KalKan asked the Sylvania team for a simpler (and cheaper) version which they could put on cases of pet food for inventory control.

In 1967, with the railway system maturing, Collins went to management looking for funding for a project to develop a black-and-white version of the code for other industries. They declined, saying that the railway project was large enough, and they saw no need to branch out so quickly.

Collins then quit Sylvania and formed the Computer Identics Corporation. As its first innovations, Computer Identics' moved from using incandescent light bulbs in its systems, replacing them with helium–neon lasers, and incorporated a mirror as well, making it capable of locating a barcode up to several feet in front of the scanner. This made the entire process much simpler and more reliable, and typically enabled these devices to deal with damaged labels, as well, by recognizing and reading the intact portions.[83]

Computer Identics Corporation installed one of its first two scanning systems in the spring of 1969 at a General Motors (Buick) factory in Flint, Michigan. The system was used to identify a dozen types of transmissions moving on an overhead conveyor from production to shipping. The other scanning system was installed at General Trading Company's distribution center in Carlstadt, New Jersey to direct shipments to the proper loading bay.

In 1966 the National Association of Food Chains (NAFC) held a meeting on the idea of automated checkout systems. RCA, who had purchased the rights to the original Woodland patent, attended the meeting and initiated an internal project to develop a system based on the bullseye code. The Kroger grocery chain volunteered to test it.

In the mid-1970s, the NAFC established the Ad-Hoc Committee for U.S. Supermarkets on a Uniform Grocery-Product Code to set guidelines for barcode development. In addition, it created a symbol-selection subcommittee to help standardize the approach. In cooperation with consulting firm, McKinsey & Co., they developed a standardized 11-digit code for identifying products. The committee then sent out a contract tender to develop a barcode system to print and read the code. The request went to Singer, National Cash Register (NCR), Litton Industries, RCA, Pitney-Bowes, IBM and many others. A wide variety of barcode approaches were studied, including linear codes, RCA's bullseye concentric circle code, starburst patterns and others.[85]

In the spring of 1971, RCA demonstrated their bullseye code at another industry meeting. IBM executives at the meeting noticed the crowds at the RCA booth and immediately developed their own system. IBM marketing specialist, Alec Jablonover, remembered that the company still employed Woodland, and heestablished a new facility in North Carolina to lead development.

In July 1972, RCA began an eighteen-month test in a Kroger store in Cincinnati. Barcodes were printed on small pieces of adhesive paper, and attached by hand by store employees when they were adding price tags. The code proved to have a serious problem; the printers would sometimes smear ink, rendering the code unreadable in most orientations. However, a linear code, like the one being developed by Woodland at IBM, was printed in the direction of the stripes, so extra ink would simply makes the code "taller" while remaining readable. So on 3 April 1973, the IBM UPC was selected as the NAFC standard. IBM had designed five versions of UPC symbology for future industry requirements: UPC A, B, C, D, and E.[86]

NCR installed a testbed system at Marsh's Supermarket in Troy, Ohio, near the factory that was producing the equipment. On 26 June 1974, Clyde Dawson pulled a 10-pack of Wrigley's Juicy Fruit gum out of his basket and it was scanned by Sharon Buchanan at 8:01 am. The pack of gum and the receipt are now on display in the Smithsonian Institution. It was the first commercial appearance of the UPC.[87]

In 1971, an IBM team was assembled for an intensive planning session, thrashing out, 12 to 18 hours a day, how the technology would be deployed and operate cohesively across the system, and scheduling a roll-out plan. By 1973, the team was meeting with grocery manufacturers to introduce the symbol that would need to be printed on the packaging or labels of all of their products. There were no cost savings for a grocery to use it, unless at least 70% of the grocery's products had the barcode printed on the product by the manufacturer. IBM projected that 75% would be needed in 1975. Yet, although this was achieved, there were still scanning machines in fewer than 200 grocery stores by 1977.[88]

Economic studies conducted for the grocery industry committee projected over $40 million in savings to the industry from scanning by the mid-1970s. Those numbers were not achieved in that time-frame and some predicted the demise of barcode scanning. The usefulness of the barcode required the adoption of expensive scanners by a critical mass of retailers while manufacturers simultaneously adopted barcode labels. Neither wanted to move first and results were not promising for the first couple of years, with *Business Week* proclaiming "The Supermarket Scanner That Failed" in a 1976 article.[87][89]

On the other hand, experience with barcode scanning in those stores revealed additional benefits. The detailed sales information acquired by the new systems allowed greater responsiveness to customer habits, needs and preferences. This was reflected in the fact that about 5 weeks after installing barcode scanners, sales in grocery stores typically started climbing and eventually leveled off at a 10–12% increase in sales that never dropped off. There was also a 1–2% decrease in operating cost for those stores, and this enabled them to lower prices and thereby to increase market share. It was shown in the field that the return on investment for a barcode scanner was 41.5%. By 1980, 8,000 stores per year were converting.[88]

The global public launch of the barcode was greeted with minor skepticism from conspiracy theorists, who considered barcodes to be an intrusive surveillance technology, and from some Christians who thought the codes hid the number 666, representing the number of the beast.[90] Television host Donahue described barcodes as a "corporate plot against consumers".[91]

Literature Survey Related to Barcodes:

In past few years, some papers have been printed on Barcode in different aspects by different researcher to get the desirable result. Some of the papers has been discussed below:

- Ernest Arendarenko has worked on a study of comparing RFID and 2D Barcode tag technologies for pervasive mobile applications[92] which combines different research methods and is focused on usability study of these two technologies. Radio frequency identification technology has been developing for many years and now became a serious concurrent for barcode technology. Nevertheless, the latter obtained its more advanced type: a two dimensional barcode. Both RFID and 2D barcodes may be used in mobile technologies, for example in ubiquitous and pervasive computing. Special attention was put on comparing strong and weak sides of each technology. The next stage was design based research on which an NFC plugin and a MemGame mobile application were implemented for experiment purposes. And on the last phase of research experiments were conducted. Feedback from users was collected by questionnaire upon usability study. The obtained data was analyzed according to the research questions. The knowledge of results of this study might be useful not only for further pervasive application development, but for mobile application development in general where RFID and/or 2D barcodes are utilized. The research has two main technical contributions: (1) development of a NFC/RFID plugin for MUPE; and (2) development of a pervasive memory game for training memory and learning vocabulary. These developments were prerequisites for the comparison of the two smart tagging technologies, namely 2D barcode and RFID, in an educational setting.

- Fang Yuan Fu Huaming Zhang Yingzi has presented a certificate anti-counterfeiting system based on encryption two-dimension barcode and fingerprint identification[93] to introduce a new method because at present fake certificates were copied more frequently. Two-dimension bar code had high information density and low cost, which used on certificate anti-counterfeiting, could ensuring certificates effectively. Furthermore storing the fingerprint information in two-dimension bar code, and using the fingerprint identification technology could ensure the carrier was true or false. Ensuring certificates in these two sides, and combining encryption technology to assure the certificate information was carried in two-dimension bar code safely. The results of experiment declared False Accept Rate was 0 percent and False reject Rate was 1.38 percent. The system of certificate anti-counterfeiting based on encryption Two-dimension barcode and fingerprint identification in this thesis has widely application.

- Leong HuayChing has worked on the randomness fingerprint authentication with barcode [94]to improve the efficiency and effectiveness of the current authentication security and attendance signature system. Most of the current authentication and attendance signature system is found that do not fulfill the criteria of security requirement. These current system have similar problem, it unable to guarantees authenticated the correct user with something that cannot be lost, forgotten, misplaced, shared or stolen. With this thesis, the feasibility of integrating the fingerprint authentication system with the barcode authentication technology will be researched and implemented. The "Randomness Fingerprint Authentication with Barcode" is a new scheme to solve the problems which was found on the traditional student attendance system and existing fingerprint authentication system. The system that proposed is not only using the static formula for request user fingerprint but will establish a randomized fingerprint algorithm. This randomized algorithm will be the most attractive and interesting features or function if compare with other authentication system. Besides, by combination of fingerprint verifying with bar code authentication mechanism, it can improves the effectively identification of the particular person in attendance signature process. In this thesis, some existing fingerprint authentication system is taken as investigate and analysis sample. Problem statement is established based on the analysis and requirement for the to-be system is captured. On the other hand, a preliminary design of the to-be system is established as well including system architecture, user interfaces design, and logical database design. As in conclusion, the wellness of "Randomness Fingerprint Authentication with Barcode" will represent through the completion of this thesis.

- LukeMcCathie has published a paper on the advantages and disadvantages of barcodes and radio frequency identification in supply chain management [95] which will aid stakeholders in understanding the advantages and disadvantages of each respective technology in SCM applications. Since the 1980s, barcodes have become the backbone of supply chain management (SCM). Recently organizations, from both government and corporate sectors have placed increasing emphasis on further streamlining SCM to deliver cost savings. This has lead to a number of leading organizations introducing mandates for their suppliers to implement radio frequency identification (RFID) technology. Many organizations are unsure which technology, barcodes or RFID offers them the best return. Furthermore, the research will examine the importance of a global standard for RFID such as the Electronic Product Code (EPC) and offer insight into the coexistence of barcodes and RFID. The research will employ a thorough documentation review as well as several interviews with users of each technology

- GuanjieMengandShabnamDarman jointly worked on label and barcode detection in wide angle image[96]to introduce new methods for detection are applicable at a short distance from the camera and with a clear background. Labels are used for managing warehouse environments by collecting information from existing items on shelves and racks. Labels enable description and identification of items accurately in a short time. Therefore, label detection from captured images is challenging especially with a large and complex background. Once a label is detected, it is ready for next process of recognition, to read out the stored information in texts and barcodes. In this thesis, they compared methods from previous works and implemented the most suitable one for detecting one-dimensional (1D) barcodes available on the captured images by standard lens. They created a dataset for label detection with an assumption on background color and they continued processing by K-means clustering and classification. After localizing label regions, a projection for determining a different candidate area is done. They have worked on two types of barcodes, one-dimensional (1D) and Data Matrix as a two-dimensional (2D) barcode. The results show a good performance of the system in terms of images, which are the most important issue in terms of industrial detection.

- RuchitaSirkanungo has worked on information management system using 2D Barcodes and cell phone technology[97] which integrates the capabilities of 1D barcode into 2D barcode to represent and classify the complex digital information collected from different sources.One of the challenging problems of pervasive computing is to link a physical object with digital information because many of the pervasive computing applications require manual inputs or complex image processing to obtain information related to a real object. The use of 2D barcodes eliminates such excess processing to acquire the needed information. The 2D barcodes have high capacity to store data, are less prone to human input error and act as a tool to acquire information on site without network access. The currently available solutions use 1D barcodes to represent dynamic information residing in a database and use 2D barcodes to represent only static information that also encode only URLs. In all such applications, the source of information gets restricted to either a database or the static data encoded inside a 2D barcode. None of such solutions takes advantage of 2D barcode capabilities to collect information from different sources and attach it to the real world entity. Moreover, a 2D barcode can also represent and categorize complex text information. He has designed and implemented an information management system on a handheld device that has image processing and barcode decoding capabilities to address the above-mentioned problem. His prototype provides a generic framework to decode either 1D or 2D barcode, parse the complex information (both dynamic and static) inside the 2D barcode, differentiate the complex information based on content types and classify the image based on the barcode format. It also assists users in decision making and information analysis. An example system application can be deployed in grocery stores as a part of the enterprise information management system.

- AlirezaEstaji has worked on automated data gathering for industrial production tracking [98] to find an effective method for accurate and reliable data collecting during production processes has been a concern of many industrial producers. Mass production in industrial environment involves fulfilling customer requirements and obligatory quality control standards. So gathering data in supply chain generally and especially in production lines is compulsory. In addition to customer requirements, competition and progress in harsh economic environment needs reliable and on time data.That thesis focuses on the production system of a company named SKC, which collects data based on user reports. Operators must report their productive activity in detail at the end of every process/task or at the end of working day. Numerous reports not only waste the valuable production time of operators, but also increase the risk of mistake and data inconsistency in manual steps of reporting and data entry. Furthermore, data is not available before the next working day which delays dynamic planning and mistake preventing actions.That thesis provides a design to replace this old-fashioned system with a system that is based on new technologies. Even in this case economical justification is a great motivation for change. The main subject is to automatically identify materials, operators, and machinery equipment for every batch of final products. This online data tracking will make a great control opportunity. To present a systematic and practical design for automated data gathering, a specified type of production has been considered, although the main idea and concept can be used in similar cases. It has been tried to describe the topic in general way, after that, any selection that has been made is based on real conditions in considered company, which is a labor-oriented assembly line.In the designed solution, any important object including and not limited to operators, batches of final products, raw materials and production machines are equipped with RFID tags. In collecting points like Production Stations a special device reads the tags and by using Wireless Sensor Network (WSN) the data is sent to the Sink, which is connected to the network and the data is inserted to a database. The reader device associated to production station is combined from RFID reader module and ZigBee module. A LCD display and a keypad are added for more functionality.

- P. C. Deka, G. J. Sharma andA. N. Rao had arranged a conference on DNA Barcoding of Indian Orchids.[99]North east India harbors about 700 orchid species. Their habitats range from tropical to sub-tropical to temperate to sub-alpine forest. In recent years, many of the habitats were destroyed due to anthropogenic activities such as deforestation and development activities. As a result, many of the species are on the brink of extinction in their natural habitats. Thus it has become necessary to conserve orchids in their natural habitats.Orchids are difficult to identify, especially when they do not flower. DNA bar-coding can help to resolve this issue. Earlier reports have indicated the possibility of utilizing both coding and non-coding sequences of chloroplast genome for DNA bar-coding in orchids. They have used two coding (rcbL and matK) and two non-coding (trnH-psbA and trnL-F) regions of plastid genome from 183 species of orchids belonging to 9 genera namely, Aerides, Coelogyne, Cymbidium, Cypripedium, Dendrobium, Eria, Phaius, Rhynchostylis, and Vanda of north east India, to study the possibility of developing universal DNA barcodes. Based on variations in length, success in amplification and sequencing, percent variation within species, percent variation between species, variable sites and tr/tv ratio, matK and trnL-F regions were found to be suitable candidates for all the species studied. Between the two, trnL-F showed maximum variations within and between species. Other orchid species are being investigated to arrive at a definite conclusion.

- Stephan Karpischek has worked on mobile barcode scanning applications for consumers [100] which will improve the daily buying decisions of millions of consumers. Application providers need access to high quality product master data for correct product descriptions. Data quality problems are emerging as product master data designated for industrial supply chains reach a wide audience of consumers in these applications. This thesis contributes to the research on mobile barcode scanning applications and product master data quality. He has described the development of a mobile barcode scanning application that enables consumers to share comments and ratings on products. The app has been deployed to thousands of Android and iPhone smartphones and the software has been released under an open source license. Analysis of usage data shows that users are less likely to share comments and ratings when product descriptions are missing. He has used aggregated product master data for more than 120,000 products to develop a method for identifying incorrect product names. He hasevaluated the performance and usefulness for consumer packaged goods businesses and measured the correctness of product master data from publicly available sources. His results show that approximately 2% of product names are incorrect. The method developed can be used to effectively monitor and control product master data quality in external sources. Implemented in master data management processes, it can help to improve the overall quality of product master data for mobile barcode scanning applications.

- Pham Thanh Son has worked on the improvement and implementation ofAztec 2-D Barcode [101] to investigate and improvethe algorithm of Aztec barcode. A complete barcode system (generating – perception) will be implemented also. Aztec barcode is a two-dimensional matrix symbology whose symbols are nominally square, made up of square modules on a square grid, with a square bulls-eye pattern at their centre. Aztec barcode symbols can encode from small to large amounts of data with user- selected percentages of error correction. Aztec barcode is widely used nowadays. Aztec barcode is used in large such as plane ticket, online ticket, car registration documents. Aztec barcode is new to our country but they can take full of its advantage to store and manage information. After completing, my program can generate, read and manipulate information Aztec code. There are two main parts in my thesis, they are encoding and decoding process. In encoding process, the input data will be encoded to binary data first. After that a Reed- Solomon code will be added to the message code also in binary, and the whole code will be filling into the framework of Aztec barcode. In the decoding process, firstly, the input image will be processed. Secondly, it will be turn into binary matrix by decoding algorithm. Finally, the binary data will be converted into text message.

- FarhangPadidaran Moghaddam has worked on development of a barcode-based key system [102] which provides a Web-based solution for issuing online key and accessing to disconnected areas which are disconnected from any server or portal. In some locations there is no facility for connecting to server, because of inaccessibility or cost of network connection. Beside, the key must be generated in the easiest way for customer’s convenience. Online users can book and reserve their desired room or can purchase their coveted event’s ticket by the internet easily. The thesis gives reliable solution to design a method and system for generating access code and issuing the key or ticket with offering a safe and reduced cost way. The issued key is perceptible for offline and standalone lock system. Barcode has been chosen, according to its advantages, such as cheapness, simple product and ease of use. The Verifier Machine can be located at each venue entry point are standalone devices, and are not connected in any way neither among them nor to any central database, server or portal. Functionality of simulator application in generating the access code, ability of portal in issuing barcode form key, stability of printed key and capability of demonstrated standalone machine in decrypting and verifying was tested successfully. The achieved system presents a simple, low cost, and flexible method for authorization and authentication in accessing doors at remote areas.

- Farah IzanaBt Abdullah has worked on the development Of Internal Transcribed Spacer region (ITS) barcode for malaysian pineapple[103]to prove thatidentification of pineapple cultivar solely based upon traditional method which only based on morphology which is inconsistent, time consuming and lead to misidentification of cultivar. Thus phenetic study was conducted to address phenetic relationship and to evaluate utility of Internal Transcribed Spacer (ITS) region as a barcode among nine Malaysian pineapple cultivars using sequence of ITS. Genomic DNA was directly extracted, and ITS region was amplified and sequenced. Phenetic analysis revealed pineapple cultivars could be classified into three groups with high DNA sequence similarity which is around 75% to 100%. This shows that the ITS region have good discrimination power to distinguish the pineapple cultivars. Thus, DNA barcode for Malaysian pineapple cultivars were developed using consensus region of ITS.

- Nor Emilia ZetfyBteKhairudinhas worked on Halal Food Recognition System Using Barcode [104]which is a low cost barcode reader, which was developed by using a simple webcam as the input device. With the steady growth and affordability of webeam, more applications technology is necessary. Nowadays the industry technology began to pay more attention to barcode applications for domestic users need. This thesis describes a. webeam support application for Muslims to identify the Halal status (prepared in accordance to Islamic law) of the product. The barcode image is using several images preprocessing technique in order to extract the bat-code into database and also barcode recognition process. Barcodes are a class of the simplest printed patterns that can be reliably recognized by a computer. These codes consist of sequence of parallel, light and dark stripes printed on papers. This is a real time application and that requires good processing power. This is the main reason for using the language MatLab for the development of the Halal Food Recognition System Using Barcode. The webcam application is an economical and effective way to speed up the Halal verification process. This thesis discusses the barcode concept and its applications in consumer product industry. The experimental results obtained have system able to shown that recognition rates of 68% have been achieved. The result also revealed that the technique is robust and invariant to rotation. For future, research and development can be done to improve the percentage of recognition so that zero error recognition is achieved.

- N. M. Z. Hashim, N. A. Ibrahim, N. M. Saad, F. Sakaguchi and Z. Zakaria has jointly worked on barcode number recognition system[105] as barcode became essential elements in sales and products services due to importance of keeping records of all items in one 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 analyze 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.

- Ou Yang has proposed an algorithm research and implementation of fast identification of barcode[106] which makes analysis through digital image processing, in which methods such as Median Filtering Noise Reduction, Sectoring Threshold Segmentation, Logical Values Match and so on are put into use to process the digital image data of barcode and to implement its fast identification. Automatic identification technology of barcode has the advantage of low cost and has been being widely used in many fields: commodity circulation, industrial production automation, office automation and so forth. The barcode, the carrier of information, plays a key role all along. With more and more information in modern enterprise, great emphasis is put on quick acquisition and efficient processing of information. As a result, it is of remarkable importance to study the fast identification of barcode.

- Joe Durbin has worked on secondary data analysis of the two-dimensional (2D) barcoding vaccine pilot study[107] as 2D bar-coding use for vaccination administration in the U.S. health delivery system has gained gradual recognition as a viable way to improve completeness and accuracy of immunization records. Recording vaccination data has been a requirement since the passage of the National Childhood Vaccine Injury Act of 1986. Historically, records have had sub-optimal results with only 60% of reported vaccinations in Immunization Information Systems (IIS) having complete lot numbers. This thesis project performed a secondary data analysis on data from the CDC/Deloitte Consulting 2011-2012 Implementation Pilot for Two-Dimensional (2D) Vaccine Barcode Utilization. The pilot provided 2D scanners to 217 public, private, and pharmacy immunizers to evaluate the impact of 2D bar-coding on electronic medical records (EMR) and IIS records. This thesis project cleaned, standardized, and analyzed two separate de-identified datasets - EMR and IIS - with 1,346,837 and 1,687,366 vaccination records respectively. The results of the analysis of pre- versus post-implementation of 2D scanning in EMR data showed 1) increases in average completeness -- 4.2% in lot number data (93.3% versus 97.5%); 9.9% in expiration dates (86.0% versus 95.9%)-- and increases in average accuracy - 5.2% in lot numbers (91.0% versus 96.2%), and a 12.8% in expiration date (79.8% versus 92.5%); 2) the public practices had greater data quality than private sites (i.e., 3.2% and 6.4% greater completeness for lot number and expiration dates respectively; and 4.7% and 12.6% greater accuracy for lot number and expiration results respectively); and 3) the private practices had greater improvement of completeness and accuracy from pre- to post-implementation than the public sites indicating that private sites may have more room for improvement. The impact of a fully integrated EMR with 2D bar-coding if expanded out to the entire U.S. population could translate into millions of more complete and accurate vaccination records. For example of the 19.2 million vaccinated children < 6, there could be 2,457,600 more with accurate expiration dates. Patient safety could benefit from 2D bar-coding by improving consistency with the Vaccine Adverse Event Reporting System (VAERS), reducing errors to free up more time for patient care, and contributing to greater accuracy in the event of vaccine safety recalls.

- Ender Tekin and James M. Coughlan have jointly introduced an algorithm enabling blind users to find and read barcodes.[108]Most camera-based systems for finding and reading barcodes are designed to be used by sighted users (e.g. the Red Laser iPhone app), and assume the user carefully centers the barcode in the image before the barcode is read. Blind individuals could benefit greatly from such systems to identify packaged goods (such as canned goods in a supermarket), but unfortunately in their current form these systems are completely inaccessible because of their reliance on visual feedback from the user. To remedy this problem, theypropose a computer vision algorithm that processes several frames of video per second to detect barcodes from a distance of several inches; the algorithm issues directional information with audio feedback (e.g. “left,” “right”) and thereby guides a blind user holding a webcam or other portable camera to locate and home in on a barcode. Once the barcode is detected at sufficiently close range, a barcode reading algorithm previously developed by the authors’ scans and reads aloud the barcode and the corresponding product information. Theydemonstrate encouraging experimental results of our proposed system implemented on a desktop computer with a webcam held by a blindfolded user; ultimately the system will be port

- Rebecca Herr has worked on radio frequency identification: smart barcode.[109]The past century has been one marked by exceptional innovations that have affected nearly every part of life. As a myriad of technological innovations become available over the next decade, one can only guess how these innovations will increasingly change the way that Americans and others around the world live. One of the most promising new technologies currently in development is that of Radio Frequency Identification tags, small microchips that can electronically track and transmit the type of information that has historically been stored by bar code.Along with the introduction of this new and innovative technology come a number of issues that must be addressed, including implementation problems, the need for consumer and industry acceptance, and the development of industry usage standards. If these issues can be addressed in a timely manner, there are a great number of benefits and efficiencies that could be gained from the usage of this technology. While Radio Frequency Identification or RFID has the potential to revolutionize many industries, it has proven to be a somewhat controversial technology because of the number of associated consumer privacy issues. This thesis discusses Radio Frequency Identification, its uses and benefits and the issues that must be overcome for the technology to be utilized on a wide scale basis. One can only speculate as to whether the technology will ever be able to overcome the issues of cost, infrastructure, and consumer acceptance to realize its full potential.

- Jen-Yu Shieh,Jia-Long Zhang,Yu-Ching Liao and Kun-Hsien Lin has together worked on the applications of barcode images by enhancing the two-dimensional recognition rate[110] which not only proposed the latest Two-Dimensional Barcodes Image-processing Module, but also captured the smallest camera screens (320 240) with different focal distances and tried to find out “Finder Pattern” for positioning images. Further, use CROBU (Conversion Ratio of Basic Unit) the thesis proposed to convert 2-D barcodes into 1-pixel ratio to match images before judging recognition rate of 2-D barcodes through matching. Normally speaking, 2-D barcodes are deciphered and recognized by software while the thesis recognizes 2-D barcodes and enhances implementation speed up to 10-cm accurate max using image matching. The 2-D barcodes image-processing module the thesis proposed does capture and standardize image with complicated background or raw edge, which enhances 2-D barcodes recognition rate. The main point of this study is to construct a platform to manage or suggest nutrients human body needs. The Quick Response Code image of 2-D barcodes represents vitamin and calories information. 2-D barcodes taken instantly by MATLAB and CCD camera can be used to list nutrients from foods you eat recently and suggest what else you should eat for the purpose of health management.

- JutharatKulsantiwong, SattrachaiPrasopdee, JirapornRuangsittichai, WipapornRuangjirachuporn, ThidarutBoonmars, VithoonViyanant, Paola Pierossi, Paul D. N. HebertandSmarnTesanahas jointly worked on DNA barcodeidentificationof freshwater snails in the family bithyniidae from Thailand.[111]Freshwater snails in the family Bithyniidae are the first intermediate host for Southeast Asian liver fluke (*Opisthorchisviverrini*), the causative agent of opisthorchiasis. Unfortunately, the subtle morphological characters that differentiate species in this group are not easily discerned by non-specialists. This is a serious matter because the identification of bithyniid species is a fundamental prerequisite for better understanding of the epidemiology of this disease. Because DNA bar-coding, the analysis of sequence diversity in the 5' region of the mitochondrial COI gene, has shown strong performance in other taxonomic groups, theydecided to test its capacity to resolve 10 species/ subspecies of bithyniids from Thailand. Our analysis of 217 specimens indicated that COI sequences delivered species-level identification for 9 of 10 currently recognized species. The mean intraspecific divergence of COI was 2.3% (range 0-9.2 %), whereas sequence divergences between congeneric species averaged 8.7% (range 0-22.2 %). Although our results indicate that DNA bar-coding can differentiate species of these medically-important snails, theyalso detected evidence for the presence of one overlooked species and one possible case of synonymy.

CHAPTER 3 : OBJECTIVE FUNCTION DEVELOPMENT

3.1: SYMBOLOGIES

The mapping between messages and barcodes is called a *symbology*. The specification of a symbology includes the encoding of the single digits/characters of the message as well as the start and stop markers into bars and space, the size of the quiet zone required to be before and after the barcode as well as the computation of a checksum.

Linear symbologies can be classified mainly by two properties:[112]

3.1.1: Continuous vs. discrete

- Characters in discrete symbologies are composed of *n* bars and *n*−1 spaces. There is an additional space between characters, but it does not convey information, and may be any width as long as it is not confused with the end of the code.
- Characters in continuous symbologies are composed of *n* bars and *n* spaces, and usually abut, with one character ending with a space and the next beginning with a bar, or vice versa. A special end pattern that has bars on both ends is required to end the code.

3.1.2: Two-width vs. many-width

- A two-width, also called a **binary bar code**, contains bars and spaces of two widths, "wide" and "narrow". The precise width of the wide bars and spaces is not critical; typically it is permitted to be anywhere between 2 to 3 times the width of the narrow equivalents.

- Some other symbologies use bars of two different heights, or the presence or absence of bars. These are normally also considered binary bar codes.
- Bars and spaces in many-width symbologies are all multiples of a basic width called the *module*; most such codes use four widths of 1, 2, 3 and 4 modules.

Some symbologies use interleaving. The first character is encoded using black bars of varying width. The second character is then encoded, by varying the width of the white spaces between these bars. Thus characters are encoded in pairs over the same section of the barcode. Interleaved 2 of 5 is an example of this.

Stacked symbologies repeat a given linear symbology vertically.

The most common among the many 2D symbologies are matrix codes, which feature square or dot-shaped modules arranged on a grid pattern. 2D symbologies also come in circular and other patterns and may employ steganography, hiding modules within an image (for example, DataGlyphs).

Linear symbologies are optimized for laser scanners, which sweep a light beam across the barcode in a straight line, reading a *slice* of the barcode light-dark patterns. Stacked symbologies are also optimized for laser scanning, with the laser making multiple passes across the barcode.

In the 1990s development of charge coupled device (CCD) imagers to read barcodes was pioneered by Welch Allyn. Imaging does not require moving parts, as a laser scanner does. In 2007, linear imaging had begun to supplant laser scanning as the preferred scan engine for its performance and durability.

2D symbologies cannot be read by a laser as there is typically no sweep pattern that can encompass the entire symbol. They must be scanned by an image-based scanner employing a CCD or other digital camera sensor technology.[112]

3.2: SCANNERS

A **barcode reader** or **barcode scanner** is an electronic device that can read and output printed barcodes to a computer. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating optical impulses into electrical ones. Additionally, nearly all barcode readers contain *decoder* circuitry analyzing the barcode's image data provided by the sensor and sending the barcode's content to the scanner's output port.

3.2.1: Types of Scanners:

1. Technology

Barcode readers can be differentiated by technologies as follows:[113][114]

a. ***Pen-type scanners***

Pen-type readers consist of a light source and photodiode that are placed next to each other in the tip of a pen or wand. To read a bar code, the person holding the pen must move the tip of it across the bars at a relatively uniform speed.

The photodiode measures the intensity of the light reflected back from the light source as the tip crosses each bar and space in the printed code. The photodiode generates a waveform that is used to measure the widths of the bars and spaces in the bar code. Dark bars in the bar code absorb light and white spaces reflect light so that the voltage waveform generated by the photodiode is a representation of the bar and space pattern in the bar code. This waveform is decoded by the scanner in a manner similar to the way Morse code dots and dashes are decoded.

b. Laser scanners

Laser scanners work the same way as pen type readers except that they use a laser beam as the light source and typically employ either a reciprocating mirror or a rotating prism to scan the laser beam back and forth across the bar code. As with the pen type reader, a photo-diode is used to measure the intensity of the light reflected back from the bar code. In both pen readers and laser scanners, the light emitted by the reader is rapidly varied in brightness with a data pattern and the photo-diode receive circuitry is designed to detect only signals with the same modulated pattern.

c. CCD readers (also known as LED scanners)

CCD readers use an array of hundreds of tiny light sensors lined up in a row in the head of the reader. Each sensor measures the intensity of the light immediately in front of it. Each individual light sensor in the CCD reader is extremely small and because there are hundreds of sensors lined up in a row, a voltage pattern identical to the pattern in a bar code is generated in the reader by sequentially measuring the voltages across each sensor in the row. The important difference between a CCD reader and a pen or laser scanner is that the CCD reader is measuring emitted ambient light from the bar code whereas pen or laser scanners are measuring reflected light of a specific frequency originating from the scanner itself.

d. Camera-based readers

Two-dimensional imaging scanners are the sixth and newest type of bar code reader. They use a camera and image processing techniques to decode the bar code.

Video camera readers use small video cameras with the same CCD technology as in a CCD bar code reader except that instead of having a single row of sensors, a video camera has hundreds of rows of sensors arranged in a two dimensional array so that they can generate an image.

Large field-of-view readers use high resolution industrial cameras to capture multiple bar codes simultaneously. All the bar codes appearing in the photo are decoded instantly (ImageID patents and code creation tools) or by use of plugins (e.g. the Barcodepedia used a flash application and some web cam for querying a database), have been realized options for resolving the given tasks.

e. Omnidirectional barcode scanners

Omnidirectional scanning uses "series of straight or curved scanning lines of varying directions in the form of a starburst, a Lissajous pattern, or other multiangle arrangement are projected at the symbol and one or more of them will be able to cross all of the symbol's bars and spaces, no matter what the orientation."[115]

Omnidirectional scanners almost all use a laser. Unlike the simpler single-line laser scanners, they produce a pattern of beams in varying orientations allowing them to read barcodes presented to it at different angles. Most of them use a single rotating polygonal mirror and an arrangement of several fixed mirrors to generate their complex scan patterns.

Omnidirectional scanners are most familiar through the horizontal scanners in supermarkets, where packages are slid over a glass or sapphire window. There are a range of different omnidirectional units available which can be used for differing scanning applications, ranging from retail type applications with the barcodes read only a few centimetres away from the scanner to industrial conveyor scanning where the unit can be a couple of metres away or more from the code. Omnidirectional scanners are also better at reading poorly printed, wrinkled, or even torn barcodes.

f. Cell phone cameras

While cell phone cameras without auto-focus are not ideal for reading some common barcode formats, there are 2D barcodes which are optimized for cell phones, as well as QR Codes and Data Matrix codes which can be read quickly and accurately with or without auto-focus.

Cell phone cameras open up a number of applications for consumers:

- Movies: DVD/VHS movie catalogs.
- Music: CD catalogs – play MP3 when scanned.
- Book catalogs and device.
- Groceries, nutrition information, making shopping lists when the last of an item is used, etc.
- Personal Property inventory (for insurance and other purposes)ode scanned into personal finance software when entering. Later, scanned receipt images can then be automatically associated with the appropriate entries. Later, the bar codes can be used to rapidly weed out paper copies not required to be retained for tax or asset inventory purposes.
- If retailers put barcodes on receipts that allowed downloading an electronic copy or encoded the entire receipt in a 2D barcode, consumers could easily import data into personal finance, property inventory, and grocery management software. Receipts scanned on a scanner could be automatically identified and associated with the appropriate entries in finance and property inventory software.

- Consumer tracking from the retailer perspective (for example, loyalty card programs that track consumers purchases at the point of sale by having them scan a QR code).

A number of enterprise applications using cell phones are appearing:

- Access contor example, ticket validation at venues), inventory reporting (for example, tracking deliveries), asset tracking (for example, anti-counterfeiting).[116]

g. ***Smartphones***

Smartphones can be used in Google's mobile Android operating system via both their own Google's application or 3rd party barcode scanners like Scan.[117] Nokia's Symbian operating system features a barcode scanner which can scan barcodes,[118] while mbarcode[119] is a barcode reader for the Maemooperating system. In the Apple iOS, a barcode reader is not automatically included, but there are more than fifty free or paid apps available with both scanning capabilities and hard-linking to URI. With BlackBerry devices, the App World application can natively scan barcodes. Windows Phone 8 is able to scan barcodes through the Bing search app.

2. Housing

A large multifunction barcode scanner being used to monitor the transportation of packages of radioactive pharmaceuticals

Barcode readers can be distinguished based on housing design as follows:

a. **Handheld scanner**

   with a handle and typically a trigger button for switching on the light source.

b. **Pen scanner (or wand scanner)**

   a pen-shaped scanner that is swiped.

c. **Stationary scanner**

   wall- or table-mounted scanners that the barcode is passed under or beside. These are commonly found at the checkout counters of supermarkets and other retailers.

d. **Fixed-position scanner**

   an industrial barcode reader, used to identify products during manufacture or logistics. Often used on conveyor tracks to identify cartons or pallets which need to be routed to another process or shipping location. Another application joinsholographic scanners with a checkweigher to read bar codes of any orientation or placement, and weighs the package. Systems like this are used in factory and farm automation for quality management and shipping.

e. **PDA scanner (or Auto-ID PDA)**

   a PDA with a built-in barcode reader or attached barcode scanner.

f. **Automatic reader**

   a back office equipment to read barcoded documents at high speed (50,000/hour).

g. **Cordless scanner (or Wireless scanner)**

   a cordless barcode scanner is operated by a battery fit inside it and is not connected to the electricity mains and transfer data to the connected device like PC.

3.2.2: Methods of connection:

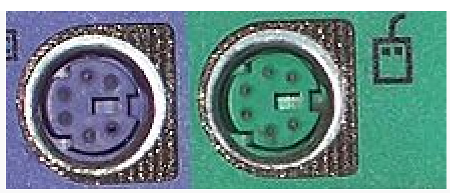
1. Early serial interfaces

Early barcode scanners, of all formats, almost universally used the then-common RS-232 serial interface. This was an electrically simple means of connection and the software to access it is also relatively simple, although needing to be written for specific computers and their serial ports.[120]

2. Proprietary interfaces

There are a few other less common interfaces. These were used in large EPOS systems with dedicated hardware, rather than attaching to existing commodity computers. In some of these interfaces, the scanning device returned a "raw" signal proportional to the intensities seen while scanning the barcode. This was then decoded by the host device. In some cases the scanning device would convert the symbology of the barcode to one that could be recognized by the host device, such as Code 39.[120]

3. Keyboard wedge (e.g. PS/2)



PS/2 keyboard and mouse ports

With the popularity of the PC and its standard keyboard interface, it became ever easier to connect physical hardware to a PC and so there was commercial demand similarly to reduce the complexity of the associated software. "Keyboard wedge" (PS/2) hardware plugged between the PC and its normal keyboard, with characters from the barcode scanner appearing exactly as if they had been typed at the keyboard.

This made the addition of simple barcode reading abilities to existing programs very easy, without any need to change them, although it did require some care by the user and could be restrictive in the content of the barcodes that could be handled.[120]

4. USB

Later barcode readers began to use USB connectors rather than the keyboard port, as this became a more convenient hardware option. To retain the easy integration with existing programs, a device driver called a "software wedge" could be used, to emulate the keyboard-impersonating behavior of the old "keyboard wedge" hardware.

In many cases, a choice of USB interface types (HID, CDC) are provided. Some have PoweredUSB.[120]

5. Wireless networking

Some modern handheld barcode readers can be operated in wireless networks according to IEEE 802.11g (WLAN) or IEEE 802.15.1 (Bluetooth). Some barcode readers also support radio frequencies viz. 433 MHz or 910 MHz. Readers without external power sources require their batteries be recharged occasionally, which may make them unsuitable for some uses.[120]

3.2.3: Resolution

The scanner resolution is measured by the size of the dot of light emitted by the reader. If this dot of light is wider than any bar or space in the bar code, then it will overlap two elements (two spaces or two bars) and it may produce wrong output. On the other hand, if a too small dot of light is used, then it can misinterpret any spot on the bar code making the final output wrong.[121][122]

The most commonly used dimension is 13 thou (0.013 in or 0.33 mm), although some scanners can read codes with dimensions as small as 3 thou (0.003 in or 0.075 mm).

Most manufacturers advertise bar code resolution in *mil*, which is interchangeable with *thou*. Smaller bar codes must be printed at high resolution to be read accurately.

3.3: QUALITY CONTROL AND VERIFICATION

Barcode verification examines scanability and the quality of the barcode in comparison to industry standards and specifications. Barcode verifiers are primarily used by businesses that print and use barcodes. Any trading partner in the supply chain can test barcode quality. It is important to verify a barcode to ensure that any reader in the supply chain can successfully interpret a barcode with a low error rate. Retailers levy large penalties for non-compliant barcodes. These chargebacks can reduce a manufacturer's revenue by 2% to 10%.

A barcode verifier works the way a reader does, but instead of simply decoding a barcode, a verifier performs a series of tests.[123]For linear barcodes these tests are:

- Edge Determination
- Minimum Reflectance
- Symbol Contrast
- Minimum Edge Contrast
- Modulation
- Defects
- Decode
- Decodability

2D matrix symbols look at the parameters:

- Symbol Contrast
- Modulation

- Decode
- Unused Error Correction
- Fixed (finder) Pattern Damage
- Grid Non-uniformity
- Axial Non-uniformity

Depending on the parameter, each ANSI test is graded from 0.0 to 4.0 (F to A), or given a pass or fail mark. Each grade is determined by analyzing the scan reflectance profile (SRP), an analog graph of a single scan line across the entire symbol. The lowest of the 8 grades is the scan grade and the overall ISO symbol grade is the average of the individual scan grades. For most applications a 2.5 (C) is the minimum acceptable symbol grade.[124]

Compared with a reader, a verifier measures a barcode's optical characteristics to international and industry standards. The measurement must be repeatable and consistent. Doing so requires constant conditions such as distance, illumination angle, sensor angle and verifier aperture. Based on the verification results, the production process can be adjusted to print higher quality barcodes that will scan down the supply chain.

3.3.1: Barcode verifier standards

- Barcode verifiers should comply with the ISO/IEC 15426-1 (linear) or ISO/IEC 15426-2 (2D).[125]

This standard defines the measuring accuracy of a barcode verifier.

- The current international barcode quality specification is ISO/IEC 15416 (linear) and ISO/IEC 15415 (2D). The European Standard EN 1635 has been withdrawn and replaced by ISO/IEC 15416. The original U.S. barcode quality specification was ANSI X3.182. (UPCs used in the US – ANSI/UCC5).

This standard defines the quality requirements for barcodes and Matrix Codes (also called Optical Codes).

- As of 2011 the ISO workgroup JTC1 SC31 was developing a Direct Part Marking (DPM) quality standard: ISO/IEC TR 29158.

International standards are available from the International Organization for Standardization (ISO).

These standards are also available from local/national standardization organizations, such as ANSI, BSI, DIN, NEN and others.

3.4: DATABASE MANAGEMENT

The barcode and product database is designed to provide product information based on barcode numbers. The **barcode database** can be searched by barcode number, to find out product information based on that barcode number, and where the product is available.[126]

The ***international barcode database*** searches for the barcode that is selected and any information found will be displayed. For some barcodes / products, this will include where the consumer are able to purchase the product.

The user can search for a product by barcode number (EAN13 or UPC). If a user owns a barcode number, and no results are found for this barcode in the database, the user can register it.[127][128]

The barcode database was created to provide users access to the information behind barcode numbers. This 'meta data' can include information such as the product name, price, quantity, and manufacturer.

3.4.1:Retail Barcodes:

Retail barcodes are unique product identifier, assigned to each finished/manufactured product that is ready to be sold in retail stores. The barcode numbers are purely unique numbers, effectively drawn from a large international database and allocated to the product. The barcode number is connected with the product information by individual retailers, and by international barcode databases.[126]

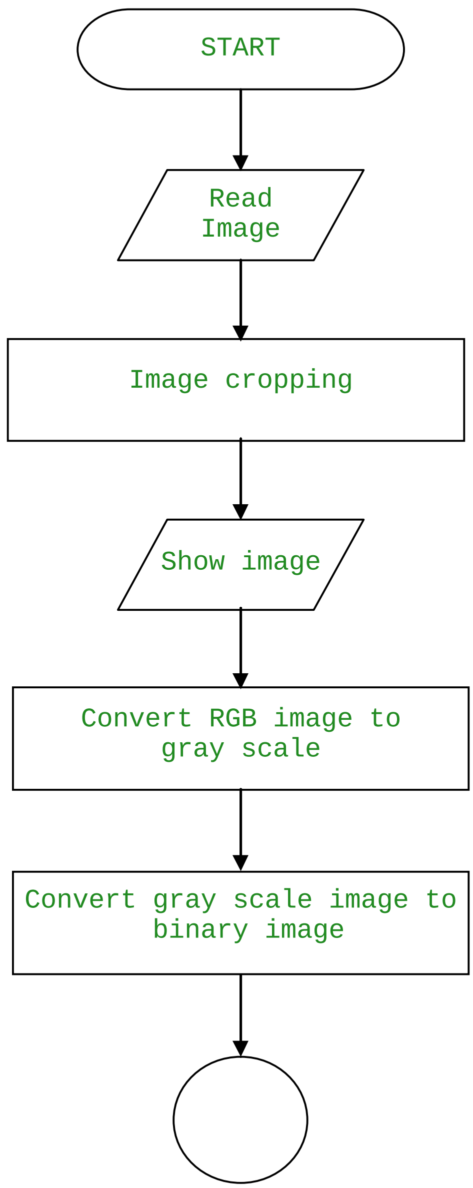
Barcode numbers make work easier for retailers – they are a fast and accurate way to identify what product is being received into the store or sold at the checkout. Computers scan and read barcodes on products as they go into and out of shops. This computer system can also be used for stock tracking, to show the store when they need to reorder a product.

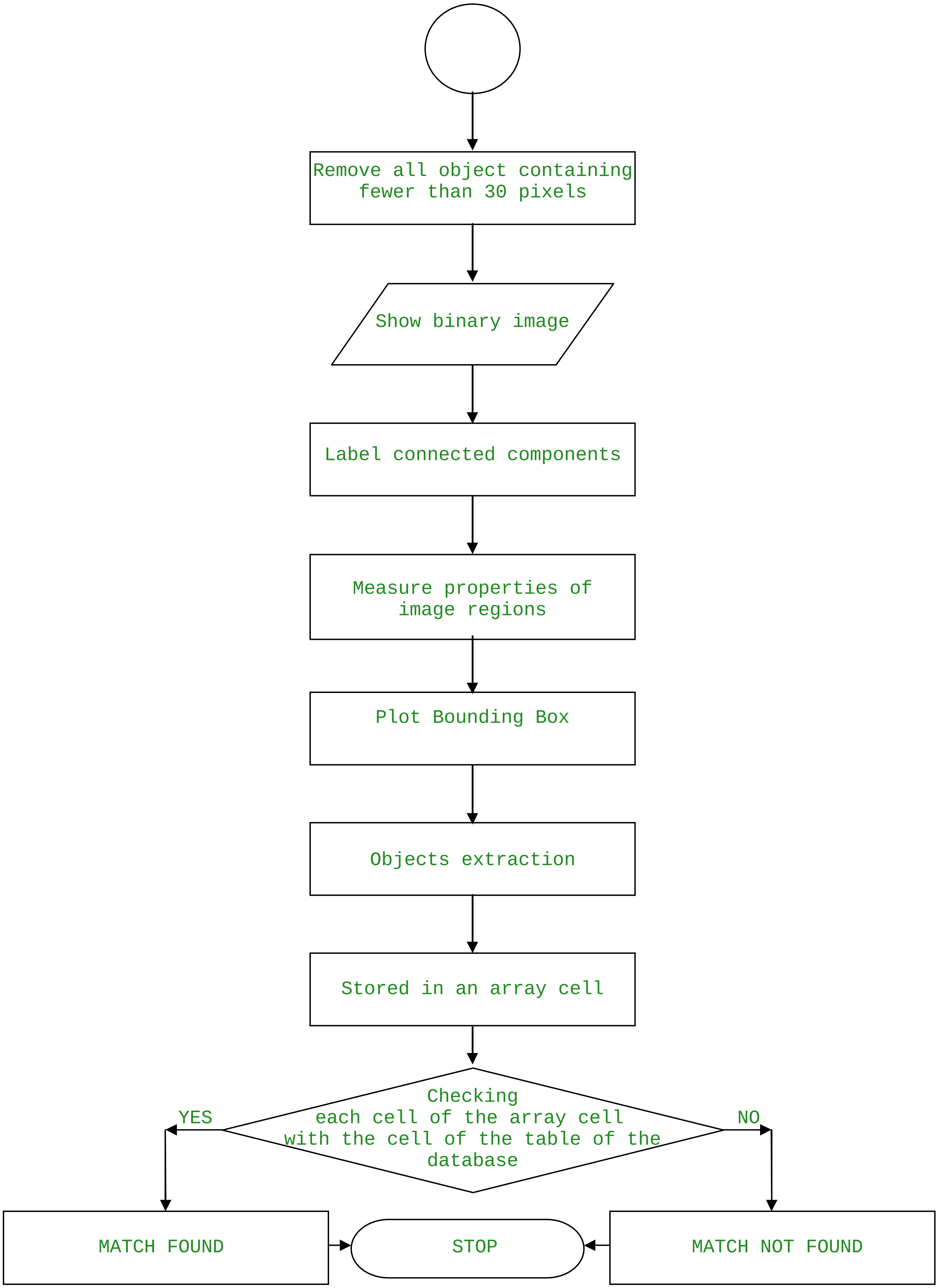
If the user needs to ***buy a barcode*** for your product, the user need to purchase one from a member of the **International Barcode Network** – an international network of reputable barcode suppliers.[129][130]

CHAPTER 4 : BARCODE EXPTRACTION TECHNIQUE UNDER SUPERIMPOSED MESH AND MATCHING WITH THE DATABASE

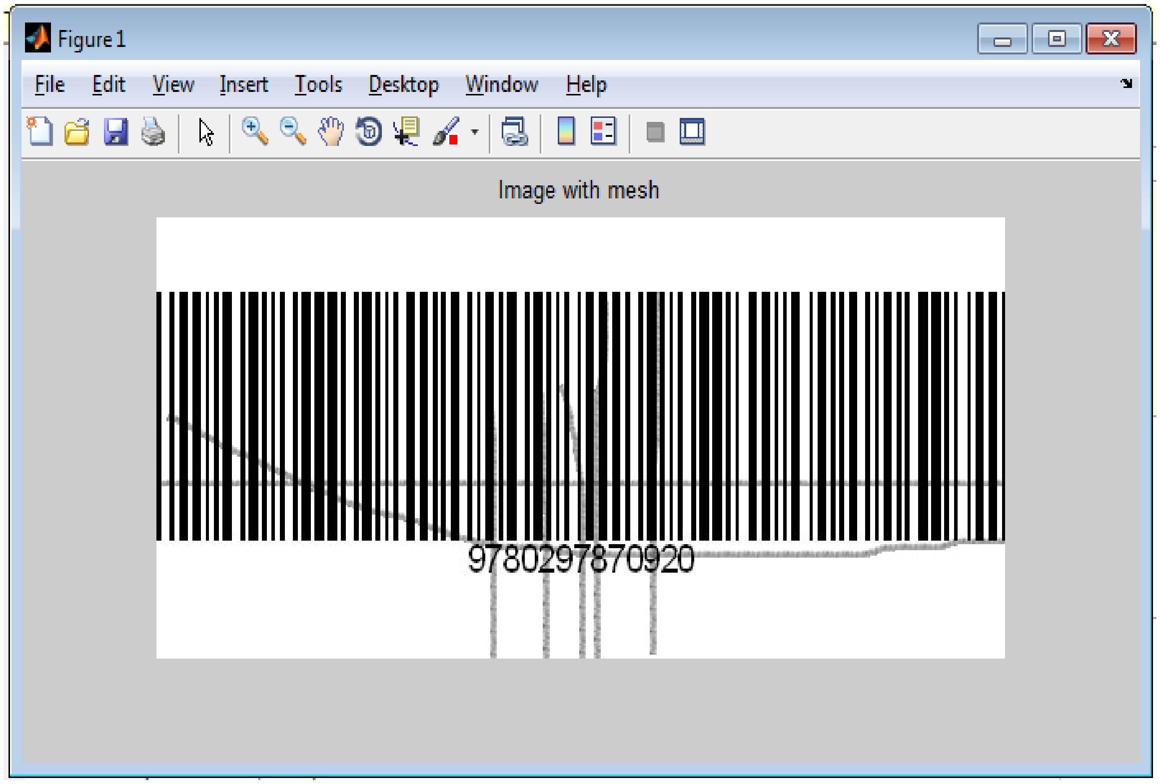
4.1: BARCODE EXTRACTION TECHNIQUE UNDER SUPER-IMPOSED MESH

- Flowchart Barcode Extraction Technique

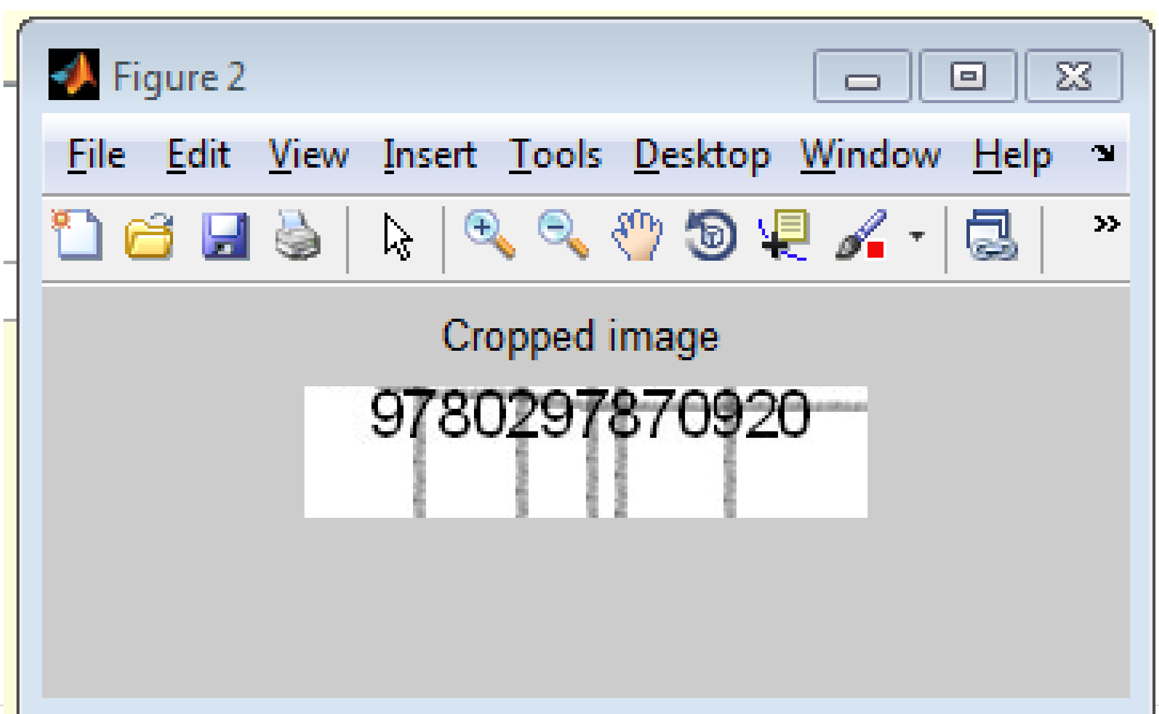



Remove all object containing fewer than 30 pixels
Show binary image
Label connected components
Measure properties of image regions
Plot Bounding Box
Objects extraction
Stored in an array cell
Checking each cell of the array cell with the cell of the table of the database
YES
NO
MATCH FOUND
STOP
MATCH NOT FOUND

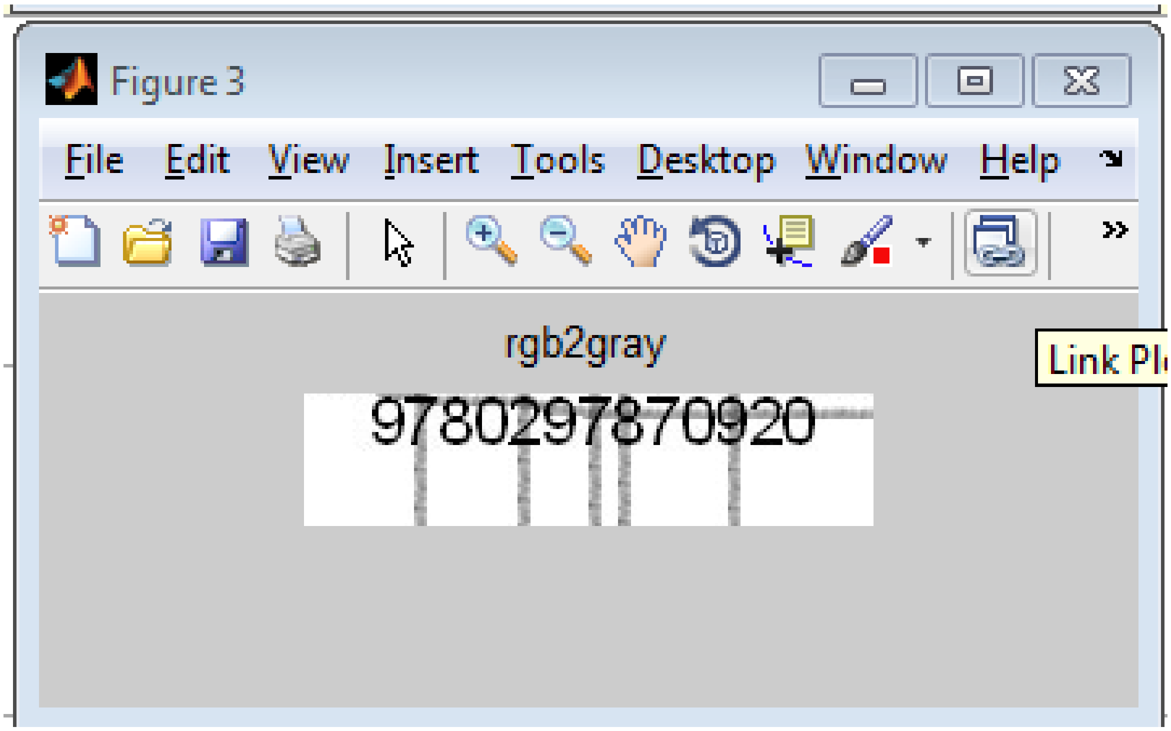
Extraction of barcode from the superimposed mesh was done using MATLAB software of R2011b version.



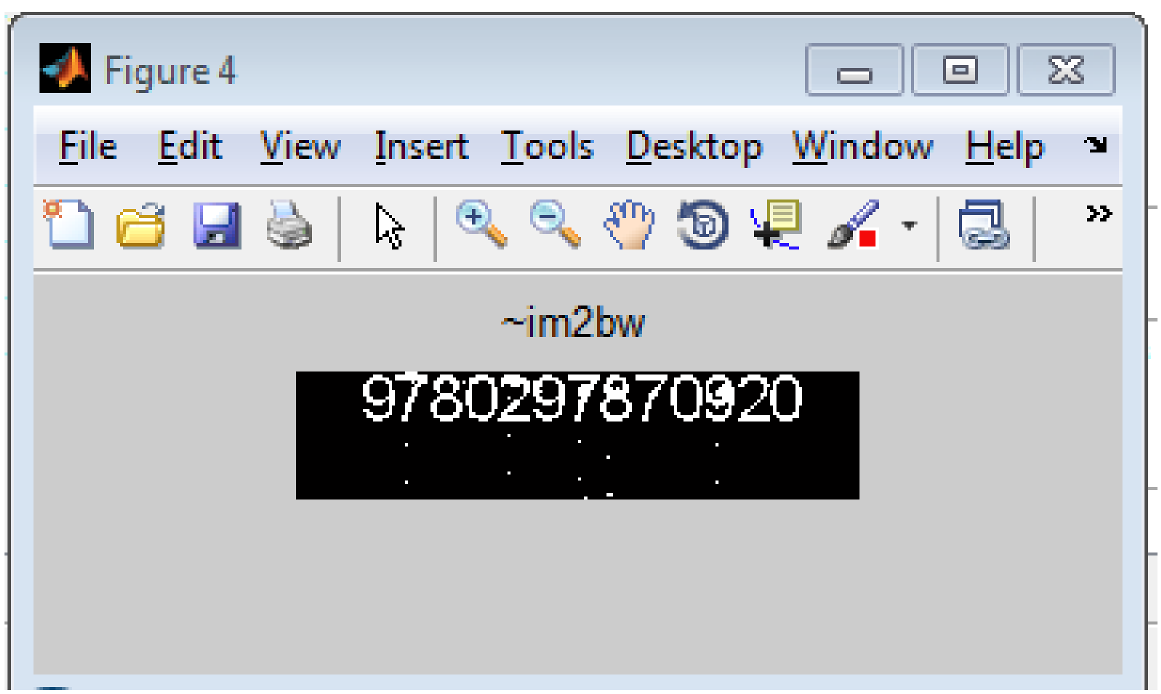
Initially, a image of barcode, which was superimposed by horizontal and vertical mesh, has been taken input by using imread method.



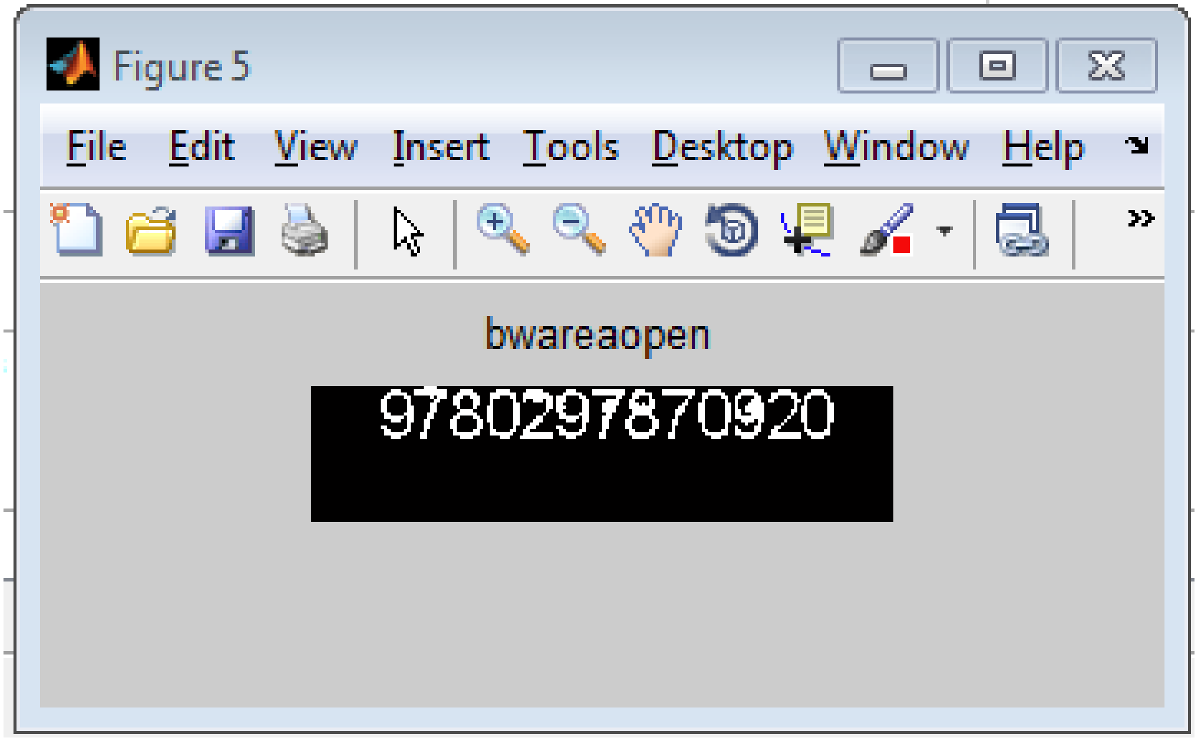
The lower part of the image has been cropped except the vertical bars using imcrop method and then the image segmentation and extraction of characters started.



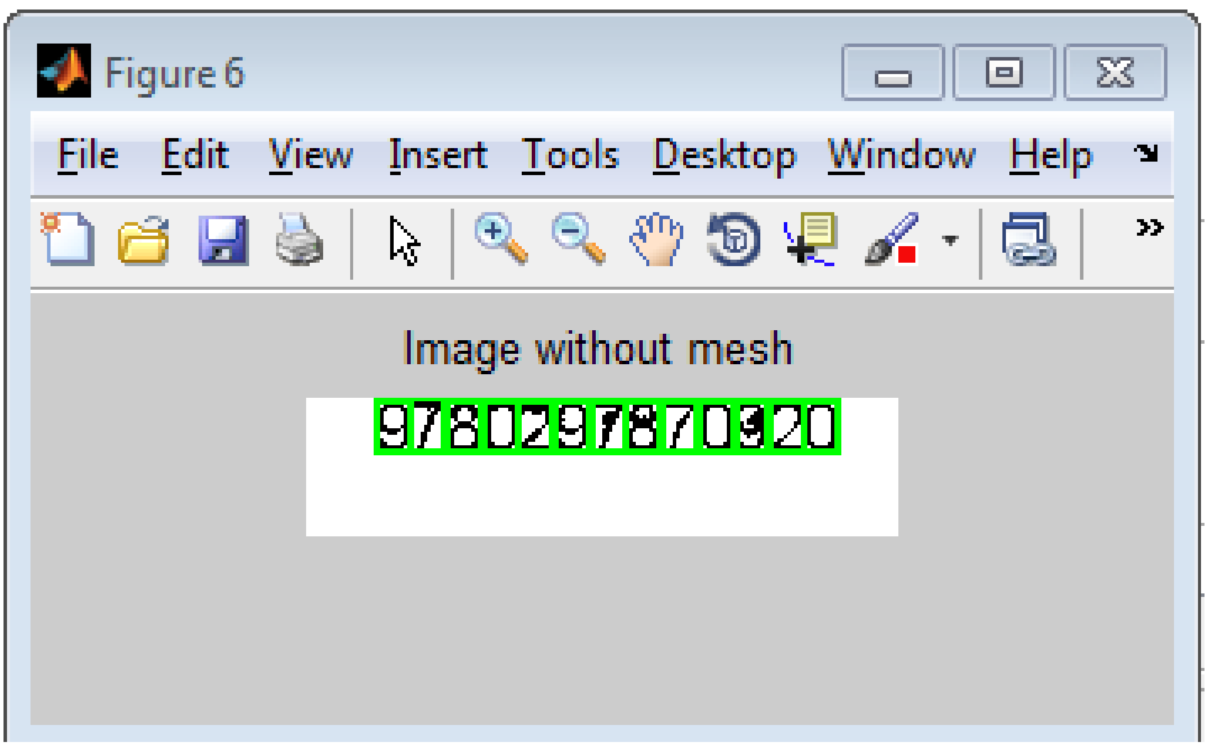
The cropped image was converted to grayscale image as the image was an RGB image by using rgb2graymethod.



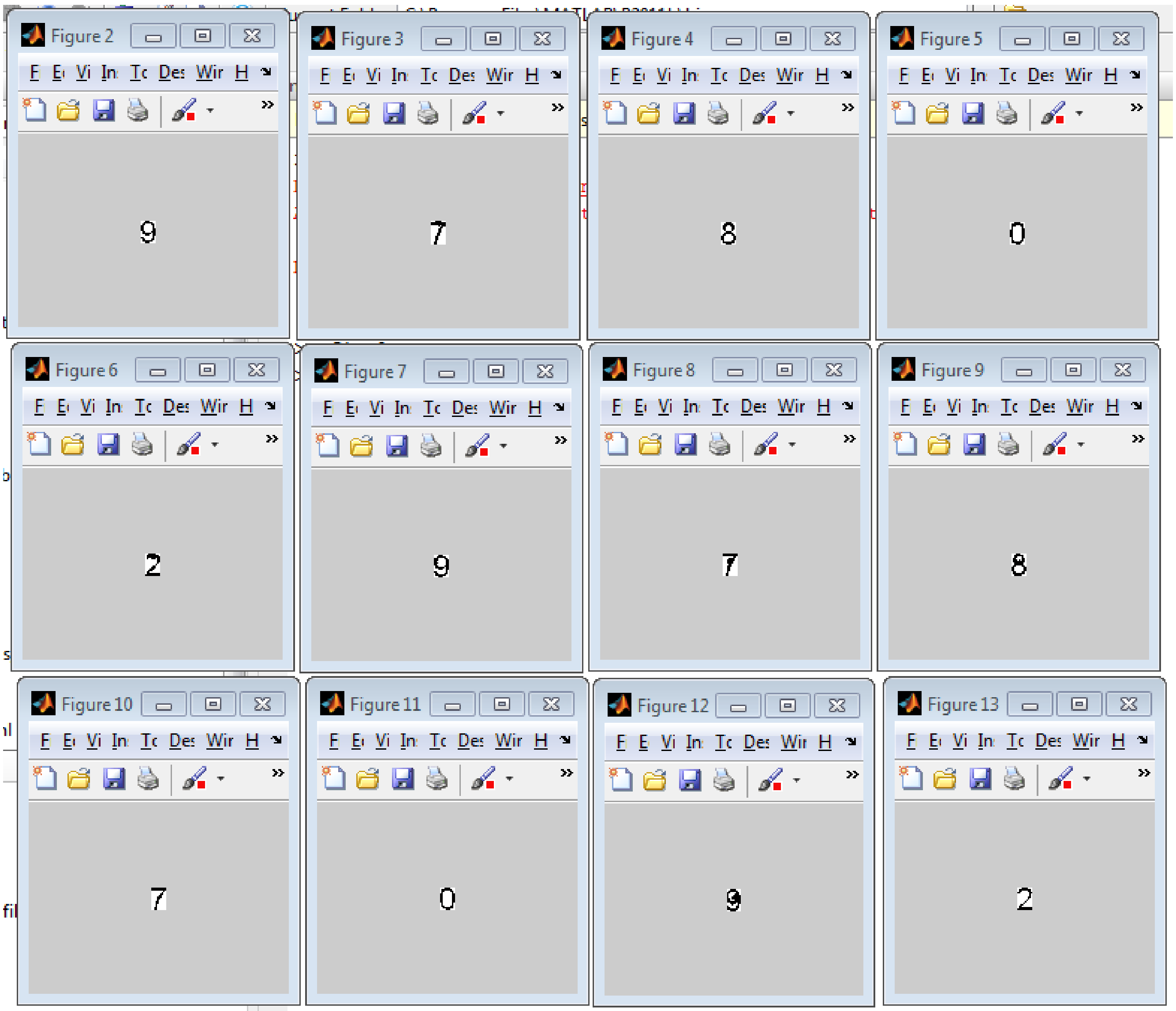
Then the converted image is again converted to binary image by using im2bw method after taking a threshold by using graythresh method.

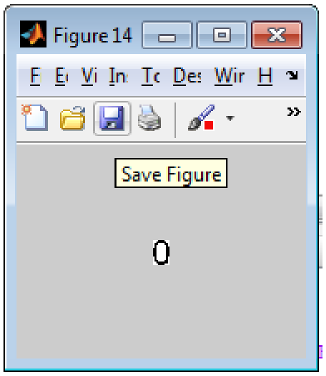


Now removing the mesh by removing all objects containing fewer than 30 pixels by using bwareaopen method.



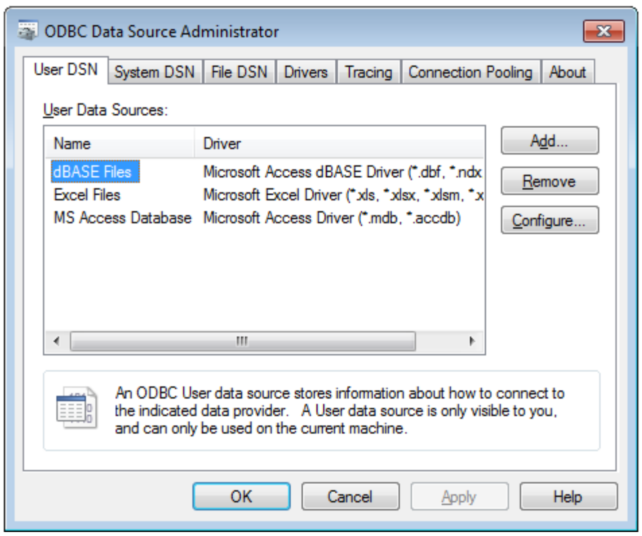
Now labeling the connected components by using bwlabel method and storing it in a 2D array.Next, measuring the properties of image regions by using regionpropsmethod. Now, plotting the bounding box by using rectanglemethod which is used to create 2-D rectangle object where the edge color has been initialized to green and the line width is 2 and it will continue till it gets the objects in the image.

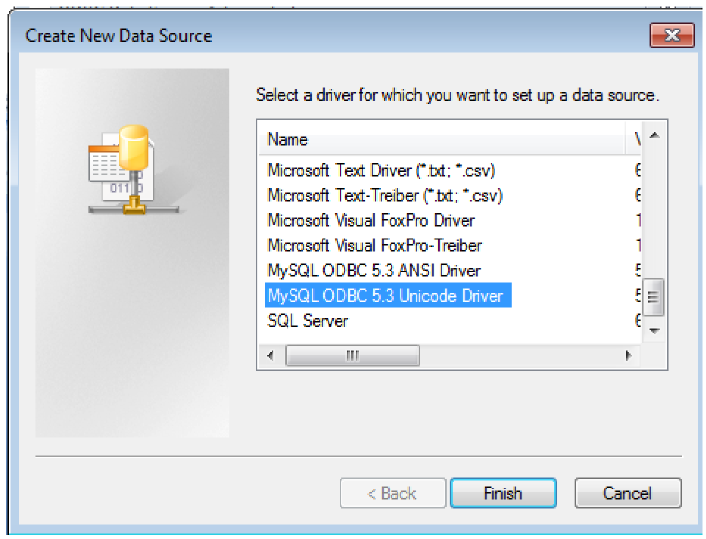


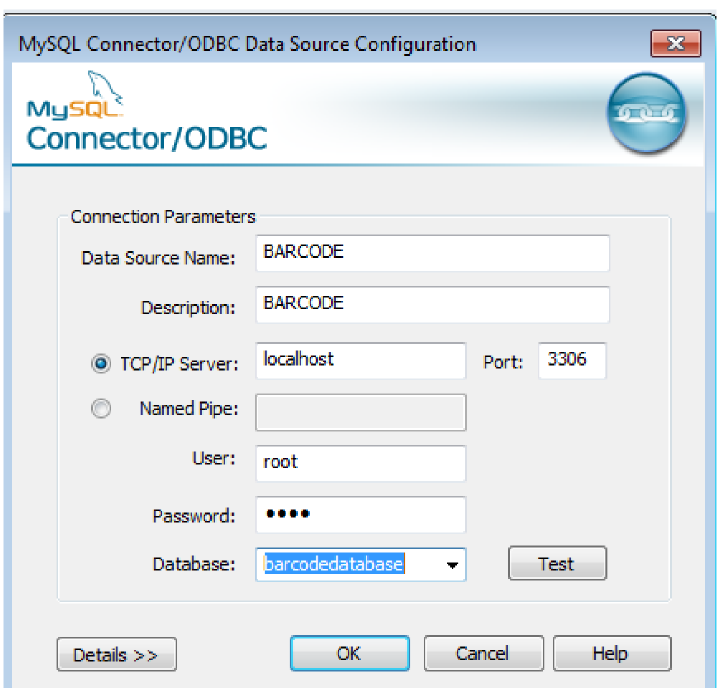


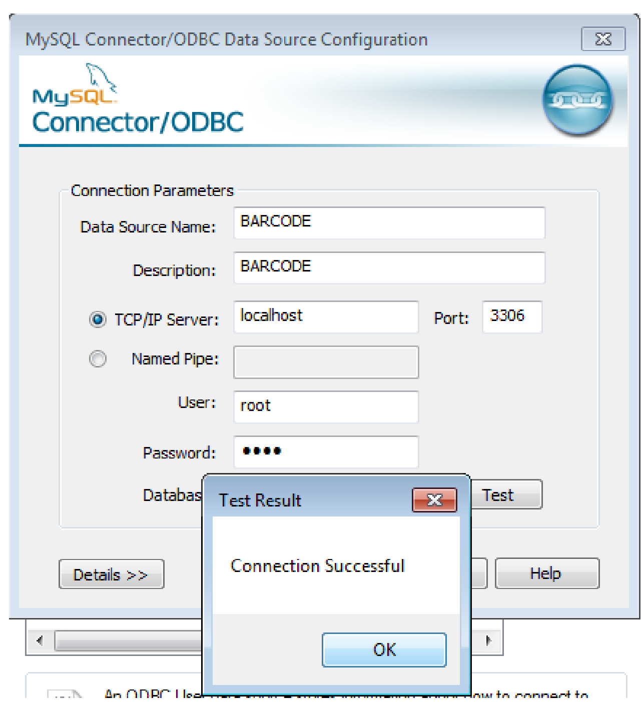
Now, in a 2d array the nonzero values of rows and columns are stored by using find method and then just taking the minimum and maximum values of rows and columns and storing each 2D array in a cell.

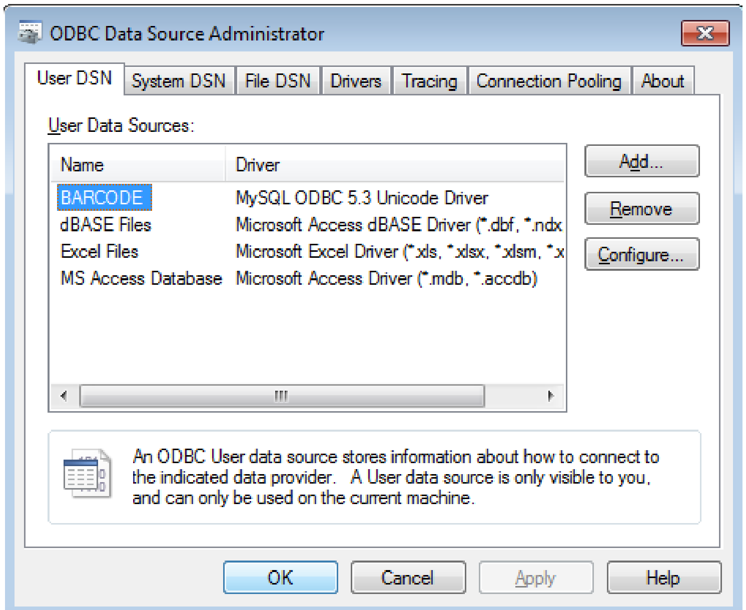
4.2: CREATION OF DATABASE











MySQL Community Server 5.7.12 has been used as the main database whare the original barcode matrices are stored in its cells of its table.

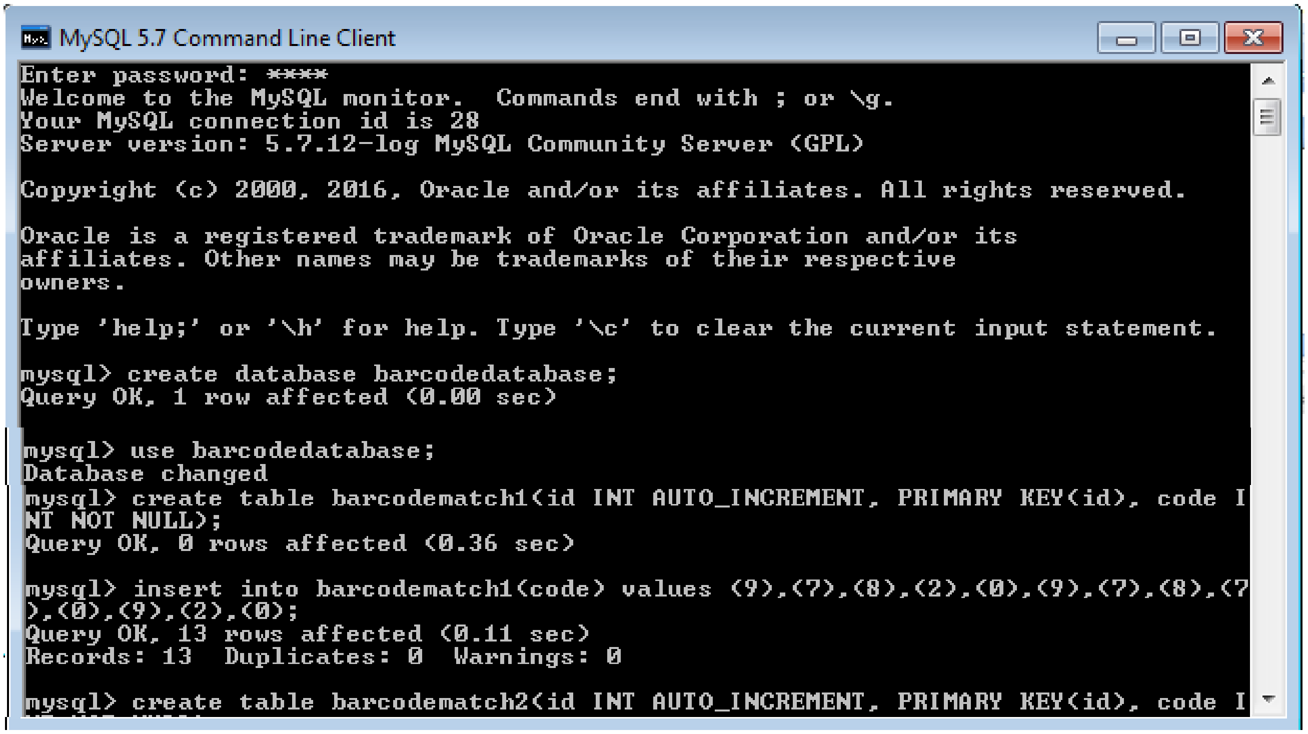
Connector/ODBC 5.3.6 has also been used as connector between MySQL 5.7.12 and MATLAB R2011b.

This connection has been created under the name – ‘BARCODE’.

The database was created was ‘root’ as user name, ‘root’ as password, ‘localhost:3306’ as the serve link and ‘mysql-connector-odbc-5.3.6-win32’ as the connector between MySQL and MATLAB.

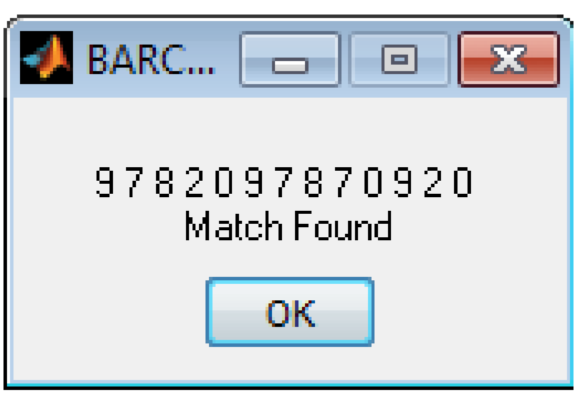
The 5 original barcode numbers has been stored in a cell array which is later saved for future use as ‘barcode1.mat’, ‘barcode2.mat’, ‘barcode3.mat’, and so on.

‘barcodedatabase’ is a database which has been created. ‘barcodematch1’, ‘barcodematch2’, ‘barcodematch3’, ‘barcodematch4’ and ‘barcodematch5’ are the tables which has been created under the database and having attributes ‘id’ and ‘code’ as column names. Under ‘code’ attribute, the original barcode number has been stored. Later, these values will be shown on the screen, if the matrix of presently extracted barcode from mesh found matching with the matrix of original barcode which was stored under ‘*.mat’ files.



4.3: MATCHING OF BARCODE WITH DATABASE

Initially, the original barcode values has been extracted and stored in the 2 dimensional array which has been stored in a cellarray. Further these has been stored in 'barcode1.mat', 'barcode2.mat', 'barcode3.mat', 'barcode4.mat', 'barcode5.mat', 'barcode6.mat' and 'barcode7.mat'. After the extraction of barcode from mesh, the barcode values are stored in the 2 dimensional array which are checked with the 2 dimensional array of original barcode values stored '*.mat' files which were previously stored. If they are found that they are matching with each other, then "BARCODE MATCH FOUND" message will displayed on the screen with the barcode numbers, which has been stored in the tables in the mentioned database, otherwise "BARCODE MATCH NOT FOUND" message will displayed on the screen.



CHAPTER 5 : RESULTS AND DISCUSSION

Testing the barcode is necessary to assure it's parameters conform to industry standards and verify the content is correct. Barcodes are usually evaluated and given a grade of A through F.

Simply, good verification will assure the barcode will be readable by all parties in the supply chain, facilitating speedy, accurate inventories and movement of goods from manufacturer to wholesaler to retailer and user.

This thesis has been done with 12 barcodes. In the database, 10 barcodes matrices are stored. Now , while extracting the barcode and matching the same, then we are taken 10 barcodes out of which only 8 barcodes were previously stored in the database and 2 barcodes are not stored in the database. Thus, only 8 are matching and 2 are not matching.

5.1: SOURCES OF POSSIBLE ERRORS

Problems with barcodes:

• Misorientation, obstruction by dirt, mist, protrusions and damage all cause failed reads or misreads.

• They have to be read at line of sight, usually at distances below one meter.

• Scanners are delicate and expensive, causing problems for e.g., New Zealand sheep farmers.

• Very little data is stored and it is read-only and not secure or even covert.

• The image is relatively large and ugly. It is impossible to put a practicable barcode on, say an earring or a single wrap of candy because of appearance and the need for high accuracy printing, substrate stability, etc,.

• Simultaneous non-collision scanning of multiple images/products is near impossible.

• Ruggedized versions for e.g., high temperature, high abrasions are expensive - even more expensive than some RFID smart labels. The usual versions printed on paper or thin plastic packaging easily fail through crumpling or tearing.

This has meant that barcodes are being replaced at given price breaks. At ten dollars RFID tags replaced bar codes for non-stop road tolling. At two dollars RFID replaced them on secure access cards. At 10-20 cents RFID tags will replace them on air baggage and at 1 cent or less it will replace them on supermarket produce provided formidable lists of associated problems are solved.

More Common Barcoding Problems:

Good practices and adhering to the generic barcode printing guidelines will alleviate most of the issues that can occur, but below are illustrations of some of the issues that was encountered:

<table>
<tr>
<td>
</td>
<td>Barcodes that have been printed using incorrect colour combinations, often red bars on a pale background which will not scan.

Reversed out images where the bars are white against a coloured background, are again not scanable.</td>
</tr>
<tr>
<td>
</td>
<td>Missing bars (when printing in picket fence) or horizontal white lines crossing the bar code (when printing in ladder)
because of faulty printheads being used for on demand printing.</td>
</tr>
</table>

	Printing barcodes that are either too large or too small.
	Labels that are peeling off as a result of extremes of heat, label degradation through age or simply the wrong adhesive for the application.
	Labels that have been applied with creases in them will distort the barcode and make it unreadable.
	Barcodes should always be printed in picket fence format and in the correct orientation.

	Barcodes printed too close to the edge of the label can result in parts not being printed, thus unreadable.
	Show through of the barcode on consumer units through the outer packaging.

CHAPTER 6 : CONCLUSION AND SCOPE OF FUTURE WORK

6.1: INTRODUCTION

In the present research work, it has been observed if the database are available to the end user , it will be reliable to the user and user can easily test the originality of the product using smart devices but for this special apps or software should have to be available to the user.

6.2: CONCLUSION

It has been found that if this technique is implemented, originality of the product can easily be checked. This can be implemented not only for the packaged consumer products containing barcodes but also to the security documents containing numbers by modifying the database discussed earlier.

6.3: SCOPE OF FUTURE WORK

This work can be extended to the following areas :-

1. This work can be extended to detect the fake currency.
2. This work can be extended to check the originality of the different security documents
3. This work can be extended to check the details of the car owners by RTO people.
4. This work can be extended to check the details of any material and logo of originality of the manufacturer together by attaching the barcode with the hologram and printing them on the material.

And so on.

REFERENCES

1. Cranstone, Ian , "CANADIAN FREIGHT CARS A resource page for the Canadian Freight Car Enthusiast", A guide to ACI (Automatic Car Identification)/KarTrak, 26 May 2013.
2. Keyes, John,"KarTrak". John Keyes Boston photoblogger. Images from Boston, New England, and beyond. John Keyes. 26 May2013.
3. Fox, Margalit"Alan Haberman, Who Ushered in the Bar Code, Dies at 81", The New York Times
4. "Benefits of Barcodes". Available: http://www.verifiedlabel.com/knowledgecenter/know_barcodes.aspx
5. "Benefits of Using Barcode Technology". Available:http://smallbusiness.chron.com/benefits-using-barcode-technology-58387.html
6. "Purpose of Barcode". Available: http://www.ehow.com/facts_7246657_purpose-barcode.html
7. Stock control. Available: http://www.infoentrepreneurs.org/en/guides/stock-control-and-inventory/
8. Inventory Control. Available: https://www.tradegecko.com/what-is-inventory-control
9. Design Inventory Management Processes. Available: https://www.handshake.com/blog/inventory-management-process/
10. Inventory Management Solutions. Available: https://www.barcodesinc.com/solutions/market-applications/inventory.htm

11. Scan and Validate barcodes against a database. Available: https://www.codereadr.com/features/database-management
12. "Inventory Management System". Available: https://www.linkedin.com/pulse/20141124093808-115970510-4-key-components-of-an-inventory-management-system
13. Barry Barcode, “The importance of inventory control in grocery stores”, Grocery Store Inventory Control, 2014, pp. 35-40.
14. Australia Post barcode. Available: https://auspost.com.au/media/documents/a-guide-to-printing-the-4state-barcode-v31-mar2012.pdf
15. Codabar. Available: http://mdn.morovia.com/manuals/bax3/shared.bartech.php#Symbology.Codabar
16. Codabar, Archived December 6, 2006, at the Wayback Machine. Available: http://aimglobal.org/aimstore/linearsymbologies.asp
17. Code 25. Available: http://www.barcodesymbol.com/barcodes/code-2-of-5-barcode.aspx
18. Patton, David Lynn; Lawrence Joseph Travis & Douglas Andrew McPherson, "Expanded film cartridge bar code", published 5 June 1995, issued 2 June 1998, assigned to Eastman Kodak Company, Patent Id: US 5761558.
19. Code 11 Symbology Specification. Available: http://www.barcodeisland.com/code11.phtml
20. Allais, D. C., AIDC Memoirs, Washington, PathGuide Technologies, Inc., 2006.
21. S10 Identification of postal items – 13-character identifier, Data definition and encoding standards, Switzerland, Universal Postal Union, October 2010
22. Bar Code 49. Available: http://www.wlp.com/bar-code-49.html
23. Bar code Island's description of the code. Available: http://www.barcodeisland.com/code93.phtml

24. Code 128 in Softmatic. Available: http://www.softmatic.com/barcode-code-128.html
25. Hamid JS, Canada Post: Postal Codes in Canada, Cpc Binary Barcode, Canadian Subnational Postal Abbreviations, Canadian Union of Postal Workers, Postbar, General Books LLC, 2010. ISBN 1157083625, 9781157083627.
26. DX Code and Decoding. Available: https://pixelfarmize.wordpress.com/2009/04/15/decoding-dx-codes/
27. U.P.C. Symbol Specification Manual. Available:http://web.archive.org/web/19990501035133/http://www.uc-council.org/d36-d.htm
28. Datenverarbeitung GmbH, Barcode Reference, TEC-IT Barcode Software, Section 6.1.46.2., Austria, TEC-IT, 2015. Available: http://www.tec-it.com/Download/PDF/Barcode_Reference_EN.pdf
29. "Alumni Hall of Fame Members". University of Maryland Alumni Association. The University of Maryland. *2005.* Available: http://www.gs1.org/barcodes/support/prefix_list
30. "Postal Bulletin 22284: New Facing Identification Mark E Pattern". *United States Postal Service. 2010-05-06*. Available: https://about.usps.com/postal-bulletin/2010/pb22285/html/updt_003.htm
31. The foundational GS1 standard that defines how identification keys, data attributes and barcodes must be used in business applications, GS1 General specifications, version 16.0,The Global Language of Business, January 2016. Available: http://www.gs1.org/docs/barcodes/GS1_General_Specifications.pdf
32. GS1 Data Bar for Grocery Checkout. Available: http://www.honeywellaidc.com/promos/0710_Ask_the_Expert_landing/images/61510GS1DataBarPres_20100709T175210Z.pdf

33. "Intelligent Mail Barcode 4-State Specification". United States Postal Service. March 11, 2009. p. 3. Retrieved 2015-11-12. Available: https://ribbs.usps.gov/intelligentmail_mailpieces/documents/tech_guides/USPSB3200IntelligentMailBarcode4State.pdf

34. GEPIR: Global Electronic Party Information Registry. Available : http://gepir.gs1.org/v32/xx/default.aspx?Lang=en-US/

35. Bar Code Guide - Barcode Types - JAN. Available : http://www.polylabel.com/barcode-types-japanese-article-number-jan/

36. Japan govt. aims to list Japan Post in three years. Reuters. October 26, 2012. Available: http://www.reuters.com/article/us-japanpost-ipo-idUSBRE89P03420121026

37. Eric Neubauer's List of ACI Ownership codes. Available: http://eaneubauer.ipower.com/aci.pdf

38. IBM Printing Systems Information Center - Check Digit Calculation Method, IBM. Available: http://www.ibm.com/support/knowledgecenter/

39. Pharmacode, Posted by Peternikolow, September 13, 2013 in Blog. Available : http://www.mobiliodevelopment.com/pharmacode-pharmaceutical-barcodecode/

40. Postal Alpha Numeric Encoding Technique. Available: https://bytescout.com/products/developer/barcodesdk/bytescoutbarcodesdk_sample_planet.html

41. Plessey Code description by Barcode 1. Available: http://www.adams1.com/plessy.html

42. Hamid JS, 4-State Bar Code Handbook, Ottowa, Canada Post Corporation, 8February 2005.

43. Designing Letter and Reply Mail,Publication 25, United States Postal Service. July 2003. pp. 37–56. Available: http://www.siemons.com/forms/pdf/designing_letter_reply_mail.pdf
44. "Know how: a user's manual for Mailsort®, Walksort®, Presstream®, Cleanmail®, Presstream® Walksort®, Royal Mail International Bulk Mail™ and Automated Standard Tariff Large Letter®", Royal Mail. April 2007. p. 80. Retrieved 23 February 2016. Available: http://www.royalmail.com/sites/default/files/docs/pdf/Know%20How%202006%20PIP%20vs%201.6a%20Accepted%20Changes.pdf
45. Nelson, Benjamin, Punched cards to bar codes : a 200 year journey ; with description and examples of over 270 different machine-readable codes. Peterborough, NH :Helmers Pub. Co., ISBN 978-0911261127.
46. Alfred, Randy, By Gum! There's a New Way to Buy GumWired magazine, June 26, 1974
47. Telepen Barcode Symbology,Telepen (telepen.co.uk). Retrieved 27 January 2013. Available: http://telepen.co.uk/wp-content/uploads/2013/06/Barcode-Symbology-Information-and-History.pdf
48. Bilgutay, Ilhan M., "Bar Code Font", published May 11, 1972, issued August 27, 1974, Patent Id: US 3832686.
49. Longacre, Jr., Andrew & Robert Hussey, "Two Dimensional Data Encoding Structure and Symbology for use with Optical Readers", published May 15, 1995, issued January 7, 1997, Patent Id: US 5591956.
50. Adams, Russ, "2-Dimensional Bar Code Page". Available: http://www.adams1.com/stack.html
51. ColorCode . Available: www.colorzip.com

52. Barcodes for TV Commercials,Adverlab, 31 January 2006. Available: http://adverlab.blogspot.in/2006/01/barcodes-for-tv-commercials.html
53. ColourConstruct Code Technologies. Available: http://fileformats.archiveteam.org/wiki/Color_Construct_Code and http://2d-code.co.uk/color-code-technologies/
54. Frequently Asked Questions - ColorCCode. Available: http://www.colorccode.net/?q=faq
55. CrontoSign Image, Cronto. Available: http://www.cronto.com/crontosign-visual-cryptogram.htm
56. Kramer, Christiane, “Particularly secure method for online banking - Free App for Android and iOS devices - photoTAN additional offer to mobileTAN”, Neubeicomdirect: photoTAN [New at comdirect: photoTAN] (in German), Comdirect Bank AG, Pascalkehre, 9 April 2013.
57. Rekimoto, Jun; Ayatsuka, Yuji, "CyberCode: designing augmented reality environments with visual tags", Proceedings of the 2000 ACM Conference on Designing Augmented Reality Environments (DARE 2000), Association for Computing Machinery, Helsingør, Denmark, pp. 1–10, DOI: 10.1145/354666.354667
58. d-touch topological fiducial recognition, MIT. Available: http://web.media.mit.edu/~enrico/research/research.php?projectTitle=d-touch
59. d-touch markers are applied to deformable gloves, MIT. Available: http://web.media.mit.edu/~enrico/research/research.php?projectTitle=Sleight%20of%20Hands
60. About Xerox. Available: http://www.tauzero.com/Rob_Tow/DataGlyph.html
61. DataGlyphs: Embedding Digital Data, Microglyphs. Available: http://www.microglyphs.com/english/html/dataglyphs.shtml

62. DataGlyph, Tauzero. Available : http://www.tauzero.com/Rob_Tow/DataGlyph.html
63. DataGlyphs, Xerox.Available: http://www.xerox.com/digital-printing/enus.html
64. Stevenson, Rick, "Laser Marking Matrix Codes on PCBs". Printed Circuit Design and Manufacture. Available: http://pcdandf.com/pcdesign/mag/0512/0512stevenson.pdf
65. Erik Sandberg - Diment, Personal Computers; Supermarket Bar Codes Are Applied To Software, The New York Times, Published: October 15, 1985. Available: http://www.nytimes.com/1985/10/15/science/personal-computers-supermarket-bar-codes-are-applied-to-software.html
66. Signer, Beat and Norrie, Moira C., “Interactive Paper: Past, Present and Future”, Proceedings of PaperComp 2010, 1st International Workshop on Paper Computing, Copenhagen Denmark, September 2010.
67. Robert L. Brass, John Glaberson, Richard W. Mason, Scott Santulli, G. Thomas Roth,William M. Feero, Richard K. Balaska, Jr.,“Method and apparatus for transforming digitally encoded data into printed data strips”,Cauzin Systems, Incorporated, Mar 1, 1988, Patent Id: US 4728783 A
68. Steeman, Jeroen, Online QR Code Decoder. Available: http://blog.qr4.nl/Online-QR-Code_Decoder.aspx
69. Hall, Nicole,"Microsoft Tag vs. QR Codes: The Debate Continues". The 60 Second Marketer, Mobilize Worldwide, 8 August, 2011.
70. Leonard, Kim, Cranberry trade group turns 40 with ubiquitous bar code", Pittsburgh Tribune-Review, March 14, 2013. Available: http://xsso.triblive.com/85af8ae2e195b7685cdd8eab3ee5b010#axzz2QpqtQ3eX
71. BarCode-1 2-Dimensional Bar Code Page, Adams. Available: http://www.adams1.com/pub/russadam/stack.html

72. InterCode, a 2-D Barcode. Available: http://www.intercodesolutions.com/case-study

73. Official MaxiCode Technical Specification. Available: http://web.archive.org/web/20060923054229/https://www.aimglobal.org/estore/AdvancedSearch.aspx?MaxPrice=0&MinPrice=0&IsExcludeShippingFiles=true&PageSize=100&Title=Document%20Library

74. High capacity Mobile Multi-Coloured Composite 2D-barcode for mobile phone applications. Available: http://www.ecu.edu.au/research/overview

75. Passas, Nikos, Legislative Guides For The Implementation Of The United Nations Convention Against Transnational Organized Crime And The Protocols Thereto, United Nations Office On Drugs And Crime Division For Treaty Affairs, New York, United Nations Publication, 2004, Sales No. E.0000000, ISBN 000000000.

76. "GBA Accessories". Available: https://en-americas-support.nintendo.com/app/social_home/kw/*/page/1

77. Wang, Ynjiun P., "System for Encoding and Decoding Data in Machine Readable Graphic Form", issued September 7, 1993, Patent Id: US 5243655.

78. Information technology — Automatic identification and data capture techniques — QR Code 2005 bar code symbology specification, ISO/IEC 18004:2006 cor. 2009, pages 3, 6.

79. ShotCode, 2D Barcode. Available: http://web.archive.org/web/20060412031020/http://www.shotcode.com:80/

80. "Barcode Contents",A rough guide to standard encoding of information in barcodes, 2010. Available: http://code.google.com/p/zxing/wiki/BarcodeContents

81. Holton, Bill, “Voiceye: A Breakthrough in Document Access”, AFB AccessWorld Magazine, Volume 14, Number 6, June 2013. Available: http://www.afb.org/afbpress/pub.asp?DocID=aw140605
82. Fishman, Charles, The Killer App – Bar None, American Way, 2001. Available: http://xsso.www.americanwaymag.com/18469815d362f3397df9465bea59a862
83. Seideman, Tony, "Barcodes Sweep the World", Wonders of Modern Technology. Available: http://xsso.www.barcoding.com/c2cf81926cf04fc3d21caf2870089a9c
84. Graham-White, Sean, Do You Know Where Your Boxcar Is?, Trains , Kalmbach Publishing, 59th edition, Volume: 8, pp. - 48–53.
85. Laurer, George, "Development of the U.P.C. Symbol". Available: http://bellsouthpwp.net/l/a/laurergj/UPC/upc_work.html
86. Nelson, Benjamin, From Punched Cards To Bar Codes, University of Chicago, Helmers Publishing Company, 2011.
87. Varchaver, Nicholas, “Scanning the Globe : The humble bar code began as an object of suspicion and grew into a cultural icon.”, FORTUNE Magazine, 2004. Available: http://money.cnn.com/magazines/fortune/fortune_archive/2004/05/31/370719/index.htm
88. Selmeier, Bill, Spreading the Barcode”, William Selmeier, 2009, pp. 26-245, ISBN 978-0-578-02417-2.
89. Rawsthorn, Alice, "Scan Artists", The New York Times Style Magazine, February 28, 2010, page M2140.
90. Watkins, Terry, “What, Dial-the-Truth Ministries. Available: http://www.av1611.org/666/barcode.html

91. Bishop, Tricia, "UPC bar code has been in use 30 years", San Francisco Chronicle, San Francisco, 2004. Available: http://www.sfgate.com/business/article/UPC-bar-code-has-been-in-use-30-years-2744217.php
92. Arendarenko, Ernest, “A Study Of Comparing Rfid And 2d Barcode Tag Technologies For Pervasive Mobile Applications”, University of Joensuu, 2009. Available: ftp://newcs.uef.fi/pub/Theses/2009_MSc_Aredarenko_Ernest.pdf
93. Fang Yuan Fu Huaming Zhang Yingzi, “Certificate Anti-Counterfeiting System Based On Encryption Two-Dimension Barcode And Fingerprint Identification”, China University of Geosciences, Wuhan, 2009. Available: http://en.cnki.com.cn/Article_en/CJFDTotal-JSSG200901031.htm
94. Ching, Leong Huay, “Randomness Fingerprint Authentication With Barcode”, UniversitiTeknikal Malaysia Melaka, UTeM 2005. Available: http://eprints.utem.edu.my/9836/1/Randomness_Fingerprint_Authetication_With_Barcode.pdfand http://eprints.utem.edu.my/9836/2/Randomness_Fingerprint_Authetication_With_Barcode.pdf
95. McCathie, Luke, “The Advantages And Disadvantages Of Barcodes And Radio Frequency Identification In Supply Chain Management”, University of Wollongong, 2004, 123p. Available: http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1009&context=thesesinfo
96. Meng, Guanjie; Darman, Shabnam, “Label And Barcode Detection In Wide Angle Image”, Halmstad University, Sweden, June 2013. , 68 p. Available: http://www.diva-portal.se/smash/get/diva2:664772/FULLTEXT01.pdf

97. Sirkanungo, Ruchita, “Information Management System Using 2d Barcodes And Cell Phone Technology”, Iowa State University, Ames, Iowa, 2009. Available: http://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1804&context=etd
98. Estaji, Alireza, “Automated Data Gathering For Industrial Production Tracking”, Oulu University of Applied Sciences, December 2011. Available: https://www.theseus.fi/bitstream/handle/10024/36338/ESTAJI_ALIREZA.PDF?sequence=1
99. Deka, P. C.;Sharma, G. J.; Rao, A. N.; “DNA Barcoding Of Indian Orchids”, Fourth International Barcode of Life Conference, Lightning Talk, Barcoding Plants, Napier LG29. Available: http://www.dnabarcodes2011.org/conference/program/abstract_page.php?uniqid=27ibH1
100. Karpischek, Stephan, “Mobile Barcode Scanning Applications For Consumers”, Austria, 2012, Diss. ETH No. 20792. Available: http://e-collection.library.ethz.ch/eserv/eth:6906/eth-6906-02.pdf
101. Son, Pham Thanh, “The Improvement And Implementation Of Aztec 2-D Barcode”, HCM-IU, 2011. Available: csc.hcmiu.edu.vn:8080/dspace/handle/123456789/525
102. Moghaddam, FarhangPadidaran, “Development Of A Barcode-Based Key System”, Universiti Putra Malaysia, 2009. Available: http://psasir.upm.edu.my/7326/1/FK_2009_13a.pdf
103. ABDULLAH, FARAH IZANA BT, “Development Of Internal Transcribed Spacer Region (Its) Barcode For Malaysian Pineapple”, UniversitiTeknologiMalaysia, 2014. Available: http://eprints.fbme.utm.my/898/1/FarahIzanaMQ102162d12ttt.pdf
104. Khairudin, Nor Emilia ZetfyBte, “Halal Food Recognition System Using Barcode”, UNEVERSITI MALAYSIA PAHANG, APRIL 2010.

Available: http://umpir.ump.edu.my/2627/1/NOR_EMILIA_ZETTY_BTE_KHAIRUDIN.PDF

105. Hashim, N. M. Z.;Ibrahim, N. A.;Saad, N. M.;Sakaguchi, F.;Zakaria, Z., "Barcode Number Recognition System", International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 2, Issue 4, July – August 2013, ISSN 2278-6856. Available: http://www.ijettcs.org/Volume2Issue4/IJETTCS-2013-08-19-097.pdf

106. Yang, Ou, "Algorithm Research and Implementation of Fast Identification of Barcode", Computer Science & Education (ICCSE), 2012 7th International Conference, Melbourne, VIC, 14-17 July 2012, IEEE, pp.- 746 – 748, Print ISBN: 978-1-4673-0241-8. Available: http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6295180&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D6295180

107. Durbin, Joe, "Secondary Data Analysis Of The Two-Dimensional (2D) Barcoding Vaccine Pilot Study", Emory University, 2014. Available: https://etd.library.emory.edu/file/view/pid/emory:gtfzb/etd/emory:gtfts/durbin_dissertation.pdf

108. Tekin, Ender ; Coughlan, James M., "An Algorithm Enabling Blind Users to Find and Read Barcodes", Proc IEEE Workshop ApplComput Vis. 2009 Dec 7; 2009: 1–8. DOI: 10.1109/WACV.2009.5403098. Available: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2898214/pdf/nihms159126.pdf

109. Herr, Rebecca, "Radio Frequency Identification: Smart Barcode or Sinister Sleuth", Western Michigan University, 2003. Available: http://scholarworks.wmich.edu/honors_theses/1524

110. Shieh, Jen-Yu; Zhang, Jia-Long; Liao, Yu-Ching; Lin, Kun-Hsien, "Applications of Barcode Images by Enhancing the Two-Dimensional Recognition Rate",

International Journal of Image, Graphics and Signal Processing (IJIGSP), MECS, IJIGSP Vol.4, No.7, July 2012, ISSN: 2074-9074(Print), ISSN: 2074-9082 (Online), DOI: 10.5815. Available: http://www.mecs-press.org/ijigsp/ijigsp-v4-n7/IJIGSP-V4-N7-3.pdf

111. Kulsantiwong, Jutharat; Prasopdee,Sattrachai; Ruangsittichai,Jiraporn; Ruangjirachuporn,,Wipaporn; Boonmars,Thidarut; Viyanant,Vithoon; Pierossi, Paola; Hebert, Paul D. N.; Tesana, Smarn, “DNA Barcode Identification of Freshwater Snails in the Family Bithyniidae from Thailand”, DNA Barcode Identification of Freshwater Snails in the Family Bithyniidae, Thailand, November 2013, Public Library of Science ONE, Volume 8 issue11 p1, DOI:10.1371/journal.pone.0079144. Available: http://journals.plos.org/plosone/article/asset?id=10.1371%2Fjournal.pone.0079144.PDF or http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3817070/pdf/pone.0079144.pdf

112. Barcode Symbologies. Available: http://www.barcoding.com/information/barcode-symbology-definition.shtml

113. Types of barcode scanners and its uses. Available: http://www.aspespos.com/barcode_scanners_types_and_uses.php

114. Types of barcode scanners. Available: http://www.thomasnet.com/articles/automation-electronics/barcode-scanner-types

115. Palmer, Roger C.,The Bar Code Book, 5th edition, Trafford Publishing, 2007, ISBN: 1425133746, 9781425133740.

116. Barcode reading apps for enterprise, codeREADr.com, 2010. Available: http://blog.codereadr.com/

117. Scan. Available: https://www.scan.me/

118. Nokia Europe – Nokia N80 – Support. Available: http://www.mobile-barcodes.com/qr-code-software/
119. Package overview for mbarcode, Maemo.org Available: https://wiki.maemo.org/MBarcode
120. Barcode Reader Connection Guide, Mitsubishi Electric. Available: http://dl.mitsubishielectric.com/dl/fa/document/manual/sol/sensor/sh081577eng/sh081577enga.pdf
121. Barcode resolution and barcode Size. Available: http://www.barcodemaking.com/barm_barcode_resolution_size_mils.html
122. Resolution of Barcode Scanner. Available: http://www.sumlung.com/en/about-barcode/232.html
123. Barcode Verification. Available: http://www.barcodeadvice.org/Verification.htm
124. Barcode Verification Service. Available: http://barcodeprinting.3sindustries.com/barcode_verification.php
125. Understanding ISO/IEC 15426-1 (CEN/ANSI In the USA). Available: http://www.isisintegration.co.uk/iso_iec_15426-1.html
126. The International Barcodes Database. Available: http://barcodesdatabase.org/
127. Barcode Search. Available: http://barcodesdatabase.org/barcode-search/
128. Barcode Registration. Available: http://barcodesdatabase.org/barcode-registration/
129. International Barcode Suppliers. Available: http://internationalbarcodes.net/barcode-suppliers/
130. International Barcode Network. Available: http://internationalbarcodes.net/

APPENDIX

<u>Matlab code to extract barcode & match it with database</u>

```
%% Read Image
I = imread('barimg11.jpg');
% Image cropping
I2 = imcrop(I,[170 175 175 40]);
imagen=I2;
%% Show image
subplot(1,2,1)
imshow(I)
title('INPUT IMAGE WITH NOISE')
%% Image segmentation and extraction
%% Convert to gray scale
if size(imagen,3)==3 % RGB image
  imagen=rgb2gray(imagen);
end
%% Convert to binary image
threshold = graythresh(imagen);
imagen =~im2bw(imagen,threshold);
%% Remove all object containing fewer than 30 pixels
imagen = bwareaopen(imagen,30);
pause(1)
%% Show image binary image
subplot(1,2,2)
imshow(~imagen);
title('INPUT IMAGE WITHOUT NOISE')
%% Label connected components
[L Ne]=bwlabel(imagen);
%% Measure properties of image regions
propied=regionprops(L,'BoundingBox');
hold on
%% Plot Bounding Box
for n=1:size(propied,1)

rectangle('Position',propied(n).BoundingBox,'EdgeColor','g','LineWidth',2)
end
hold off
pause (1)
%% Objects extraction
k = 1;
x=cell(Ne,1);
for n=1:Ne
  [r,c] = find(L==n);
  n1=imagen(min(r):max(r),min(c):max(c));
  x{k} = ~n1;
  figure;imshow(x{k})
```

```
  pause(0.5)
  k=k+1;
end
%% Database Connection and Barcode Matching
load ('barcode1.mat')
load ('barcode2.mat')
load ('barcode3.mat')
load ('barcode4.mat')
load ('barcode5.mat')
load ('barcode6.mat')
load ('barcode7.mat')

dbName = 'BARCODE';
user = 'root';
password = 'root';

dbConn = database(dbName, user, password);

if isequal(x, y1)
    query = 'select code from barcodematch1';
    rs = exec(dbConn, query);
    setdbprefs('DataReturnFormat','cellarray')
    res = fetch(rs);
    d = res.Data;
    msgbox(sprintf('     %u %u %u %u %u %u %u %u %u %u %u %u %u \n
Match Found
',d{1},d{2},d{3},d{4},d{5},d{6},d{7},d{8},d{9},d{10},d{11},d{12},d{13}),'B
ARCODE')
elseif isequal(x, y2)
    query = 'SELECT code FROM barcodematch2';
    rs = exec(conn, query);
    res = fetch(rs);
    d = res.Data;
    msgbox(sprintf('     %u %u %u %u %u %u %u %u %u %u %u %u %u \n
Match Found
',d{1},d{2},d{3},d{4},d{5},d{6},d{7},d{8},d{9},d{10},d{11},d{12},d{13}),'B
ARCODE')
elseif isequal(x, y3)
    query = 'SELECT code FROM barcodematch3';
    rs = exec(conn, query);
    res = fetch(rs);
    d = res.Data;
    msgbox(sprintf('     %u %u %u %u %u %u %u %u %u %u %u %u %u \n
Match Found
',d{1},d{2},d{3},d{4},d{5},d{6},d{7},d{8},d{9},d{10},d{11},d{12},d{13}),'B
ARCODE')
elseif isequal(x, y4)
    query = 'SELECT code FROM barcodematch4';
    rs = exec(conn, query);
    res = fetch(rs);
    d = res.Data;
```

```
    msgbox(sprintf('     %u %u %u %u %u %u %u %u %u %u %u %u %u \n
Match Found
',d{1},d{2},d{3},d{4},d{5},d{6},d{7},d{8},d{9},d{10},d{11},d{12},d{13}),'B
ARCODE')
elseif isequal(x, y5)
    query = 'SELECT code FROM barcodematch5';
    rs = exec(conn, query);
    res = fetch(rs);
    d = res.Data;
    msgbox(sprintf('     %u %u %u %u %u %u %u %u %u %u %u %u %u \n
Match Found
',d{1},d{2},d{3},d{4},d{5},d{6},d{7},d{8},d{9},d{10},d{11},d{12},d{13}),'B
ARCODE')
else
    msgbox('BARCODE Match Not Found','BARCODE','warn')
end
```

MySQL query to insert the barcode values to database

```
mysql>create database barcodedatabase;
Query OK, 1 row affected (0.00 sec)

mysql> use barcodedatabase;
Database changed

mysql> show tables;
Empty set (0.00 sec)

mysql> create table barcodematch1(id INT AUTO_INCREMENT, PRIMARY KEY(id),
code INT NOT NULL);
Query OK, 0 rows affected (0.36 sec)

mysql> insert into barcodematch1(code) values
(9),(7),(8),(2),(0),(9),(7),(8),(7),(0),(9),(2),(0);
Query OK, 13 rows affected (0.11 sec)
Records: 13  Duplicates: 0  Warnings: 0

mysql> create table barcodematch2(id INT AUTO_INCREMENT, PRIMARY KEY(id),
code INT NOT NULL);
Query OK, 0 rows affected (0.39 sec)

mysql> insert into barcodematch2(code) values
(9),(7),(8),(8),(1),(2),(0),(3),(3),(2),(3),(6),(2);
Query OK, 13 rows affected (0.15 sec)
Records: 13  Duplicates: 0  Warnings: 0

mysql> create table barcodematch3(id INT AUTO_INCREMENT, PRIMARY KEY(id),
code INT NOT NULL);
Query OK, 0 rows affected (0.25 sec)
```

```
mysql> insert into barcodematch3(code) values
(9),(7),(8),(9),(3),(8),(0),(5),(0),(1),(6),(4),(2);
Query OK, 13 rows affected (0.11 sec)
Records: 13  Duplicates: 0  Warnings: 0

mysql> create table barcodematch4(id INT AUTO_INCREMENT, PRIMARY KEY(id),
code INT NOT NULL);
Query OK, 0 rows affected (0.24 sec)

mysql> insert into barcodematch4(code) values
(9),(7),(8),(9),(3),(8),(0),(5),(0),(1),(6),(1),(1);
Query OK, 13 rows affected (0.06 sec)
Records: 13  Duplicates: 0  Warnings: 0

mysql> create table barcodematch5(id INT AUTO_INCREMENT, PRIMARY KEY(id),
code INT NOT NULL);
Query OK, 0 rows affected (0.18 sec)

mysql> insert into barcodematch5(code) values
(9),(1),(2),(9),(3),(8),(0),(5),(0),(1),(6),(1),(1);
Query OK, 13 rows affected (0.06 sec)
Records: 13  Duplicates: 0  Warnings: 0

mysql> show tables;
+--------------------------+
| Tables_in_barcodedatabase |
+--------------------------+
| barcodematch1            |
| barcodematch2            |
| barcodematch3            |
| barcodematch4            |
| barcodematch5            |
+--------------------------+
5 rows in set (0.00 sec)

mysql>exit
```