DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
THE UNIVERSITY OF TEXAS AT ARLINGTON

SYSTEM REQUIREMENTS SPECIFICATION
CSE 4316: SENIOR DESIGN I
SUMMER 2023

TEAM MAJESTIC
RFID SMART STETHOSCOPE

MICHAEL ALLEN
JAMIE BARAJAS
EFRAIN MORALES LOYA
CHAU NGUYEN
KHOI TRAN

Revision History

Revision	Date	Author(s)	Description
0.1	7.8.2023	CN	document creation
0.2	7.11.2023	MA, CN	complete draft
0.3	7.12.2023	MA, CN, JB, KT, EL	Review draft

CONTENTS

List of Figures

List of Tables

1 Product Concept

This section provides a comprehensive statement of the proposed product concept, its functionalities, and intended use. It specifically details the purpose, use, and target audience of the RFID Smart Stethoscope (RSS), a sophisticated, education-oriented technology system. The RSS system utilizes programmable RFID chips to simulate a variety of auscultation sounds. This technological innovation aids learners in experiencing diverse health scenarios on a healthy individual or static patient simulators, enhancing their diagnostic skills and medical understanding.

1.1 Purpose and Use

The primary purpose of the RFID Smart Stethoscope (RSS) is to provide a practical and effective learning platform for medical students, aspiring health professionals, and educators. The RSS utilizes programmable RFID chips that can reproduce a wide range of auscultation sounds. These chips are strategically placed in a wearable shirt, designed to simulate various health conditions realistically.

Users can program the RFID chips with desired auscultation sounds using a compatible device. Once programmed, learners can use a stethoscope on the shirt, worn by a healthy person or a patient simulator, to listen to these sounds. This facilitates an interactive learning experience where medical students can learn to identify and differentiate various auscultation sounds without needing an actual patient. It also enables educators to provide comprehensive training and assessments in a controlled and safe learning environment.

1.2 Intended Audience

The intended audience for the RFID Smart Stethoscope (RSS) is broad and diverse, covering various stakeholders in the medical and healthcare educational field. These include:

- **Medical Students:** The RSS provides a hands-on learning experience to medical students, enabling them to familiarize themselves with different auscultation sounds and their corresponding health conditions.
- **Healthcare Professionals:** Even for experienced practitioners, the RSS serves as an effective tool for refining their diagnostic skills and staying updated with various pathological sounds.
- **Medical Trainers and Educators:** For those teaching healthcare, the RSS is a versatile tool for demonstrating different health scenarios, testing students' understanding, and giving real-time feedback.
- **Simulation Centers:** The RSS can be a significant addition to any medical simulation center as it can be integrated with static patient simulators to simulate complex medical scenarios.
- **UTA Nursing and Healthcare Department:** These entities can use the RSS for continuous professional development and training of their healthcare staff.

While the RSS is designed as a standalone system, it can also be incorporated into a broader educational technology system within a medical curriculum, enhancing the overall teaching and learning process.

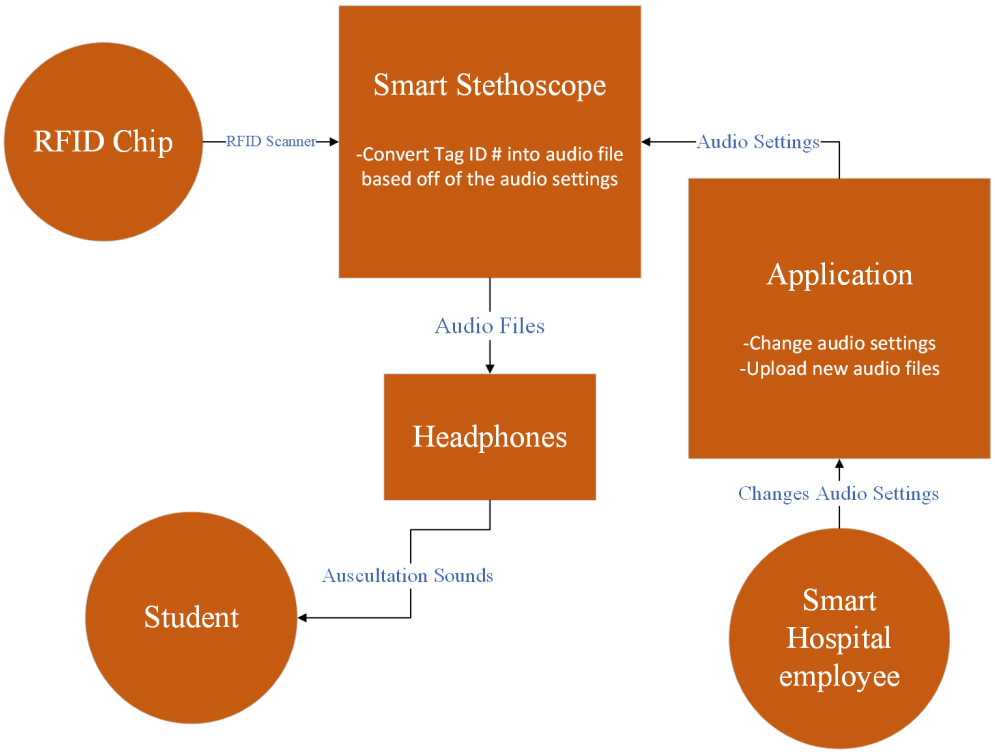

Figure 1: RFID Smart Stethoscope conceptual drawing

2 Product Description

This section provides an overview of the RFID Smart Stethoscope (RSS) system, its main features, and its functionality. It offers the reader insights into the operational aspects of the product from the perspectives of end-users, maintainers, and administrators. Key features and functions, user interactions, and interfaces are detailed here.

2.1 Features & Functions

The RSS system is designed to create a dynamic and interactive learning experience for individuals studying or working in the medical field. At its core, the RSS uses programmable RFID chips to reproduce a variety of auscultation sounds. These chips are placed in a wearable shirt and can be programmed to simulate different health conditions.

The primary components of the RSS system include the wearable shirt embedded with RFID chips and a device used for programming these chips. The shirt acts as the patient simulator, while the device used for programming could be a computer or a mobile device with a dedicated application installed.

The RSS does not diagnose diseases or suggest treatment options. It is strictly an educational tool, designed to help medical students and professionals refine their auscultation skills.

Please refer to Figure 1 for a conceptual diagram of the system.

2.2 External Inputs & Outputs

The RSS system has critical data flows that ensure its functionality. The table below summarizes these flows:

Name	I/O	Description	Use
RFID tag number	Input	Identification number of the RFID tagged scanned by the Smart Stethoscope	Determine which body part was scanned
Audio Files	Input	Audio files of auscultation sounds uploaded to the software by the user	Future use within the software
Sound Settings	Input	Sounds selected by the user to program the RFID chips	Program patient scenarios
Presets	Input	User saves current settings to a preset	Allows for quick reuse of settings
Sound Playback	Output	The auscultation sounds programmed to the scanned RFID chip	Allows the student to hear the desired sound

Table 2: External Inputs & Outputs

2.3 Product Interfaces

The RSS system interface is mainly twofold: the RFID-embedded shirt that the users interact with using a stethoscope, and the device interface (computer/mobile application) that the users interact with to program the RFID chips.

The device interface allows users to select the auscultation sounds they want to program onto the RFID chips. It features a simple, user-friendly design, displaying a list of available sounds categorized by health condition.

The shirt does not have a visible interface in the traditional sense. Instead, users listen to the programmed auscultation sounds through their stethoscope, creating an interactive and immersive learning experience.

Please refer to Figure 2 for a conceptual diagram of the system interface.

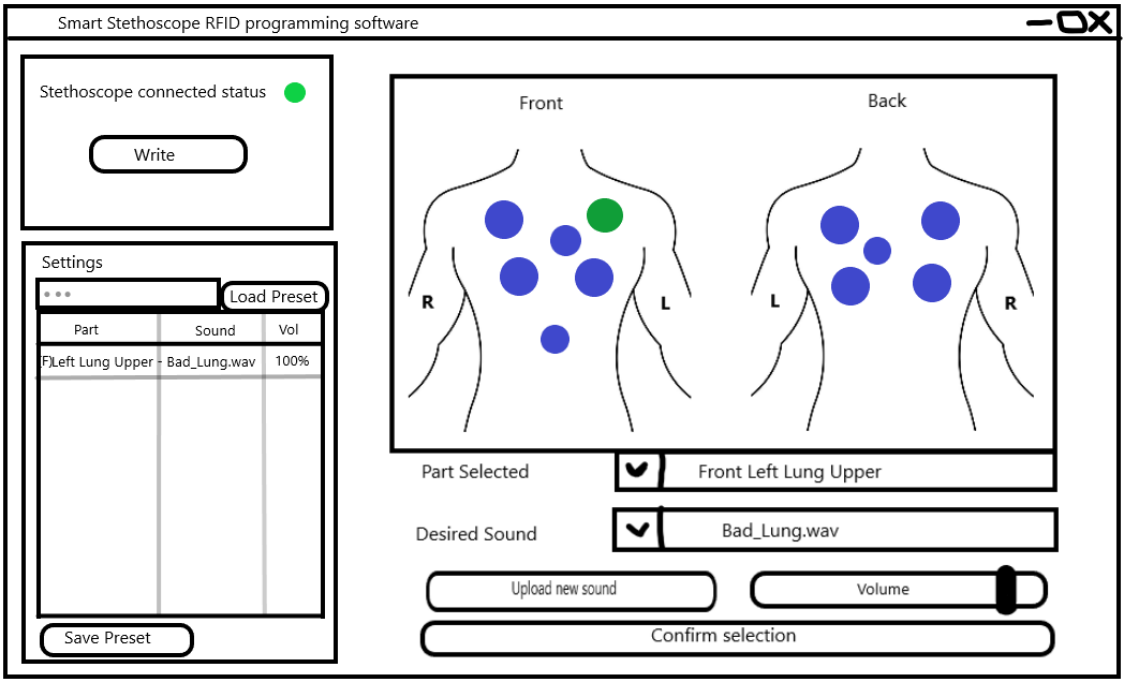

Figure 2: RFID Smart Stethoscope user interface concept

3 Customer Requirements

This section outlines the customer-specific requirements for the RFID Smart Stethoscope (RSS) system. These requirements encapsulate the desired characteristics and feature as specified by potential users. It establishes a precise understanding of product's aesthetics, functionalities and limitations. Each requirements outlined here directly correlates with a distinct customer need. These are features and functions that will be directly observed and utilized by its users. Modifications to these requirements must be agreed upon explicitly by the customer/Sponsor.

3.1 The user shall be able to scan the shirt and hear the auscultation sounds

3.1.1 Description

The user must be able to use the smart stethoscope in a similar fashion to that of a regular stethoscope, and be able to hear the programmed simulated auscultation sounds.

3.1.2 Source

Sponsor: Smart Hospital

3.1.3 Constraints

RFID shirt may only contain a limited number of scanning points limiting how realistic the system can be.

3.1.4 Standards

EPC UHF Gen2 Air Interface Protocol
AES Audio standards

3.1.5 Priority

Critical

3.2 The Smart Stethoscope shall have high audio fidelity

3.2.1 Description

The RFID Smart Stethoscope (RSS) system is required to replicate auscultation sounds with high fidelity. It should closely imitate the sounds a user would hear during a physical examination using a stethoscope. This will aid the product's effectiveness as a learning tool.

3.2.2 Source

Sponsor: Smart Hospital

3.2.3 Constraints

Audio fidelity may be constrained by the quality of audio files supplied as well as the headphones used within the system.

3.2.4 Standards

AES Audio standards

3.2.5 Priority

High

3.3 The user shall be able to reprogram the auscultation sounds

3.3.1 Description

Whoever is designing the simulations for the smart hospital should be able to easily change what auscultation sounds play from each part of the body when scanned. This allows them to tailor the smart stethoscope to whatever situation they wish the train the students on that day.

3.3.2 Source

Sponsor: Smart Hospital

3.3.3 Constraints

RFID shirt may only contain a limited number of re-programmable scanning points limiting the number of different situations the Smart Hospital can train their students on.

3.3.4 Standards

N/A

3.3.5 Priority

Critical

3.4 The user shall be able to upload new sounds to the software

3.4.1 Description

Whoever is designing the simulations should be able to upload any sounds files that they wish to use to expand the possible scenarios that can be simulated. This allows them to set up scenarios that may have not been able to be created within the default sounds on the software.

3.4.2 Source

Team Majestic

3.4.3 Constraints

File must be of a specific file type, and cannot exceed a specific file size or audio length.

3.4.4 Standards

N/A

3.4.5 Priority

High

3.5 RFID shirt shall contain a minimum of 14 scan points

3.5.1 Description

The shirt worn by the standardized patients must contain at least 14 points for the students to scan. On the front of the shirt there must be 4 points for the lungs, left and right upper and lower, 1 for the heart, and 4 for the bowels. The back of the shirt will also contain 4 points for the lungs and 1 for the heart.

3.5.2 Source

Sponsor: Smart Hospital

3.5.3 Constraints

The number of RFID chips and scan points on the shirt are constrained by how close we can put the RFID chips to one another and how many we can fit on one shirt.

3.5.4 Standards

EPC UHF Gen2 Air Interface Protocol

3.5.5 Priority

High

3.6 The RFID shirt must be adjustable

3.6.1 Description

The RFID shirt will be worn by a wide variety of standardized patients with different shapes and body types. The shirt must be adjustable to allow for a wider selection of patients to sill be able to wear it regardless of their body type.

3.6.2 Source

Sponsor: Smart Hospital

3.6.3 Constraints

Some body types might be too extreme for use to make the shirt adjustable to fit, and the locations of the RIFD chips to stay accurate with the locations of the organs in body.

3.6.4 Standards

N/A

3.6.5 Priority

High

3.7 The RFID shirt must fit under patient gown

3.7.1 Description

The RFID shirt must be able to fit comfortably under a patient gown, and disrupt the standardized patients in any way.

3.7.2 Source

Sponsor: Smart Hospital

3.7.3 Constraints

The adjust-ability might make it difficult to fit seamlessly under a patient gown depending on the approach used.

3.7.4 Standards

N/A

3.7.5 Priority

Moderate

3.8 The user shall be able to save presets in the software

3.8.1 Description

Whoever is developing settings for use in the smart hospital can save their settings into presets for future use within the smart hospital.

3.8.2 Source

Team Majestic

3.8.3 Constraints

Application storage space may only allow for so many presets to be saved.
Presets must have a unique name from any other presets.

3.8.4 Standards

N/A

3.8.5 Priority

Future

3.9 User shall be able to control volume of sounds within the settings documents

3.9.1 Description

To simulate muffed sounds within the lungs or heart the user can use previously loaded sounds and change the volume that they will play at to simulate muffled sounds in the lungs.

3.9.2 Source

Sponsor: Smart Hospital

3.9.3 Constraints

Signal processing to change the volume may be out of the scope of this project.

3.9.4 Standards

IEEE signal processing standards.

3.9.5 Priority

Future

4 Packaging Requirements

In this section, the specific packaging requirements for the RFID Smart Stethoscope (RSS) system are detailed. These requirements are crucial in ensuring that the product is presented and delivered to the end-user in a manner that not only preserves its functionality but also enhances the overall customer experience. The RSS system comprises of a smart stethoscope and RFID tags that are to be adhered to a shirt. Careful attention has been given to the packaging of these hardware components as well as the software necessary for operation. The requirements specified herein are unique to this section and do not overlap with those provided in other parts of this document.

4.1 The hardware components shall be delivered in a safe and organized manner

4.1.1 Description

The hardware components, namely the RFID Smart Stethoscope system, must be surely and neatly packed in an organized fashion within the packaging box. The packaging should be designed to prevent damage during transit and storage, ensuring the safety of the components.

4.1.2 Source

Team Majestic
Sponsor: Smart Hospital

4.1.3 Constraints

Cost of packaging materials, size of the packaging for storage and shipping purposes, and ensuring that the packaging is secure yet easy to open for the customer.

4.1.4 Standards

Industry standards for consumer electronics, ensuring optimal safety and presentation of the product components.

4.1.5 Priority

High

4.2 The RFID Shirt shall be delivered in a packaged securely

4.2.1 Description

The shirt will be neatly packed to avoid any damage to the shirt itself or the RFID chips attached to the shirt.

4.2.2 Source

Team Majestic
Sponsor: Smart Hospital

4.2.3 Constraints

Cost of packaging materials, size of the packaging for storage and shipping purposes, and ensuring that the packaging is secure yet easy to open for the customer.

4.2.4 Standards

N/A

4.2.5 Priority

High

4.3 The Software shall be delivered via an install drive with User Manual

4.3.1 Description

The software required for the operation of the RSS system should be preloaded on the stethoscope. The user-end software will be delivered via an install drive with user-friendly installation instructions provided. The packaging should also include a comprehensive user manual that guides the user on how to adhere new RFID tags to the shirt, use the stethoscope to read these tags, and operate the software.

4.3.2 Source

Team Majestic
Sponsor: Smart Hospital

4.3.3 Constraints

The primary constraints involve ensuring that the software can be preloaded and is compatible with the device. There should also be a contingency plan for scenarios where the software cannot be preloaded due to unforeseen issues.

4.3.4 Standards

The preloaded software should comply with industry standards regarding usability and accessibility. The user manual should follow technical communication standards for clarity and comprehensibility.

4.3.5 Priority

Critical

5 Performance Requirements

Performance requirements for the RFID Smart Stethoscope (RSS) system address operational speed, battery life, and setup time. They are crucial to ensure the product meets the demands of its users in a healthcare training environment.

5.1 Audio Playback Speed

5.1.1 Description

The RSS system should process and play the audio files associated with the RFID tags within 1 second of tag detection. This is to ensure a seamless and realistic experience for users.

5.1.2 Source

Sponsor: Smart Hospital
Team Majestic

5.1.3 Constraints

Processing capabilities of the RFID reader and the quality of the audio files.

5.1.4 Standards

EPC UHF Gen2 Air Interface Protocol.

5.1.5 Priority

High

5.2 Battery Life

5.2.1 Description

The battery life of the RSS system, when fully charged, should last for at least 4-6 hours of continuous usage. This is to ensure that it can be used for a session of training without needing recharging.

5.2.2 Source

Sponsor: Smart Hospital

5.2.3 Constraints

Power draw of the RFID reader, Power draw of the microprocessor, and the capacity of the battery.

5.2.4 Standards

N/A

5.2.5 Priority

Critical.

5.3 Setup Time

5.3.1 Description

The time required to set up the RSS system, from unpacking to first use, should not exceed 1 hour. This includes assembling the system and any required software setup.

5.3.2 Source

Sponsor: Smart Hospital.

5.3.3 CONSTRAINTS

Complexity of the system assembly, the user's familiarity with similar systems, and the clarity of the provided instructions.

5.3.4 STANDARDS

N/A

5.3.5 PRIORITY

High

6 Safety Requirements

Include a header paragraph specific to your product here. Safety requirements might address items specific to your product such as: no exposure to toxic chemicals; lack of sharp edges that could harm a user; no breakable glass in the enclosure; no direct eye exposure to infrared/laser beams; packaging/grounding of electrical connections to avoid shock; etc.

6.1 Laboratory equipment lockout/tagout (LOTO) procedures

6.1.1 Description

Any fabrication equipment provided used in the development of the project shall be used in accordance with OSHA standard LOTO procedures. Locks and tags are installed on all equipment items that present use hazards, and ONLY the course instructor or designated teaching assistants may remove a lock. All locks will be immediately replaced once the equipment is no longer in use.

6.1.2 Source

CSE Senior Design laboratory policy

6.1.3 Constraints

Equipment usage, due to lock removal policies, will be limited to availability of the course instructor and designed teaching assistants.

6.1.4 Standards

Occupational Safety and Health Standards 1910.147 - The control of hazardous energy (lockout/tagout).

6.1.5 Priority

Critical

6.2 National Electric Code (NEC) wiring compliance

6.2.1 Description

Any electrical wiring must be completed in compliance with all requirements specified in the National Electric Code. This includes wire runs, insulation, grounding, enclosures, over-current protection, and all other specifications.

6.2.2 Source

CSE Senior Design laboratory policy

6.2.3 Constraints

High voltage power sources, as defined in NFPA 70, will be avoided as much as possible in order to minimize potential hazards.

6.2.4 Standards

NFPA 70

6.2.5 Priority

Critical

6.3 RIA robotic manipulator safety standards

6.3.1 Description

Robotic manipulators, if used, will either housed in a compliant lockout cell with all required safety interlocks, or certified as a "collaborative" unit from the manufacturer.

6.3.2 SOURCE

CSE Senior Design laboratory policy

6.3.3 CONSTRAINTS

Collaborative robotic manipulators will be preferred over non-collaborative units in order to minimize potential hazards. Sourcing and use of any required safety interlock mechanisms will be the responsibility of the engineering team.

6.3.4 STANDARDS

ANSI/RIA R15.06-2012 American National Standard for Industrial Robots and Robot Systems, RIA TR15.606-2016 Collaborative Robots

6.3.5 PRIORITY

Critical

7 Security Requirements

For the RFID Smart Stethoscope (RSS) it is not connected to the internet, and does not contain any personal user data, but it does contain an RFID reader that can read any RFID tags

7.1 The Smart Stethoscope must only scan correct tags

7.1.1 Description

The RFID Smart Stethoscope will have an RFID reader on the end to prevent reading tags that were not intended to be read from causing issues the software will return error an ignore any not white listed RFID Tag IDs.

7.1.2 Source

Team Majestic

7.1.3 Constraints

N/A

7.1.4 Standards

EPC UHF Gen2 Air Interface Protocol

7.1.5 Priority

Moderate

8 Maintenance & Support Requirements

Team Majestic will provide support to the Smart Hospital through supplied documentation, application updates, and replacement guides.

8.1 Hardware documentation

8.1.1 Description

The smart hospital will be given a detailed documentation of the hardware used within the RFID Smart Stethoscope (RSS).

8.1.2 Source

Team Majestic

8.1.3 Constraints

Exact part numbers may be difficult to find.

8.1.4 Standards

N/A

8.1.5 Priority

Moderate

8.2 Application updates

8.2.1 Description

The software will be updated as any new bugs arise that may cause issues for use within the Smart Hospital.

8.2.2 Source

Team Majestic

8.2.3 Constraints

Due to the application not being a web application a fresh install of the updated application must be supplied.

8.2.4 Standards

N/A

8.2.5 Priority

High

8.3 Replacement guide for RFID tags

8.3.1 Description

If any of the RFID tags wear down due to repeated use a guide for ordering replacement parts and setting it up within the program will be supplied to the smart hospital.

8.3.2 Source

Team Majestic

8.3.3 Constraints

Replacing the RIFD tag might be difficult for people with less computer expirence to understand.

8.3.4 STANDARDS

N/A

8.3.5 PRIORITY

High

9 Other Requirements

9.1 RFID Smart Stethoscope software must be compatable with Smart Hospital computers

9.1.1 Description

The software to program the smart stethoscope and load it with the audio files must be compatible with the standard computers used within the Smart Hospital

9.1.2 Source

Sponsor: Smart Hospital

9.1.3 Constraints

Some computers within the smart hospital might be very limiting with processing power.

9.1.4 Standards

N/A

9.1.5 Priority

Critical.

10 Future Items

10.1 The user shall be able to save presets in the software

10.1.1 Description

Whoever is developing settings for use in the smart hospital can save their settings into presets for future use within the smart hospital.

10.1.2 Source

Team Majestic

10.1.3 Constraints

Application storage space may only allow for so many presets to be saved.
Presets must have a unique name from any other presets.

10.1.4 Standards

N/A

10.1.5 Priority

Future

10.2 User shall be able to control volume of sounds within the settings documents

10.2.1 Description

To simulate muffed sounds within the lungs or heart the user can use previously loaded sounds and change the volume that they will play at to simulate muffled sounds in the lungs.

10.2.2 Source

Sponsor: Smart Hospital

10.2.3 Constraints

Signal processing to change the volume may be out of the scope of this project.

10.2.4 Standards

IEEE signal processing standards.

10.2.5 Priority

Future

REFERENCES

[1] EPCglobal, *EPC Compliant Class-1 Generation-2 UHF RFID Devices Conformance Requirements*, https://www.gs1.org/docs/epc/Gen2$_c onf ormance_r equirements.pdf, Oct$2015, $ratified$.$