UTA
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RFID SMART STETHOSCOPE

Senior Design

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Background

At the university's smart hospital they bring in paid actors called standardized patients who act like they have particular ailments and diseases to help train the nursing students to identify and treat those ailments. The issue that the university is having with these patients is that they are actually healthy so their internal body sounds are those of a healthy individual, and so the university cannot train the nurses to listen for unhealthy sounds within the patients body. To help train their nursing students to use a stethoscope to listen for different auscultation sounds within the heart, lungs, and bowels of the healthy standardized patients this project will use a set of chips that the standardized patient can wear. When these chips are scanned it will play the audio corresponding to the part of the body that was just scanned. This allows for the nursing students to hear sounds that the standardized patients body would normally not be making.

To allow for a wide variety of different simulations that the smart hospital might want to run these chips must be able to be reprogrammed easily to allow for any ailment that the smart hospital wishes to train the students for that particular day.

Key Requirements

The RFID Smart Stethoscope (RSS) project introduces a pioneering approach in medical education, specifically designed to enhance practical training for medical students, health professionals, and educators. This innovative system leverages programmable RFID chips embedded in a wearable shirt, simulating a range of auscultation sounds associated with various health conditions.

The core objective of the RSS is to create a realistic and interactive learning environment where students can practice and refine their diagnostic skills using a stethoscope on either a healthy individual or a static patient simulator. This approach allows for a detailed and nuanced understanding of different health scenarios without the need for actual patients. It’s a technological leap in medical training, fostering a deeper comprehension of diagnostic sounds, and offering educators a versatile platform for effective teaching and assessment.

This system stands as a testament to the intersection of technology and healthcare education, aiming to bridge the gap between theoretical knowledge and practical application. It's a forward-thinking solution, ensuring that the medical professionals of tomorrow are well-equipped with the necessary skills and experience to excel in their field.

Architectural Design

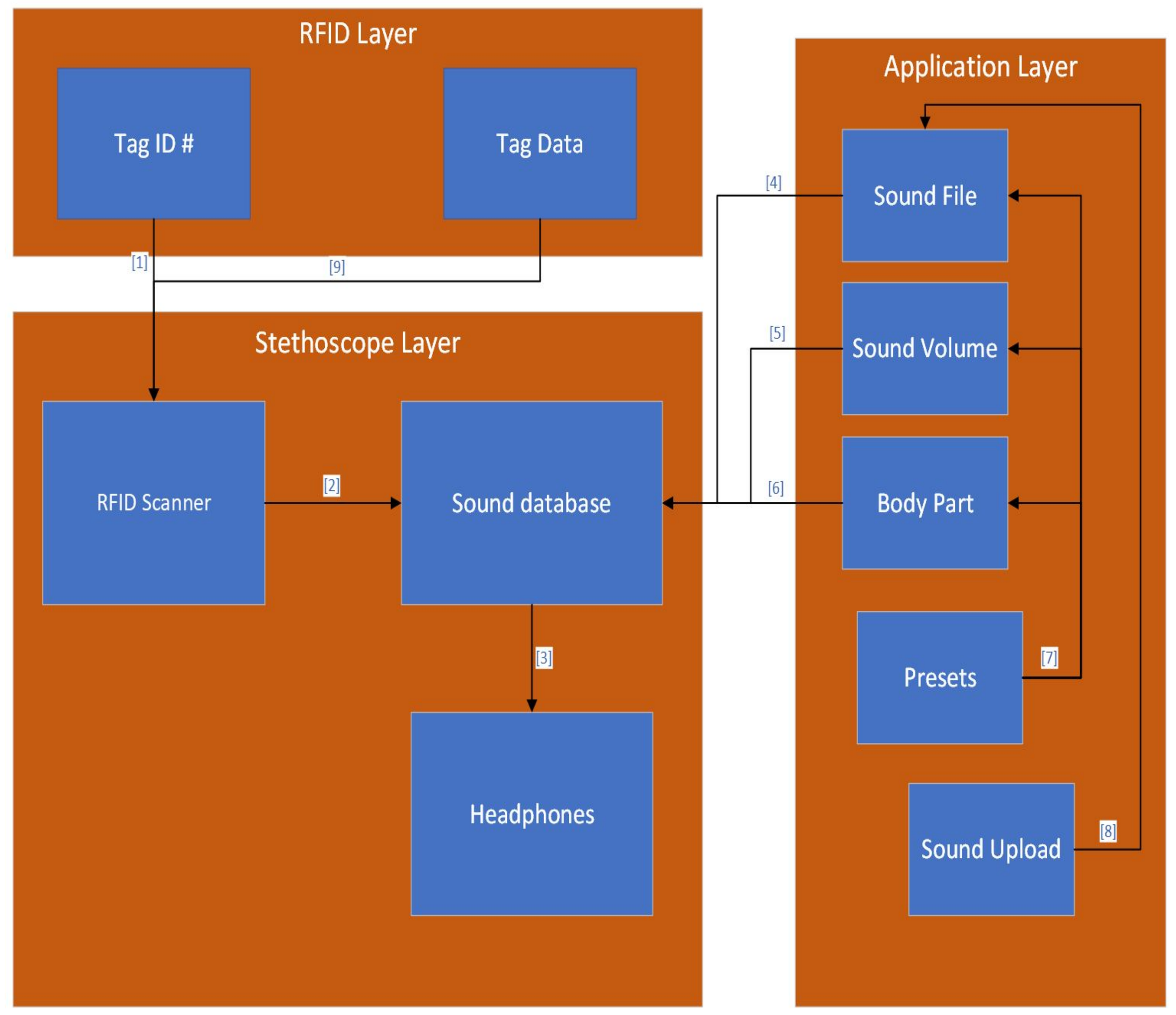
The architectural design of your RFID Smart Stethoscope (RSS) project is structured into three primary layers, each serving a distinct function:

RFID Layer: This is the foundational layer of the RSS, responsible for managing interactions with the RFID tags. It comprises 13 different RFID tags, each programmed to return a unique ID number when scanned by the Smart Stethoscope. The ID numbers are crucial as they inform the stethoscope about the specific body part being examined.

Stethoscope Layer: This layer includes the RFID scanner, a computer/database system, and headphones. It receives sound settings and files from the Application layer and the RFID tag ID numbers from the RFID layer. The sound database within this layer utilizes the tag ID numbers to determine the appropriate sounds to output through the headphones, allowing users to hear the programmed auscultation sounds corresponding to the scanned body part.

Application Layer: This top layer enables Smart Hospital staff to upload and program audio files specific to various body parts. These programmed sounds are then sent to the Stethoscope layer to update the sound database. The layer can also receive updates directly from users or utilize pre-saved presets, ensuring flexibility and ease of use in various training scenarios.

Each layer of the RSS is intricately designed to ensure a seamless and efficient operation, from the initial interaction with RFID tags to the final auditory output, thereby creating a comprehensive and immersive training tool for medical education



Implementation Details and Test Plan

Implementation Synthesis

The RFID Smart Stethoscope project was meticulously implemented in three layers: the RFID layer for tag interaction, the Stethoscope layer for audio processing, and the Application layer for sound programming and management. Initial prototyping was focused on ensuring hardware reliability and software accuracy, with subsequent iterations refining the integration of the layers. Through iterative development, the project achieved a seamless synergy between the physical components and the software interface.

Prototyping and Simulation

Prototyping encompassed both the physical assembly of the RFID-enabled stethoscope and high-fidelity simulations to emulate real-world clinical conditions. The testing regimen included functional verification of tag readability, audio fidelity assessments, and end-user interface usability. Simulations played a critical role in replicating the clinical environment, allowing for adjustments to system responses and user interaction before deployment.

Test Plan and Future Enhancements

The test plan for the RSS project was comprehensive, covering unit, integration, system, and usability testing. Future work will look towards expanding the system’s capabilities, including a wider range of simulated conditions, and exploring the integration of machine learning to adapt to user proficiency. Enhancements will be guided by ongoing user feedback and technological advancements in RFID and audio output systems.

Conclusions and Future Work

The RFID Smart Stethoscope is a useful tool for the UTA Smart Hospital to use to help train nursing students here at UTA. Future enhancements could include expanding the singular stethoscope into a full fleet of stethoscopes so that a whole class of students could have access to this new training method. Introduction of more body parts and more accurate sounds would also improve the accuracy of simulations.

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