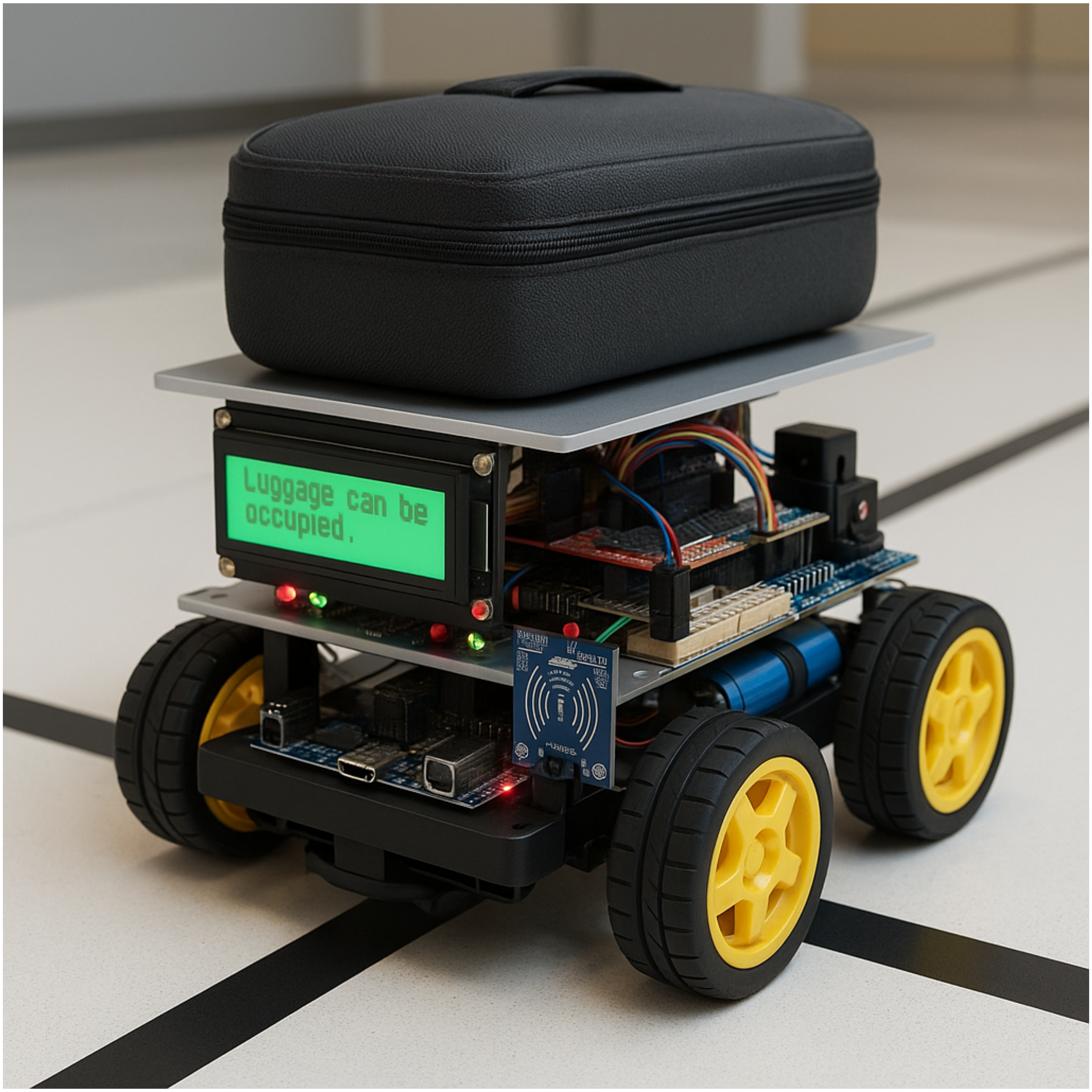

Luggage Carrying and Location Finding Line Following Robot in Airports

GROUP NUMBER 9

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IOT & ROBOTICS

Content.

1) Introduction.

This project proposes an autonomous luggage carrying robot designed for airport environments. The robot is capable of weighing luggage, verifying that the load does not exceed a maximum limit of 1.00 kg, and allowing passengers to select a destination using an RFID card. After verification, the robot follows a pre defined line on the floor to transport the luggage to the selected location.

Once the luggage is collected, the robot automatically returns to the starting point. The system combines microcontrollers Arduino Nano and NodeMCU ESP8266, sensors load cell, RFID reader, IR line sensors, actuators, DC motors, buzzer, LEDs, and a clear user interface (LCD). This work aims to provide a safe, reliable, and cost effective robotic solution for small-scale airport logistics.

2) Defined the problem.

a) Identifying the purpose of the construction.

The purpose of this robot is to provide passengers with an automatic luggage assistant that reduces the physical effort of carrying items between counters, check in points, or boarding gates in an airport. By automating the task of luggage transport, the robot improves passenger convenience, saves valuable time, and reduces dependency on airport staff for small loads.

Another important purpose is to reduce the need for passengers to ask for directions or assistance in reaching their gate or service counter. Once the passenger places their luggage and scans their RFID card, the robot will automatically navigate to the exact destination location along its track. This not only improves independence for passengers but also enhances the overall efficiency of the airport service process.

The system enforces a maximum weight of 1kg in this prototype model, ensuring that the robot operates safely within its design limits. It not only demonstrates how robotics can be applied in practical, real world scenarios but also integrates concepts of IOT and automation.

This project highlights the potential of using affordable technologies such as microcontrollers, sensors, and rechargeable batteries to solve common logistical problems in public spaces, making it both an educational prototype and a foundation for future commercial applications.

b) Identifying the specific requirements.

- The robot must carry luggage up to 1 kg only.
- It measure weight automatically before accepting luggage.
- It reject overweight luggage with a message and alert.
- Allow destination selection using RFID cards.
- It navigate using line following, including T-Junctions.
- It display clear message on an LCD and give buzzer / LED signals.
- The robot return to the start location after uploading luggage.
- Robot operate with BMS protected batteries and regulated power.

3) Researching and Designing.

a) Gathering information and feasibility study.

Research was carried out on line following robots, RFID systems, and load cell integration. Existing robots in airports are often complex and expensive, but a simpler line-based solution is feasible for demonstration. Hardware such as Arduino Nano, NodeMCU ESP8266, HX711, and RC522 are affordable and widely available, making the project cost-effective

b) Identifying specific details of the design which must be satisfied.

1. Weighing and User Display :-
   A 1 kg load cell is used to measure luggage weight accurately. The system must reject luggage over 1 kg and display an error message.

   It shows message like :-
   "Ready. Place your luggage."
   "Weight : x kg. Exceeds max (1kg)."
   "Weight accepted. Please scan RFID card"
   "Destination : Location ON"
   "Arrived at location. Please take luggage"

2. Authentication and Location Selection :-
   An RFID reader is used to read passenger RFID cards. Each RFID cards encodes a unique destinations (Location 1 - 4). The robot will not start navigation until a valid RFID cards is detected.

3. Navigation system :-
   A 5 IR sensor panel is used for accurate line following and T-junction detection. The robot follow black tape on a white chart and make correct turns based on the selected location.

   A 4 wheel chassis used for movement. An motor driver drives the motor under the control of the Arduino Nano. The robot must stop precisely at the chosen location and wait until luggage is removed. After luggage removal the robot automatically returns to the starting point.

c) Identifying possible and alternative design solutions.

- We can use QR code instant RFID module.
- Instant of IR panel we can use laser.
- For return starting point we can use IR reflective maker at station instant of Load cell (0kg).

4) Creating a Prototype.

Prototype Goals.

The prototype is designed to validate the integration of all essential components and to ensure that each part works together effectively.

- Validate RFID and Display Integration: Confirm that the RFID module works correctly with the LCD display, and that it correctly displays location information after a successful scan.
- Test Line-Following System: Ensure that the IR line sensors (5-channel array) and motor system accurately follow the black line on the track, including T-junction detection for navigation.
- Test Weight Measurement: Check that the load cell correctly measures the luggage weight and enforces the 1.00 kg weight limit.
- Validate Mobility and Motor Control: Ensure that the DC motors driven by the L298N motor driver can move the robot reliably, and test that the robot can follow the path to the correct location and return.

Troubleshooting.

During testing, if any of the systems fail, troubleshoot using the following steps:

- RFID Not Detecting :-
  - Action: Check wiring, and ensure correct baud rate and library configuration. Test the RFID module with a simple code (Serial Monitor prints UID).
- Line Following Not Working :-
  - Action: Adjust IR sensor sensitivity by changing the threshold in code. Ensure the track (black tape on white paper) has good contrast and is clean.
- Motor or Mobility Issues :-
  - Action: Ensure the L298N motor driver is correctly wired. Check the motor connections and ensure the robot’s wheels are not obstructed.

- Weight Measurement Issues (Load Cell):
  - Action: Recalibrate the HX711 amplifier with a known weight (500 g) and fine-tune the scale factor.
- Obstacle Detection (Ultrasonic Sensor) Fails:
  - Action: Adjust the trigger threshold in the code to filter out false readings. Test with known objects at a specific distance.

5) Building the robot.

Step-by-Step Implementation

1. Assemble the Base:
   - Chassis: Start by assembling the 4-wheel chassis (RB0002), fixing the DC motors to their respective positions on the frame.
   - Motor Driver: Mount the L298N motor driver and connect the motors to the driver's output pins.
   - Arduino Nano: Attach the Arduino Nano to the chassis using standoffs or double-sided foam tape.
   - Test motor movement by uploading a simple motor control sketch to check forward, backward, and turning actions.
2. Mount the Sensors:
   - IR Line Sensors: Mount the 5-channel IR sensor panel at the front of the robot, about 1 cm above the floor, ensuring accurate line detection.
   - Ultrasonic Sensor: Position the ultrasonic sensor at the front to detect obstacles. This will stop the robot or let it wait if the path is blocked.
   - Wiring: Connect the IR sensors to D2, D3, D4, D5, D6 on the Nano. Connect the ultrasonic sensor to Trig (D8) and Echo (D9) pins.
3. Attach the Dispenser Unit (Luggage Platform):
   - Luggage Platform: Attach the platform to the load cell. Ensure it is firmly secured to avoid flexing when luggage is placed.
   - Load Cell: Connect the load cell to the HX711 amplifier, which will then connect to D7 and D8 on the Arduino Nano for weight measurement.

    - Test Load Cell: Upload a simple code to test the load cell calibration with a known weight (500 g) and adjust accordingly.
4. Install the Control Unit:
    - RFID Module: Mount the RC522 RFID module near the user-facing side of the robot (easy access for scanning).
    - LCD (16x2 I²C): Position the LCD display on the front of the robot for easy viewing, ensuring that it is angled for clear visibility.
    - Wiring: Connect the LCD to SDA (A4) and SCL (A5) pins on the Nano. Connect the RFID module to SPI pins (MISO, MOSI, SCK, SS) of the NodeMCU. Ensure common ground between all parts.
5. Integrate Power Supply:
    - Battery: Mount the 2S 18650 battery holder on the chassis. Ensure the BMS is connected to the batteries for protection.
    - Buck Converters: Connect Buck #1 (6 V) for motor power and Buck #2 (5 V) for Arduino/NodeMCU, sensors, and display.
    - Wiring: Ensure all grounds are connected together (battery, motors, Arduino, NodeMCU).
6. Upload Arduino Code:
    - RFID Verification: The code will check if the RFID card is scanned and pass the destination data (Location 01–04) from the NodeMCU to Arduino Nano.
    - Motor Control: The Arduino Nano will control the L298N motor driver to follow the line based on IR sensor input.
    - Line-following Logic: Implement logic to follow the line towards the destination and return after the luggage is removed (weight = 0).
    - Feedback: Use the LCD to display the status (weight, location, error messages), and the buzzer + LEDs for alerting the user.

6) Evaluating the Robot

a) Evaluate the Design

Strengths:

- Combines multiple tasks (weighing, RFID, navigation) into one robot.
- Uses simple, affordable components (Arduino, IR sensors, RFID) for a practical robot.
- Clear user feedback (LCD, buzzer, LEDs) and easy interaction.

Limitations:

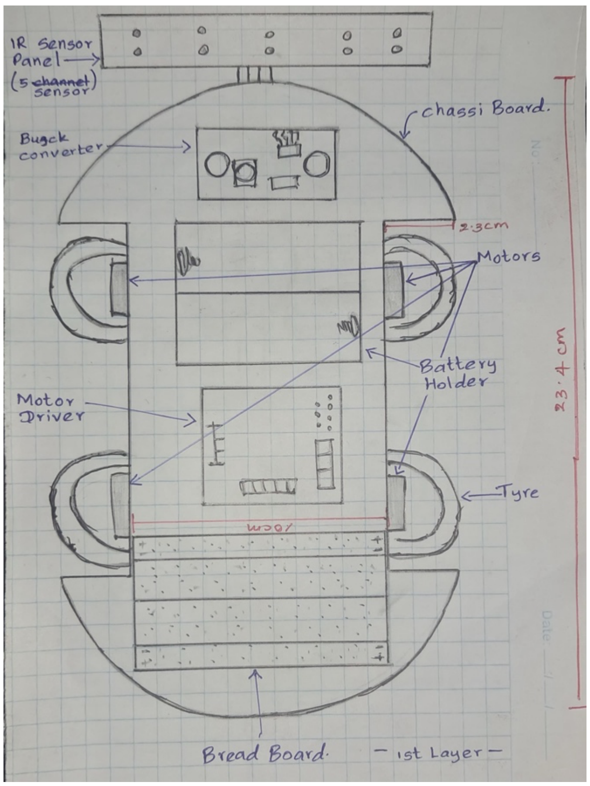
- Track-dependent (requires black tape on a white surface).
- Limited to small luggage (1.00 kg max weight).
- Power consumption might be high, especially with motors running continuously.
- If an object is detected on the line, the robot avoids it and then returns to the track.

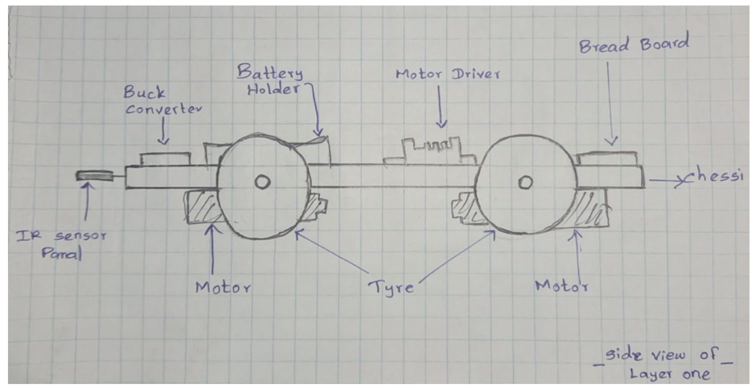
Opportunities for Improvement:

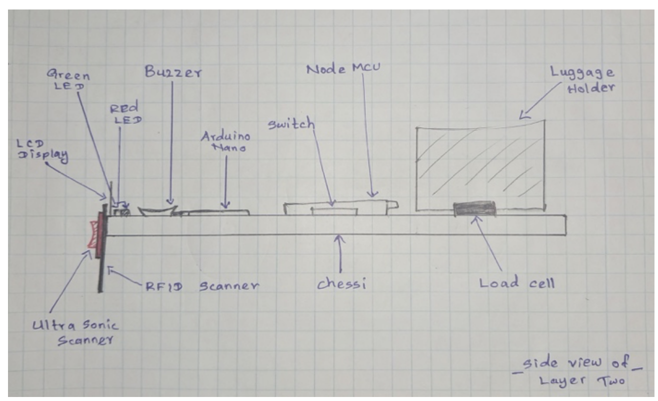
- Add wireless payment via NFC or QR code scanning.
- Increase luggage capacity with a more powerful motor system.
- Integrate GPS for autonomous navigation in future versions, replacing line following.
- Automate luggage unloading at destination.
- Smarter pathfinding and adaptive obstacle avoidance by using Machine Learning.

Sketch design.

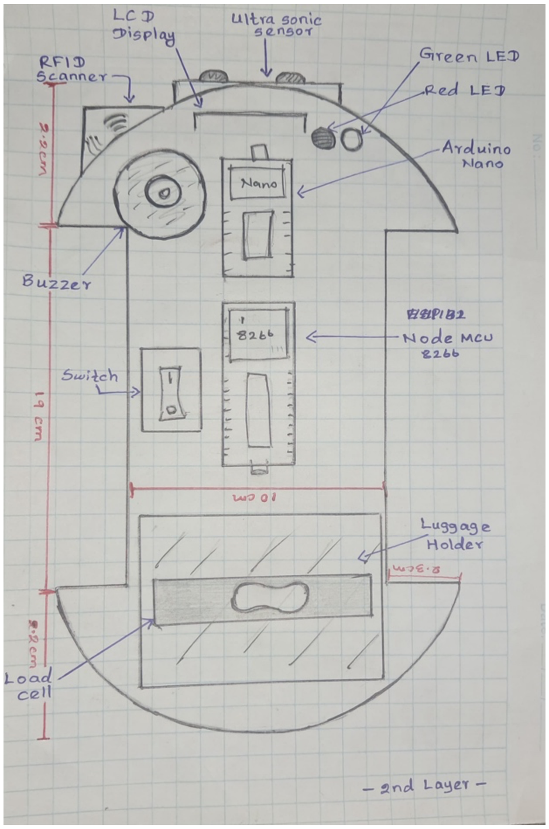
1st Layer of the chassis.

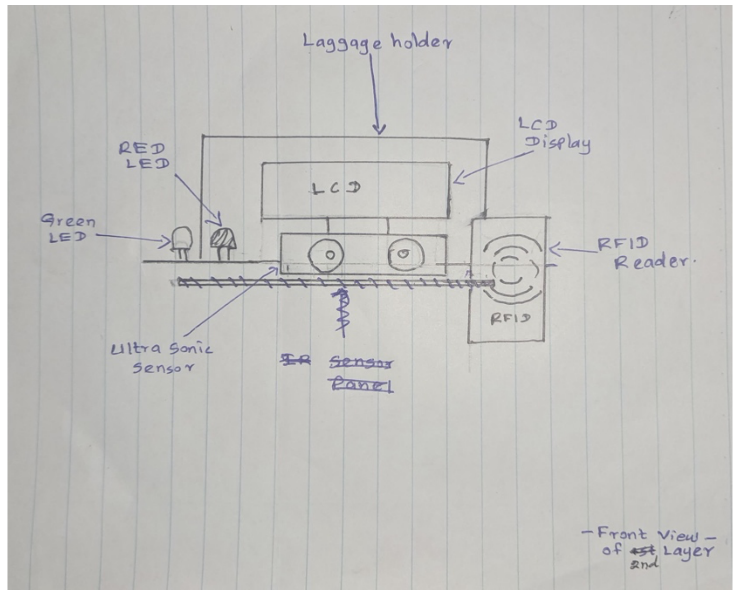


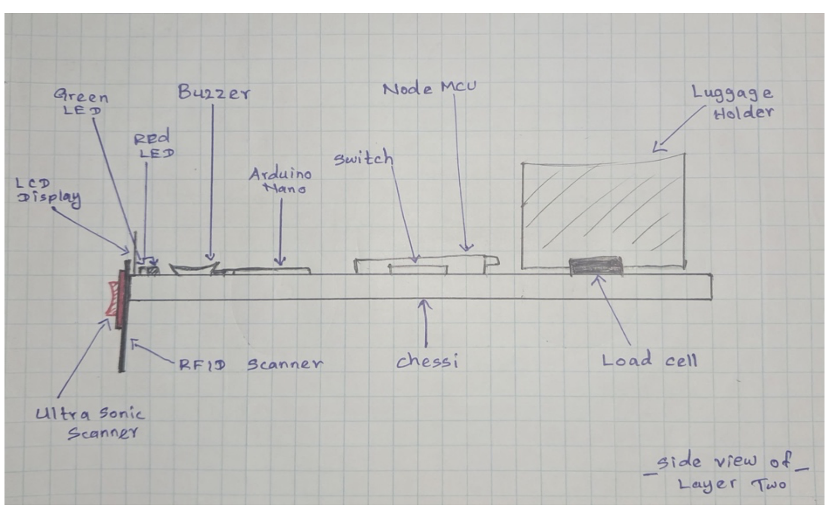




2nd Layer of the chassis







b) Evaluate the Planning Process

- Structured Approach: The 6-step process provided clarity in defining requirements, ensuring all components work together.
- Feasibility Study: Research confirmed that using Arduino Nano + NodeMCU for control and communication is practical within the project scope.
- Prototype Feedback: Early testing showed that calibration for the load cell was critical and the line-following algorithm needed fine-tuning for junction handling.
- Final Robot Evaluation: The robot meets the core objectives: weighing luggage, navigating to selected locations, and returning. It demonstrates a working solution for a luggage transport robot in an airport-like setting.

Conclusion.

The Luggage Carrying and Location Finding Robot successfully combines several engineering concepts to automate luggage transport in a confined area. Using line-following, RFID for location, and a load cell for weight verification, the robot completes its task of transporting luggage with simple user interaction. Future work can improve the robot’s autonomy, speed, and capacity, as well as adding obstacle avoidance and wireless control.