uOttawa

Capstone Project Proposal

Group Number: 6

CEG 4912 – Capstone Project

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1. Project Rational

1.1 Why did we choose this project?

Medications adherence is one of the most critical challenges in healthcare, especially for the elderly and patients with chronic illnesses.
Missing doses or taking incorrect amounts of medication can lead to serious health complications, hospitalizations, or even death.
Existing solutions, such as manual pill organizers, do not provide automated reminders or dosage control and do not keep track of the treatment period, leaving patients dependent on caregivers.

Our project aims to address this gap by designing the MediTrack, an Automatic Pill Dispenser that combines hardware and software to provide reliable, user-friendly, and cost-effective solution ensuring correct dosage at the right time for all.

We choose this project because it aligns with our interests in embedded systems, IoT, and human-centered design, while making a meaningful contribution to society by promoting health, safety, independence, and inclusivity.

1.2 Who will benefit from it?

- **Elderly individuals** who often forget or struggle to manage multiple medications.
- **Patients with chronic diseases** (e.g., diabetes, hypertension, cardiovascular conditions) who must follow strict medication schedules.
- **People with hearing impairments**, who will benefit from the vibrating bracelet notification system as an alternative to audio alerts.
- **Caregivers and families** who need reassurance that patients are taking medication correctly without constant supervision.
- **Healthcare providers** who seek improved patient adherence and reduced medication errors.

1.3 How will they benefit?

- **Increased autonomy**: Users can manage their medication without heavy reliance on caregivers.
- **Error prevention**: Automated scheduling and compartment-based dispensing minimize risks of overdosing or missing doses.

- **Convenience**: Clear audio/visual reminders and a vibrating bracelet make the system accessible even for users with hearing impairments or non-technical backgrounds.
- **Peace of mind**: Caregivers and families can be alerted if a dose is missed
- **Improved health outcomes**: Consistent adherence leads to more stable health, fewer emergency visits, and lower healthcare costs.

2. Project Description

2.1.1 Functional Requirements

1. The system must store multiple doses of medication in separate compartments.
2. The system must automatically dispense medications at the scheduled times.
3. The system must provide audible notifications to the user.
4. The system must provide visual notifications to the user (to refill the stock, take the medication, errors, etc.).
5. The system must provide haptic notifications through a bracelet that vibrates when it is time to take medication.
6. The system must securely always lock the pill compartment
7. The system must only unlock when the bracelet is authenticated via NFC/BLE proximity.
8. The system must detect whether the medication has been taken through integrated sensors.
9. The system must record whether the medication has been taken and update logs in the mobile application.
10. The system must allow schedule configuration (time, dosage, compartment assignment) through a mobile application.

2.1.2 Non-Functional Requirements

1. The system should operate with a dispensing accuracy greater than 90%.
2. The system must include a backup power supply to ensure operation during power outages.
3. The system must have a secure and tamper-resistant design, preventing unauthorized access (e.g., children).
4. The system must provide a simple, intuitive interface, suitable for elderly users (large display, easy-to-use navigation, vibration feedback on bracelet).
5. The system should use low-power communication between the dispenser and bracelet to extend battery life.

2.1.3 Functional Requirements (Healthcare Provider & Emergency Contacts)

1. The system must provide access to medication logs for healthcare providers.

2. The system must notify caregivers, doctors, or emergency contacts if multiple doses are missed.
3. The system must allow authorized healthcare providers to update medication schedules remotely through the mobile application.
4. The system must generate alerts when pill compartments are running low
5. The system must share refill reminders with both the patient and caregivers.

Software Requirements

1. User Authentication: Secure login with two roles – Patient and Doctor.
2. Medication Scheduling: Patients or doctors can set treatment times and durations through the app.
3. Automatic Dispensing: At the scheduled time, the carousel rotates to the correct position.
4. Intake Detection: Sensors confirm if the pill was removed; if not, the system sends reminders.
5. Refill Monitoring: The system detects when a compartment is low or empty and alerts the user.
6. Notifications & Reminders: The bracelet vibrates and its LED blinks when it's time for medication.
7. Confirmation & Unlocking: The patient places the bracelet near the device. The system authenticates the bracelet and unlocks the compartment. The action is logged as confirmation of intake.
8. History Tracking: All dispensing events, reminders, and confirmations are logged in the database.
9. Remote Alerts: If doses are missed, both the doctor and emergency contacts are notified through the app.
10. Cross-Platform Support: The mobile app is available for both Android and iOS.
11. Compartment Security: The dispenser remains locked at all times and only unlocks when the bracelet is authenticated, preventing unauthorized access (e.g., children).

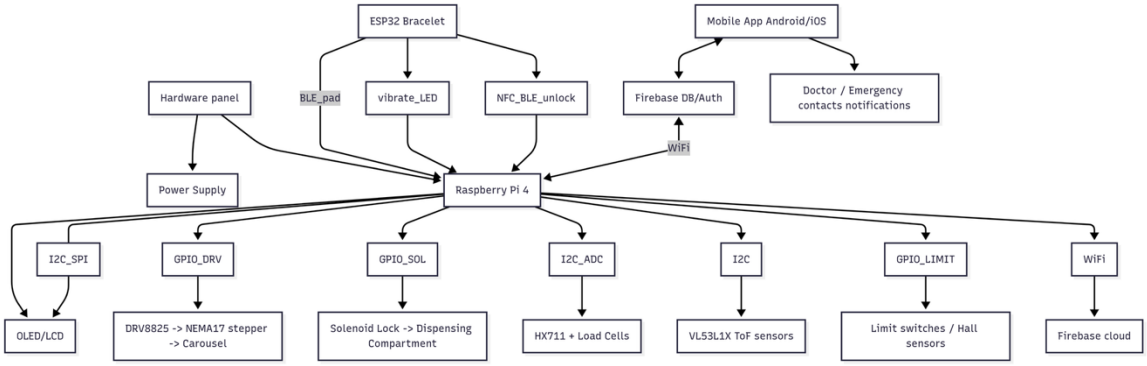
Hardware Requirements

Components Used

- Main Controller: Raspberry Pi 4 manages scheduling, database, Wi-Fi communication, motor control, and lock control.
- Microcontroller: ESP32 low-power BLE device controlling vibration motor, LED, and proximity-based unlocking mechanism.
- Actuators:
    - NEMA17 stepper motor + driver (DRV8825): rotates the pill carousel.
    - Vibration motor + LED (bracelet): notify the user when it's pill time.
    - Electromechanical Lock: keeps the pill compartment closed by default. Unlocks only when the bracelet is placed near the dispenser, using an authentication system (e.g., NFC or BLE proximity).

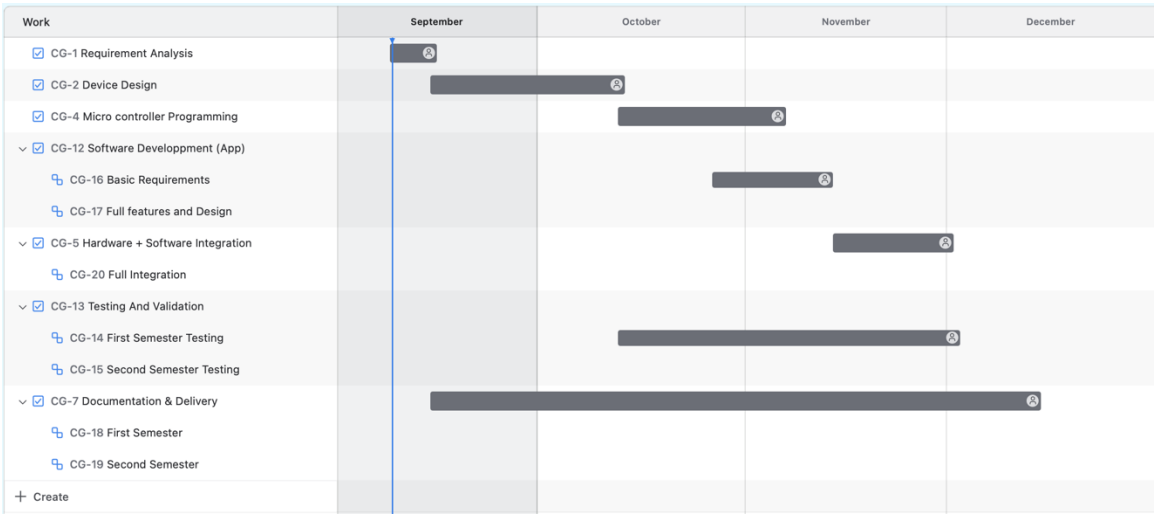
- Sensors:
    - HX711 load cells (one per compartment): detect pill presence and refill status.
    - VL53L1X ToF sensors: confirm pill drop/removal.
    - Limit switches/Hall sensors: track carousel alignment.
- Power Supply: Li-ion 7.4V battery + TP4056 charging module (dispenser); rechargeable Li-Po battery (bracelet).
- User Interface (local): OLED/LCD display on the dispenser for time, status, and error messages.

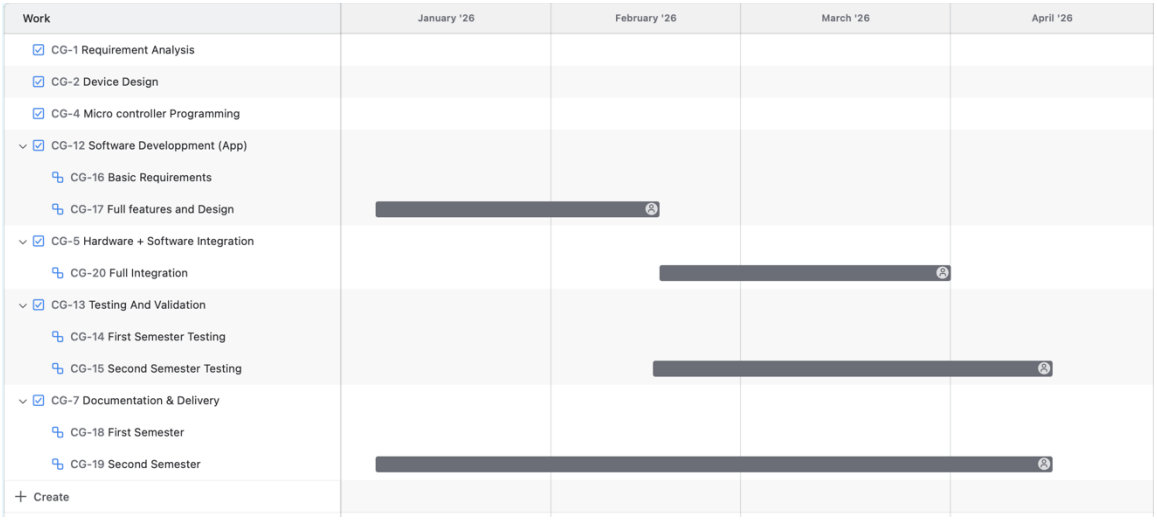
Architecture



2.3 Work Breakdown Structure

2.4 Gantt Chart





2.5 Agile Management

Type	Key	Summary	Status	Comments	Category	Assignee	Due date
	CG-1	Requirement Analysis	TO DO	Add comment			Sep 15, 2025
	CG-2	Device Design	TO DO	Add comment			Oct 13, 2025
	CG-4	Micro controller Programming	TO DO	Add comment			Nov 3, 2025
	CG-12	Software Developpment (App)	TO DO	Add comment			
	CG-16	Basic Requirements	TO DO	Add comment			Nov 13, 2025
	CG-17	Full features and Design	TO DO	Add comment			Feb 16, 2026
	CG-5	Hardware + Software Integration	TO DO	Add comment			Dec 1, 2025
	CG-20	Full Integration	TO DO	Add comment			Mar 31, 2026
	CG-13	Testing And Validation	TO DO	Add comment			
	CG-14	First Semester Testing	TO DO	Add comment			Dec 2, 2025
	CG-15	Second Semester Testing	TO DO	Add comment			Apr 15, 2026
	CG-7	Documentation & Delivery	TO DO	Add comment			Dec 14, 2025
	CG-18	First Semester	TO DO	Add comment			
	CG-19	Second Semester	TO DO	Add comment			Apr 15, 2026

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3. Meetings

The meeting will be held on campus, with the option to attend online upon prior notice to the team.

Each member must inform the group in advance if they will join remotely.

4. Sprint Time Organization

Sprint / Task	Due Date	Objectives	Deliverables
Requirement Analysis	Sep 15, 2025	Define and document system requirements	Requirements specification document
Device Design	Oct 13, 2025	Design hardware structure and dispenser mechanism	Device design document, initial diagrams
Microcontroller Programming	Nov 3, 2025	Develop and test ESP32 programming for communication and notifications	Microcontroller firmware prototype
Software Development (App)	Nov 13, 2025	Implement core app functions (scheduling, reminders, logging)	App prototype v1
Basic Requirements	Nov 13, 2025	Validate that minimal hardware/software requirements are met	Checklist validation
Hardware + Software Integration	Dec 1, 2025	Integrate dispenser hardware with software modules	Working integrated prototype
Testing & Validation	Dec 2, 2025	Conduct unit testing and first validation	Test report + fixes
First Semester Testing	Dec 14, 2025	Keep testing and iterating throughout the semester	Interim report + demo
Full Features and Design	Feb 16, 2026	Implement advanced features (refill alerts, caregiver notifications)	App + hardware features completed
Full Integration	Mar 31, 2026	Integrate advanced features into the final system	Fully integrated prototype
Second Semester Testing	Apr 15, 2026	Conduct full system testing and performance validation	Final test report
Documentation & Delivery	Apr 15, 2026	Prepare final documentation and deliver the prototype	User manual, technical documentation, final demo