Adherascent - Team 22

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Introduction:

Problem:

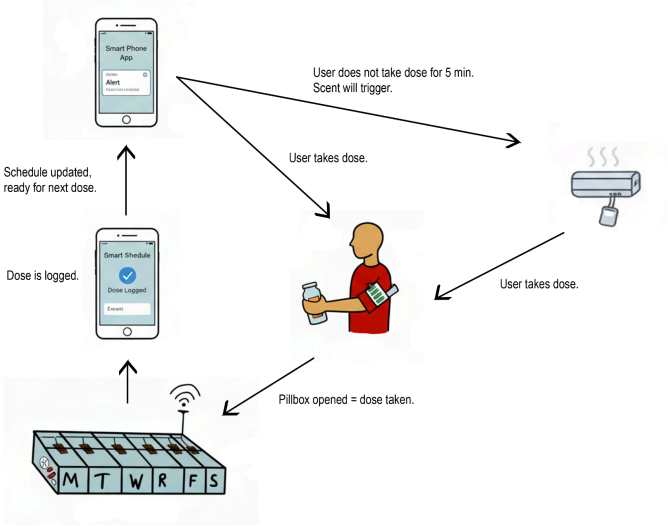
Approximately 66% of adults in the United States take prescription medication, and for many, maintaining a consistent schedule is essential for the medication's effectiveness. However, medication non-adherence is a major challenge, especially among older adults, with up to 50% of people with chronic illnesses not taking their medications as prescribed. This can lead to serious consequences, including 125,000 deaths and an estimated $100 billion in annual healthcare costs in the U.S.. A significant cause of missed doses is simple forgetfulness or disruptions in daily routines. While traditional reminders like alarms exist, they often have limited effectiveness due to alert fatigue, sensory deficits, and a lack of digital literacy in older populations. There is no existing commercial product that combines real-time medication tracking with a scent-based reminder system, which presents a significant opportunity for a new solution.

Solution:

AdheraScent is a system designed to improve medication adherence using a three-part approach: a smart pill container, a mobile app, and a wearable scent emitter. The smart pill container detects when its cap is opened and sends this data via Bluetooth to a mobile app. The app then tracks the user's dosing schedule and determines if a dose is missed. If a dose is overdue, the app wirelessly triggers the wearable scent emitter to release a pleasant, customizable aroma near the user. This unique reminder method leverages the direct neurological connection between scent and memory, offering a non-intrusive and effective way to prompt a user to take their medication.

Visual Aid:

For the wearable device, we intend to either use a fan and liquid chemical for the smell, or a heated transistor and scented wax.



High-Level Requirements:

1. The system must be portable in order to serve patients who are busy, on the move, or have inconsistent schedules. It should function offline without internet dependence.
2. Smart bottles must reliably detect when a medication container has been opened and maintain consistent performance over extended daily use.
3. The wearable must emit a noticeable scent cue shortly after a scheduled dose is missed. The aroma should be safe, pleasant, and clearly perceptible to the user without causing irritation or distraction.

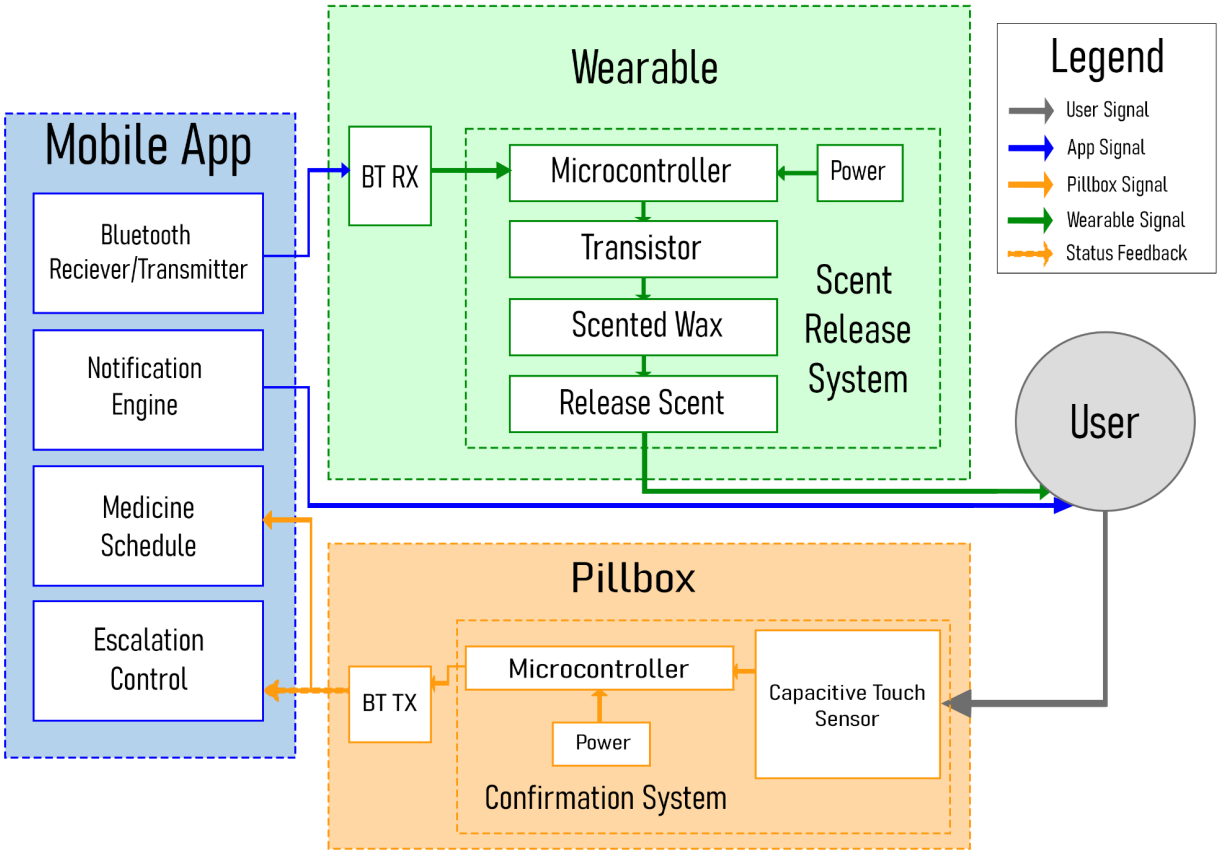
Design:

The wearable device will consist of a small enclosure for the PCB as well as an additional section for the scented wax and transistor. This enclosure will contain a PCB with the following:

- Microcontroller
- Bluetooth RX

Upon receiving the Bluetooth signal stating that a scent reminder is needed, the transistor will heat up. There will be safeguards in place to prevent the individual from burning themselves accidentally. We will use a thermal insulating material such as mineral wool to line the enclosure. At this point, the scented wax will melt and cause a smell to be emitted from the device. For the sake of our design, we would be using a piece of a scented candle for the wax.

Block Diagram:



Subsystem Overview:

The AdheraScent system includes a smart pill container that sends data to a smartphone app when its cap is opened. The mobile app acts as the central hub, processing this information against a user's medication schedule. If a dose is missed, the app sends a signal to a wearable scent emitter, which releases an olfactory cue. The wearable device comes in two proposed forms, an armband or a clip-on, both designed to position the scent outlet near the user's nose. The entire system is Bluetooth-enabled, allowing for real-time communication and the ability to function offline.

Subsystem Requirements:

- **Scent Emitter:** The scent emitter will consist of a small wearable device containing several components. This includes a microcontroller, a bluetooth antenna, an external transistor and a small container. Within this wearable device, the microcontroller acts as the brain of the device. When a signal is received via the bluetooth antenna, the microcontroller starts sending electricity to the external transistor. This transistor will heat up, and as it heats up, it melts the wax stored in the small container. This wax is similar to scented candle wax, once it begins to melt, the scent is released. This process occurs

if the individual does not interact with the pillbox within a certain amount of time. After this individual interacts with the pillbox, the pillbox will send a bluetooth signal to the wearable device. The microcontroller will then stop supplying power to the transistor, causing the scent to stop releasing after a few minutes.

- **Mobile Application:** The mobile application serves as the central hub of the AdheraScent system, linking the smart pill container and wearable scent emitter into a cohesive solution. Its primary responsibility is to track medication events, evaluate them against the user's dosing schedule, and, when necessary, trigger the wearable device to release a scent reminder. Functionally, the app must run on both Android and iOS platforms and communicate with devices through Bluetooth Low Energy (BLE). Each time the pill container cap is opened, the event must be logged and stored in a local database. If a dose is not recorded within a configurable grace period, the app must send a command to the wearable within ten seconds. To ensure reliable operation without internet access, the app must retain at least thirty days of events locally and provide fallback reminders through vibration, on-screen alerts, or text-to-speech notifications when the wearable is unavailable. Accessibility is a key priority, with large fonts, high-contrast visuals, haptic cues, and voice prompts built into the interface. Safety features include duplicate-dose checks that require user confirmation if two events occur too closely together. Non-functional requirements specify fast device connections, minimal storage overhead, secure data encryption, and efficient operation on older smartphones. To meet these needs, the app will be developed using React Native. Libraries such as react-native-ble-plx and react-native-permissions will manage Bluetooth communication, while react-native-sqlite-storage and redux-persist will handle event storage. UI and accessibility will be supported by react-native-paper, react-native-vector-icons, react-native-haptic-feedback, and react-native-tts. For security, react-native-encrypted-storage and crypto-js will protect sensitive data. Testing will use Jest for unit testing and Detox for end-to-end scenarios. Through this architecture, the mobile application ensures secure, reliable, and user-friendly operation, forming the backbone of the AdheraScent system.
- **Pill Container:** The pill container or pillbox will consist of a simple pillbox with seven compartments. One for each day. This pillbox will have several features added onto it. The pillbox will have a bluetooth antenna to send a signal when the box is opened or closed. This signal will be sent to the wearable device discussed earlier, either stopping or starting the scent emission. We plan to use a touch sensor to determine when the pillbox has been opened, in order to send this signal.

Tolerance Analysis:

We foresee that the wearable device could pose the most significant risk to completing the project. The wearable device has to be small enough and compact, while also housing the chemical to be released when needed. In addition to this, there has to be a mechanical or electrical mechanism to release said chemical.

Ethics and Safety:

Our project deals with the usage of prescription medications. It is intended to help remind individuals when they should take their medication. However, if the device were to malfunction this could lead to health concerns. There are two main concerns we are considering. The first one is when the device reminds an individual to take their medication at an incorrect time. This can lead to accidental overdosing, if the time between doses isn't long enough. The other scenario is when the device fails to remind the user to take their medication. This could lead to them forgetting to take life saving medication which can cause death.