ADVANCED FALL&VITALS ALERT SYSTEM

PROJECT REPORT

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INTRODUCTION

This project outlines the development of a wearable, real-time patient monitoring system designed to automatically detect and respond to medical emergencies, specifically focusing on patient falls.
The system utilizes an accelerometer to constantly analyze the patient's motion and a heart rate sensor to assess their physiological state. The core objective is to minimize the time between a critical event (a fall) and the commencement of emergency aid.

PROBLEM STATEMENT

The core problem is the critical delay and poor reliability inherent in current fall alert systems for at-risk individuals.

Falls are major injury causes, but existing systems either fail to notify if the patient is incapacitated (the long-lie problem) or generate too many false alarms, wasting caregiver time.

FUNCTIONAL REQUIREMENTS

Detect Impact: Trigger on >=2.5G

Confirm Fall: >=10 seconds stillness (=<0.2G).

Check Pulse: Wait 3s. Alert if < 50 or >20 BPM.

Notify: Send alert on confirmation/
critical pulse
set **is_patient_safe** to **FALSE**.

NON FUNCTIONAL REQUIREMENTS

Performance: Real-time data processing (< 100 ms latency).

Reliability: High accuracy (>= 95% TPR, =<1% FPR).

Availability: High uptime (99.9%).

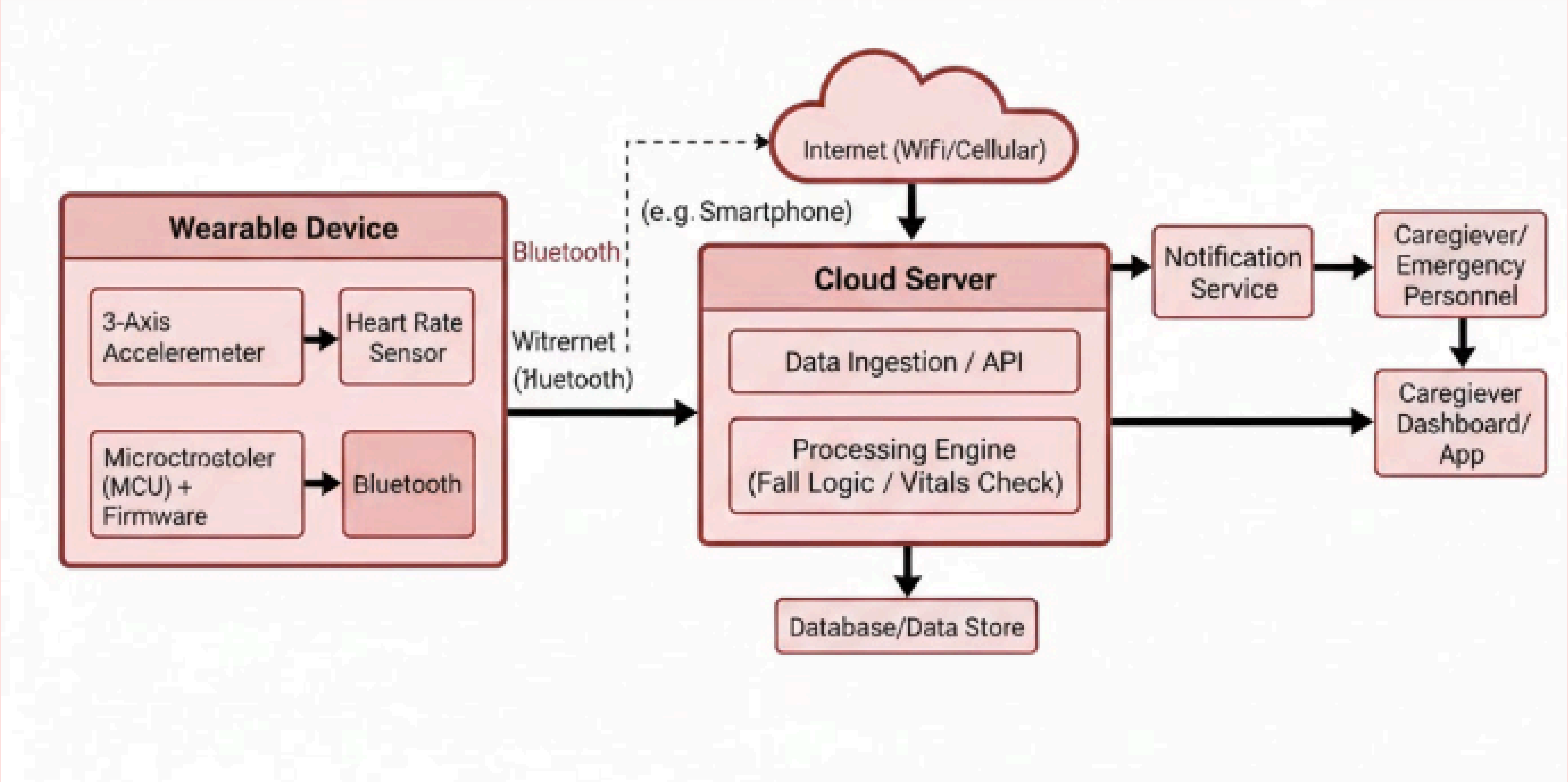
Security: Data encryption (HIPAA/GDPR) and access authentication.

Constraint: Battery life >=24 hours.

SYSTEM ARCHITECTURE

Wearable: Sensors (Accel + Pulse) to
MCU (Logic >= 2.5G /10sStillness).
Gateway: Relays Wearable data (BLE) to Cloud (Wi-Fi/Cellular).
Cloud Server: Validates Alerts, Logs Data, Sends Notifications.
UI: Caregiver Dashboard for Alerts and Acknowledgment.

DESIGN DIAGRAMS



IMPLEMENTATION DETAILS

Fall Confirmation (Accelerometer): A high impact followed by 10 seconds of stillness confirms the fall and triggers a primary alert. Condition Check (Pulse): 3seconds after the fall, the patient's heart rate is checked. An alert is critically escalated if the pulse is outside the 50 to 120 BPM

```python
# --- Constants ---
FALL_G = 2.5
STILL_G = 0.2
PULSE_LOW = 50
PULSE_HIGH = 120

# --- Simple Fall + Pulse Check ---
g = float(input("Enter G-force: "))

if g > FALL_G:
    print(" Impact detected!")

    still = float(input("Enter stillness G-force: "))
    if still < STILL_G:
        print("Fall Confirmed!")

        bpm = int(input("Enter Heart Rate: "))
        if bpm < PULSE_LOW or bpm > PULSE_HIGH:
            print("Critical Pulse Alert!")
        else:
            print("Pulse Normal")
    else:
        print(" No Fall. Patient moved.")

else:
    print("Normal Activity")
```

TESTING APPROACH

Unit Testing: Verify individual constants work

Integration Testing: Test the full logic flow using simulated data.

System Testing: Test real-world reliability using physical scenarios (deliberate falls, ADL false alarms) and check alert latency

CHALLENGES FACED

- False Alarms: High rate of False Positives (e.g., sitting heavily) and False Negatives (missing slow falls).
- Calibration: Fixed thresholds (2.5G) don't adapt to individual patients or environments.
- Power: Continuous monitoring of G-force and pulse is a major battery drain.
- Data Quality: Motion artifacts corrupt heart rate data after a fall.
- Compliance: Device must be comfortable for 24/7 wear to be effective.

LEARNING AND TAKEAWAY

- Learning: Simple, static thresholds (like 2.5G for impact) are efficient but fundamentally limited. They cannot distinguish between a real, dangerous fall and vigorous everyday activities.
- Takeaway: Robust safety systems require adaptive algorithms or machine learning to minimize false alarms (reducing caregiver "alarm fatigue") while ensuring high sensitivity to genuine falls.

FUTURE ENHANCEMENTS

- AI/ML: Implement Adaptive Thresholds to reduce false alarms.
- Sensor Fusion: Add Gyroscope and Ambient Sensors for better fall confirmation.
- Optimization: Use Edge Computing for better battery life and integrate with telemedicine.

REFERENCES

1.Academic Papers/Articles Referred

2.World Health Organization. "Patient safety." WHO Fact Sheet.

3.Oliver D, Healey F, Haines TP. "Hospital Fall Prevention: A Systematic Review of Implementation, Components, Adherence, and Effectiveness." J Am Geriatr Soc. 2013-03-24. https://pmc.ncbi.nlm.nih.gov/articles/PMC3670303/