IoT Clinical Task Tracking

THE TEAM

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THE PROBLEM

The healthcare industry's record-keeping practices suffer from inefficiencies and inaccuracies due to manual paperwork requirements, leading to a strain on valuable resources and potential errors. Clinicians are burdened with the time-consuming task of documenting daily operations like hand washing and sterilization to comply with healthcare standards and audits. This cumbersome process not only diverts clinicians from their clinical expertise but also introduces risks to data accuracy.

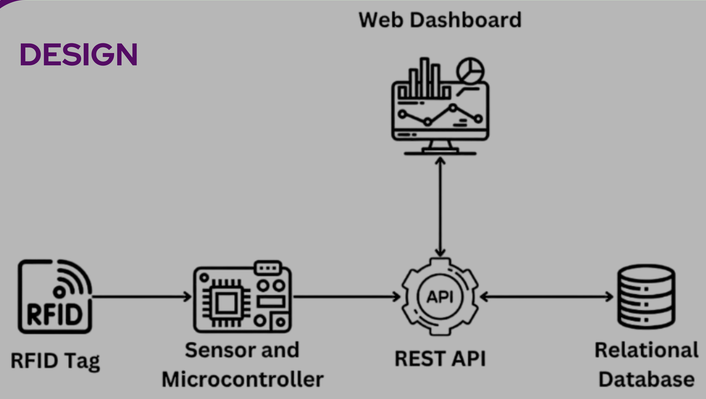
THE SOLUTION

This project introduces a modern solution to upgrade healthcare record-keeping using IoT technology. Clinicians receive personalized RFID tags, which they can quickly scan with strategically placed sensors in the clinic to log essential tasks with ease and speed. These recorded tasks are securely stored and accessible through a user-friendly web portal. The portal allows for real-time monitoring of clinic performance and task records. Admins have the capability to register users and manage the system, ensuring smooth operation. Robust security measures like encryption and hashing ensure the confidentiality and accuracy of the data. This innovative approach transforms traditional healthcare practices, reducing the workload on clinicians and improving overall clinic efficiency.

SCHULICH School of Engineering — UNIVERSITY OF CALGARY

WOSLER DIAGNOSTICS

DESIGN

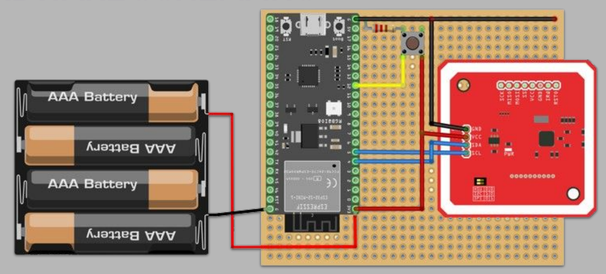


HARDWARE

At the center of the sensor stations lies the ESP32-S2-DEVKITC-1, a Wi-Fi-connected microcontroller serving as the central processing unit. This versatile component communicates with the RFID sensor (PN532) via a UART connection. To conserve power, the station can be awakened by pressing a push button, signalling its readiness to scan through the built-in LED indicator. Powered by AA batteries, each station operates reliably for up to four months.

Our system enhances clinician workflow by equipping each staff member with a personalized RFID tag containing crucial account details. When a station is activated, clinicians simply bring their RFID tags close to the sensor, prompting seamless data retrieval and communication with the microcontroller. This efficient process logs clinician data alongside timestamps for compliance auditing and securely transmits it to the central server using mutual TLS encryption, safeguarding confidentiality. Should connectivity falter, clinician information is safely stored in the ESP32's flash memory for subsequent re-transmission.

HARDWARE SCHEMATIC



MATERIALS

- **Microcontrollers -** ESP32-S2-DEVKITC-1
- **RFID Sensors -** PN532
- **RFID Tags**
- **AA Batteries, Charger, and Holder**
- **Resistors & Push Buttons**
- **Prototype Board**

SOFTWARE - BACKEND

The backend of the system is designed with a focus on flexibility, security, and efficiency to meet the diverse needs of users and ensure seamless communication between various components. Utilizing Express.js, the REST API serves as a robust communication protocol facilitating CRUD operations between clients, including the UI and sensors, and the server-side application. Express.js was selected for its simplicity, speed, and alignment with the sponsor's preferences, operating under Node.js to efficiently handle concurrent connections and real-time data updates from sensors.

Data integrity and security are paramount considerations, leading to the adoption of a PostgreSQL relational database. This choice ensures structured storage of all data collected from sensors and user interactions, supporting complex queries and enforcing ACID properties for data reliability. PostgreSQL's open-source nature allows deployment flexibility across different cloud providers or on-premises environments, aligning with the project's requirement for vendor independence.

Security measures extend to user authentication and authorization, employing OAuth 2.0 with JWT Tokens over TLS-encrypted channels to safeguard user sessions and transactions. Role-Based Access Control (RBAC) further enhances security by limiting user access to appropriate resources based on predefined roles. Additionally, password security is upheld through one-way hashing with Bcrypt and enforced password policies to mitigate the risk of unauthorized access.

SOFTWARE - FRONTEND

The web portal dashboard was developed using React and styled with MUI, ensuring both a visually appealing and highly responsive interface. Through seamless integration with the API, it facilitates the retrieval and display of logged tasks for organizations, clinics, and clinicians in real-time. Admin users benefit from comprehensive management functionalities, enabling them to oversee and modify various entities such as organizations, clinics, clinicians, sensors, task types, and task entries efficiently.

In addition to task management capabilities, the dashboard offers valuable insights into clinic performance through intuitive data visualization tools. This emphasis on performance monitoring enhances transparency and accountability within the organization, fostering a culture of continuous improvement and ensuring compliance with provincial and federal auditing requirements.

To further enhance reliability, the front end undergoes rigorous testing using Cypress end-to-end tests, ensuring robustness and resilience against potential vulnerabilities.

ACKNOWLEDGEMENTS

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