PROJECT TITLE

DoseMate

STUDENT/TEAM INFORMATION

Team Name if any: **Team # on Canvas you have self-signed-up for:**	**The Spaniards** **Group10**
Team member 1	Salvador Camacho, Mario msalvadorcamac6617@sdsu.edu 
Team member 2 (Team Lead)	Garaulet Tovar, Pablo pgaraulettovar6176@sdsu.edu 

ABSTRACT (15 points)

(Summarize your project (motivation, goals, system design and results). Max 300 words).

Missing medication is a widespread issue, particularly among elderly and chronically ill patients, often leading to serious health complications and increased healthcare costs. DoseMate is a smart, user-friendly reminder system designed to address this problem by helping users take their medication on time through a combination of physical and electronic alerts.

The system uses an ESP32 TTGO microcontroller to manage scheduled dose reminders via LED and buzzer alerts, as well as Bluetooth Low Energy (BLE) notifications to a mobile device. A built-in button allows users to confirm dose intake, which is logged in the EEPROM with a timestamp. In case of a missed dose, the system repeats the alerts and notifications to reinforce adherence. The device is designed to support flexible medication schedules and is especially suited for elderly users or those managing multiple prescriptions.

The final architecture integrates core hardware components with BLE and Wi-Fi communication protocols, enabling both local reminders and the foundation for future cloud integration through REST APIs. A mobile app was used to receive BLE notifications, and initial Wi-Fi connectivity was successfully tested.

Testing confirmed the system's ability to deliver accurate reminders, detect user confirmations, and differentiate between on-time, late, and missed doses. While some features such as a full web dashboard and structured long-term data logging remain as future work, the project successfully demonstrates a functional prototype that improves medication adherence through intuitive interaction and reliable alert mechanisms.

INTRODUCTION (15 pts)

Motivation/Background (3 pts)

(Describe the problem you want to solve and why it is important. Max 300 words).

Medication adherence is a key part of quality health care, yet it is a persistent issue among elderly and patients with chronic illness. It has been estimated that the World Health Organization approximates that approximately 50% of long-term ill patients are non-compliant regarding taking medications according to prescriptions. This kind of non-compliance leads to undesirable health consequences, hospital readmission, increased health care costs, and decreased quality of life.

The motivations for non-compliance are numerous. Some have trouble keeping track of complex medication schedules with multiple doses a day. Others simply forget to take their medication when they do not feel the immediate effects. Solutions on offer today (mobile phone alarms or traditional pillboxes) are frequently inappropriate, particularly among older individuals who are not highly proficient with smartphones or suffer from cognitive decline that diminishes the effectiveness of digital reminders.

The importance of addressing this problem extends beyond improving the health of each patient and also includes reducing the burden on the healthcare system. Simple to use, reliable, and responsive to unique needs is what the technology solution must be. That is where DoseMate comes in.

DoseMate aims to be a lightweight but effective application that provides physical and electronic cues to remind patients when it is time to take their medication. Through use of visual (LED), auditory (buzzer), and mobile (Bluetooth Low Energy) cues in conjunction with a physical confirmation button, it maximizes awareness and responsibility. Through storage of timestamped confirmation records, the system also enables monitoring and tracking, either locally or through cloud services.

The endeavor is designed to create an assistive device that is accessible, easy to install, and suitable to a large portion of users, most notably the most vulnerable patients of non-adherence. In addressing this vital issue, DoseMate aims to assist in creating improved health outcomes and a more sustainable healthcare system.

Project Goals (6 pts)

(Describe the project general goals. Max 200 words).

The general aim of the project is to design and implement a smart pill reminder gadget in order to boost treatment schedule compliance. The gadget, DoseMate, promises to offer a simple, yet effective, exit strategy for people (mainly the elderly and those suffering from chronic diseases) who have bad memory and therefore are good at not keeping to recommended drug dosage regimens.

DoseMate has several channels of notification: visual through an LED, auditory through a buzzer, and mobile through BLE notifications. There is a physical confirm button to mark each dose taken, and these confirmations are logged with timestamps in EEPROM memory for later recall. In the event of a missed dose, the system will give extra alerts and notifications reminding the user.

The system is intended to be small, simple, and flexible to accommodate multiple medication regimens and user requirements. Eventually, Wi-Fi connectivity and cloud integration will be added to allow remote monitoring and schedule changes through RESTful APIs. DoseMate ideally will ensure patient health by eliminating forgotten doses, assisting caregivers with accurate tracking data, and providing a scalable system that can be implemented for long-term healthcare uses.

Assumptions (3 pts)

(Describe the assumptions (if any) you are making to solve the problem. Max 180 words).

First, it is assumed that the device will be used by a single user at a time, and that each device will manage only one medication schedule, or a small number of regimens with non-overlapping times. This simplifies the scheduling logic and hardware interaction.

We also assume that users will have the physical and cognitive ability to press the confirmation button when taking their medication. While the system is designed with simplicity in mind, it presumes that users can perceive visual and auditory alerts.

Additionally, we assume that BLE communication with the mobile device will function within typical indoor ranges and that users will have access to a smartphone capable of receiving BLE notifications. For cloud integration, it is assumed that Wi-Fi credentials can be securely configured once, and that the home network provides a stable internet connection.

Finally, we assume that EEPROM storage will be sufficient to log dose confirmations over a reasonable timeframe before requiring offloading to a cloud or mobile interface.

SYSTEM ARCHITECTURE (20 pts)

(Describe the final architecture you have implemented listing sensors, communication protocols (Wi-Fi, BLE, ...), cloud services and user interfaces. Include a block diagram of the system. Max 300 words).

The final architecture of DoseMate integrates hardware components, communication protocols, and user interfaces to deliver a robust medication reminder system. At the core of the device is the ESP32 TTGO LoRa32 V1 microcontroller, which manages the logic for dose scheduling, alert triggering, user interaction, data logging, and wireless communication.

The system uses the following sensors and actuators:

- LED for visual alerts.
- Buzzer for auditory alerts.
- Push button for manual dose confirmation.
- Temperature and Humidity Sensor for ensuring correct medicine storage conditions.

For communication, the device incorporates two wireless protocols:

- Bluetooth Low Energy (BLE) to send notifications to the user's smartphone via a mobile application.
- Wi-Fi, used for connecting the device to the internet and enabling cloud synchronization.

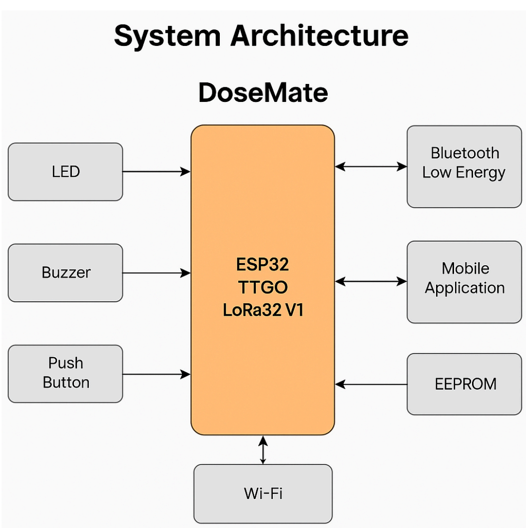
Local storage of dose confirmations is handled using the EEPROM memory of the ESP32, where timestamped records of user interactions are stored.

The user interface is twofold:

1. A physical interface, consisting of the LED, buzzer, and button for immediate interaction.
2. A mobile interface, which displays BLE notifications and in future versions will include a configuration and monitoring app for managing dose schedules and accessing adherence logs.
3. A web page where the user is able to check profile's statistics and manage his/her account.

The system is modular, allowing future enhancements such as additional sensors (for example pill presence detection), extended cloud features, or caregiver dashboards.

Example block diagram:



FINAL LIST OF HARDWARE COMPONENTS (5 pts)

(Write the final list and quantity of the components you have included in your system)

Component/part	**Quantity**
ESP32 TTGO (with Wi-Fi and BLE)	1
Red, Green, Yellow LEDs	1 each
Buzzer	1
Push Button	1
Resistors (220Ω - for LEDs)	3
USB Type-C Cable	1
Smartphone (for BLE notifications)	1
Temperature and humidity sensor	1
EEPROM (built-in on ESP32)	1

PROJECT IMPLEMENTATION (30 PTS)

Tasks/Milestones Completed (15 pts)

(Describe the main tasks that you have completed in this project. Max 250 words).

Task Completed	**Team Member**
Hardware setup and wiring: Connected and configured all hardware components, including the LED, buzzer, and push button and temperature and humidity sensor, to the ESP32r.	Pablo and Mario
Implementation of alert logic and display status messages on TTGO TFT screen: Standby mode: system remains idle until a scheduled dose time. ● Reminder mode: triggers yellow LED blinking and buzzer sound when a dose is due. ● Confirmation mode: upon button press, the system flashes a red LED to indicate successful dose intake and disables the alert.	Pablo and Mario
Bluetooth Low Energy (BLE) integration: Enabled BLE communication between the ESP32 and a mobile device to send real-time notifications for upcoming and missed doses, as well as confirmations.	Pablo

EEPROM data logging: Programmed the system to store each button-press event (dose confirmation) along with a timestamp in the onboard EEPROM memory, allowing adherence records to be saved locally. Also storing temperature and humidity data.	Mario
Web page development: web page for DoseMate, where a user may be able to create an account, modify his/her profile to add their medications and set the time for the dose intake. The user can see statistics/dashboard about the intake of the doses (humidity, temperature over time, device logs…)	Pablo and Mario
Wi-Fi and cloud integration: configured the ESP32 to connect to a Wi-Fi network and tested initial REST API communication, setting the groundwork for cloud-based schedule management and remote data syncing.	Pablo and Mario

Challenges/Roadblocks (5 pts)

(Describe the challenges that you have faced and how you solved them if that is the case. Max 300 words).

One of the first challenges we faced was establishing reliable communication between the ESP32 and a mobile phone via BLE. Initially, the BLE connection was unstable, especially after device reboots or long idle times. To overcome this, we implemented improved pairing logic, added timeout management, and refined connection handling to ensure more consistent behavior.

Another issue was related to data persistence using EEPROM. While logging button presses was straightforward, structuring the stored data to include meaningful timestamps presented difficulties due to the limited memory and lack of a built-in real-time clock. This required careful data formatting and memory management to avoid corruption and ensure accurate records.

We also encountered problems when trying to print medication reminders on the OLED display. At first, the ESP32 either failed to display the messages. Resolving this required multiple iterations of display initialization logic and optimization of I2C communication.

A particularly time-consuming task was creating the data table on the dashboard. Although the device sent data correctly to the backend, the database entries often appeared in the wrong columns, likely due to misaligned JSON keys or inconsistent formatting during transmission. We had to carefully revise both the backend logic and the frontend rendering to ensure all entries appeared in the correct structure.

When integrating the temperature and humidity sensor (DHT20), we initially wired the pins incorrectly, reversing SDA and SCL. This led to a complete lack of data readings, and it took time to diagnose the physical wiring issue. Even after correcting the connections, it was difficult to transmit environmental readings consistently to the server. We eventually resolved this by adjusting the I2C communication frequency and adding retry logic to handle sensor read failures.

Tasks Not Completed (5 pts)

(Describe the tasks that you originally planned to complete but were not completed. If all tasks were completed, state so. Max 250 words).

Task	Reason
We completed all the tasks we planned, and wrote on the proposal and progress report, but we would like to make it functional for many people and we want to differentiate between the patient's various doses and medications, as well as the specific times they need to be taken.	

WEAK POINTS / FUTURE WORK (15 pts)

(Mention at least two points of your project that have room for improvement. These points can be additions to the existing project setup (components) or improvement of the current implementation. Max 200 words).

In the future, we aim to enhance the functionality of our system to support multiple users and allow for personalized medication schedules. Specifically, we would like to implement the ability to differentiate between a patient's various medications and dosages, as well as the exact times each dose must be taken. Another improvement we are considering is configuring the buzzer to emit different tones depending on the type or importance of the dose, this would help both patients and caregivers quickly identify the medication type through auditory cues.

We also plan to develop a dedicated mobile application for managing notifications and tracking adherence. This app could include features such as real-time alerts, dose confirmation buttons, missed dose warnings, caregiver notifications, and even integration with wearable health devices. Additionally, we hope to improve the data analysis component, by generating visual dashboards, detecting non-adherence patterns, and exporting reports for healthcare professionals or family members.

SOURCE CODE (25 pts)

Please include a link to the source code of your project. A link to a repository (like GitHub) is preferred.

https://github.com/pablogaraulet/DoseMate.git