Cover Page

AutoNanoBot – Assistive Following Robot
User Manual

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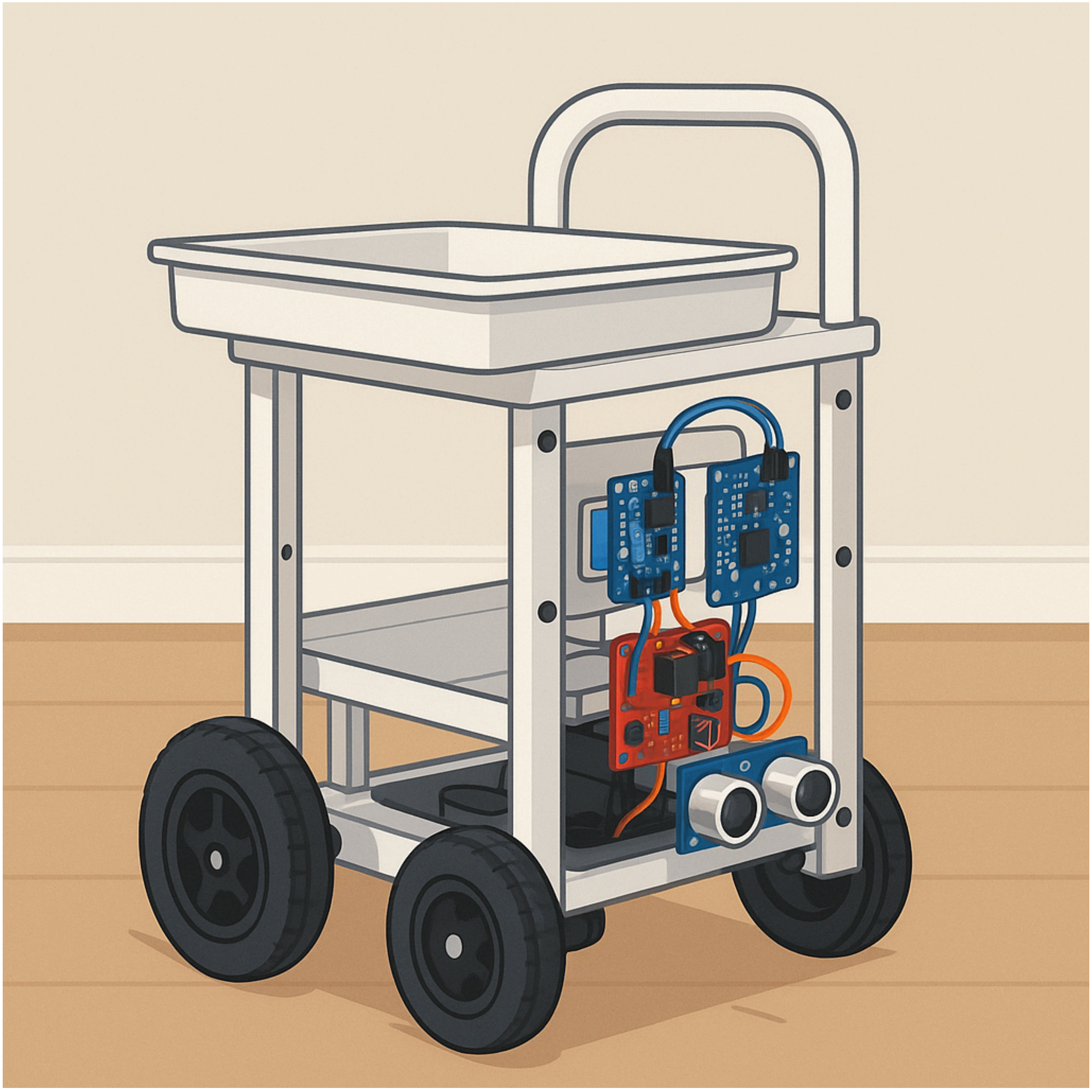

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Introduction

AutoNanoBot is an assistive robot designed to carry items and automatically follow a user. Using sensors and programmed control, it detects movement, maintains distance, and avoids obstacles. This project demonstrates practical learning in robotics, electronics, and programming, allowing users to apply real-world concepts hands-on.

About AutoNanoBot

AutoNanoBot integrates manual and automatic control using:

- Arduino Nano 33 BLE Sense – for automatic following and sensor processing
- ESP32 – for manual Wi-Fi control

Key features:

- Follows a person via Bluetooth LE
- Avoids obstacles using ultrasonic sensors
- Switches between manual (Wi-Fi) and automatic (Bluetooth) operation
- Synchronizes data between two microcontrollers via UART

Acknowledgment

This project was completed as part of a given assignment. Special thanks to instructors, mentors, and peers for guidance, feedback, and support throughout the design, assembly, and testing process.

Objective

The goal of AutoNanoBot is to reduce physical strain by helping users carry heavy or multiple items over short distances. It assists:

- Elderly individuals
- People with mobility challenges
- Anyone transporting groceries, tools, or equipment

Additional goals:

- Build a functional robot capable of following, avoiding obstacles, and carrying items
- Gain hands-on experience with electronics, sensors, motors, and programming

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Functionalities

- Automatic Following Mode: Tracks a smartphone via Bluetooth LE
- Obstacle Avoidance: Detects obstacles within 70 cm using ultrasonic sensors
- Dual Operation: Switch between manual Wi-Fi control and automatic Bluetooth mode

- Two-Board Communication: UART synchronization between ESP32 and Arduino Nano BLE 33 Sense
- Safety Feature: Stops automatically if Bluetooth is lost or an obstacle is too close

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Hardware Requirements

Component	Purpose	Quantity
ESP32	Manual Wi-Fi control	1
Arduino Nano BLE 33 Sense	Automatic following and sensors	1
L298N Motor Driver	Controls motor speed and direction	1
12V DC Geared Motors	Drive robot movement	2
Li-ion 18650 Battery Cells	Power electronics	4
18650 Battery Holder	Battery safety	1
5V DC-DC Step-Down Regulator	Converts battery voltage to 5V	1
On/Off Rocker Switch	Power control	1
USB Cable	Programming and debugging	1
Breadboard	Temporary prototyping	1
Capacitors (0.1μF, 220μF, 10μF)	Power stabilization	4
Ultrasonic Sensors	Detect obstacles	2
Caster Wheel	Supports chassis stability	1
T-Slot Aluminium Extrusion	Frame and mounting	3

Additional Materials: LEDs, connecting wires, 3D-printed brackets, laser-cut frames, nuts, bolts, heat inserts, zip ties

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Software Requirements

Software / Library	Purpose
Arduino IDE	Programming and uploading code
ESP32 Board Package	Adds ESP32 support
ArduinoBLE Library	Bluetooth LE communication
WiFi Library (ESP32)	Wi-Fi manual control
BluetoothSerial Library (ESP32)	Bluetooth communication
Wire Library	I^2C communication
Onshape	CAD design
CorelDRAW	Laser-cut application

Project Description

1. Defined requirements: automatic following, obstacle avoidance, dual communication
2. Designed chassis using CAD software for stability
3. Mounted L298N motor driver for DC motors
4. Completed circuit wiring for motors, sensors, and controllers
5. Mounted Arduino Nano BLE 33 Sense and motor driver securely
6. Installed ultrasonic sensors for obstacle detection
7. Configured Wi-Fi and Bluetooth LE connectivity
8. Integrated ESP32 for manual control and data collection
9. Established UART communication for synchronized control

Applications

- Assists people with mobility challenges
- Home automation or delivery robots
- Personal assistant for daily tasks
- Educational tool for robotics and programming
- Prototype for warehouse or factory following carts

Performance Flow

1. Power ON → Sensors and microcontrollers initialize
2. Bluetooth connects to the mobile device (automatic mode)
3. Ultrasonic sensors detect obstacles
4. Motors adjust speed and direction based on sensor input
5. ESP32 allows manual override via Wi-Fi
6. Robot follows user safely

How to Use / Setup Instructions

Hardware Setup

1. Assemble chassis with frame, motors, caster wheel, and brackets
2. Mount Arduino Nano BLE 33 Sense, ESP32, and L298N motor driver
3. Install ultrasonic sensors and LED indicators
4. Insert Li-ion batteries and connect via 5V step-down regulator
5. Install rocker switch for safe power control

6. Secure wiring and capacitors for stabilization

Software Setup

1. Install Arduino IDE and ESP32 board support
2. Install required libraries: ArduinoBLE, WiFi, BluetoothSerial, Wire, Adafruit_Sensor, Servo, EEPROM
3. Upload Arduino Nano BLE 33 Sense and ESP32 sketches via USB
4. Connect mobile app via Bluetooth LE (automatic) or Wi-Fi (manual)

Mobile App (MIT App Inventor)

App Name: AutoNanoBot Controller

Setup:

1. Open the app on your smartphone.
2. Turn on Bluetooth and connect to the robot's BLE name.
3. Connect to the robot's Wi-Fi network for manual mode (if needed).
4. The app contains the following **button functions:**
    - **Forward / Backward / Left / Right:** Manual movement controls.
    - **Automatic Mode:** Enables following via Bluetooth LE.
    - **Stop Button:** Immediately stops all motor movement.
    - **Connect / Disconnect:** Manages BLE or Wi-Fi pairing.
    - **Sensor Toggle:** Displays obstacle distance readings (optional).

Quick Start

1. Turn on robot using rocker switch
2. Connect phone via Bluetooth or Wi-Fi
3. Place items on robot platform

4. Walk and allow the robot to follow, observing obstacles

Maintenance

To ensure the AutoNanoBot functions properly and lasts long, perform the following routine maintenance:

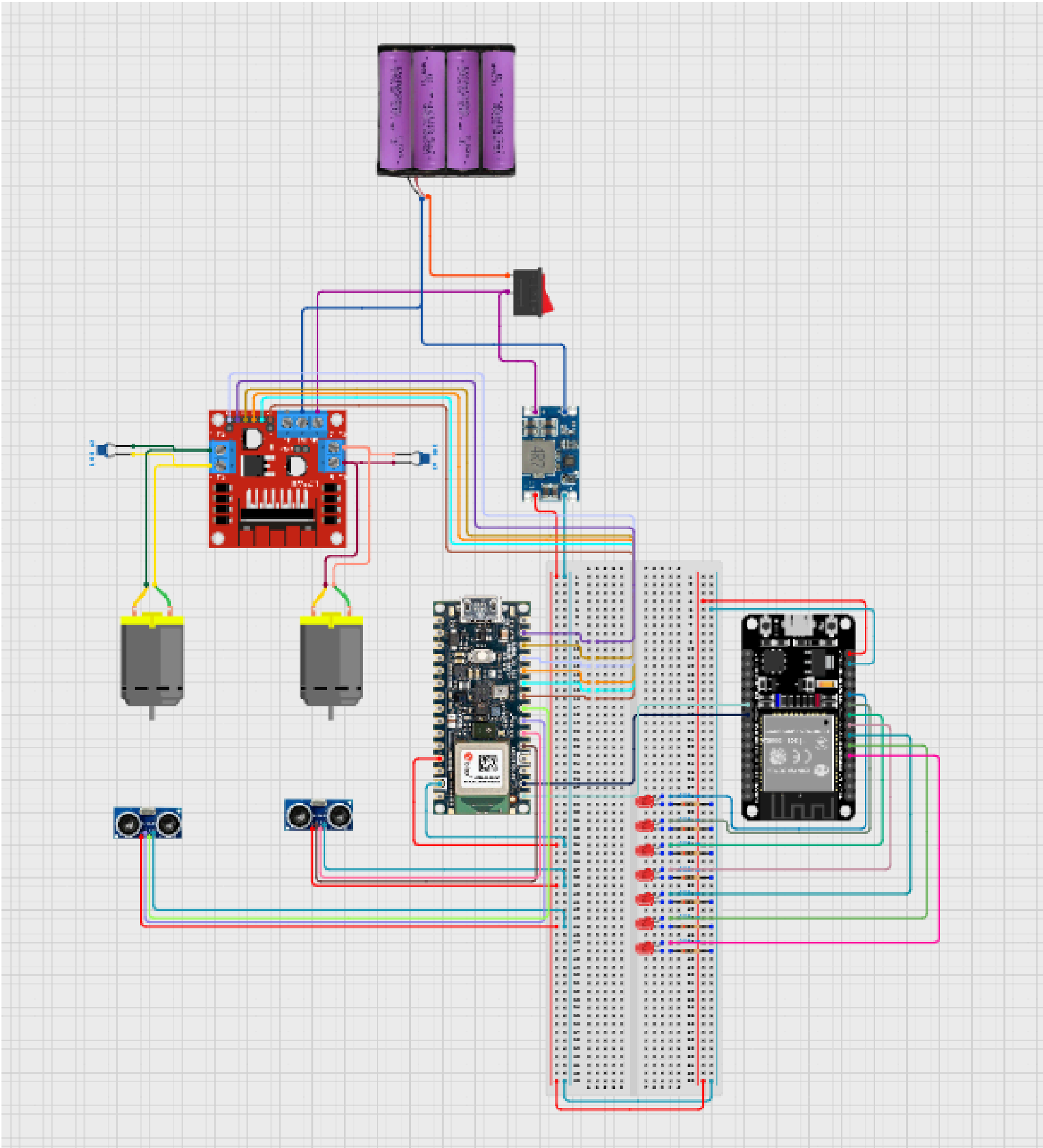
- **Battery Care:**
  Recharge the Li-ion batteries regularly and avoid full discharge. Replace cells if performance decreases.
- **Connection Check:**
  Inspect Bluetooth and Wi-Fi connections for stability; reset the microcontrollers if they become unresponsive.
- **Motor Inspection:**
  Check motors for debris or loose connections. Clean gears and wheels periodically.
- **Sensor Cleaning:**
  Wipe ultrasonic sensors gently with a soft cloth to prevent false readings.
- **Wiring & Components:**
  Ensure all jumper wires and power connections remain secure and insulated.
- **Software Updates:**
  Re-upload or update Arduino sketches if bugs or new features are added.

Troubleshooting

Problem	Possible Cause	Solution
Robot does not power on	Battery not connected or switch off	Check power switch and battery voltage
Motors not moving	Loose motor wires or faulty driver	Reconnect motor wires and test L298N output
Bluetooth not connecting	BLE pairing issue	Restart the robot and re-pair through app

Wi-Fi mode not responding	Incorrect SSID or code error	Verify ESP32 sketch and serial communication
Robot not following user	Phone not detected or BLE out of range	Keep within 3–5 meters and ensure BLE is on
Obstacle detection not working	Ultrasonic sensor misaligned or blocked	Adjust sensor position and clean sensor face
Robot moves erratically	Power fluctuations or faulty capacitor	Recheck regulator output and capacitor placement

Circuit Diagram



Performance Flow Diagram

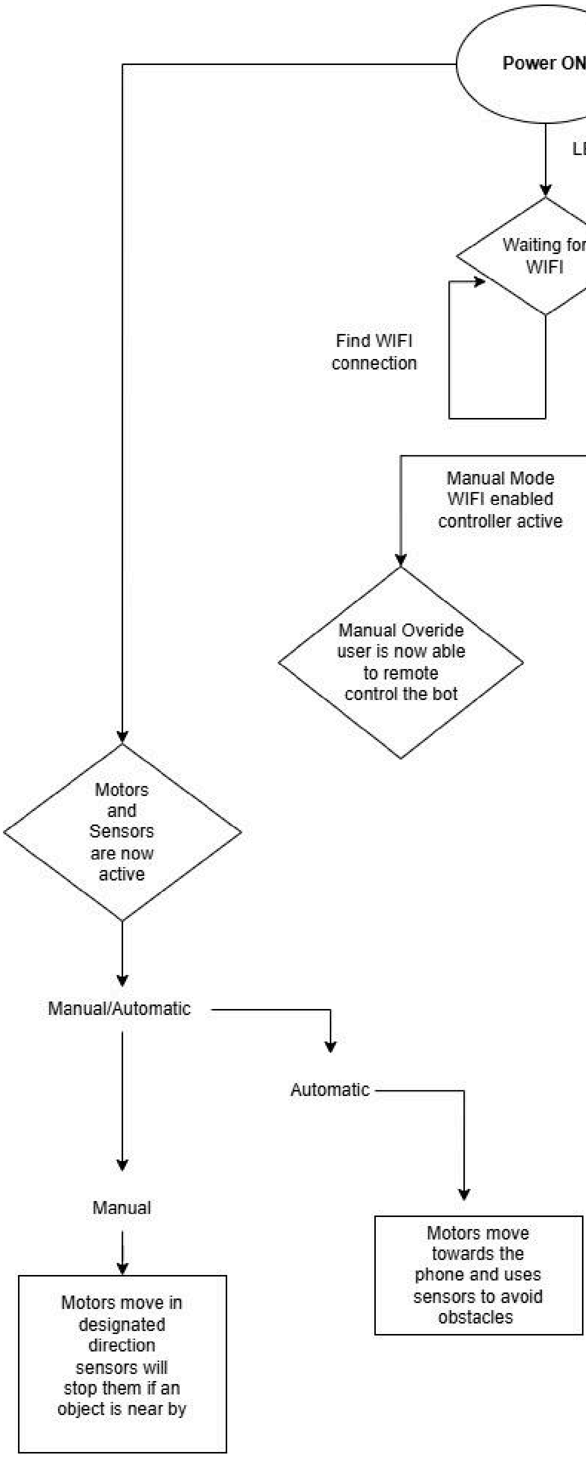
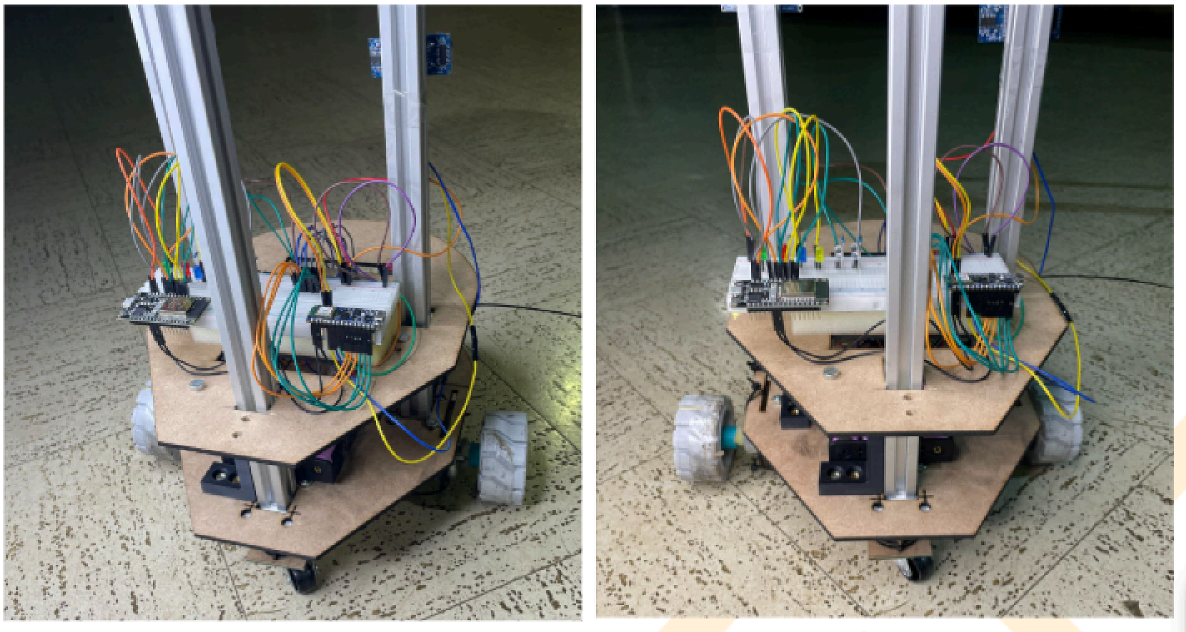


Image of Prototype



Conclusion

AutoNanoBot demonstrates integration of multiple microcontrollers, sensors, communication protocols, and motors to create a functional assistive robot. It provides practical experience in electronics, programming, and robotics, and can be expanded with features like camera tracking, voice control, or advanced navigation.