PROJECT ABSTRACT

IoT Weighbridge Automation using RFID and Load Cells

A working model of an automated weighbridge: a steel platform on four load cells via an HX711 amplifier, ESP32 controller, RC522 RFID vehicle tagging, 16x2 LCD readout, tare/calibration/overload-alarm firmware and a cloud transaction log. Delivered built-to-order with the prototype, firmware, diagrams, report, PPT and viva kit.

01. Title

IoT Weighbridge Automation using RFID and Load Cells

02. Introduction / Background

At quarries, warehouses and farm collection centers, every truck that enters and leaves must be weighed — and the weighing is still often a manual ritual: the operator reads a display, writes the number in a register, and mistakes, disputes and outright fraud creep in. An automated weighbridge fixes the weak link by tying each weight reading to a vehicle identity automatically: the truck drives on, the RFID reader captures its tag, the load cells settle, and the weight is logged against that tag with a timestamp — no handwriting, no transcription error. This project builds that system at demonstrator scale: a steel platform on four button load cells, an HX711 precision amplifier, an ESP32 controller, an RC522 RFID reader and a 16x2 LCD, with firmware handling tare, calibration and overload alarming and a cloud log of every tagged transaction.

03. Problem Statement

Manual weighbridge operation has three failure modes: transcription errors when the operator copies the display reading, disputes when the vehicle identity is recorded wrongly or not at all, and fraud when readings are altered after the fact. Small collection centers cannot afford commercial automated weighbridges, and students learning industrial IoT have no hands-on model of how weighing, identity and logging combine. The project addresses this by building a demonstrator that automates the whole transaction: multi-cell weighing with proper tare and calibration, RFID binding of each weight to a vehicle tag, stable-reading detection so vibrations do not corrupt records, an overload alarm, and a timestamped cloud log that makes every transaction auditable.

04. Objectives

- Build the weigh platform: steel plate on four button load cells with mechanical mounting that sums corner loads correctly.
- Interface the HX711 24-bit ADC to an ESP32 (Arduino-IDE firmware) with multi-sample averaging and stable-reading detection.
- Implement tare, known-weight calibration and a configurable overload alarm with buzzer in firmware.
- Integrate the RC522 RFID reader so each weighing is automatically bound to the presented tag's ID.
- Display live weight, tag status and messages on a 16x2 LCD for standalone operation.
- Push every transaction (tag ID, weight, timestamp) over Wi-Fi to a cloud log with export for the report.
- Deliver the complete student kit: prototype, firmware, diagrams, calibration procedure, report, PPT and viva Q&A.

05. Proposed Methodology

The build follows four stages. (1) Mechanical: the steel platform is mounted on the four button cells with proper load introduction; wiring runs to the HX711 board. (2) Firmware: the ESP32 reads the HX711 differentially, averages samples, applies the tare offset and scale factor, and implements the state machine — idle, weighing (awaiting stability within the tolerance band), tag capture, log, alarm. (3) RFID and UI: the RC522 is polled over SPI during the weighing window; the LCD state display and buzzer outputs are driven from the same state machine. (4) Cloud: on a completed transaction the ESP32 POSTs (or MQTT-publishes) the record to the configured endpoint; the setup guide covers endpoint configuration and log export. Calibration uses the standard known-weight procedure documented for the buyer.

06. System Architecture / Working

The platform is tared empty (or calibrated with a known weight) before the session. A load is placed on the platform; the four load cells' signals are summed by the HX711 24-bit ADC. The ESP32 averages readings and waits for the value to stabilize within the configured tolerance band. The operator presents the RFID tag and the RC522 captures its ID. Weight, tag ID and timestamp appear on the LCD and are pushed to the cloud log over Wi-Fi. If the load exceeds the overload threshold, the buzzer sounds and the event is flagged in the log. Weighing, tare, calibration, RFID capture and the LCD all work offline; only the cloud log needs Wi-Fi.

07. Hardware / Software Requirements

- ESP32 development board; firmware in Arduino IDE (C++)
- 4x button load cells with HX711 24-bit ADC amplifier module

- RC522 RFID reader module (13.56 MHz) with tags/cards
- 16x2 character LCD, buzzer, regulated 5 V power supply
- Steel platform, acrylic base, wiring and mounting hardware
- Wi-Fi network and a cloud HTTP/MQTT endpoint for the transaction log (setup guide included); a known mass for calibration

08. Expected Outcomes

- Working weighbridge demonstrator: stable tagged weight readings on the LCD.
- Firmware implementing tare, known-weight calibration, stability detection and overload alarm.
- RFID-bound transaction records in a cloud log, exportable for the report.
- Calibration procedure the buyer runs to characterize their own build's accuracy.
- Complete documentation: report, PPT, wiring diagram, component list and viva Q&A.

09. Applications

- Teaching platform for industrial IoT: sensors, ADC chains, RFID, embedded firmware, cloud logging.
- Demonstrator of automated-weighbridge logic for logistics and materials courses.
- Reference build for other load-cell applications (inventory scales, force measurement).
- Base for extensions: barrier control, ANPR camera, SMS alerts on overload.

10. Future Scope

- Automatic number-plate recognition to complement RFID tagging.
- Barrier-gate actuator driven from the weighing state machine.
- Offline-first log with store-and-forward for unreliable networks.
- Larger platform with higher-capacity cells for heavier demonstrator loads.

11. References

- Avia Semiconductor — HX711 24-bit ADC datasheet.
- NXP — MFRC522 RFID reader datasheet (13.56 MHz).
- Espressif ESP32 Series Datasheet — microcontroller specifications.
- Standard strain-gauge load-cell application notes — Wheatstone bridge weighing principles.