Automated Package Separator

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Advanced Mechatronics ROB-GY6103

Term Project -1

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This journey would not have been possible without the support and encouragement of these exceptional individuals. Thank you for being constant pillars of knowledge and inspiration in our academic endeavors."

Abstract

This project revolves around the development of an innovative Automatic Package Separator system using Arduino technology. The primary objective is to streamline and enhance the efficiency of package segregation based on their respective addresses.

Key Components:

Arduino Microcontroller: The core of the system, managing the integration of various components and facilitating seamless communication.
1D/2D Barcode Scanner (Waveshare): Utilizing the Waveshare barcode scanner with UART communication protocol for accurate and efficient address detection.
Servo Motors: Employing multiple servo motors to actuate the conveyor system, ensuring precise and controlled movement of packages.
DC Motor: A DC motor converts direct current (DC) electrical energy into rotational mechanical energy
Ultrasonic Sensor: The Parallax PING))) Ultrasonic Sensor utilizes ultrasonic sound waves to measure distances and is commonly employed for object detection, navigation, and avoidance in various projects.
LCD Display Module: An LCD (Liquid Crystal Display) module is a versatile electronic visual display that is commonly used to provide real-time information in various devices.

Operational Overview:

1D/2D Barcode Address Detection: The system employs a 2D barcode scanner for quick and accurate reading of package addresses. The simplicity and efficiency of 2D barcodes contribute to the speed and reliability of the detection process.
Conveyor Actuation: Arduino, in collaboration with servo motors, controls the conveyor system. Upon successful address detection, the servo motors activate, guiding the packages towards their designated bins for further processing.
Segregation Mechanism: The servo motors play a crucial role in diverting packages to specific bins based on their 1D barcode addresses. This automated approach ensures a systematic and error-free package segregation process.

- **Introduction**

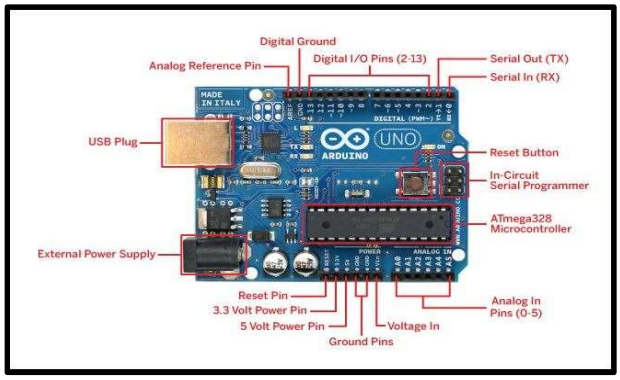
In the dynamic landscape of logistics and supply chain management, the demand for innovative solutions to optimize package handling has never been more critical. This project endeavors to meet this demand by introducing an Automatic Package Separator, a sophisticated system driven by Arduino Uno, designed to revolutionize the segregation process through the incorporation of a 1D/2D barcode scanner.

- **Problem Statement**

Traditional manual sorting processes are inherently time-consuming, error-prone, and resource-intensive. In response to these challenges, our project aims to automate the segregation of packages based on their addresses, mitigating errors and significantly increasing operational efficiency.

- **Technological Foundation**

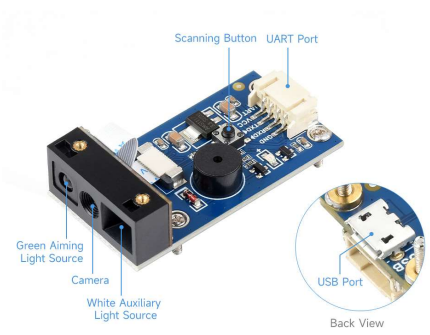
Arduino Uno Microcontroller: At the core of our system lies the Arduino Uno, a versatile and widely-used microcontroller. Its compact size and capabilities make it a suitable choice for coordinating the various components of our Automatic Package Separator.



Microcontroller	ATmega328
Clock Speed	16MHz
Operating Voltage	5V
Maximum supply Voltage (not recommended)	20V
Supply Voltage (recommended)	7-12V
Analog Input Pins	6
Digital Input/Output Pins	14
DC Current per Input/Output Pin	40mA
DC Current in 3.3V Pin	50mA
SRAM	2KB
EEPROM	1KB
Flash Memory	32KB of which 0.5KB used by boot loader

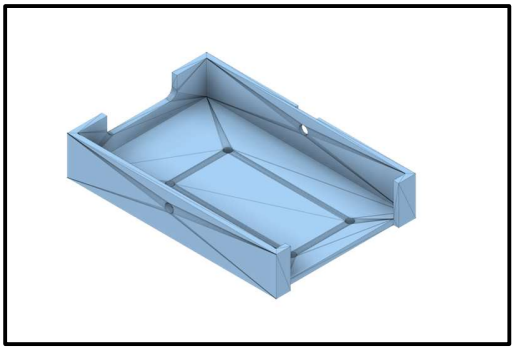
- **1D/2D Barcode Scanner (Waveshare)**

The heart of our address detection mechanism is the Waveshare 1D/2D barcode scanner, utilizing a UART communication protocol. This scanner is strategically chosen for its accuracy, efficiency, and simplicity in reading 1D/2D barcodes.

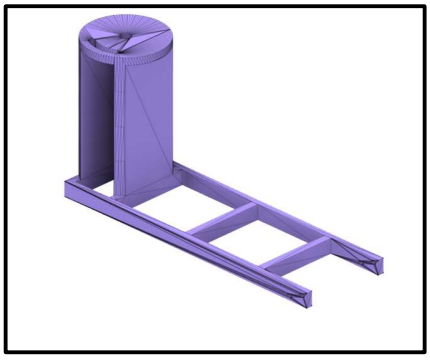


Operating Voltage	5V
Operating Current	135mA
Standby Current	58mA
Sleep Current	2mA
Operating Temperature	0°C~60°C
Operating Humidity	5%~95%(Non-condensing)
Interfaces	UART, USB
Light Source	White
Scan Angle	Tilt 360°, Skew ±65°, Pitch ±60°
FOV	28°(Horizontal), 21.5°(Vertical)

Specifications of the Barcode scanner



barcode scanner housing

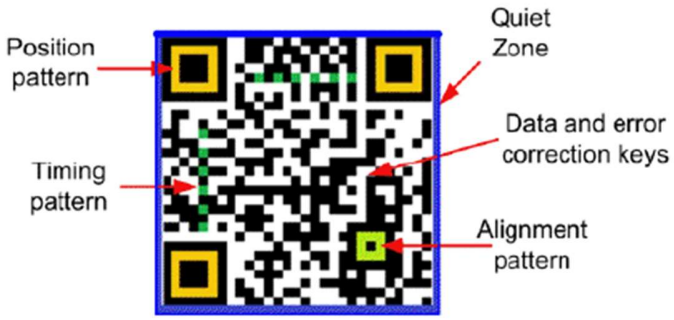


Barcode scanner mount

- **Operational Mechanism**

Address Detection: The 1D/2D barcode scanner is integrated into the system to facilitate the swift and accurate reading of package addresses. As a package passes through the scanning point, the barcode scanner decodes the information embedded in the 2D QR code.

The QR Codes illustrate various addresses according to the Area Code and Zip Code of NYC's Brooklyn(718-11201), Queens(929-11355) and Manhattan(212-10002)

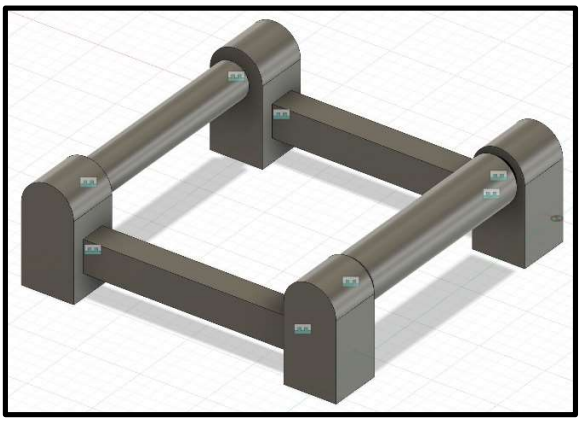


- **Arduino Uno Control**

The Arduino Uno processes the information received from the barcode scanner, leveraging its processing power to interpret the package's destination based on the scanned address. This information serves as the trigger for the subsequent stages of the segregation process.

- **Conveyor Mechanism**

One DC motor, intricately connected to the Arduino Uno, is employed to actuate the conveyor system. Upon successful address detection, the Arduino commands the servo motors to guide the package towards its designated bin.



- **Segregation Mechanism**

A dual-axis turntable with servomotors is a mechanism that allows for rotation along two independent axes. This type of system is commonly used in applications such as robotics, photography, or any scenario where precise control of rotation in two dimensions is required.

Image illustrates the segregation mechanism employed by two servos

Components of the segregation mechanism

- ***Servo Motors:***

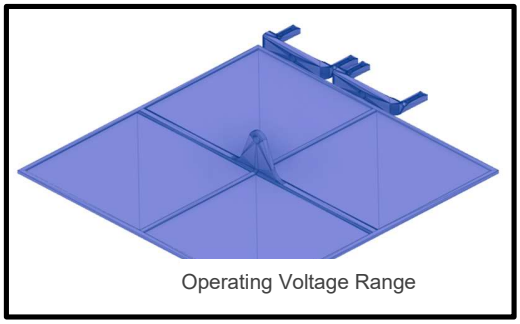
Two servo motors are used, each responsible for controlling rotation along one axis.
Servo Motors are preferred due to their precision, ease of control, and ability to maintain specific positions.

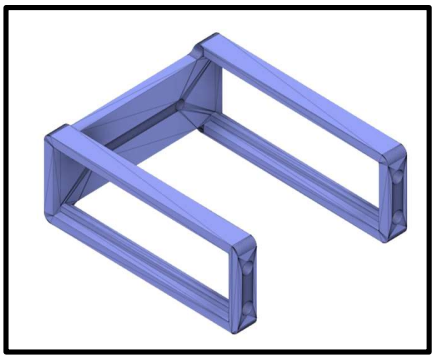
Feature/Specification	***Value***
Stall Torque	9.4 kgf·cm (4.8 V), 11 kgf·cm (6 V)
Operating Speed	0.17 s/60° (4.8 V), 0.14 s/60° (6 V)
Operating Power Range	4.8V - 7.2V
Operating Current Range	500mA - 900mA
Bearing Design	Stable and shockproof double ball bearing
Temperature Range	0 °C – 55 °C

Specs of MG 996R servo motor

- ***Turntable Platform:***

The turntable platform is the surface on which the object or device is placed for rotation.
It should be designed to handle the weight and size of the objects being rotated. This was designed in CAD and was later 3D printed.





Tilt-table & Tilt-table Servo Mount

- ***Turntable mount:***

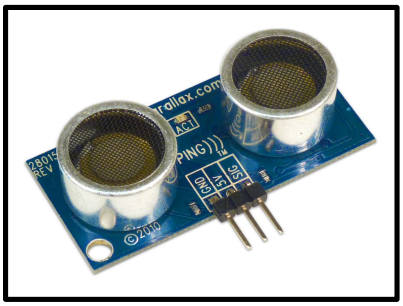
A mount was designed in CAD which will help in holding the servo motors. This mount will be mounted on the conveyor body.

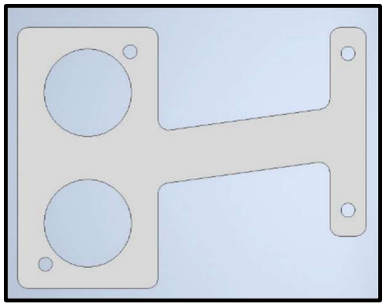
- ***Base Structure:***

The base structure holds and supports the turntable platform, ensuring stability during rotation.
It may include bearings or other mechanisms to reduce friction and facilitate smooth rotation.

- **Parallax PING)))**

The Parallax PING))) Ultrasonic Sensor is a popular ultrasonic range finder used in robotics and automation applications. It utilizes ultrasonic sound waves to measure distances and is commonly employed for object detection, navigation, and avoidance in various projects.



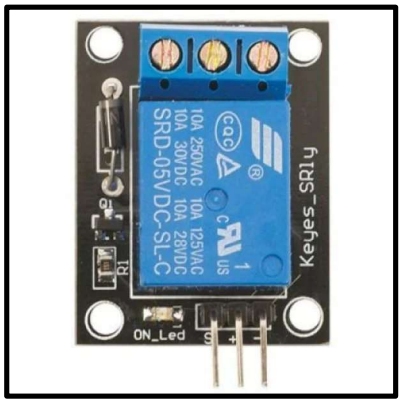


Parameter	***Value***
Range	2 cm to 3 m
Interface	Bidirectional TTL pulse
	Single I/O pin
Communication Compatibility	5 V TTL or 3.3 V CMOS microcontrollers
Input Trigger	Positive TTL pulse
	2 µs min, 5 µs typ.
Echo Pulse	Positive TTL pulse
	115 µs minimum to 18.5 ms maximum
Operating Power	5V

Specs of PING))) sensor

- **Relay**

A relay is an electrically operated switch that uses a small current to control a larger current.

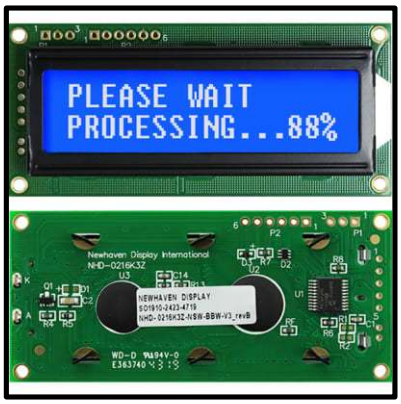


Feature/Specification	***Value***
Switching Capacity	10A
	(despite small size design for high-density P.C. board mounting technique)
Material	Plastic (selected for high temperature and better chemical solution performance)
Magnetic Circuit	Simple relay magnetic circuit
Cost	Low (to meet the low cost of mass production)
Rating	7A/240VDC, 10A/250VDC, 10A/125VAC 28VDC 10A/240VAC 28VDC
Operating Voltage	5V

Specs of the relay

- **LCD Display Module**

An LCD (Liquid Crystal Display) module is a versatile electronic visual display that is commonly used to provide real-time information in various devices.



Feature/Specification	***Value***
Display Type	Clear 40-pixel characters (8 H x 5 W)
Character Set	ASCII DEC characters 32-127
Text Handling	Automatic text wrapping
Clear Command	Single command clears the display
Baud Rate Options	2400, 9600, or 19,200 baud (selectable)
Interface Switches	Switches on the device for baud rate selection
Contrast Adjustment	Adjustable contrast knob on the back
Operating Power	5V
Power Consumption	20mA (light off), 80mA (light on)

Specs of the LCD module

- **Technological Choice:**

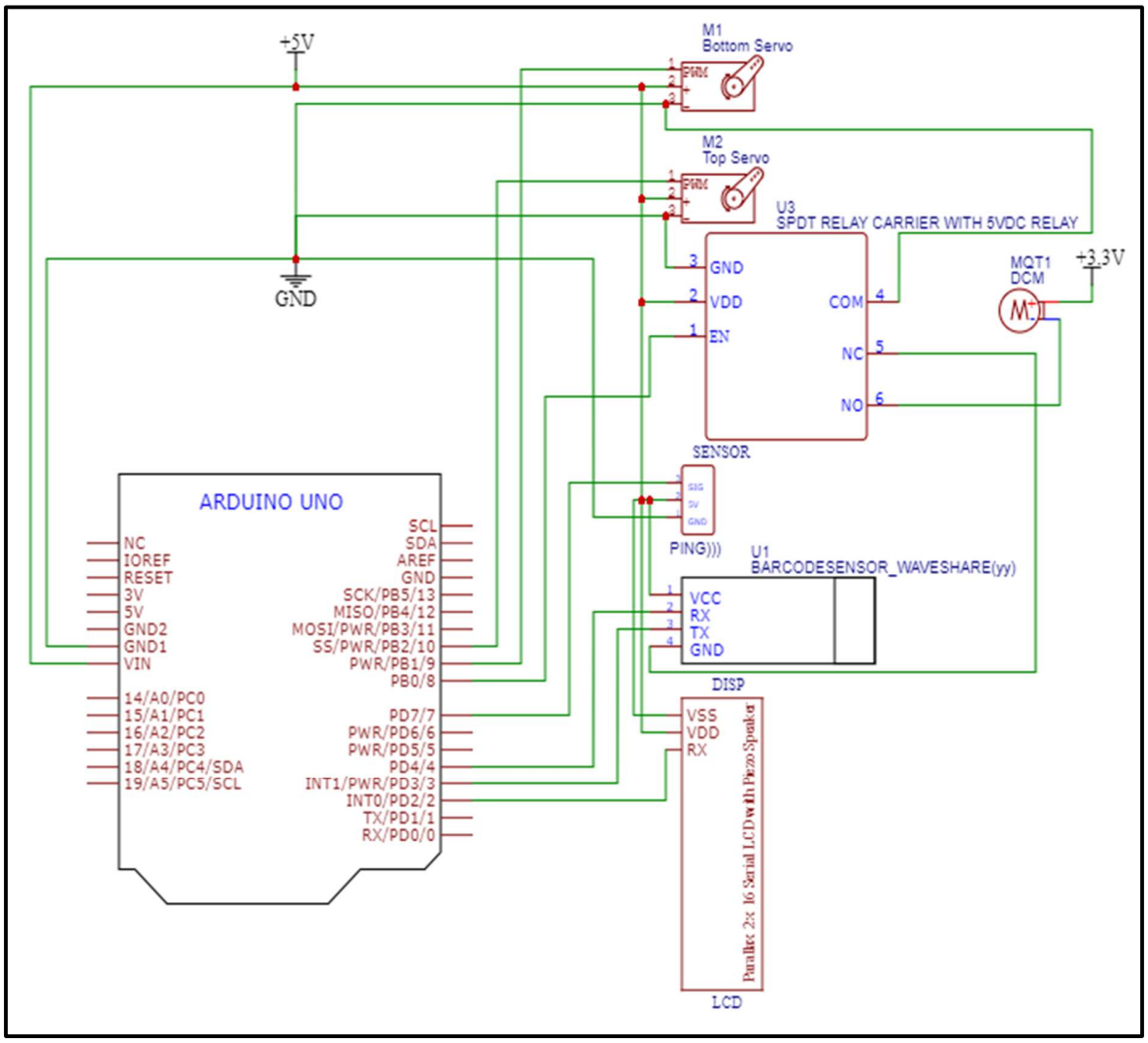
The decision to employ 2D barcode scanning over alternative methods is grounded in the technology's proven simplicity and efficiency. By opting for 2D barcodes or QR codes, we enhance the overall precision of address detection, a crucial factor in the success of our Automatic Package Separator.

- **Project Objectives:**

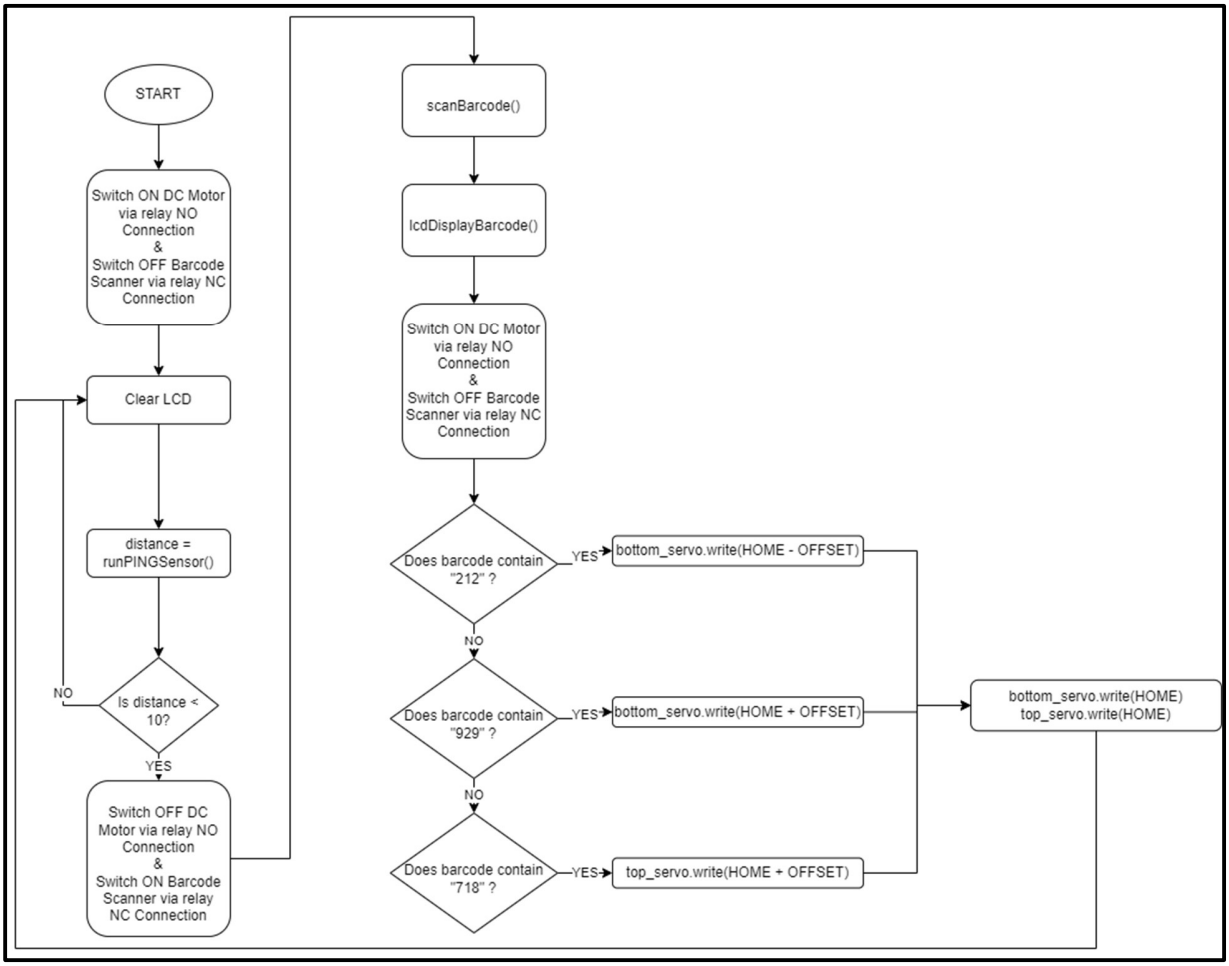
This project seeks to minimize manual efforts, decrease the occurrence of sorting errors, and significantly improve the speed and accuracy of the package handling process. Through the integration of advanced technologies, we aspire to set a new standard for automated logistics solutions.

As we delve deeper into the subsequent sections of this report, we will provide detailed insights into the system design, operational functionalities, and potential avenues for future enhancements, showcasing the meticulous planning and execution that underpins the success of our Automatic Package Separator.

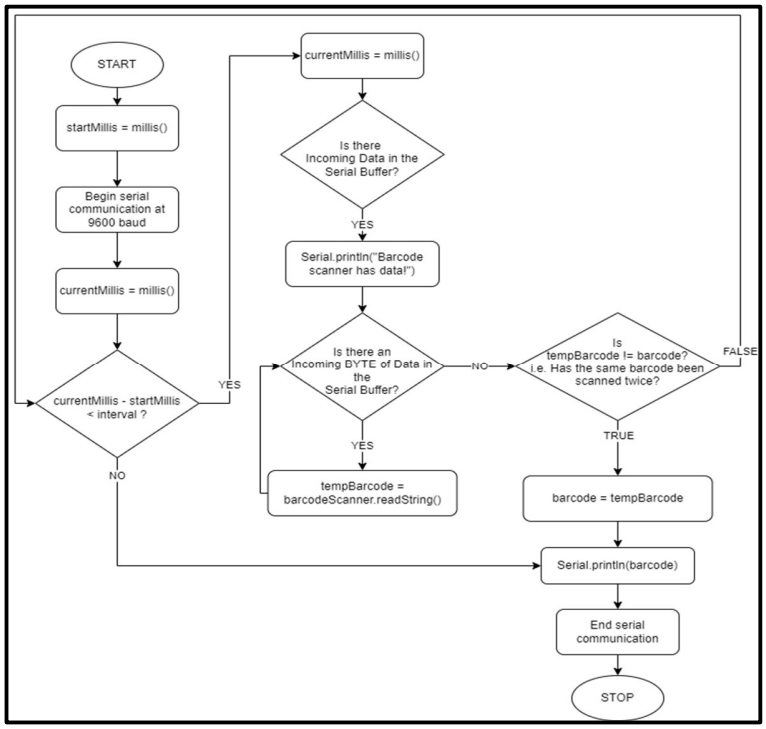
Circuit Schematic



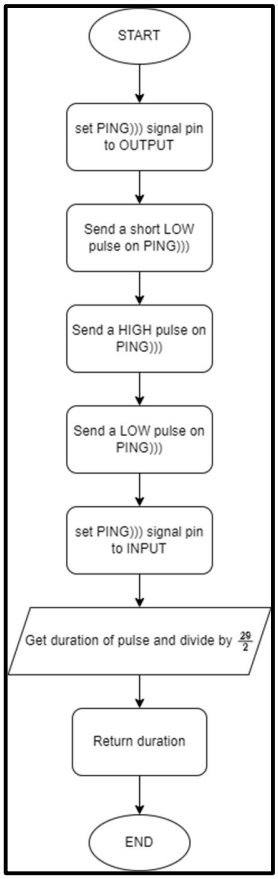
Flowcharts



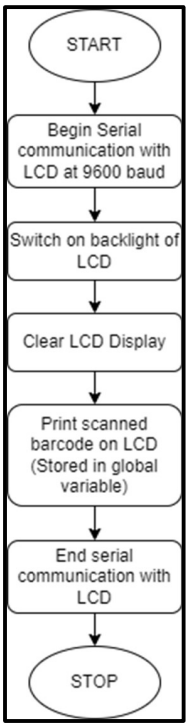
Main flowchart



QR Code Scanner flowchart



PING Sensor flowchart



LCD Flowchart

Applications:

1. ***E-commerce warehousing:*** In e-commerce fulfillment centers, an intelligent package sorter streamlines the sorting and routing of packages, ensuring timely and accurate deliveries.The system can handle a high volume of packages with different sizes and destinations efficiently.

2. ***Distribution Centers***: Distribution centers for retail, manufacturing, or any industry can benefit from an intelligent package sorter to automate the sorting process, reducing manual labor and minimizing errors.

3. ***Postal Services:*** National and international postal services can utilize intelligent package sorters to enhance the speed and accuracy of package sorting, leading to faster and more reliable deliveries.

Future Enhancements

1. ***Machine Learning Integration:*** Implement machine learning algorithms to continuously optimize sorting algorithms based on historical data, package types, and destination patterns. This can enhance predictive sorting accuracy.

2. ***Robotics Integration:*** Explore the integration of robotics for more automated handling of packages. Robots could assist in loading and unloading packages onto conveyor systems, further reducing the need for manual labor.

3. ***Cascaded Network of Modules:*** Each such system can be considered as a module and many such modules can be integrated and synchronized for multilevel sorting. Its working would be akin to that of transistors in a processor.

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