DESIGN AND IMPLEMENTATION OF AUTONOMOUS DELIVERY ROBOT USING ADUINO AND PROTEUS.

200 LEVEL 1ST SEMESTER PROJECT.

ICT 215-ROBOTICS.

COLLEGE OF ENGINEERING

BELLS UNIVERSITY OF TECHNOLOGY-NEW HORIZONS

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DECLARATION

We hereby declare that this is our own original work of the project design “AUTONOMOUS DELIVERY ROBOT”. We therefore declare that the information in this report is original and has never been submitted to any other institution, university or college other than Bells University of Technology.

Names and Signatures:

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CHAPTER ONE

1.0 INTRODUCTION

A lot of businesses are now doing online shopping and ordering. The autonomous delivery robot are used now as an easier means to deliver products and goods that have been ordered.

Autonomous delivery robots are self-driving robots designed to transport goods and packages without human intervention. These robots use advanced technologies such as Artificial Intelligence (AI), computer vision, machine learning, and sensor integration to navigate their environment and execute delivery tasks efficiently.

They are usually equipped with GPS systems, cameras, LiDAR, and ultrasonic sensors, these robots can map their surroundings, avoid obstacles and adapt to dynamic conditions. They are usually used in urban areas, campuses, warehouses and other controlled environment to deliver food, groceries, parcels or other supplies.

The use of autonomous delivery robots is driven by their potential to enhance delivery efficiency, reduce costs and minimize carbon footprints. Major companies like Amazon, Starship Technologies and FedEX are at the forefront of deploying this robots to revolutionize last mile delivery.

As technology advances, autonomous delivery robots are becoming extremely reliable and capable of operating in complex environment, paving the way for a new era of logistics and transportation.

1.1BACKGROUND OF THE STUDY

Delivery robots are an innovative solution that emerged from advancement in robotics, artificial intelligence (AI), and automation. They were developed to address challenges in logistics, like increasing demand for faster deliveries, rising operational costs and environmental concerns.

1.1.1 HISTORICAL CONTEXT

- EARLY DEVELOPMENT

The concept of delivery robots can be traced back to the mid-20th century when autonomous systems were first explored for industrial automation. The first electronic autonomous delivery robots with complex behavior were created by William Grey Walter of the Burden neurological Institute in Bristol, England in 1948 and 1949. However, the idea gained traction in the 2010s with the rise of E-commerce and urban delivery challenges.

- COMMERCIAL INTRODUCTION

Companies like Starship Technologies and Amazon began experimenting with the delivery robots around 2015. These early prototypes were small, ground-based robots designed for short distance, last-mile deliveries.

- TECHNOLOGICAL ADVANCES

The integration of AI, machine learning, GPS, LiDAR, and advanced sensors enabled robots to navigate complex environments, avoid obstacles and interact with humans effectively.

1.1.2 KEY MILESTONES

- Early Autonomous Robotics: In the 1990s autonomous mobile robots were initially developed for industrial and warehouse use, focusing on material handling. These early systems laid the groundwork for outdoor delivery applications.

- DARPA Grand Challenge: In 2005 autonomous vehicle research advanced significantly with the DARPA Grand Challenge, which spurred innovation in navigation and obstacle avoidance. Many technologies developed for autonomous cars influenced the design of delivery robots.

- Starship Technologies: In 2014,Starship Technologies pioneered small autonomous robots for urban delivery, setting the stage for commercial adoption.

- Dominos Pizza Delivery Robot: In 2016 Dominos unveiled the DRU(Dominos Robotic Unit), an autonomous robot designed to deliver pizza in Australia, showcasing how robots could enhance food delivery.

- Marble Robots Launch in San Francisco: In 2017 Marble introduced delivery robots equipped with advanced sensors and cameras, marking one of the first major deployment in a bustling city environment.

- JD.com’s Autonomous Deliveries in China: In 2018 Chinese e-commerce giant launched autonomous delivery robots in urban areas, signaling rapid adoption in the Asian market.

- Amazon Scouts: Amazon introduced its delivery robots in 2019, designed for efficient last-mile delivery in residential areas.

- Pandemic Driven Adoption: In 2020 the COVID-19 pandemic accelerated the deployment of delivery robots to meet demand for contactless deliveries.

- Regulatory Approvals: Governments and municipalities began establishing regulations to accommodate autonomous robots on sidewalks and streets, enabling wider deployment.

- There are many more key milestones that have occurred and many more yet to occur.

1.2 OBJECTIVES OF THE STUDY

- Enhancing efficiency of delivery robots.
- Reducing costs.
- Increasing accessibility to delivery robots around the world.
- Enhancing safety relating to delivery robots.
- Increasing sustainability.
- Reducing human labour.

1.3 RESEARCH QUESTIONS.

ON TECHNOLOGY AND DESIGN:

- What are the key technological components required for the effective operation of autonomous delivery robots?
- What are the limitations of current sensor technologies (e.g cameras,LiDAR) in complex urban environments?

4

ON APPLICATION AND PERFORMANCE:

- How can delivery robots be optimized for specific industries such as healthcare, food delivery or e-commerce?
- What are the challenges in scaling autonomous delivery robots operation in densely populated cities?

ON ECONOMIC AND BUSINESS IMPACT:

- How do delivery robots influence the cost structure of last-mile delivery?
- How can small businesses leverage delivery robots to compete with larger companies?

ON SOCIETAL IMPACT:

- How do delivery robots contribute to reducing carbon emissions and promoting sustainable logistics?
- What are the ethical implications of deploying delivery robots in public spaces?

ON REGULATION AND POLICY:

- What measures can ensure the safety and security of delivery robots in public spaces?
- How do different countries and regions approach the regulation of delivery robots?

ON FUTURE INNOVATIONS:

- What are the potential applications of delivery robots beyond logistics suh as emergency response or disaster relief?
- What role can delivery robots play in smart cites and urban planning?

ON USER EXPERIENCE:

- What factors influence customer satisfaction when interacting with delivery robots?

- How can companies address privacy concerns related to data collected by delivery robots?

1.4 SIGNIFICANCE OF THE STUDY.

- It leads to improved innovations.
- It leads to problem solving.
- It increases cost effectiveness.
- It increases market opportunities.
- It increases sustainability.
- It leads to increase in urban mobility.
- It explores ways to ensure accessibility.
- It allows for informed decision making.
- It allows for global competitiveness.
- It acts as a foundation for future innovations.

In summary, the study of delivery robots is significant for advancing technology, improving business operations, fostering sustainability, shaping the future of logistics and automation and many more. It has potential to create a lasting impact on industries and society as a whole.

1.5 SCOPE OF THE STUDY.

The scope of this study defined the areas to be covered, ensuring a comprehensive understanding of delivery robots and their applications. It includes an analysis of their technological, economic, societal, and environmental aspects while focusing on their current use and future potential.

CHAPTER 2

METHODOLOGY.

The methodology outlines the research approach, data collection, components used in the delivery robots, system design and analysis methods to systematically study delivery robots. This ensures a structured investigation of their design, application, challenges and impacts.

2.1 SYSTEMS COMPONENT.

- ❖ Arduino as the brain: It is a microcontroller that acts as the central control unit processing inputs from sensors and sending command to actuators. It executes the programmed instructions such as navigating, obstacle avoidance e.t.c.

Arduino is made of other components for the development of the robot like sensors in which we used the ultrasonic sensor, the actuator where we used L293D as the motor driver, MOTOR as the DC motor and the power supply where we used Vsource.

- ❖ ULTRASONIC SENSORS: This is a device that uses ultrasonic waves to measure distances or detect objects. It is usually used for robotics, automation and obstacles detection so, it is a good choice when picking a sensor.

HOW DO ULTRASONIC SENSORS WORK.

- Emission: The sensors transmitter emits ultrasonic sound waves in the air.
- Reflection: When waves hit an object the bounce back to the sensors.
- Reception: The sensor’s receivers captures the reflected waves.

- Calculation: The time taken for the waves to travel the object and back is measured. Using the speed of sound, the distance to the object is

$$\text{Distance}=\frac{\text{time taken}*\text{speed of sound.}}{2}$$

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Another sensor that can be used is HC-SR04. It is the most popular and affordable. LiDAR can also be used as a sensor.

ADVANTAGES OF ULTRASONIC SENSORS.

- It works in low light and no light conditions.
- It is inexpensive and widely available.
- It has high precision for short to medium distances.

LIMITATIONS OF ULTRASONIC SENSORS.

- They are unsuitable for long distance measurements.
- It is temperature dependent because the speed of sound changes with temperature.
- There is difficulty when certain surfaces like soft surfaces, irregular shapes and transparent materials are involved.
- Precision can be incorrect with environmental interference such as noise.

❖ L293D as the motor driver: This is an integrated circuit (IC) used to control DC motors, stepper motors and other actuators in robotics and automation projects. It works as an intermediary between a microcontroller (arduino) and a DC motor allowing the microcontroller to control the motors speed and directions safely.

HOW IT WORKS.

❖ Purpose: It is an H-bridge motor driver IC that can control the direction and speed of up to two DC motors simultaneously. It protects the microcontroller from high current and voltage spikes generated by motors.

❖ Key Features:

- Voltage range: It operates between 4.5V and 36V for motors.
- Current: It provides up to 600mA per channel (peak 1.2A).
- Dual H-Bridge: It can drive two motors independently.
- Enable Pins: It is used to turn each motor on and off and to control speed via PVM (Pulse Width Modulation).

ADVANTAGES OF USING L293D.

- It simplifies motor control in robotics projects.
- It protects the microcontroller from high currents and voltage spikes.
- It can control two motors independently.
- It is affordable.

LIMITATIONS OF USING L293D.

- It has limited current handling (600mA per channel).
- It may require additional heat dissipation for high current application.
- It is inefficient compared to modern motor drivers like L298N or MOSFET-based drivers.

❖ DC Motor as the motor: A DC motor is an electrical device that converts direct current electrical energy to mechanical energy (rotational energy).

HOW IT WORKS

- Purpose: It is a motor widely used in various application where precise control of speed, direction, and torque is required.

- Key Features.
  - Simplicity: It has a simple design that allows it to be used easily.
  - Speed control: The speed can be easily adjusted by varying voltage input and PWM.
  - Direction control: The direction of the robot can be adjusted easily by reversing the polarity of the input voltage.
  - Torque characteristics: They have high starting torque, making them suitable for applications requiring rapid acceleration or heavy loads.
  - Variability: There are different types of DC motors, therefore enabling a wide range of options.
  - Compact and lightweight: They are available in small sizes, making them ideal for portable and space constrained devices.
  - Versatility: It can be used for a wide range of work and in different fields.
  - Response: They have excellent response which allows for fast changes in speed and direction.

ADVANTAGES OF USING DC MOTORS.

- DC motors are easy to replace which reduces cost. In particular brushed DC motors.
- It operates efficiently over a wide speed range.
- They have excellent response which allows for quick change in direction.

LIMITATIONS OF USING DC MOTORS.

- They have a limited lifespan.
- Electrical noise is bound to happen.
- It is sensitive to environment.
- It can become inefficient and generate heat when continuously operated on high speed.

❖ Vsource as the power supply: This refers to the primary power supply or voltage source used to power the delivery robots components such as motors, sensors etc. Examples of common Vsources are Batteries, Supercapacitors, Hybrid power systems.

ROLES OF VSOURCE IN DELIVERY ROBOTS.

- It powers the electric motors responsible for locomotion.
- It supplies power for sensors.
- It supports the robots processing units for decision making.
- It supports additional features like lighting, displays etc.

KEY CONSIDERATIONS FOR VSOURCE IN DELIVERY ROBOTS.

- Voltage requirements.
- Energy capacity.
- Efficiency.
- Safety features.
- Rechargeability.

ADVANTANGES OF USING VSOURCE AS THE POWER SUPPLY.

- It provides a stable and consistent power supply to all components of the robot ensuring smooth operation.
- It can be altered to the specific voltage and current requirements for the delivery robots, improving performance and efficiency.

- It is compatible with various power storage allowing flexibility in power source design.
- It can be scaled up or down depending on the functionality and size of the robot.
- It is easy to integrate into electronic circuits enabling precise control of power distribution to different sub-systems.
- It supports regenerative braking systems allowing energy recovery and reuse which increases operational efficiency.

LIMITATIONS OF USING VSOURCE AS POWER SUPPLY.

- Power losses can occur due to resistance in circuits, inefficiency in voltage regulation or during energy conversion.
- It relies on batteries or other energy storage systems.
- Excessive current draw from Vsource can lead to heat buildup in circuits, requiring additional thermal management systems.
- If powered by poorly recycled batteries it can contribute to environmental pollution.

2.2 DESIGN OF THE SYSTEM.

This is a comprehensive collection of reusable components, guidelines

The designed system employs Arduino, Ultrasonic Sensors, and an L293D Motor Driver to create an efficient and reliable autonomous robot capable of obstacle detection, avoidance, and navigation. Each component plays a crucial role in ensuring the functionality and adaptability of the system. This section describes the design in detail, outlining the purpose and integration of each component and their contributions to the overall workflow.

1. Arduino as the Brain

Arduino serves as the central processing unit (CPU) and the decision-making hub of the system. It controls the interaction between the sensors and the motor driver, ensuring smooth and logical operation based on sensor input.

Role and Functions:

1. Data Collection:

The Arduino collects data from the ultrasonic sensor continuously.

It interprets this data to measure the distance between the robot and obstacles.

2. Data Processing:

It uses predefined algorithms and logic to process the sensor input.

The Arduino determines whether the robot should move forward, stop, or change direction.

3. Motor Control Signals:

After processing the sensor data, it generates appropriate commands for the motor driver.

These commands dictate the speed and direction of the robot's motors.

Features and Advantages:

● Open-source platform, providing flexibility and ease of programming.

● Cost-effective and beginner-friendly, making it ideal for robotics applications.

●Equipped with multiple GPIO pins for connecting sensors and actuators.

●Fast and reliable real-time decision-making capabilities.

●Implementation in the System:

●The Arduino IDE is used to write and upload the code to the Arduino board.

●Sensor inputs are read via the GPIO pins, and motor driver outputs are controlled accordingly.

●The system is programmed to handle dynamic obstacles and respond to changes in the environment.

2. Ultrasonic Sensor for Obstacle Detection

The ultrasonic sensor is the primary component for detecting obstacles in the robot's path. It ensures the robot can navigate without collisions by continuously scanning the environment.

Working Principle:

■The sensor emits ultrasonic waves via its trigPin.

■These waves travel through the air, hit an obstacle, and return to the sensor via the echoPin.

■The time delay between sending and receiving the wave is measured and used to calculate the distance:

■\text{Distance} = \frac{\text{Time (microseconds)} \times 0.034}{2}

■Specifications

■Detection Range: Typically 2 cm to 400 cm.

■Accuracy: ±3 mm.

■Operating Voltage: 5V.

■Trigger Frequency: 40 kHz.

Functions in the System:

1. Continuous Monitoring:

The sensor scans the environment for obstacles and reports distance to the Arduino.

2. Obstacle Avoidance:

If the distance is less than a predefined threshold (e.g., 30 cm), the system identifies an obstacle and takes corrective action (e.g., stopping or turning).

3. Dynamic Adaptation:

The sensor enables the robot to adapt to real-time changes in the environment, ensuring efficient navigation.

Advantages:

●High precision in detecting obstacles.

●Reliable in various lighting and environmental conditions.

●Compact and energy-efficient, making it suitable for mobile robots.

3. L293D Motor Driver for Motor Control

The L293D Motor Driver is used to interface the Arduino with the robot's motors. It serves as an intermediary, allowing the Arduino to control the motors' speed and direction.

Features:

◇Dual H-Bridge design, enabling independent control of two DC motors.

◇Can handle currents up to 600 mA per channel, with a peak of 1.2A.

◇Supports a wide operating voltage range (4.5V–36V).

◇In-built diodes to protect against back EMF from the motors.

Functions in the System:

1. Motor Direction Control:

The L293D allows the motors to move forward or backward by adjusting the polarity of the motor connections.

Arduino signals determine the HIGH/LOW states of the motor driver pins.

2. Motor Speed Control:

The system uses pulse-width modulation (PWM) to control motor speed.

The Arduino generates PWM signals, which the L293D converts into appropriate motor actions.

3. Differential Motor Control:

Independent control of left and right motors enables turning and maneuvering.

Role in the System:

Enables precise and stable movement of the robot in all directions.

Ensures smooth transitions between different movements, such as forward motion, turning, and stopping.

Protects the Arduino from high current demands by directly powering the motors.

System Workflow

The system operates in a continuous loop, where the Arduino, ultrasonic sensor, and motor driver work together to navigate the environment effectively:

1. Obstacle Detection:

The ultrasonic sensor measures the distance to the nearest obstacle and sends the data to the Arduino.

2. Data Processing:

The Arduino processes the sensor input and compares the distance with a predefined threshold (e.g., 30 cm).

3. Decision-Making:

If the distance is greater than the threshold, the robot moves forward.

If the distance is less than the threshold, the robot stops and decides whether to turn left or right to avoid the obstacle.

4. Motor Control:

Based on the decision, the Arduino sends commands to the L293D motor driver.

The motor driver adjusts the speed and direction of the motors to execute the required movement.

5. Navigation Execution:

The robot continues moving, detecting and avoiding obstacles as necessary.

Advantages of the System Design

●Modularity: Components can be upgraded or replaced independently, ensuring flexibility.

●Cost-Effectiveness: All components are affordable and widely available.

●Reliability: The system uses robust components for accurate sensing and motor control.

●Efficiency: Real-time obstacle detection and avoidance ensure smooth and reliable operation.

●Ease of Implementation: The Arduino platform simplifies programming and debugging.

CHAPTER 3

RESULT OF SYSTEM

The code is for Arduino with ultrasonic sensors, motors, and an LCD; there is a pin configuration for each component as the code is compiled for the setup of functions and operation of the sensors and motors to assess distance and display results.

Purpose

The completed code shows that the purpose is to:

1. Take a distance measurement via ultrasonic sensor (echoPin and trigPin).
2. Operate two motors with the ability to spin forward/backward.
3. Use an LCD for display purposes.

Specifics of the Code

Pin Configuration:

Sensor Pins:

echoPin - Pin 7 (output).

trigPin - Pin 6 (output).

Motor pins

FwdRot_leftMotor: Pin 2 (left motor forward rotation).

BckRot_LeftMotor: Pin 3 (left motor backward rotation).

FwdRot_RgtMotor: Pin 4 (right motor forward rotation).

BckRot_RgtMotor: Pin 5 (right motor backward rotation).

LCD Pins:

Pins 13, 12, 8, 9, 10, and 11.

2. Libraries included: the <LiquidCrystal.h> library is included in the control the LCD display.

3. Global variable declared:

long duration; // to store the duration of the ultrasonic pulse coming back

int distance; // to store the distance sensed by the sensor

4. The setup() method: All pins for sensor usage and motors are set to output. Initializes LCD for 16 columns and 2 rows with lcd.begining at(16, 2).

Strengths:

Modular Code Design: Use of #define for pin assignments allows for easy changes while also being a breeze to read.

Proper Hardware Configuration: All pins are accounted for in the setup()

Functionality

1. Ultrasonic Sensor Trigger:

The code sends a short pulse to the trigPin to start the ultrasonic sensor.

It then uses the pulseIn() function to measure the time it takes for the echo to return to echoPin.

The distance is calculated using the formula:

distance = duration * 0.034 / 2;

This converts the time into distance in centimeters.

2. LCD Display:

The calculated distance is displayed on the LCD at the specified cursor positions.

The text "Distance" is printed, presumably followed by the actual distance value.

3. Conditional Logic:

If the measured distance is greater than or equal to 500 cm:

The LCD is cleared, and a message "Moving Back" is displayed.

Both motors are set to rotate backward by setting BckRot_LeftMotor and BckRot_RgtMotor pins to HIGH.

4. Left Movement:

The code moves the system to the left by:

Setting both forward rotation motors (FwdRot_leftMotor and FwdRot_RgtMotor) to LOW.

Activating the backward rotation of the left motor (BckRot_LeftMotor) and keeping the right motor inactive.

A delay of 1 second (delay(1000)) is introduced for the left turn.

The LCD is updated to display "Moving Left".

5. Right Movement:

Similar logic applies for right movement:

The left motor's backward rotation is set to LOW, while the right motor's forward rotation is set to LOW.

This creates a differential motion for turning.

LCD is updated accordingly.

6. Forward Movement:

In the else block, the system moves forward:

The motors are set to move both left and right forward.

CHAPTER 4

RECOMMENDATION

1. Improve System Scalability

□To make the system more adaptable to future needs and applications, consider the following:

□Multi-Sensor Integration: Add additional sensors like infrared (IR) or proximity sensors to complement the ultrasonic sensor. This would help detect obstacles with better accuracy, especially in environments where ultrasonic sensors may struggle (e.g., soft objects or uneven surfaces).

□Multiple Ultrasonic Sensors: Incorporate multiple ultrasonic sensors at different positions or angles on the system. This setup would enable 360-degree environmental awareness, reducing blind spots and improving overall obstacle avoidance capabilities.

□Advanced Motor Driver: Upgrade from the L293D motor driver to more efficient options like the L298N or TB6612FNG. These alternatives offer higher current capacity, thermal protection, and better power efficiency, allowing for more robust motor control in demanding applications.

2. Enhance System Accuracy

□Improving the system's detection precision and response can significantly impact performance:

□Optimized Sensor Placement: Carefully position the ultrasonic sensor to maximize its field of view. This would help in detecting obstacles more effectively and provide accurate distance measurements.

□Noise Filtering: Implement signal processing techniques to filter out noise or false echoes from the ultrasonic sensor, ensuring reliable distance calculations even in challenging environments.

□Redundancy: Use overlapping detection zones from multiple sensors to reduce false positives or negatives in obstacle detection.

3. Add Power Management Features

□Power management is essential for ensuring reliable and long-lasting system operation:

□Battery Management System (BMS): Incorporate a BMS to monitor battery health, charge level, and power consumption. This would enhance the longevity of the battery and provide consistent power output.

□Energy-Efficient Components: Use components with lower power consumption, such as energy-efficient microcontrollers and sensors, to extend the system's operational time.

□Rechargeable Batteries: Replace standard batteries with rechargeable lithium-ion or lithium-polymer batteries for higher energy density, lighter weight, and longer life.

4. Develop Advanced Navigation Algorithms

□!Navigation is a critical aspect of the system's functionality. Improvements in this area can significantly enhance performance:

□Path Planning: Develop and integrate advanced algorithms for autonomous pathfinding and obstacle avoidance. For example, algorithms like A* or Dijkstra can help determine the most efficient route to a destination.

□Feedback Mechanisms: Use rotary encoders or gyroscopes to provide feedback on motor movements, ensuring precise control over the system's navigation.

□Adaptive Movement: Implement machine learning techniques to allow the system to adapt to different environments and optimize its movements over time.

5. Improve User Interaction and Feedback

□Enhancing the way users interact with the system and receive feedback can improve usability:

□LCD Display or LEDs: Add a display to show system status, error messages, or real-time data such as battery level or detected distance. LEDs can also be used to indicate basic statuses, such as power on/off or obstacle detected.

□!Audio Alerts: Include a buzzer or speaker to give auditory feedback for warnings or successful operations, making the system more user-friendly.

□Data Logging: Integrate a feature to log system data, such as distance measurements and movement history. This would help in troubleshooting, performance evaluation, and further system improvements.

6. Strengthen System Protection

□Protecting the system from external factors and internal failures can improve reliability and longevity:

□Circuit Protection: Use fuses, current limiters, or diodes to safeguard the electronic components from voltage spikes, overheating, or short circuits.

□Physical Shielding: Encase sensitive components, such as the Arduino and sensors, in a protective housing to prevent damage from dust, moisture, or accidental impacts.

□Thermal Management: Add heat sinks or cooling fans to prevent the motor driver or other components from overheating during extended use.

7. Expand Potential Applications

□Enhancing the system for broader uses will increase its versatility:

□Line-Following Capability: Integrate a line sensor to enable the system to follow pre-defined paths, making it useful for applications such as warehouse automation or delivery systems.

□Wireless Communication: Add Bluetooth, Wi-Fi, or RF modules to enable remote control and monitoring of the system via a smartphone or computer.

□Payload Capabilities: Design the system to carry light loads, such as small packages, for use in delivery or logistics applications.

8. Test and Evaluate System Performance

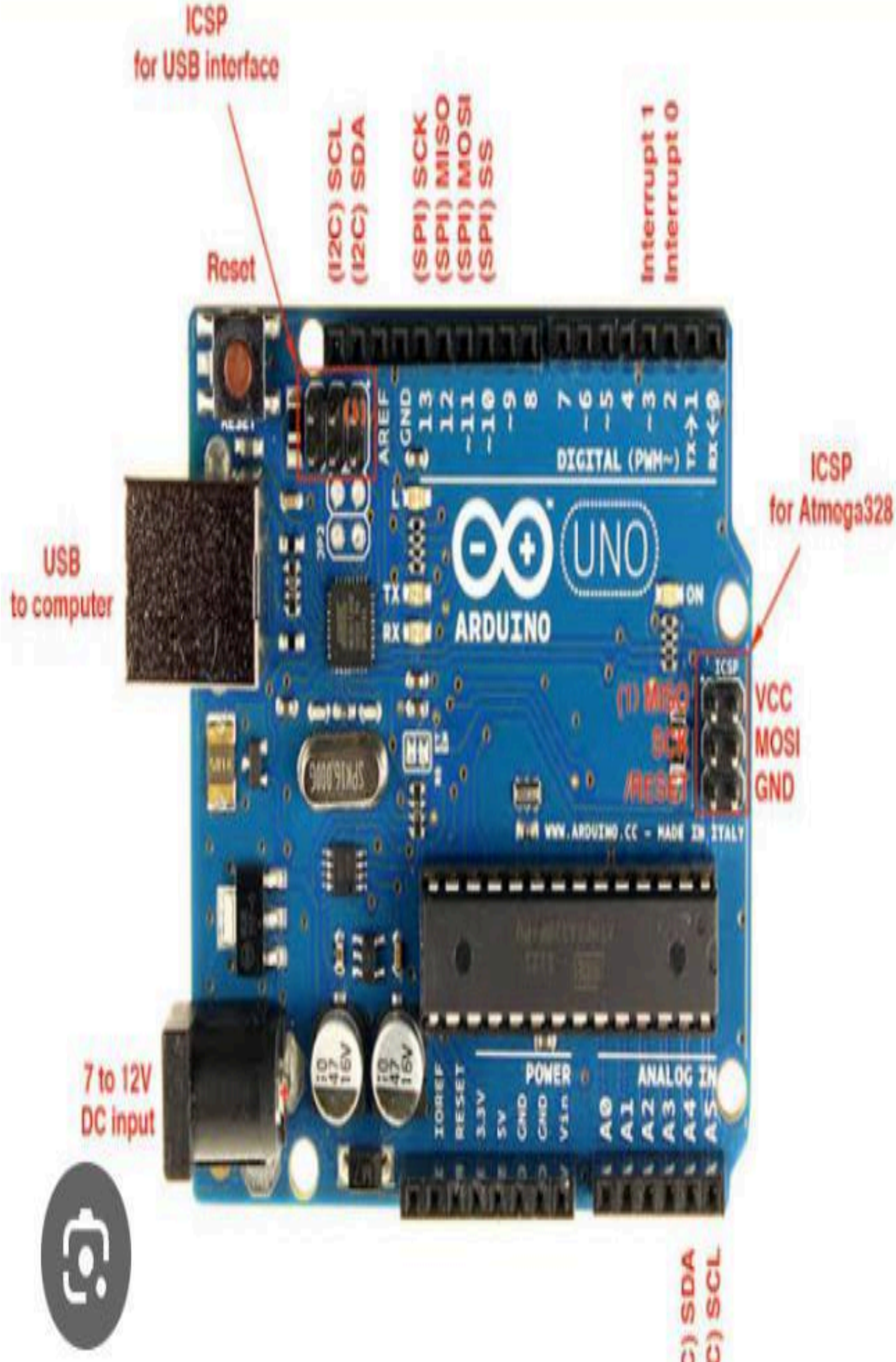
□Regular testing and evaluation are necessary for continuous improvement:

Field Tests: Conduct tests in real-world scenarios to identify any limitations or weaknesses in the system.

□User Feedback: Collect feedback from end-users or testers to identify areas where usability or performance can be improved.

□Iterative Development: Use the results from tests and feedback to refine and upgrade the system, ensuring it meets user requirements and performs reliably in diverse environments.

□By implementing these recommendations, the system can be enhanced in terms of functionality, reliability, efficiency, and user satisfaction, making it suitable for more advanced and practical applications.


ICSP
for USB interface
Reset
(I2C) SCL
(I2C) SDA
(SPI) SCK
(SPI) MISO
(SPI) MOSI
(SPI) SS
Interrupt 1
Interrupt 0
USB
to computer
ICSP
for Atmoga328
DIGITAL (PWM~)
AREF
GND
13
12
~11
~10
~9
8
7
~6
~5
4
~3
2
TX→1
RX←0
UNO
ARDUINO
ON
TX
RX
ICSP
(1) MISO
SCK
/RESET
VCC
MOSI
GND
WWW.ARDUINO.CC - MADE IN ITALY
7 to 12V
DC input
POWER
ANALOG IN
IOREF
RESET
3.3V
5V
GND
GND
Vin
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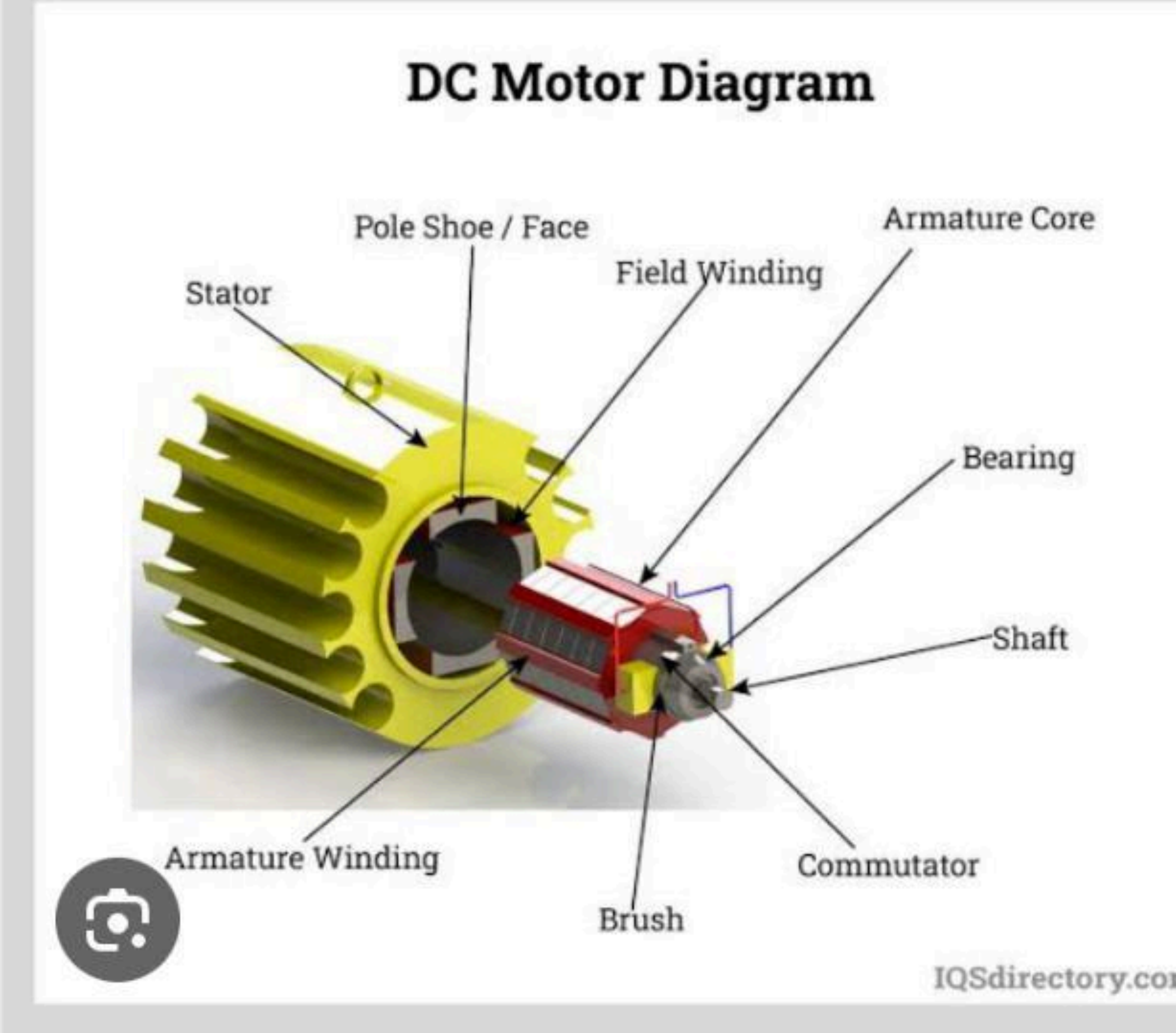
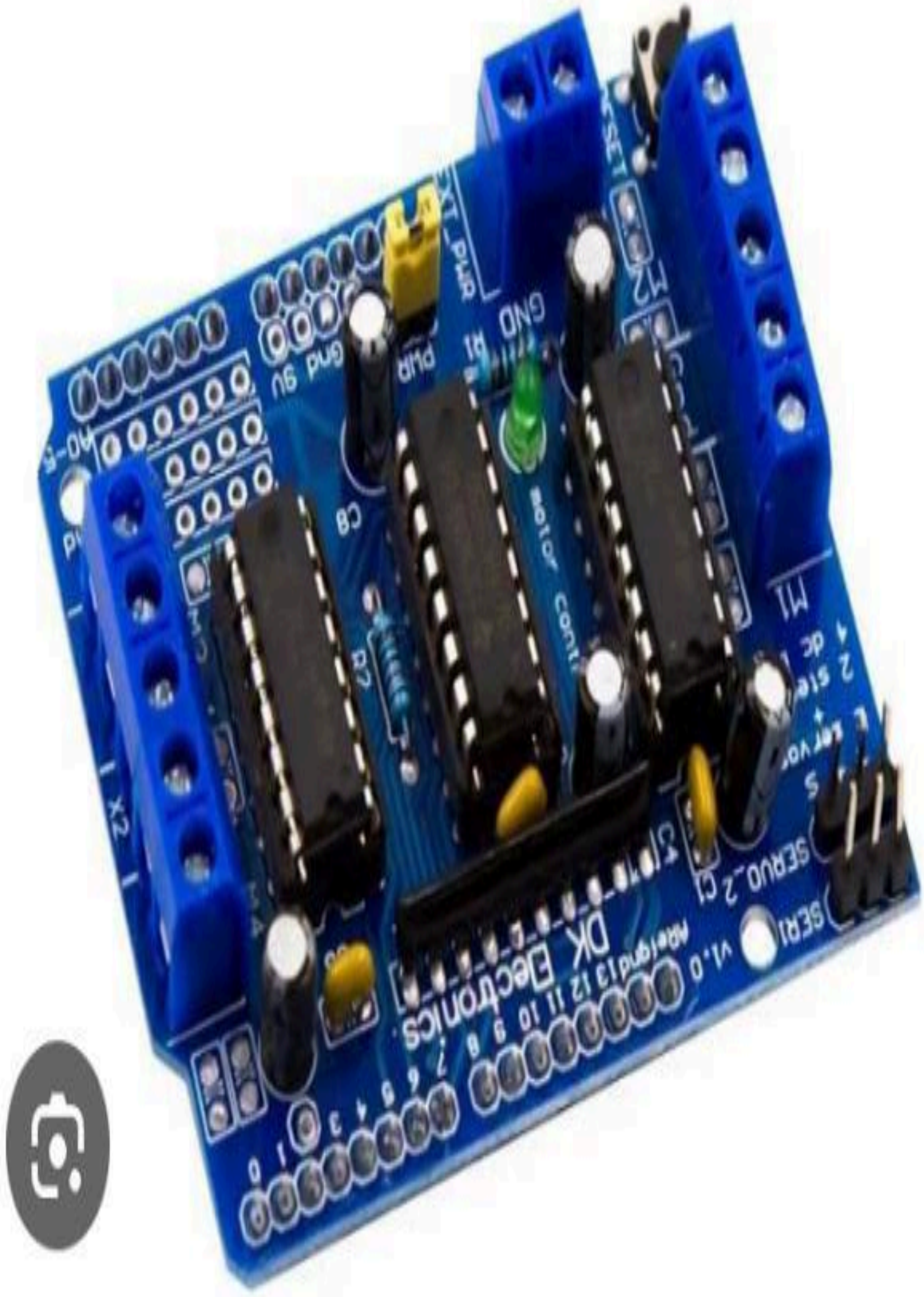
A1
A2
A3
A4
A5
SDA
SCL


DC Motor Diagram
Pole Shoe / Face
Armature Core
Field Winding
Stator
Bearing
Shaft
Armature Winding
Commutator
Brush


HC-SR04
Vcc
Trig
Echo
Gnd
T
R



DK Electronics
v1.0
M1
GND
SERVO_2

Conclusion.

The study of autonomous delivery robot and their components highlight their transformative potential in the revolution of last-mile logistics and urban mobility. This robots powered by advanced technologies and robust power systems that offer numerous benefits across various domains including efficiency, sustainability and cost effectiveness. These robots are helping in various aspects of life like logistics, health care and many more.

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   LCD Pins:

   Pins 13, 12, 8, 9, 10, and 11.

2. Libraries included: the <LiquidCrystal.h> library is included in the control the LCD display.

3. Global variable declared:

   a. long duration; // to store the duration of the ultrasonic pulse coming back
   b. int distance; // to store the distance sensed by the sensor

4. The setup() method: All pins for sensor usage and motors are set to output. Initializes LCD for 16 columns and 2 rows with lcd.begining at(16, 2).

Strengths:

Modular Code Design: Use of #define for pin assignments allows for easy changes while also being a breeze to read.

Proper Hardware Configuration: All pins are accounted for in the setup()

Functionality

1. Ultrasonic Sensor Trigger:

The code sends a short pulse to the trigPin to start the ultrasonic sensor.

It then uses the pulseIn() function to measure the time it takes for the echo to return to echoPin.

The distance is calculated using the formula:

distance = duration * 0.034 / 2;

This converts the time into distance in centimeters.

2. LCD Display:

The calculated distance is displayed on the LCD at the specified cursor positions.

The text "Distance" is printed, presumably followed by the actual distance value.

3. Conditional Logic:

If the measured distance is greater than or equal to 500 cm:

The LCD is cleared, and a message "Moving Back" is displayed.

Both motors are set to rotate backward by setting BckRot_LeftMotor and BckRot_RgtMotor pins to HIGH.

4. Left Movement:

The code moves the system to the left by:

Setting both forward rotation motors (FwdRot_leftMotor and FwdRot_RgtMotor) to LOW.

Activating the backward rotation of the left motor (BckRot_LeftMotor) and keeping the right motor inactive.

A delay of 1 second (delay(1000)) is introduced for the left turn.

The LCD is updated to display "Moving Left".

5. Right Movement:

Similar logic applies for right movement:

The left motor's backward rotation is set to LOW, while the right motor's forward rotation is set to LOW.

This creates a differential motion for turning.

LCD is updated accordingly.

6. Forward Movement:

In the else block, the system moves forward:

The motors are set to move both left and right forward.

The LCD is cleared and updated to display:

"Moving Forward".