VIETNAM GENERAL CONFEDERATION OF LABOUR

TON DUC THANG UNIVERSITY

FACULTY OF ELECTRICAL ENGINEERING

DINH NGUYEN GIA PHU

DESIGNING A PRODUCT CLASSIFICATION SYSTEM BASED ON BARCODE

PROJECT OF EMBEDDED SYSTEM

CONTROL & AUTOMATION ENGINEERING

HO CHI MINH CITY, YEAR 2023

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Advised by

Dr. Nguyen Thi Phuong Thao

HO CHI MINH CITY, YEAR 2023

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Ho Chi Minh city, day month year

Author

Dinh Nguyen Gia Phu

LỜI CAM ĐOAN ĐỒ ÁN HỆ THỐNG NHÚNG

This thesis was carried out at Ton Duc Thang University.

Advisor: Dr. Nguyen Thi Phuong Thao

(Title, full name and signature)

This thesis is defended at the Undergraduate Thesis Examination Committee was hold at Ton Duc Thang University on … /…/……

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Dinh Nguyen Gia Phu

DESIGNING A PRODUCT CLASSIFICATION SYSTEM BASED ON BARCODE

ABSTRACT

With the topic of designing a barcode-based product classification system, I want to apply advanced scientific and technological products to the automatic production process to create productivity, quality, and minimize human labor in industrial production.

For this topic, I have designed a barcode product sorting conveyor using the PIC 16F877A microcontroller and infrared sensors to implement an automated system for product classification by reading barcodes using GM65 and using SG90 servo motors to control the sorting process into two different channels based on the infrared sensor reader. The display of classified product information on the LCD makes it more convenient to monitor and supervise the production process. The techniques used, including the use of PIC 16f877A microcontroller and infrared sensor, will be described in detail in the following section of the project.

After the implementation period, I have met the requirements set out. Completing the project on time has helped to strengthen and supplement my knowledge.

TRƯỜNG ĐẠI HỌC TÔN ĐỨC THẮNG

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Tên đề tài: Hệ thống phân loại sản phẩm bằng mã vạch.

Tuần/Ngày	**Khối lượng**		**GVHD ký**
	Đã thực hiện	**Tiếp tục thực hiện**	
1	• Thống nhất đề tài • Thiết kế lịch trình trong 10 tuần • Tìm hiểu đề tài	• Tìm hiểu cấu trúc, nguyên lý hoạt động, sơ đồ chân của các linh kiện	
2	• Tìm hiểu cấu trúc, nguyên lý hoạt động, sơ đồ chân của các linh kiện	• Tiếp tục tìm hiểu cấu trúc, nguyên lý hoạt động, sơ đồ chân của các linh kiện	
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5	• Lưu đồ giải thuật • Viết chương trình điều khiển	• Viết chương trình điều khiển	
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7	• Viết chương trình điều khiển • Viết chương I của bài báo cáo	• Thi công, lắp đặt phần cứng	
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CHAPTER 1. INTRODUCTION

1.1 OVERALL

Currently, with the constant development of society and specific conditions in our country's industrial modernization campaign, more and more modern devices are used to control the automation of production, processing and product processing processes. This has led to the formation of flexible production systems that allow for high-level automation of large, small, and medium-scale mass production using CNC machines and industrial robots. An important step affecting the quality of the product is product classification, and there are many different ways to classify products using barcodes, such as image processing or using sensors to classify products.

Image processing is the use of image enhancement and processing from cameras, webcams, and more. It is therefore utilized in numerous fields:

+ Healthcare: X-rays, MRIs
+ Security: facial recognition, motion monitoring
+ Entertainment: electronic games
+ In industry: product classification by height, by color, etc.

However, image processing requires skills, expertise, and extensive knowledge, and has high implementation costs. In addition to image processing, sensor types can also be used to classify products. This method is simpler than image processing, by using the GM 65 module to read data from barcodes. The GM 65 module communicates with the PIC 16f877A microcontroller via UART standard and sends barcode data in the form of character strings. The PIC 16f877A will receive and process the character string to classify products into different groups. This method has lower implementation costs and is suitable for systems where only barcode classification is applied.

To meet the actual production needs and to match the skills and expertise, I would like to undertake a research on "Designing a Product Classification System based on Barcode".

1.2 Reason for choosing topic

Currently, in many factories and manufacturing businesses, such as product labeling, input material inspection, and output product testing, outdated production technologies are still being used that cannot keep up with the development trend and meet the production needs both domestically and internationally.

With the growing development of domestic and international commodity economies, products are becoming more diverse, belonging to many types and coming from many manufacturing businesses, even many countries. Therefore, humans cannot manually classify products given the huge amount of labor required, and if human labor is used to classify products, a large number of workers and a considerable amount of time are needed.

Therefore, I propose to carry out a research with the aim of providing a solution to improve the production process by reducing labor costs, increasing productivity while still ensuring product quality, and reducing product costs in order to compete in the market. For example, in a supermarket, there are many types of goods produced by many domestic and foreign businesses. When customers buy goods, they choose from many product lines. When it comes to payment, staff cannot calculate it manually or using a conventional calculator because the number is too large. Instead, modern point-of-sale systems must be utilized that use barcode scanning to accurately and quickly calculate the payment amount. From there, sellers and customers can know what the product is, which country it came from, and which business produced it. Then, the product price can be set based on the work requirements (depending on the programming).

Therefore, I have undertaken a research topic on conveyor belts and barcode scanners.

1.3 Target implementation

Designing a barcode-based product sorting conveyor using PIC 16f877A, utilizing gm 65 to read barcode data, two 60-degree servo motors to push products into two guide grooves, and two infrared obstacle sensors to determine the position of the product.

1.4 Object and scope of the study

- Learn about the structure and applications of barcodes.
- Research and understand the GM65 1D 2D QR code reader circuit and how to use it.
- Investigate and understand barcode data differentiation algorithms and functions.
- Learn about the 16f877A microcontroller.
- Learn about the IR obstacle sensor.
- Learn about the SG90 servo motor.
- Understand how to connect to the 1602 LCD.

- Design and build the hardware of the model.
- Test the prototype circuit and troubleshoot the model.
- Write a thesis report.
- Present the embedded project topic report.

1.5 Research method

Design the principle diagram and circuit diagram of the system, including the main blocks such as power supply, PIC 16f877A microcontroller, GM 65 barcode scanner module, 16x2 LCD screen, obstacle sensor, relay to control the conveyor motor and the product selection mechanism.

Program the PIC 16f877A microcontroller using C language on the PIC C Compiler software. The program needs to perform functions such as initializing I/O pins, setting up UART communication with the GM 65 module, receiving and processing barcode data from the GM 65 module, displaying the barcode on the 16x2 LCD, reading signals from the obstacle sensor to determine the position of products on the conveyor, controlling the relay to turn on/off the conveyor motor and the product selection mechanism based on the barcode.

Manufacture a physical model of the barcode-based product classification conveyor system, including components such as the conveyor frame, conveyor motor, GM 65 module, 16x2 LCD screen, PIC 16f877A microcontroller and related electronic components, obstacle sensor, relay, and product selection mechanism (which can be guide arms of servo or additional conveyor belts).

Verify and evaluate the performance of the system by putting products with different barcodes on the conveyor belt and observing the classification results.

1.6 Practical significance

My project has high practical significance in manufacturing and distribution industries. By applying the barcode-based product classification system, it is possible to save time, labor, and costs in checking, sorting, and packaging products. Moreover, the system also reduces errors and mistakes caused by humans during the process of product classification. My project can also be expanded and improved to meet different requirements of various industries.

1.7 Expected results

- The system is capable of reading barcodes with the GM65 barcode reader sensor.

- The sensor can send a character string to the 16F877A microcontroller for processing.
- The 16F877A microcontroller can classify the barcodes received from the GM65 barcode reader sensor into three different types.
- After classification, the corresponding servo motor will push the product down the chute and the infrared obstacle sensor can detect the position of the product on the conveyor.

CHAPTER 2. THEORETICAL BASIS

2.1 Overview of PIC 16F877A microcontroller

2.1.1 Introduction to PIC 16F877A microcontroller

The PIC 16F877A is a popular 8-bit microcontroller with a wide range of features and applications. It is part of the PIC16 family of microcontrollers and is widely used in various industries such as automotive, robotics, and consumer electronics.

The PIC 16F877A supports a wide range of communication protocols such as I2C, SPI, and USART, making it suitable for use in various applications such as automotive, industrial control, consumer electronics, and medical devices.

The microcontroller also has a range of internal and external peripherals that can be interfaced with various sensors and actuators to achieve specific functions.

Programming the PIC 16F877A is done using assembly language or high-level languages such as C or Basic. A range of development tools, including compilers, programmers, and development boards, are available for the PIC 16F877A.

Overall, the PIC 16F877A is a reliable microcontroller with many features and capabilities, making it versatile and suitable for various applications.

2.1.2 Characteristics of PIC 16F877A

+ It has program memory ROM and EEPROM data memory.
+ High operating speed, up to 20MHz.
+ Low operating voltage, from 2.0 to 5.5V.
+ Able to operate at a wide temperature range, from -40 to 85°C.
+ It has full communication features such as SPI, I2C, USART...
+ Supports PWM (Pulse Width Modulation) and pulse generation functions.
+ Has low power consumption modes to minimize energy consumption when not in use.
+ It has multiple I/O pins for connecting to external devices.

2.1.3 Function of the ports

Port A: consists of 6 I/O pins. These are bi-directional pins that can be used as both input and output. The I/O function is controlled by the TRISA register (address 85h). Port A is also the output port of the ADC, comparator, and input clock of timer0.

Port B: consists of 8 I/O pins. The corresponding input/output control register is TRISB (address 86h). In addition, 2 pins of Port B are used for the programming process. Port B is also related to interrupts and timer0.

Port C: consists of 8 I/O pins. The corresponding input/output control register is TRISC (address 87h). Port C contains the functional pins of the comparator, timer1, PWM, timer1 event counting, and communication standards.

Port D: consists of 8 I/O pins. The corresponding input/output control register is TRISD (address 88h). Port D is also the data output port of the PSP communication standard.

Port E: consists of 3 I/O pins. The corresponding input/output control register is TRISE (address 89h). The Port E pins are analog input ports, and they are also control pins of the PSP communication standard.

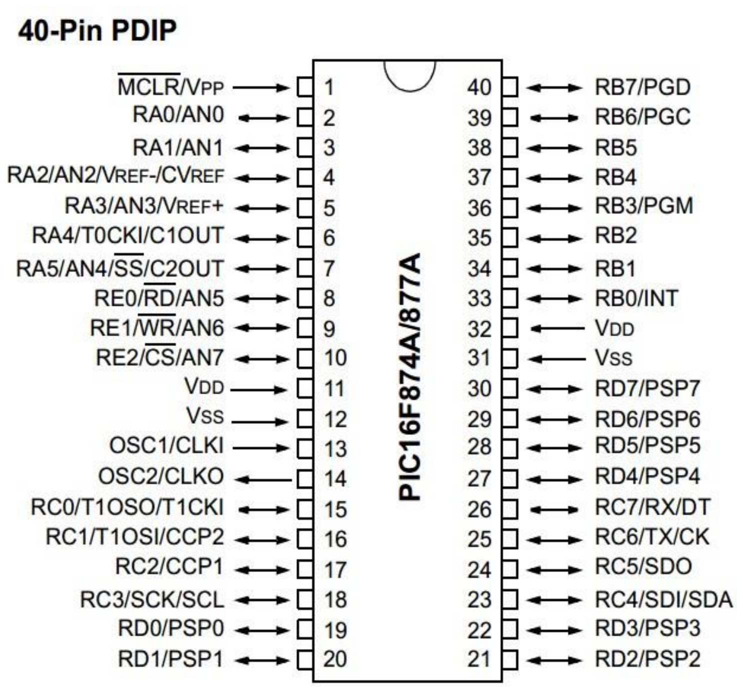


Figure 2-1 Pinout of microcontroller

2.2 GM65 barcode sensor module

The GM65 barcode sensor module is a highly advanced and versatile sensor designed to accurately scan 1D and 2D barcodes. It is commonly used in industries like logistics and warehousing, retail and healthcare, where fast and reliable scanning is essential for efficient inventory management and product tracking.

The GM65 barcode sensor module is easy to use and offers a range of features, including:

+ High Scan Speed: The GM65 offers a fast scanning speed and can easily scan up to 60 times per second, making it ideal even for high volume scanning operations.

+ Accurate & Reliable Scanning: The GM65 Barcode sensor module uses advanced imaging technology to scan 1D and 2D barcodes accurately and efficiently, even when they are partially damaged or are of poor quality.

+ Compact Design: The GM65 barcode sensor module is compact and can be integrated easily into different systems without taking up much space.

+ Versatile: The sensor supports a wide range of barcodes, including 1D and 2D codes, making it suitable for a variety of applications.

+ Serial Communication: The GM65 barcode sensor module can communicate using Serial RS-232 or TTL interface, providing flexibility in integration with other systems.

+ Integrated Illumination: The sensor module has an integrated LED illumination, which ensures fast and accurate scanning even in low light conditions.

Overall, the GM65 barcode sensor module is an advanced and reliable sensor that offers high scanning speed, high accuracy, and easy operation. Its compact design and wide range of features make it ideal for use in various industries.

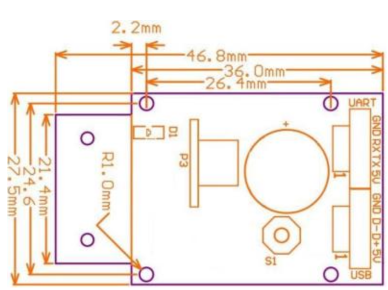


Figure 2-3 GM65 barcode sensor structure

Figure 2-2 GM65 barcode sensor module

- **Technical specifications**

- Operating Voltage DC 4.2 - 6.0V
- Standby Current 30mA
- Operating Current 160mA
- Sleep Current 3mA
- Interface: USB, UART (HID or VSP)
- Optical system: CMOS
- Capture light source: 617nm LED
- Lighting source: 6500K LED
- Reading angle: rotating 360 °
  - Deflection ± 60 °
  - Tilt ± 65°
- Scanning angle: + 34 ° (horizontal); + 26 ° (vertical)
- Minimum contrast: 30%
- Resolution: ≥ 0. 1mm (4mil)
- Ambient light: Ambient light: 0~86,000 lux

The special thing here is that the GM65 can scan almost all types of barcodes such as:

- 1D barcode types such as UPC/EAN, UPC/EAN with supplementals, BooklandEAN, ISSN, UCC Coupon Extended Code, Code 128, Code 39, Code 39 Full ASCII, Trioptic Code 39, Code 32, Code 93, Code 11, GS1-128, ISBT 128, Matrix 2 of 5, Interleaved 2 of 5, Discrete 2 of 5, Codabar, MSI, Chinese 2 of 5, GS1 DataBar variants, Korean 3 of 5, ISBT Concat.
- 2D barcode types such as QR Code, PDF417, Data Matrix.

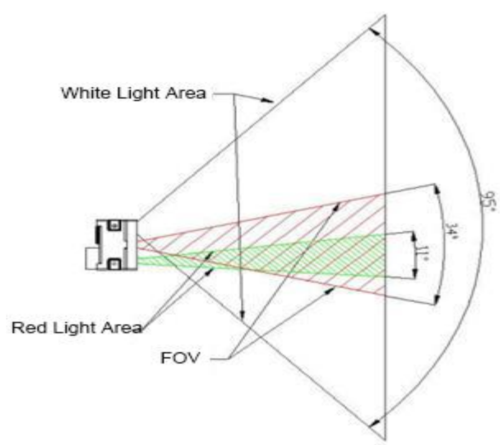


Figure 2-4 Scanning area of GM65

2.3 LCD 1602

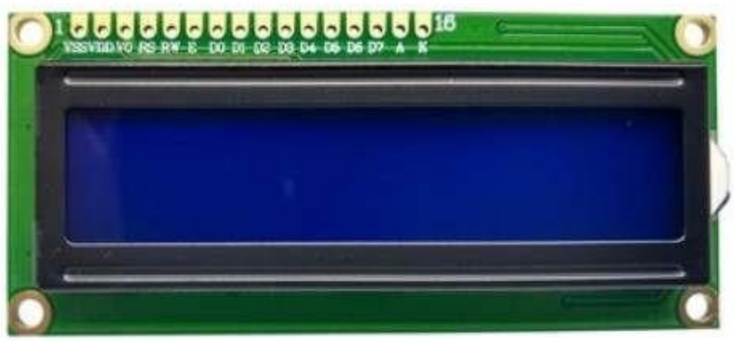


Figure 2-5 LCD 1602

Nowadays, LCD (Liquid Crystal Display) displays are used in many devices and have many advantages over other types of displays: They are capable of displaying various characters, easily integrated into applications with many different communication protocols, and have a low cost.

The LCD1602, also known as the 16x2 LCD display, is a extensively used alphanumeric LCD module that can be used for displaying messages, alphanumeric characters or symbols. It is commonly used in embedded system projects such as temperature sensors, timers, counter displays, and many more.

❖ **Technical specifications**

- Screen size: 16 x 2 characters
- Operating voltage: 5V
- Number of pins: 16 pins (8 data pins and 8 control pins)
- Communication through: Parallel interface
- Backlight: Single-color green/blue LED backlight
- Dimensions: 80 x 36 x 12.5mm

It allows displaying ASCII characters, special symbols such as arithmetic operations, arrows, punctuation marks, and other special symbols.

Each character displayed on the module has a size of 5x8 pixels. The screen is divided into two rows with a maximum of 16 characters each row.

Similar to other LCD screens, LCD 1602 also requires a startup kit, including power supply and control circuit to operate and display information.

LEG	CHARACTERISTIC	LOGIC STATE	I/O	FUNCTION
1	Vss	-	-	GND
2	Vcc	-	-	+5V
3	Vee	-	-	Adjusting the contrast of an LCD
4	RS	0/1	I	0: Instruction input 1: Data input
5	R/W	0/1	I	0: write data 1: read data
6	E	1->0	I	Enable signal
7	DB0	0/1	I/O	Data bus 0
8	DB1	0/1	I/O	Data bus 1
9	DB2	0/1	I/O	Data bus 2
10	DB3	0/1	I/O	Data bus 3
11	DB4	0/1	I/O	Data bus 4
12	DB5	0/1	I/O	Data bus 5
13	DB6	0/1	I/O	Data bus 6
14	DB7	0/1	I/O	Data bus 7
15	BLA	-	-	BlackLight +5V
16	BLK	-	-	BlackLight 0V

Table 2-1 Function of LCD's pins

2.4 Servo SG90

The SG90 servo can be easily controlled by any microcontroller or embedded system that has a pulse-width modulation (PWM) output. By sending specific PWM signals to the servo, the user can control the angular position of the motor shaft. The pulse width of the PWM signal determines the position of the shaft, with the minimum pulse width corresponding to 0 degrees and the maximum pulse width corresponding to 180 degrees.

The SG90 servo is commonly used in robotics and remote-controlled models, such as cars, airplanes, and quadcopters. It can also be used in animatronics, camera gimbals, and other motion control applications. Due to its small size, low cost, and precise motion control capabilities, the SG90 servo has become a popular choice for hobbyists, students, and makers who want to experiment with motion control and automation projects.

Figure 2-7 Servo SG90

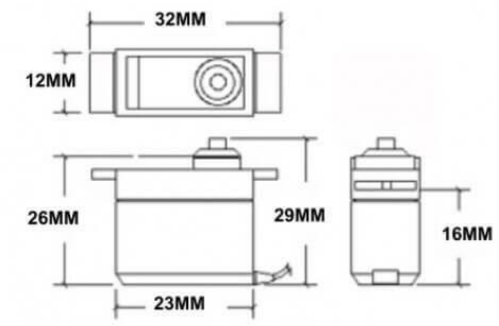


Figure 2-6 Servo SG90 structure

❖ **Technical specifications**

+ Operating voltage: 4.8V to 6V
+ Stall torque: 1.8kg/cm (4.8V); 2.2kg/cm (6V)
+ Rotational range: 180 degrees
+ Operating speed: 0.1 seconds/60 degrees (4.8V); 0.08 seconds/60 degrees (6V)
+ Control signal: PWM (50Hz)
+ Operating temperature: -30°C to +60°C
+ Gear material: Plastic
+ Motor type: Coreless motor
+ Dimensions: 23mm x 12.2mm x 29mm
+ Weight: 9 grams

From the image, we can understand that the PWM signal must have a frequency of 50Hz and a cycle of 20ms. The on-time can be varied from 1ms to 2ms. Therefore, when the on-time is 1ms, the motor will be at 0°, and when it is 1.5ms, the motor will be at 90°. Similarly, when it is 2ms, it will be at 180°. By varying the on-time from 1ms to 2ms, the motor can be controlled from 0° to 180°.

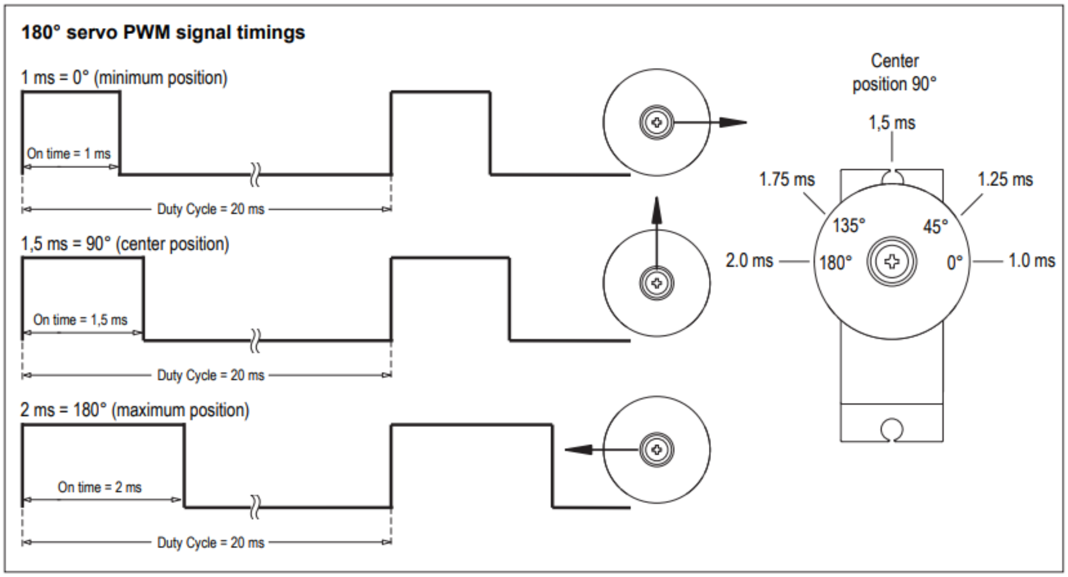


Figure 2-8 Servo PWM signal timings

2.5 IR Infrared Obstacle Avoidance

IR (Infrared) obstacle avoidance is a technology that allows a device to detect and avoid obstacles in its path by using infrared radiation.

In order to detect obstacles, an IR transmitter and an IR receiver are used. The IR transmitter sends out infrared signals, which bounce off nearby objects and return to the IR receiver. If an object is detected in the path of the incoming infrared signal, the receiver will detect a change in the signal and trigger a response from the device.

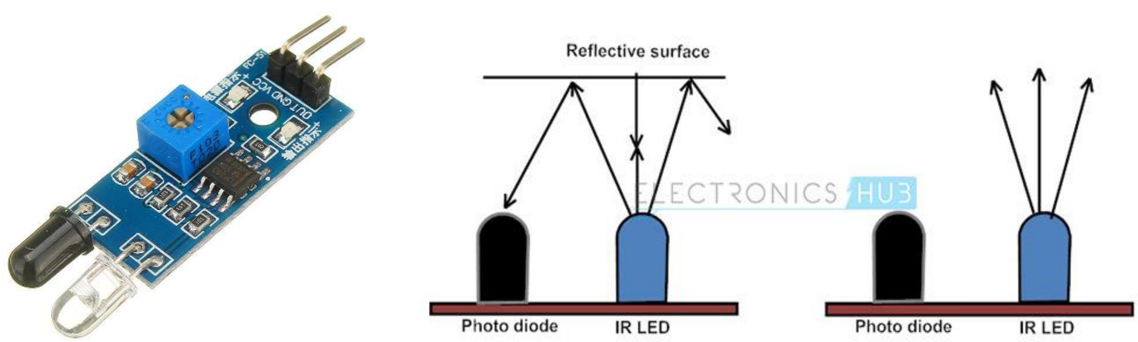


Figure 2-9 IR Infrared Obstacle Avoidance

❖ **Technical specifications**

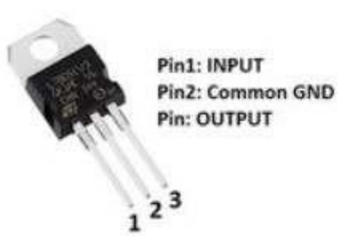
- \+ Voltage: 3.3V - 6VDC
- \+ Consumption:
  - o Vcc = 3.3V: 23 mA
  - o Vcc = 5.0V: 43 mA
- \+ Operating angle: 35°
- \+ Detection range: 2 ~ 30 cm
- \+ Output logic levels:
  - o Low level - 0V: when the obstacle is detected
  - o High level - 5V: when there is no obstacle
- \+ Dimensions: 3.2cm x 1.4cm

2.6 7805 Voltage Regulator

The 7805 voltage regulator is extensively utilized as a linear voltage regulator. It is designed to regulate the output voltage of a power supply circuit to a fixed 5 volts DC. The 7805 voltage regulator operates using a three-terminal design, with an input, output, and ground terminal. The 7805 voltage regulator is known for its simplicity and reliability. It is easy to use and requires very few external components.

❖ **Technical specifications**

- \+ Input voltage range: 7V - 35V DC
- \+ Output voltage: 5V DC fixed
- \+ Maximum output current: 1A
- \+ Operating temperature range: 0°C to 125°C



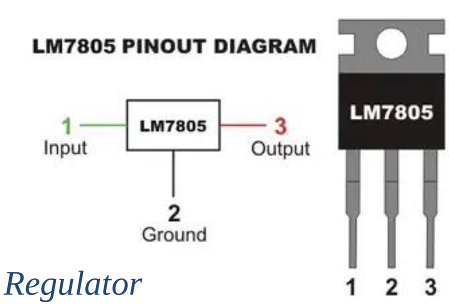


Figure 2-10 7805 Voltage Regulator

2.7 Relay

A relay is a type of electrical switch that is operated by an electromagnet. It is used to control a circuit by a low-power signal or to switch power to a high-power load. A relay typically consists of a coil, a set of contacts, and a spring.

When an electrical current is applied to the coil, it generates a magnetic field that pulls the contacts together, closing the circuit. When the current is removed, the spring returns the contacts to their open position, breaking the circuit. This makes a relay useful for controlling circuits that carry high currents or voltages that may be dangerous to switch directly.

Relays can be used in a variety of applications, from simple switches to more complex control systems. They are commonly used in industrial control systems, power distribution, automotive systems, and home automation, among others.

Figure 2-11 Relay

❖ **Advantages of using relays include:**

+ They allow for remote control of electrical circuits.
+ They provide electrical isolation between the control circuit and the load.
+ They can switch high-power loads without destroying the control circuit.
+ Their dependability and prolonged life span are remarkable.
+ They are compatible with both AC and DC circuits.

2.8 Opto-isolator pc817

Opto-isolator, also known as an optocoupler, is an electronic component that protects one circuit from another by using an optically coupled isolation system. It is essentially a combination of a light source (typically an LED) and a photo-detector inside an opaque package. The opto-isolator keeps the input and output portions of a circuit electrically isolated from each other while still allowing for communication between them.

The PC817 is a common type of opto-isolator that is widely used in electronic circuits for various applications. It is a single-channel opto-isolator that consists of an infrared LED and a phototransistor in a compact package. The PC817 provides a reliable way to isolate high voltage and low voltage circuits and protect them from electrical interference and noise.

Figure 2-12 Opto-isolator pc817

❖ **Technical specifications**

+ Isolation voltage: 5,000 VRMS
+ Input forward current: 50 mA
+ Input reverse voltage: 6V
+ Power Dissipation: 150mW
+ Collector to emitter voltage (Vceo): 80 V
+ Emitter to collector voltage (Vebo): 6V
+ Collector current (Ic): 50mA
+ Current transfer ratio (CTR): 50% - 600% at If=5mA, Vce=5V
+ Maximum operating temperature (Topr): -55°C to 110°C

2.9 The software used

2.9.1 CCS C Compiler

CCS is a C programming language compiler for Microchip's PIC microcontrollers. Like many other C compilers for the PIC, CCS helps users quickly understand and use the PIC in their projects. The highlight of this toolkit is its smart code optimization compiler. The library of functions is diverse, allowing for the rapid development of applications without requiring extensive knowledge of the PIC.

2.9.2 Proteus 8 Professional

Proteus 8 Professional is a software tool used for simulating and designing electronic circuits. It offers a comprehensive suite of tools for creating and testing digital and analog circuits, as well as microcontroller-based designs. Proteus 8 Professional includes schematic capture and PCB layout modules, as well as a simulation module that allows users to test their circuitry before prototyping it. The software provides a range of simulation models, including microcontroller models, which allow users to test firmware designs on virtual hardware. Additionally, Proteus 8 Professional has a range of interactive debugging tools to help detect and fix design errors quickly. It is widely used in the electronics industry and education sectors for developing and testing circuits without the need for physical prototypes.

CHAPTER 3. RESEARCH ON BARCODES

3.1 Introduce to Barcodes

3.1.1 Overview

The barcode technology has been widely applied in many industries around the world, including healthcare, commerce, logistics, and inventory control. However, the application of barcode technology in the Vietnamese market only began to develop significantly from 2005 till now. Barcode technology is becoming more advanced in various fields. For each specific business characteristic in each field, a certain type of barcode scanner is required. Therefore, choosing a suitable barcode scanner is something that we need to research and consider carefully.

3.1.2 The concept of barcode

A barcode is a machine-readable representation of data in the form of lines of varying widths and spaces that can be easily scanned and interpreted by a barcode reader. It is a way of representing information in a visual form that can be easily read and processed by machines. Barcodes are used in a wide range of applications including inventory management, product identification, asset tracking, and document handling.

Barcodes typically consist of a series of vertical bars and spaces of varying widths that represent different numbers or characters. These symbols are then decoded by a barcode scanner or reader and converted into a digital signal that can be processed by a computer or other electronic device. The most common type of barcode is the Universal Product Code (UPC), which is used to identify products in grocery stores and retail environments.

Barcodes provide a number of benefits over traditional methods of data entry and identification. They are fast, accurate, and can be read by machines with a high degree of reliability. This makes them ideal for use in environments where large amounts of data need to be processed quickly and efficiently. Additionally, barcodes are easy to generate and print, making them a cost-effective solution for a wide range of applications.

3.1.3 The structure of Barcode

The structure of a barcode consists of a series of bars and spaces arranged according to a specific pattern. The pattern of bars and spaces represents a code that can be read and interpreted by a barcode scanner. Here are the components of a typical barcode structure:

+ Start and Stop Characters: These are special characters that signal the beginning and end of a barcode.

+ Quiet Zone: This is a blank space on both sides of the barcode that separates it from other text or graphics.

+ Barcode Bars: These are vertical bars of varying widths that encode the information in the barcode. The pattern of bars represents specific characters or data.

+ Barcode Spaces: These are the white spaces between the bars that also encode information. The relative widths of bars and spaces are critical for accurate scanning.

+ Checksum Character: This is a special character used to verify that the barcode has been scanned correctly. Usually, it can be found at the termination point of the barcode.

There are different types of barcodes, each with its own unique structure and encoding scheme. Some barcodes use a combination of bars and spaces of different widths, while others use only different widths of bars or spaces. The specific structure and encoding mechanism used in a barcode depend on the intended use and compatibility with barcode readers and applications.

3.2 Some basic concepts of barcode scanners

Depending on the manufacturing technology and the usage purposes, barcode scanners are classified in various ways such as by technology, function, interface, structure, etc

❖ **Based on manufacturing technology:**

Currently, optical barcode scanners are divided into 2 types:

- CCD Scanner
- Laser Scanner

3.2.1 Laser Barcode Reader

A laser barcode reader is an electronic device that uses a laser beam to read the data encoded in a barcode. The laser barcode technology is more advanced than CCD-based barcode scanners as it emits a thin, bright beam of light that scans at high speed and from a greater distance.

The laser reader "reads" the barcode by measuring the reflected light that bounces back to the reader's detector. The information is then transmitted to a computer or another device that interprets the code's data.

Laser barcode readers are widely used in the retail industry, warehouses, and manufacturing because they can read barcodes from a greater distance and are exceptionally fast. Additionally, laser barcode readers are capable of scanning both 1D and 2D barcodes, making them more versatile and practical than CCD barcode scanners.

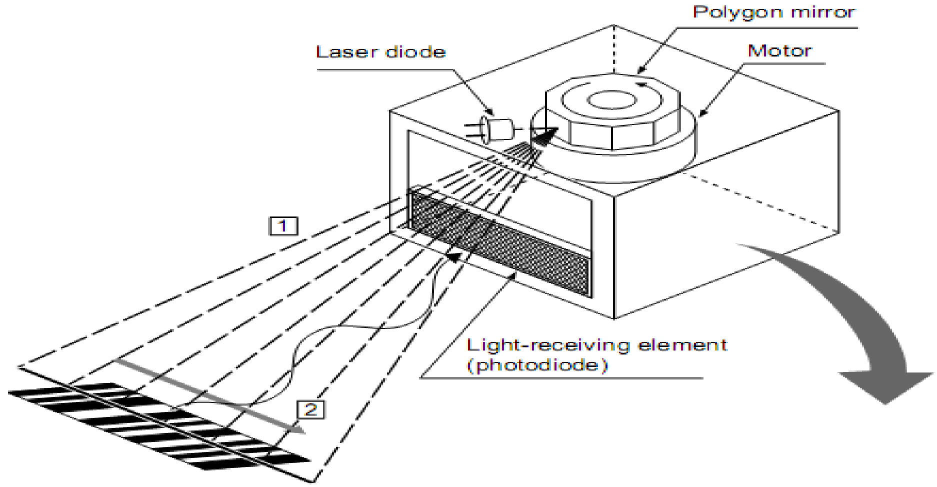


Figure 3-1 Laser Barcode Reader

The Laser Barcode Reader includes the following components: a laser diode, a polygon mirror, a motor, and a light-receiving element (photodiode).

- **The principle of reading barcodes is as follows:**

(1) The laser beam is emitted from the laser diode and is reflected by the polygon mirror to scan the barcode.

(2) The light-receiving element (photodiode) receives the reflected light from the barcode.

(3) The reflected light is in the form of an analog waveform.

(4) The barcode reader converts the analog waveform into a digital signal (A/D conversion).

(5) The barcode reader determines the width of the bars and spaces using the digital signal.

(6) The barcode reader decodes the combination of bars and spaces into data according to the barcode rules. The decoded data is then transmitted to an external device through RS232C or an equivalent communication interface.

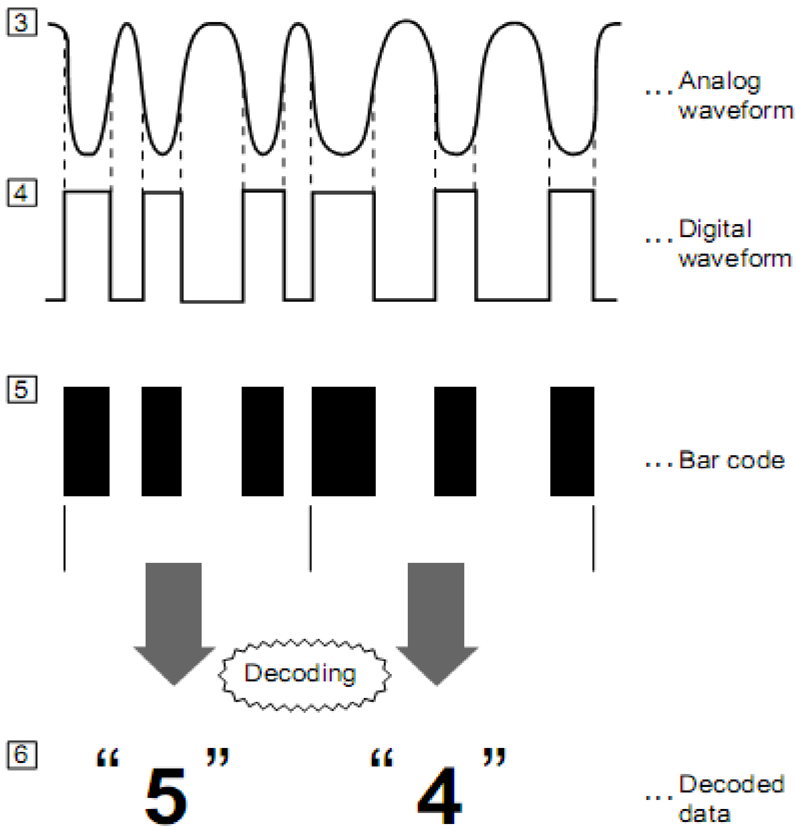


Figure 3-2 Laser Barcode Reader Signal

- **Advantages of Laser Barcode Readers:**
- Speed: Laser barcode readers scan barcodes quickly and accurately.
- Distance: They can scan barcodes from a greater distance compared to other barcode scanner technologies.
- Omnidirectional Scanning: Modern laser barcode readers can scan barcodes from any angle, making them ideal for retail checkout counters and self-checkout scanners.
- Compatibility: Laser barcode readers can read both 1D and 2D barcodes, including QR codes.

- Durability: They are durable and can withstand falls, drops, and rough handling.
- Availability: Laser barcode readers are readily available, and their accessories and replacement parts are widely available.

❖ **Disadvantages of Laser Barcode Readers:**

- Cost: They are more expensive than other types of barcode scanners, such as CCD-based scanners.
- Complexity: Laser barcode readers have a more complex operating mechanism and require more maintenance.
- Size: They can be bulkier and heavier than other barcode scanners, making them challenging to use for extended periods.
- Reflective Surfaces: Laser barcode readers are not suitable for reading barcodes from reflective surfaces, which can result in errors and loss of data.
- Power Usage: They consume more power and, therefore, require frequent battery charges or a reliable power source.

3.2.2 CCD Barcode Reader

A CCD (Charge-Coupled Device) barcode reader, also known as a linear imager, is a type of handheld scanner that reads barcodes using rows of sensors arranged in a linear array. CCD barcode readers are commonly used in retail, manufacturing, logistics, and healthcare industries.

Unlike laser barcode scanners that use a scanning mirror or oscillating prism to scan barcodes, CCD scanners use a linear image sensor that captures the image of the barcode as it passes through the scanner. This linear array of sensors contains hundreds of photodiodes arranged in a single row, which are used to sense the light reflected from the barcode.

To scan a barcode, the CCD scanner is held close to the barcode and the image sensor is illuminated by a light source. As the barcode is moved past the scanner, the sensor captures an image of the barcode and sends it to the scanner's processor for decoding. The processor then decodes the image and sends the data to the connected computer or system.

❖ **The principle of reading barcodes is as follows:**

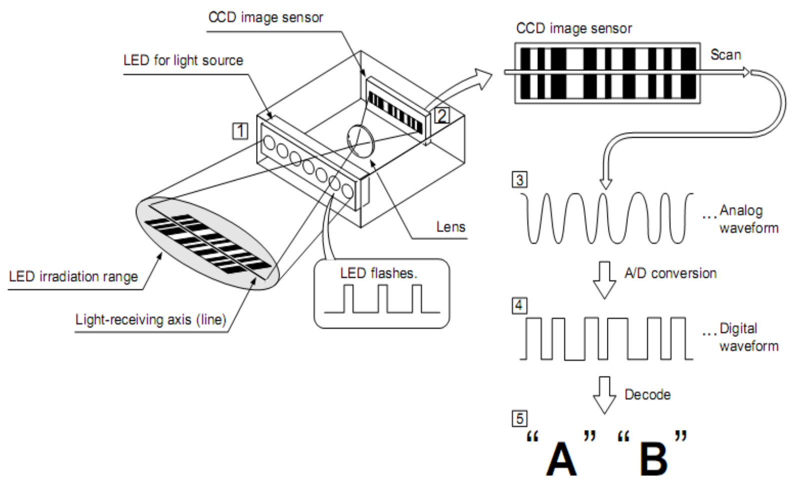


Figure 3-3 CCD Barcode Reader

(1) The LED emits light above the barcode.

(2) The CCD image sensor detects the reflected light from the barcode as an image.

(3) The barcode reader scans the image data of the barcode on the CCD image sensor into an analog wave.

(4) The barcode reader converts the analog wave into a digital wave (A/D conversion).

(5) The barcode reader decodes the received digital wave into data according to the barcode rules. The encoded data output is transmitted to external devices through RS232C or equivalent communication.

❖ **Advantages of CCD Barcode Reader:**

- CCD barcode readers have fewer moving parts than laser scanners, making them more reliable and require less maintenance.
- They consume less power and are more cost-effective compared to laser scanners due to their simple design.
- CCD readers are highly effective for reading 1D barcodes at close range with high accuracy.
- They are usually lightweight and ergonomic, making them more comfortable to use for long periods.

- **Disadvantages of CCD Barcode Reader:**
- CCD readers have limited scanning range compared to laser scanners, making them less useful for reading barcodes from a long distance.
- They are generally slower than laser scanners and cannot read barcodes at high speeds, which can be a disadvantage in applications that require rapid scanning.
- CCD readers typically cannot scan 2D barcodes or codes with low contrast, unlike some laser or image-based scanners.
- They usually have a small reading width, which means they may not be suitable for reading larger or wider barcodes.

- **How to differentiate between a CCD scanner and a Laser scanner:**

CCD scanners have a thick light beam of around 1cm and scan at a close range of under 8 inches (203mm), usually around 100mm. Laser scanners, on the other hand, emit a very thin scan line of a few millimeters and can scan at a long range of up to 8 inches or more (typically 12 inches or above).

3.3 Types of barcodes

There are many types of barcodes, however, they are divided into two basic types: 1D barcodes (linear barcodes) and 2D barcodes (matrix barcodes).

1D barcodes are linear barcodes, which are commonly used in retail and transportation industries. They have a simple design, consisting of parallel lines.

2D barcodes are matrix barcodes, which are commonly used in healthcare, education, warehouse management, transportation, and food/beverage industries. They have a square or rectangular shape divided into smaller cells than 1D barcodes, and they can contain more information.

In addition to the two basic types, there are other types of barcodes, including color barcodes, ASCII-encoded barcodes, deister barcodes, and active barcode solutions, such as RFID (Radio Frequency Identification).

3.3.1 Barcode UPC (Universal Product Code)

The UPC barcode, with its full name being Universal Product Code, is a 1D linear barcode consisting of black bars of varying widths on a white background, parallel to each other, and composed of 12 digits (no letters or special characters), with each digit having a value ranging from 0 to 9. The UPC barcode is applied to consumer goods and widely used in the United States, Canada, the United Kingdom, Australia, New Zealand, Europe and other countries managed by the European article number association GS1.

Figure 3-4 UPC Barcode

- **Types of current UPC Barcodes**

The UPC barcode has various forms depending on the market's development, with UPC-A currently being the most commonly used, followed by the following types:

- UPC-B, designed for National Drug Code and National Health Related Item Code, has 12 digits without a check digit
- UPC-C, which consists of 12 digits, including product code and check digit, but is not used frequently
- UPC-D is a variable-length code, with a minimum of 12 digits, or more, with the last digit representing the check digit
- UPC-E has a system of digits 0 or 1 and consists of only 6 digits
- UPC-2 is a supplementary code comprising of just 2 digits that indicate the publication or version of a periodical or magazine
- UPC-5 is a supplementary code containing 5 digits, indicating the suggested retail price.

- **The characteristic of the UPC barcode, or specifically UPC-A, consists of 12 digits with 4 main groups:**

Group 1 - System digit: the first digit of the UPC-A sequence, ranging from 0 to 9, has different meanings as follows:

0, 7: Regular UPC-A

1, 6, 8, 9: Reserved

2: Used for products sold by weight

3: Pharmaceuticals/Healthcare items

4: Non-food items with no format restrictions, for internal use by the company

5: Coupons

Group 2 - Manufacturer code: the next 5 digits after the first group, ranging from 00000 to 99999, assigned to companies by the UCC council to use UPC codes.

Group 3 - Product code: the next 5 digits after the second group, ranging from 00000 to 99999. If a company produces more than 100,000 types of products, they can request additional manufacturer codes from the UCC.

Group 4 - Check digit: the twelfth digit of the UPC-A sequence with a value ranging from 0 to 9, calculated based on the preceding digit string."

Figure 3-5 UPC Barcode Structure

3.3.2 Barcode EAN

The EAN (European Article Number) barcode is a type of linear barcode symbology used for product identification worldwide. It is widely used in retail and distribution industries for tagging products and managing inventory.

Regarding the classification of EAN barcodes, there are currently 2 types, EAN-13 and EAN-8.

3.3.2.1 Structure of EAN-8:

Essentially similar to EAN-13, except that EAN-8 comprises 8 integers, depending on the arrangement and selection of digits from 0 to 9, divided into 3 groups:

- Country code: The first 3 digits (on the left)
- Product code: The next 4 digits.
- Check digit: The final digit. Check digit C is calculated from the other 7 digits in a similar manner to EAN-13.

3.3.2.2 Structure of EAN-13:

EAN-13 is a sequence of 13 integers (from 0 to 9), divided into 4 groups. Each group has the following significance:

Group 1: In terms of the barcode structure, the country code is represented by the first three digits from left to right.

Group 2: The subsequent four digits are the company code.

Group 3: The following five digits are the product code.

Group 4: The last digit (on the right) is the check digit.

Figure 3-6 Barcode EAN 13 And EAN 8

❖ **Advantages:**

- EAN barcodes can be read quickly and accurately by barcode scanners, making it efficient to manage inventory and track products.
- The use of EAN barcodes reduces the chance of human error in data entry, reducing the risk of errors in pricing and inventory management.
- EAN barcodes can be used globally, making it easy to track products across borders.

❖ **Disadvantages:**

- Limited characters in the encoding, so there is no possibility of further development.

❖ **CHECK DIGIT CALCULATION RULES**

The check digit is the 13th digit of the EAN-13 and depends on the 12 digits before it, calculated as follows:

Digit A is the sum of all digits in odd positions (1, 3, 5, 7, 9, 11).

Digit B is the sum of all digits in even positions (2, 4, 6, 8, 10, 12), multiplied by 3.

Digit A+B is the sum of Digit A and Digit B.

If the sum (Digit A+B) is divisible by 10, then the check digit is 0. If the sum is not divisible by 10 and has a remainder, the check digit is the complement of the remainder to 10.

3.3.3 Barcode 128

Barcode 128 for applications requiring data for the International Society of Blood. The Code 128 barcode law encodes all 128 ASCII characters. It provides excellent density for all digital data and good density for numerical data. Symbols can be waived if not necessary to store the encoded data.

❖ **Features:**

Code 128 is segmented into three subsets: A, B, and C, each identified with one of three distinct start codes. Control characters are included in each subset to allow switching to another subset within a barcodeA - digits, uppercase letters, standard ASCII symbols, and control codes.

B - digits, uppercase and lowercase letters, standard ASCII symbols, and control codes.

C - digits only. Two digits are compressed into each character, providing excellent density.

Each character is 11 times the narrow bar width and composed of three bars and three spaces. An even number of elements is used for bars and an odd number is used for spaces, with a check character for consistency during scanning.

Barcode 128 requires a quiet zone, which must be at least 10 narrow bars wide.

Barcode 128 is often chosen over Barcode 39 because of the higher density and larger number of supported characters.

Figure 3-7 Barcode 128

3.3.4 2D barcode

Used on small products: If linear barcodes, i.e. common 1D barcodes, are printed on small items, there is usually a barrier to their size. The barcode is still too large for extremely small items. With the development of 2D barcodes, people can print barcodes small enough to be placed directly on very small items.

2D technology allows a large amount of information to be encoded in a narrow area. The amount of information stored in a 2D barcode can be considered as a small data file. Therefore, when using 2D barcodes, it may not be necessary to have other databases. The following encoding standards are commonly used for 2D barcodes:

Stacked codes: Code 16K, Code-49, PDF-417.

Figure 3-8 Code 16K

Matrix codes: Data Matrix, Maxicode, Vericode.

Figure 3-9 Data Matrix Code

3.4 Applications of barcodes

Barcodes have a wide range of applications in various industries and contexts. Here are some of the most common applications of barcodes:

Retail: Barcodes are widely used in retail to manage inventory and track sales. They can help businesses to quickly and accurately record sales transactions, manage stock levels, and reorder items when needed.

Manufacturing: Barcodes are used in manufacturing to track parts and components as they move through the production process. This can help businesses to identify and address quality control issues, and to ensure that products are assembled correctly.

Healthcare: Barcodes are used in healthcare to track patient records, medical supplies, and medications. This can help to improve patient safety by reducing errors and making it easier to access important medical information quickly.

Libraries: Barcodes are used in libraries to track books, DVDs, and other items. This can help to reduce the time and effort required to manage inventory, and to ensure that items are not lost or stolen.

Transportation and Logistics: Barcodes are used in transportation and logistics to track shipments and packages. They can help businesses to manage the movement of goods more efficiently, and to ensure that packages are delivered to the correct destination.

Overall, barcodes are a versatile tool that can help businesses and organizations to manage inventory, track assets, and improve efficiency and accuracy in a variety of contexts.

CHAPTER 4. Design block diagrams and principle diagrams

4.1 Block diagram of the system

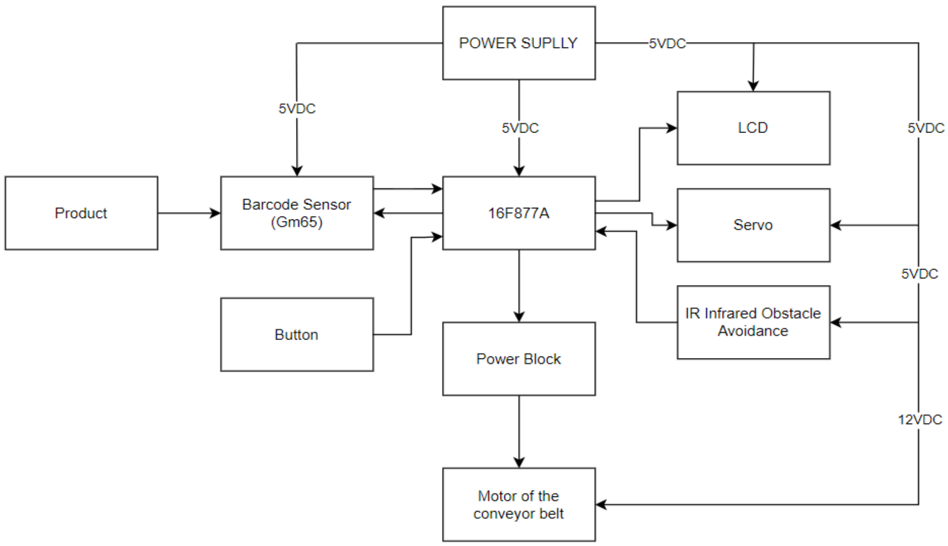


Figure 4-1 Block diagram of the system

4.2 Principle diagrams of the system

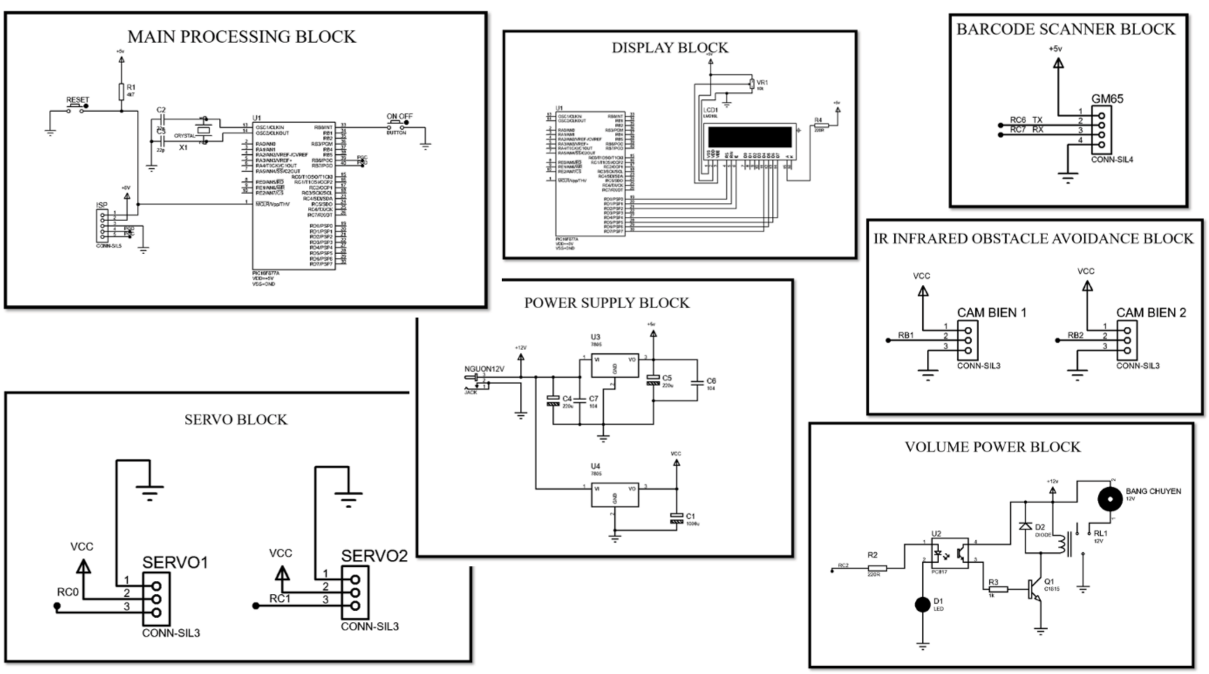


Figure 4-2 Principle diagrams of the system

4.2.1 Power supply block

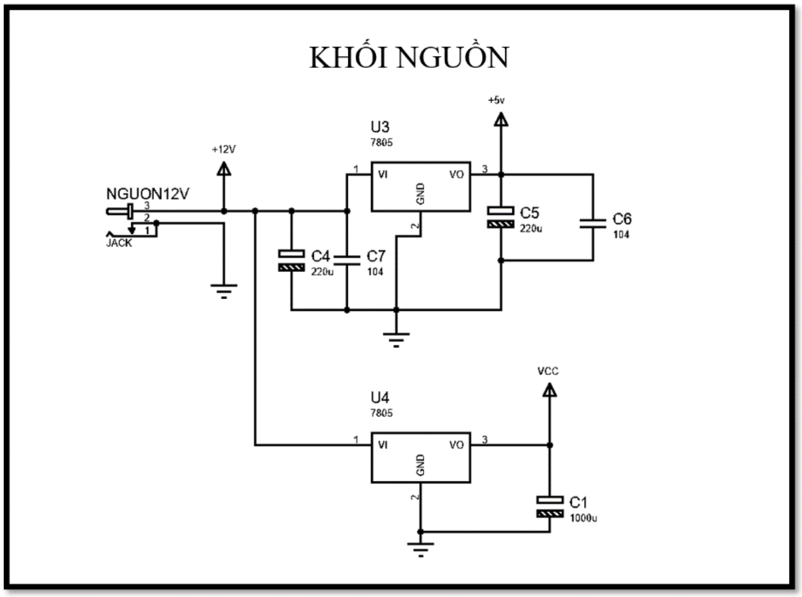


Figure 4-3 Power supply block

The adapter 12Vdc is the input of the power supply circuit. It supplies 12 volts of direct current (DC) power to the circuit.

Then the IC 7805 is a voltage regulator that regulates the 12VDC input voltage to a stable 5VDC output voltage. The IC 7805 maintains a constant voltage output even if the input voltage fluctuates or the amount of load changes. It also has a built-in protection mechanism for overheat and overvoltage conditions.

The capacitor 104 is connected to the input and output of the IC 7805. It works as a filter capacitor to reduce high-frequency noise and interference that may be present in the input voltage. It smooths out the voltage output of the IC 7805 and makes it more stable.

The capacitor 220u is connected to the the input and output of the IC 7805. It works as a reservoir capacitor to ensure a stable output voltage under high current situations. It stores an adequate amount of charge, and when the current demand is high, it releases the charge and prevents a drop in voltage.

Together, these components form a basic DC-to-DC converter that can convert a 12VDC input voltage to a 5VDC output voltage while maintaining a stable and smooth output. The adapter 12Vdc supplies the input voltage, the IC 7805 regulates and stabilizes the voltage, and the two capacitors work to filter and smooth out the output voltage.

4.2.2 Power block

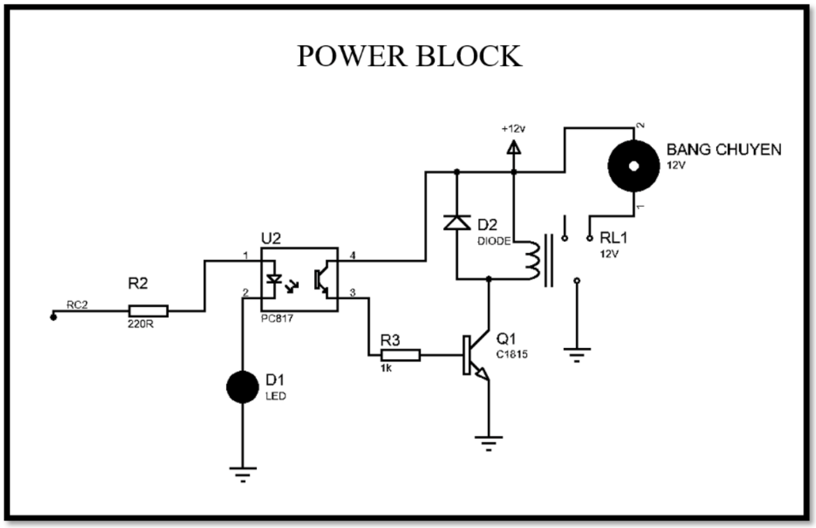


Figure 4-4 Power block

Opto PC817 is used to isolate the signal from RC2 pin of the microcontroller and isolate the control signal from the actuator, with a 220 ohm resistor connected to limit the current for the opto LED. C1815 transistor with a 1k resistor is used to limit the current for the base of C1815 transistor (IB max=50mA) receiving signal from the opto to activate the relay state switch.

Power block: receives control signals (start, stop) from the microcontroller to make the motor operate or stop.

4.2.3 Display block

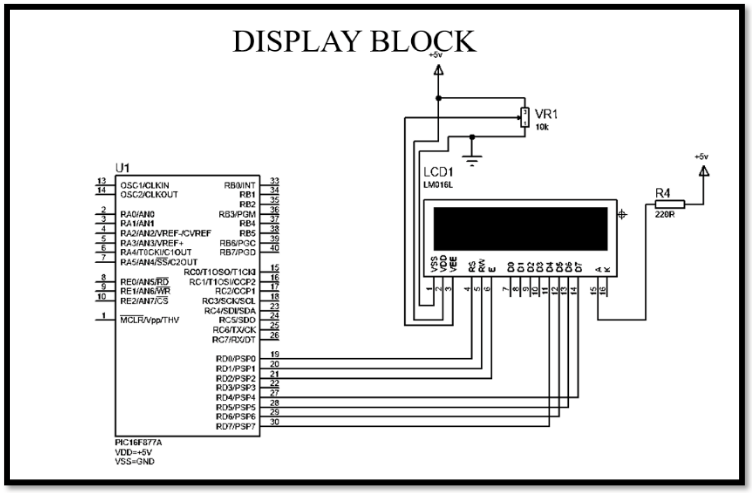


Figure 4-5 Display block

This block uses a 1602 LCD connected to a Pic16F877A microcontroller and receives a 4-bit control signal.

Data Bus: It consists of four legs and is used for transmitting data between the microcontroller and an external device such as the LCD display module.

Control signals: These are other legs that include signals such as Enable, Read/Write, and Register Select (RS), which communicate with the LCD display module to control its operation.

The variable resistor is connected to the power supply and ground and is used to adjust the voltage level in the circuit for different purposes such as regulating the contrast level of the LCD 1602 display.

This screen displays the parameters of the system, for the user to observe easily.

4.2.4 Barcode scanner block

In this block, there is a 4-pin header to connect from the microcontroller to the GM65 barcode sensor module. Includes a Vcc pin to connect to 5Vdc from the power supply circuit, a ground pin (GND) and two UART pins to communicate with pins RC6 and RC7 of the microcontroller.

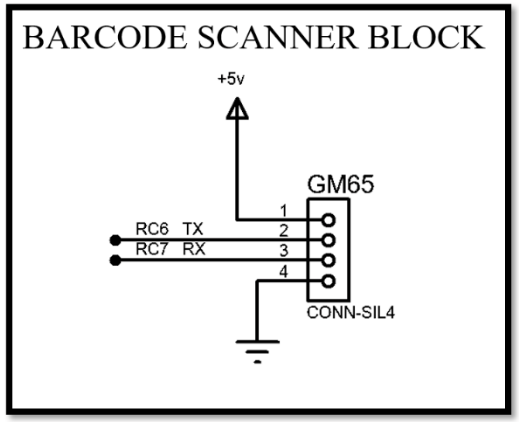


Figure 4-6 Barcode scanner block

4.2.5 Servo block

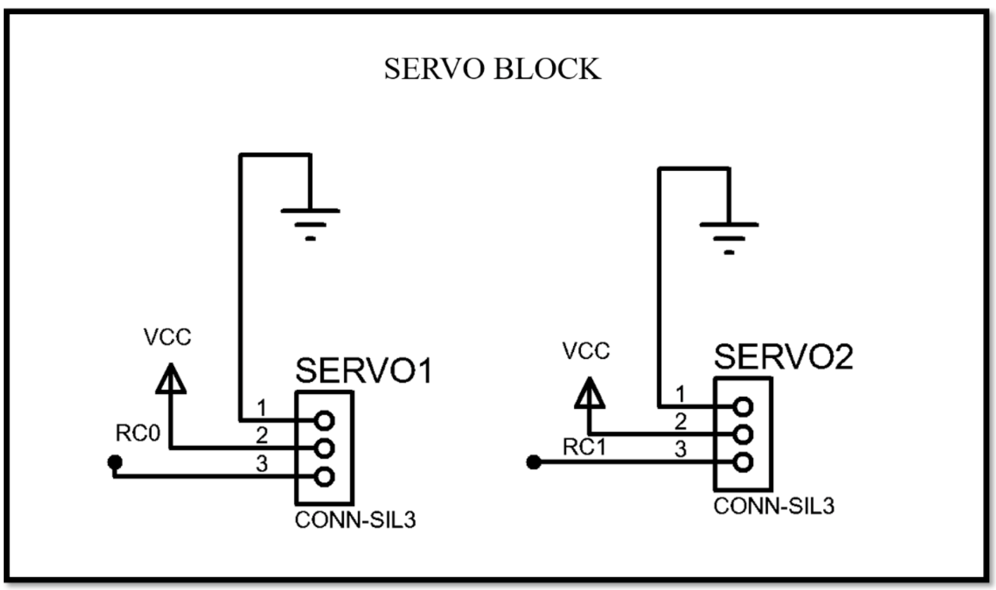


Figure 4-7 Servo block

This module has a header with 3 pins to connect from the microcontroller to the servo, including a Vcc pin to connect to the 5Vdc power supply, a ground (GND) pin, and a communication pin with the controller's RC0/RC1 pin.

4.2.6 Ir infrared obstacle avoidance block

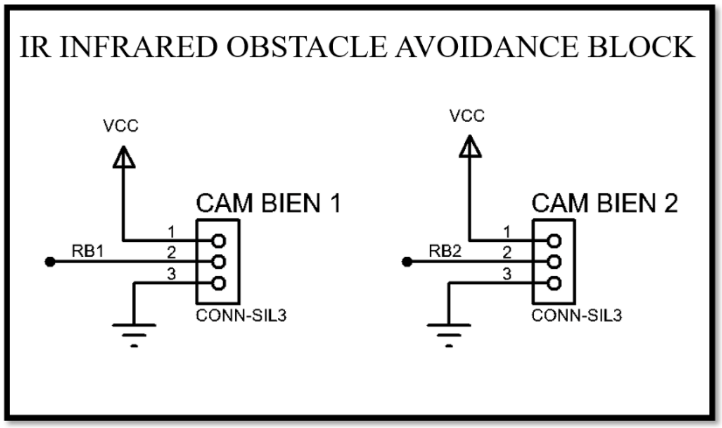


Figure 4-8 Ir infrared obstacle avoidance block

This module has a header with 3 pins to connect from the microcontroller to the Ir infrared obstacle avoidance sensor, including a Vcc pin to connect to the 5Vdc power supply, a ground (GND) pin, and a communication pin with the controller's RB1/RB2 pin.

4.2.7 Main processing block

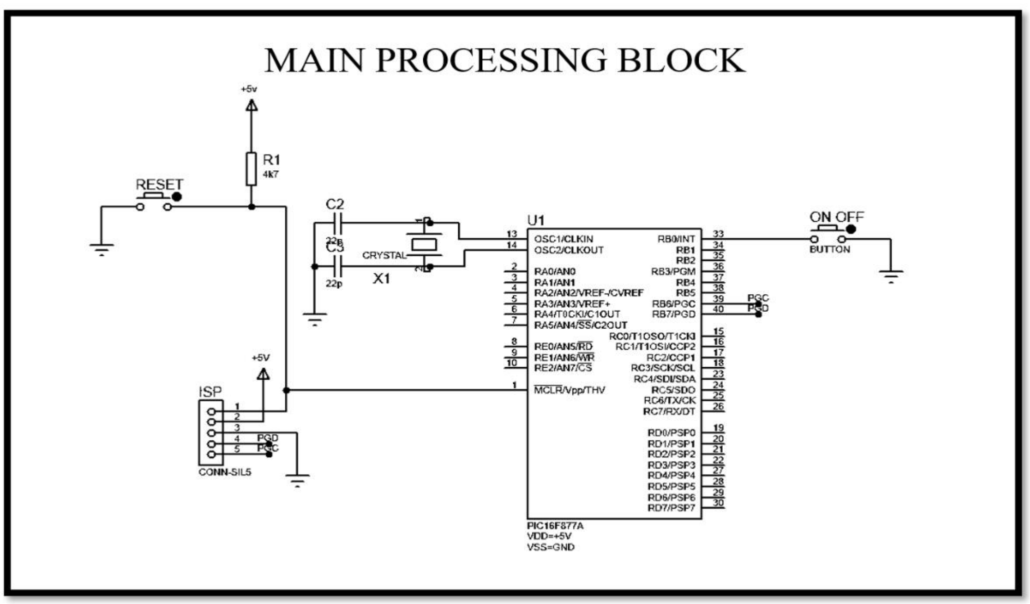


Figure 4-9 Main processing block

This block uses the Pic16F877A microcontroller to receive signals from functional blocks, then process and output control signals as required. This module includes a crystal oscillator, buttons, and connection pins for programming the microcontroller.

Button block: sends signals to the main processing block, PIC16F877A, to allow the user to reset the system or turn it on/off.

4.3 Complete printed circuit board (PCB) circuit

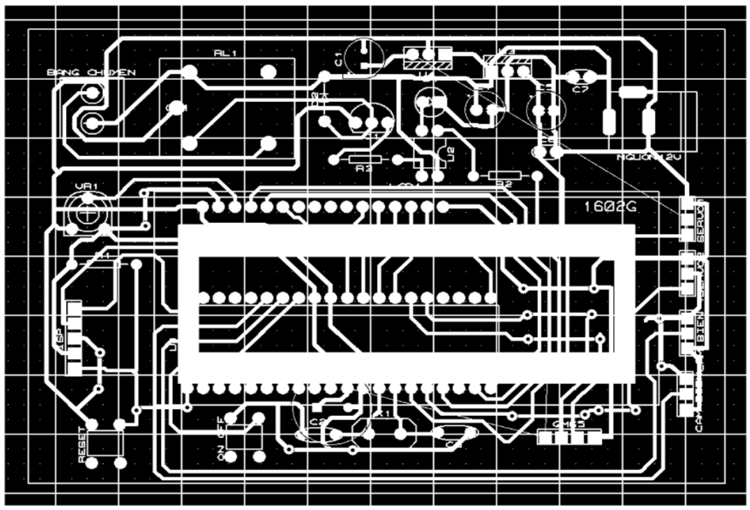


Figure 4-10 Printed circuit board in 2D

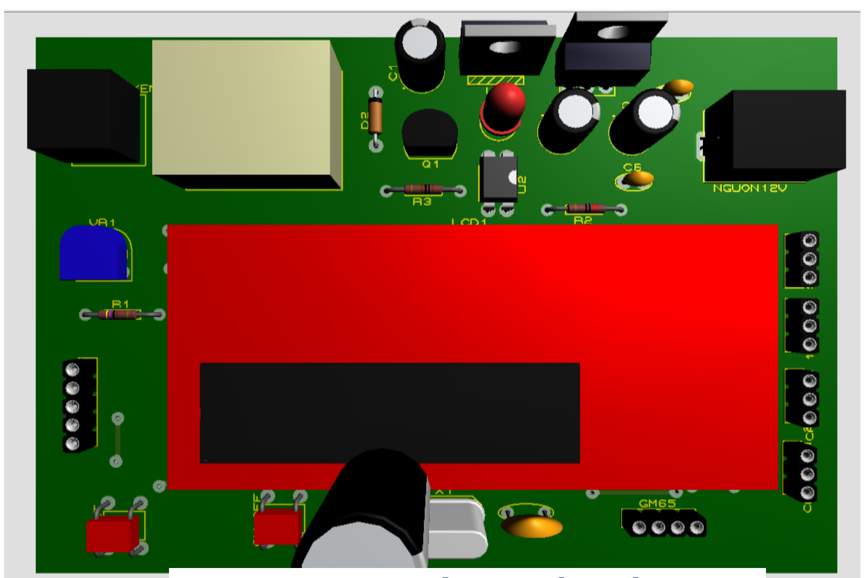


Figure 4-11 Printed circuit board in 3D

4.4 Flowchart

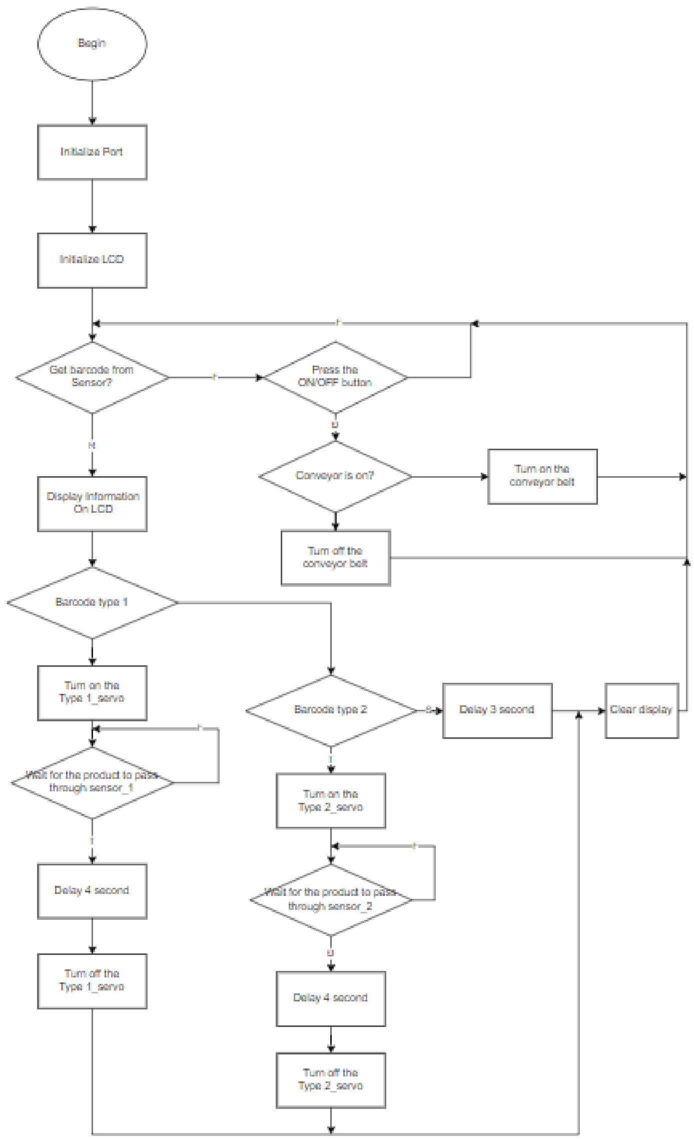


Figure 4-12 Flowchart of the system

4.5 System model

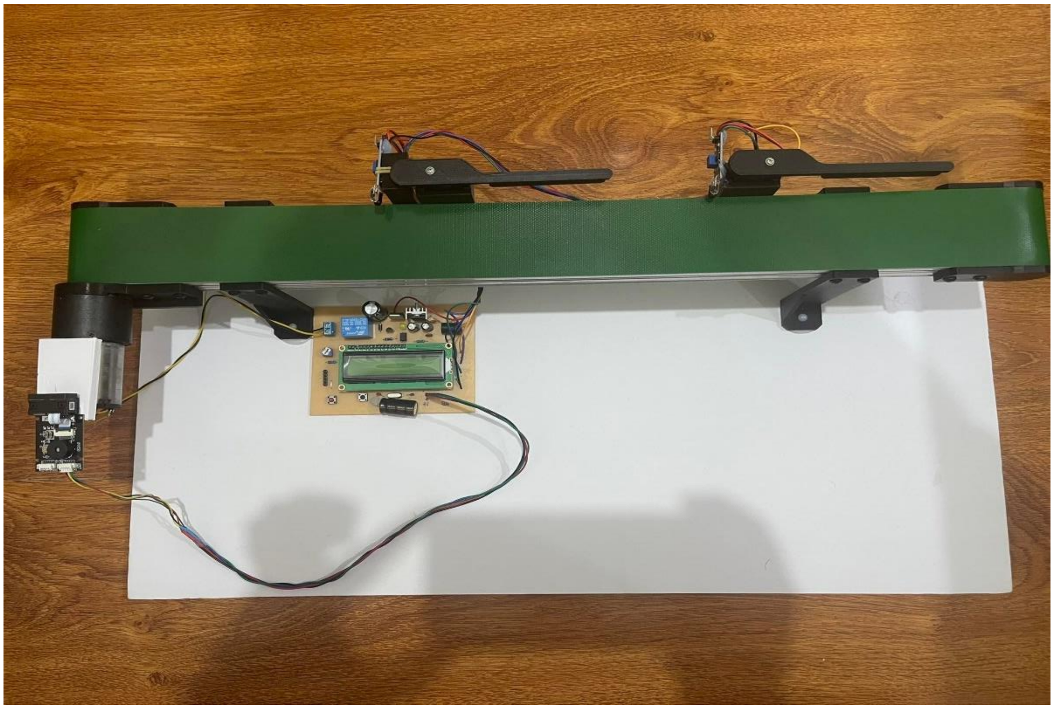


Figure 4-13 System module

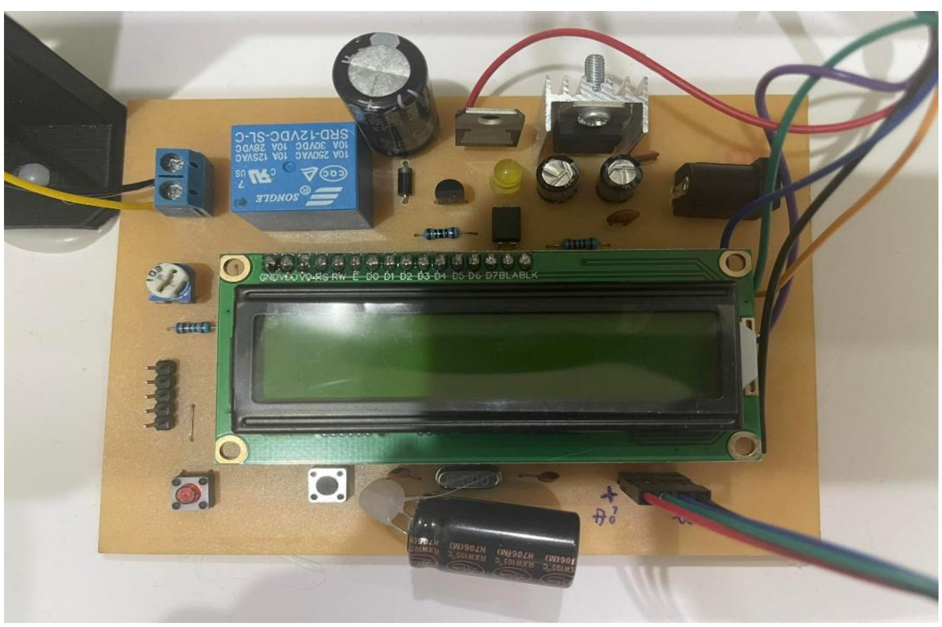


Figure 4-14 Printed circuit

CHAPTER 5. CARRY OUT EXPERIMENT

5.1 Experimental process

Step 1: Supply power using a 12VDC-3A adapter

Step 2: Press the Start button

Step 3: Put product type 1 on the conveyor belt

Step 4: Put product type 2 on the conveyor belt

Step 5: Put other types of products on the conveyor belt

Step 6: Wait for the other types of products to finish running on the conveyor belt

Step 7: Press the Stop button

Step 8: Disconnect the power supply from the circuit

5.2 Experimental results

After supplying power, the two lights on the infrared obstacle sensor light up, and the barcode reader GM65 also lights up. The LCD displays the text "HT PHAN LOAI SP" (Product Classification System) and "STOP" below it. After pressing the Start button, pin C2 of the microcontroller goes high, and the conveyor belt starts running.

When product type 1 passes through the GM65 barcode reader sensor, the sensor sends a character string to the 16F877A microcontroller for processing. The microcontroller compares the received barcode string with the two pre-defined barcodes. If it matches barcode type 1, servo motor 1 will immediately sweep, and after the product passes through infrared obstacle sensor 1, servo motor 1 returns to its original position after 4 seconds. The scanned barcode will be displayed on the LCD screen, along with the product type. This will also be done in the same way for product type 2.

For other types of products, the LCD screen only shows the barcode, and the servo motor does not operate, and the product goes straight to the end of the conveyor belt.

The experimental results achieved were consistent with the initial expectations in Chapter 1.

CHAPTER 6. CONCLUSION

6.1 Advantages

- High accuracy: The GM65 barcode reader sensor is a highly accurate barcode reader sensor that can provide the value of many different types of barcodes.
- Easy to use: This system uses very popular hardware components such as pic 16F877A, sg90 servo motor, and infrared obstacle sensor, which are familiar components to many students, making it very easy to install and use the system.
- Easy to expand and repair: The system is designed for easy expansion and repair. It is easy to add features or upgrade hardware.
- Convenient: by reducing labor costs, increasing productivity while still ensuring product quality, and reducing product costs in order to compete in the market.
- Components: Sensitive sensor with instant response without delay, the barrier is controlled by servo, so the rotation angle is very accurate and the LCD screen displays clear text and sufficient information.

6.2 Disadvantages

- Difficulty in displaying data on a small screen: The 1602 LCD screen is small in size, therefore displaying all the data can be challenging.
- No storage feature: This system only has the function of reading and directly displaying values, there is no storage function to track the quantity and types of barcodes read over time.

6.3 Development

- Increasing the quantity and types of products requiring classification by changing or expanding the conveyor.
- Increasing the speed and reliability of barcode reading by using higher-end GM65 modules or combining with vision technology to recognize products through cameras.
- Enhancing connectivity and data transmission by utilizing wireless interfaces such as Bluetooth, WiFi, Zigbee, etc., to send barcode information from pic 16f877A to computers or smartphones.
- Improving management and statistical capabilities by developing software or mobile applications to display, store, and process barcode data of classified products.

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APPENDIX

Program code on CCS C Compiler:

```
#include <16F877A.h>
#fuses NOWDT, PUT, HS, NOPROTECT, NOLVP
#use delay(crystal=8000000)
#use rs232(baud = 9600, parity=N, xmit = pin_c6, rcv = pin_c7, bits=8)

#define LCD_ENABLE_PIN  PIN_D2
#define LCD_RS_PIN      PIN_D0
#define LCD_RW_PIN      PIN_D1
#define LCD_DATA4       PIN_D4
#define LCD_DATA5       PIN_D5
#define LCD_DATA6       PIN_D6
#define LCD_DATA7       PIN_D7
#include <lcd.c>

#define SERVO1 PIN_C0
#define SERVO2 PIN_C1

#define MOTOR PIN_C2
#define BTONOFF PIN_B0

#define SENSOR1 PIN_B1
#define SENSOR2 PIN_B2
```

```
char Code1[8]={'8','9','3','5','3','2','1','2'};
char Code2[8]={'6','9','0','6','7','8','1','0'};

char UARTBuffer[50];
int8 ByteCount=0;
int8 RunState=0;
int8 BarCodeReady=0;
int8 NumberOfChar=0;
int8 CheckResult=0;

#INT_RDA
void  RDA_isr(void)
{
  char c = getc();

   if(c==0x0D)
    {
      NumberOfChar=ByteCount;
      ByteCount=0;
      BarCodeReady=1;
    }
    else
    {
      UARTBuffer[ByteCount]=c;
      ByteCount++;
```

```
    if(ByteCount>49)
    {
      ByteCount=0;
    }
  }
}

void CheckCode()
{
  int8 Result;
  int8 i;

  Result=1;
  for(i=0;i<NumberOfChar;i++)
  {
    if(UARTBuffer[i]!=Code1[i])
    {
      Result=0;
    }
  }
  if(Result==1)
  {
    CheckResult=1;
    return;
  }
```

```
  Result=2;
  for(i=0;i<NumberOfChar;i++)
  {
    if(UARTBuffer[i]!=Code2[i])
    {
      Result=0;
    }
  }
  if(Result==2)
  {
   CheckResult=2;
   return;
  }
  CheckResult=0;
}

void RunServo1(int32 Angle)
{
 int8 i;
 int32 TimePulseHigh;

 TimePulseHigh=1650*Angle/180;

 for(i=0;i<10;i++)
 {
```

```
    output_high(SERVO1);
    delay_ms(1);
    delay_us(TimePulseHigh);
    output_low(SERVO1);
    delay_ms(18);
  }
}

void RunServo2(int32 Angle)
{
  int8 i;
  int32 TimePulseHigh;

  TimePulseHigh=1650*Angle/180;

  for(i=0;i<10;i++)
  {
    output_high(SERVO2);
    delay_ms(1);
    delay_us(TimePulseHigh);
    output_low(SERVO2);
    delay_ms(18);
  }
}
```

```
void RunMotor()
{
 output_high(MOTOR);
}

void StopMotor()
{
 output_low(MOTOR);
}

void DisplayMain()
{
 lcd_putc("\f");
 lcd_putc(" HT PHAN LOAI SP");
 lcd_gotoxy(1,2);
 if(RunState==0) lcd_putc("      STOP     ");
 else lcd_putc("MA:          L: ");
}

void DisplayType(int8 TypeDisplay)
{
  lcd_gotoxy(16,2);
  lcd_putc(TypeDisplay+48);
}
```

```
void OnGate1()
{
  RunServo1(0);
}
void OffGate1()
{
 RunServo1(60);
}
void OnGate2()
{
  RunServo2(0);
}
void OffGate2()
{
 RunServo2(60);
}

void main()
{
   int i;
   SET_TRIS_D(0x00);
   SET_TRIS_B(0xFF);
   SET_TRIS_C(0x80);
   enable_interrupts(INT_RDA);
   enable_interrupts(GLOBAL);
```

```
Output_low(SERVO1);
Output_low(SERVO2);
port_B_pullups(0x01);
OffGate1();
OffGate2();

StopMotor();
lcd_init();
DisplayMain();
while(1)
{
  if(input(BTONOFF)==0)
  {
   delay_ms(250);
   while(input(BTONOFF)==0);
   if(RunState==0)
   {
    RunState=1;
    RunMotor();
    DisplayMain();
    ByteCount=0;
   }
   else
   {
```

```
  RunState=0;
  StopMotor();
  DisplayMain();
  ByteCount=0;
 }
}

if(BarCodeReady==1)
{
 if(RunState==1)
 {
   lcd_gotoxy(4,2);
   for(i=0;i<NumberOfChar;i++)
   {
       lcd_putc(UARTBuffer[i]);
   }
       CheckCode();
       if(CheckResult==1)
       {
         DisplayType(1);
         OnGate1();
         while(input(SENSOR1)==1);
         delay_ms(4000);
         OffGate1();
         DisplayMain();
```

```
            }
            else if(CheckResult==2)
            {
              DisplayType(2);
              OnGate2();
              while(input(SENSOR2)==1);
              delay_ms(4000);
              OffGate2();
              DisplayMain();
            }
            else
            {
              delay_ms(3000);
              DisplayMain();
            }
         }
         ByteCount=0;
         BarCodeReady=0;
      }
   }
}
```