Ahsanullah University of Science and Technology

Department of Computer Science and Engineering

CSE-4264 Internet of Things Lab

RFID-Enabled Smart Water Dispensing System with Card Control and Live Billing Usage Tracking
Group : 04

Submitted by

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Submitted To:

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Hardware Implementation Details

- **Power Supply**:
    - **7.7V Li-ion battery** powers the system.
    - Voltage is regulated using **MP1584 step-down converter** to supply ESP32 and peripherals.
- **Microcontroller**:
    - **ESP32** controls pumps, reads RFID tags, and handles logic.
    - Uses two hardware serial ports for two RDM6300 readers.
- **RFID Readers**:
    - Two **RDM6300 modules** connected to RX pins (GPIO 27 and GPIO 26).
    - Each RFID reader corresponds to one pump line.
- **Pumps**:
    - Two **DC water pumps** (one for each line) controlled through **NPN transistors** (acting as electronic switches).
    - **220 Ω resistors** limit current to transistor base from ESP pins (GPIO 18 for Pump1, GPIO 19 for Pump2).
- **Buzzer**:
    - **Buzzer on GPIO 4** for audio feedback (card detection, low balance, or stop events).
- **Switch (Planned but Not Active)**:
    - Switch is connected but functionality not yet implemented in software (planned for manual enable/disable of dispensing).

Software Implementation Details

- **Initialization**:
    - ESP32 starts serial communication for debugging and initializes both RFID readers via `HardwareSerial`.
    - Pumps and buzzer set to OFF at startup.
- **Task Separation**:
    - Two FreeRTOS tasks (`taskReader1` and `taskReader2`) handle each RFID reader independently on separate cores.
- **Card Detection & Balance**:
    - Each card is mapped to a specific pump (`CARD1_ID → Pump1`, `CARD2_ID → Pump2`).
    - Initial balance is set (`INITIAL_BALANCE = 1000 TK`).
- **Billing & Water Control**:
    - Pumps run while the valid card is present.
    - Billing rate: **3 TK/sec** (3 TK per second = 10 ml/sec water).
    - Balance deduction occurs every second.
    - Pump stops if balance drops below required rate.
- **Buzzer Alerts**:
    - Short beep each second during operation.
    - Buzzer also alerts when balance is exhausted or water stops.

Data Collection

```
[Reader 1]7s passed, charged 21 TK. Remaining: 637
[Reader 2]7s passed, charged 21 TK. Remaining: 979
[Reader 1]8s passed, charged 24 TK. Remaining: 634
[Reader 2]8s passed, charged 24 TK. Remaining: 976
[Reader 1]9s passed, charged 27 TK. Remaining: 631
[Reader 2]9s passed, charged 27 TK. Remaining: 973
[Reader 1]10s passed, charged 30 TK. Remaining: 628
[Reader 2]10s passed, charged 30 TK. Remaining: 970
[Reader 1]11s passed, charged 33 TK. Remaining: 625
[Reader 2]11s passed, charged 33 TK. Remaining: 967
[Reader 1]12s passed, charged 36 TK. Remaining: 622
[Reader 2]12s passed, charged 36 TK. Remaining: 964
[Reader 1]13s passed, charged 39 TK. Remaining: 619
[Reader 1] Water stopped.
[Reader 1] Total Time: 13s | Total Bill: 39 TK | Water Used: 130 ml | Remaining Balance: 580 TK
[Reader 2]13s passed, charged 39 TK. Remaining: 961
[Reader 2]14s passed, charged 42 TK. Remaining: 958
[Reader 2]15s passed, charged 45 TK. Remaining: 955
[Reader 2]16s passed, charged 48 TK. Remaining: 952
[Reader 2]17s passed, charged 51 TK. Remaining: 949
[Reader 2]18s passed, charged 54 TK. Remaining: 946
[Reader 2]19s passed, charged 57 TK. Remaining: 943
[Reader 2]20s passed, charged 60 TK. Remaining: 940
[Reader 2]21s passed, charged 63 TK. Remaining: 937
[Reader 2]22s passed, charged 66 TK. Remaining: 934
[Reader 2] Water stopped.
[Reader 2] Total Time: 23s | Total Bill: 69 TK | Water Used: 230 ml | Remaining Balance: 865 TK
```

Challenges Faced

1. **Dual RFID Reading in Parallel**
    - Needed **separate UART instances** and **FreeRTOS tasks** to avoid data collision.
2. **Pump Activation Delay**
    - Initial testing showed slight delay in pump activation due to serial tag parsing. Optimized by checking card state efficiently.
3. **Card-to-Pump Mapping**
    - Ensuring correct pump activates with correct card required unique ID checks and separate state tracking for each pump.
4. **Power Stability**
    - Running pumps caused voltage drop and ESP resets. Solved with **MP1584 regulator** and proper grounding.
5. **Switch Integration Pending**
    - Physical switch hardware is connected but not yet coded to override dispensing logic.

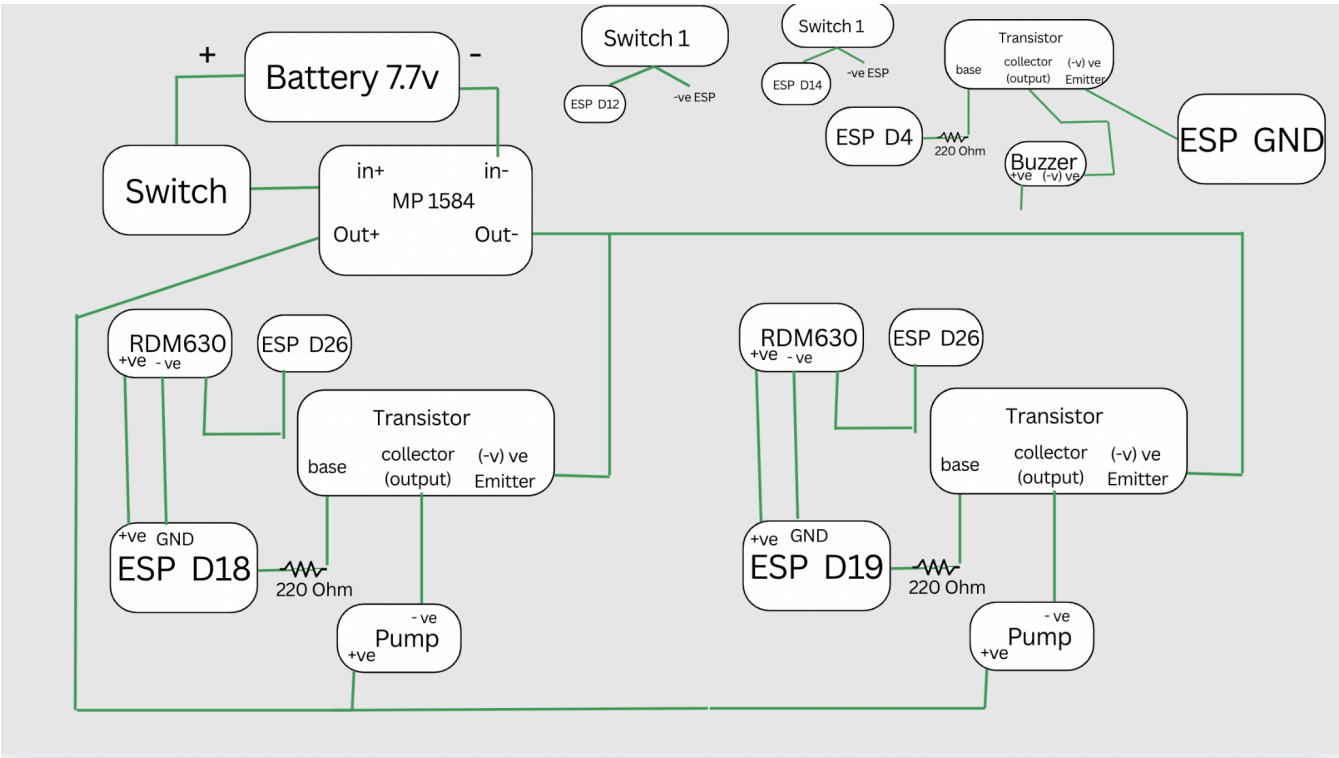
Future Work

- **Switch Integration**
    - Add logic to allow manual start/stop of pumps with Switch 1.
- **Card-to-Tap Mapping Expansion**
    - Extend system to support **multiple cards per pump** or assign individual quotas.
- **Cloud Integration**
    - Log water usage and balances in **Google Sheets** for monitoring.
- **Flow Sensor Addition**
    - Use flow meters to **measure actual water volume** rather than calculating by time for higher accuracy.
- **Recharge System**
    - Add balance recharge feature via master card or mobile app.

Additional Information

- **Flow Rate Assumption**: Currently assumes **10 ml/sec** fixed rate. Actual flow may vary with pump voltage or pipe resistance.
- **Security Considerations**: Present code checks only **specific card IDs**.
- **Scalability**: Current hardware supports **two pumps**, but design can be scaled to more lines by adding RFID readers and relays/transistors.

Connection Diagram



Workload Distribution Among Team Members

Week	**Sadman Salman Saad (114)**	**Abdullah Al Maruf (116)**	**Sharun Tawsif (124)**	**Nafisa Tabassum (127)**
1. Topic Selection & Project Proposal	Literature Review, Initial Idea Draft	Architecture Sketch, Feature Planning	Documentation, Problem Definition	Use Case Scenario, Contribution Planning
2. Component Collection & Veroboard Setup	Purchase Components, Battery Holder	Schematic Design, Female Header Mounting	MP1584 Soldering, Jumper Wiring	Veroboard Layout, RFID Reader Pins Setup
3. ESP32 Setup, RFID & Power Management	ESP32 Firmware Burn, Serial Test	RFID Reader Communication (RDM6300)	Voltage Regulator Setup (MP1584)	Power Routing, Breadboard-to-Veroboard Shift
4. Pump Control, Tank Setup, Dual Line Flow	TIP122 Transistor Control Coding	Water Pump Activation, Line Switching Logic	Parallel vs Sequential Testing, Flow Stability	Tank Mounting, Pipe Layout and Water Flow Test
5. Google Sheets, Usage Time & Billing Logic	Apps Script/HTTP API to Google Sheets	Data Fields: Card ID, Time, Line Usage	Billing Algorithm & Timer-based Costing	Live Monitoring Dashboard, Billing Format
6. Full System Integration & Final Presentation	RFID + Pump + Billing End-to-End Demo	Final Hardware Testing and Debugging	Poster and Presentation Slide Design	Oral Presentation, Report Compilation

Pie Chart Distribution