Department of Computer Science & Engineering
The University of Texas at Arlington

System Requirements Specification
CSE 4316: Senior Design I
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Raytheon Team
WiDROS

Daniel Tam
Joell Soriano
Joshua Pearson
Renato Cruel Amado
Tiffany Frias

Revision History

Revision	Date	Author(s)	Description
0.1	08.03.2021	RCA	document creation
0.2	08.05.2021	DT, JS, JP, RCA, TF	complete draft

CONTENTS

List of Figures

1 PRODUCT CONCEPT

This section describes the purpose, use and intended user audience for the product. WiDROS is a system that allows users to see real-world coverage range of wireless networks present at a specific building in the University of Texas at Arlington, through a virtual reality environment. Users of WiDROS software will be able to see and experience an accurate virtual reality environment of the building surroundings. They will also be able to see information and coverage range of all wireless network present on the building through this virtual reality environment.

1.1 PURPOSE AN DUSE

The system accepts real-world wireless signal data collected by a Raspberry Pi placed on a drone. Then, the signal information is processed and packaged into visual domes that indicate the coverage range of each network. Our product will map these visual domes on to an accurate virtual reality environment of the building in the University of Texas at Arlington. The product will allow users use a virtual reality goggles to experience the virtual reality environment of the building along with the network coverage domes. It can be used to accurately view the coverage of each wireless signal coming from the building and optimize router placement to ensure better coverage.

1.2 INTENDED AUDIENCE

The product is useful for anyone who would benefit from real-life wireless signal coverage and signal information. The product is sponsored by Raytheon Company hence it is more specifically designed to fit the companyâs requirements. However, network engineers and other companies are potential customers of this product.

Figure 1: Conceptual drawing

2 PRODUCT DESCRIPTION

This section provides the reader with an overview of team WiDROS Virtual Reality portion.

2.1 FEATURES & FUNCTIONS

The WiDROS system produces a virtual environment that makes wireless signals visible to the user occupying the environment. The environment can be rendered from Unity. The principle parts/components of this system are Unity and VR Headset.

2.2 EXTERNAL INPUTS & OUTPUTS

Users can expect an immersive visual environment that gives them the ability to visualize and manipulate wireless signals in the world around them.

Critical Data Element	**Inputs**	**Outputs**
VR Headset	Data from drone produced by Raspberry Pi	Same data, but formatted to use
Unity	File formatted for 3d rendering	Environment for visualizing signals
Raspberry Pi	Power and Information	Raw Data

Table 2: Critical external data flow

2.3 PRODUCT INTERFACES

The user will be able to see the VR Headset along with the computer running the simulation. When the user enters into the Virtual Reality by means of placing the headset over their eyes, they will then see the environment that the Unity embodies. For team WiDROS, this includes a building yet to determine.

3 CUSTOMER REQUIREMENTS

The WiDROS system will be designed and developed with the sponsorship of Raytheon Company hence, most of the customer requirements specified in this section are features that were put forward by the representatives of Raytheon. The requirements in this section were elicited to fit the needs of the intended user. This section mostly covers details regarding the display components of the VR environment including the contents and their nature. It also describes details on how the user will be able to interact with the VR environment of the system in order to satisfy their needs.

3.1 THE SYSTEM SHALL DISPLAY WIFI SIGNALS AS DOMES AND THEIR RESPECTIVE META-DATA

3.1.1 DESCRIPTION

When the user selects a WiFi signal dome, the system must display relevant meta-data such as SSID and signal strength. The signal domes are placed on the building VR environment.

3.1.2 SOURCE

Jesse Lee, Raytheon

3.1.3 CONSTRAINTS

The building in the virtual environment must be created to scale, and in accordance to GPS coordinates. The WiFi data must also be recorded with an accurate GPS coordinate so that the WiFi domes can be correctly placed.

3.1.4 STANDARDS

None

3.1.5 PRIORITY

Critical

3.2 THE SYSTEM SHALL DISPLAY A VR ENVIRONMENT OF A BUILDING YET TO DETERMINE

3.2.1 DESCRIPTION

The building must be built to scale and be mapped to specific GPS coordinates to facilitate the accurate placement of the WiFi domes.

3.2.2 SOURCE

Jesse Lee, Raytheon

3.2.3 CONSTRAINTS

The building must be accurately modeled to scale, and the GPS coordinates recorded.

3.2.4 STANDARDS

None

3.2.5 PRIORITY

Critical

3.3 THE VR ENVIRONMENT SHALL BE A SCALED MODEL OF THE BUILDING

3.3.1 DESCRIPTION

The buildings and any surrounding landmarks in the environment will be true to scale and location.

3.3.2 SOURCE

Jesse Lee, Raytheon

3.3.3 CONSTRAINTS

Virtualizing the building can not facilitate the use of a drone, as flying a drone is not allowed on campus.

3.3.4 STANDARDS

None

3.3.5 PRIORITY

Critical

3.4 THE USER SHALL BE ABLE TO CLICK ON SIGNALS TO LEARN MORE ABOUT THAT SIGNAL

3.4.1 DESCRIPTION

The user will have the ability to use the joysticks of the VR Headset to click on WiFi domes within the VR environment.

3.4.2 SOURCE

Jesse Lee, Raytheon

3.4.3 CONSTRAINTS

The data that can be displayed is dependent on the data that can be gathered by the Raspberry Pi.

3.4.4 STANDARDS

None

3.4.5 PRIORITY

High

3.5 THE VR ENVIRONMENT SHALL BE MAPPED TO GPS COORDINATES OF THE REAL WORLD CAMPUS ENVIRONMENT

3.5.1 DESCRIPTION

The wireless signal obtained is mapped to the building VR environment based on the GPS coordinates of real world campus.

3.5.2 SOURCE

Jesse Lee, Raytheon

3.5.3 CONSTRAINTS

An accurate method of obtaining GPS coordinates of landmarks is required to ensure an accurate model.

3.5.4 STANDARDS

None

3.5.5 PRIORITY

Critical

3.6 THE USER SHALL BE ABLE TO MANEUVER AROUND THE VR ENVIRONMENT

3.6.1 DESCRIPTION

The user will be able to walk around the VR environment with the help of VR Headset joystick.

3.6.2 SOURCE

Jesse Lee, Raytheon

3.6.3 CONSTRAINTS

Accurate "hitboxes" must be created around objects to control collisions between the userâs character and the environment.

3.6.4 STANDARDS

None

3.6.5 PRIORITY

Critical

3.7 THE VR ENVIRONMENT SHALL DISPLAY THE WIFI SIGNALS WITH VARYING TRANSPARENCY ACCORDING TO THE RELATIVE STRENGTH

3.7.1 DESCRIPTION

The WiFi signals will vary in strength. This will be indicated by how visible the signal is in the environment. The more transparent the visualization, the weaker the signal.

3.7.2 SOURCE

Jesse Lee, Raytheon

3.7.3 CONSTRAINTS

The Raspberry Pi must record data pertaining to signal strength.

3.7.4 STANDARDS

None

3.7.5 PRIORITY

Moderate

3.8 THE SYSTEM SHALL USE A DATA FILE FOR WIFI DATA

3.8.1 DESCRIPTION

The data from the Raspberry Pi will be stored in a data file.

3.8.2 SOURCE

Jesse Lee, Raytheon

3.8.3 CONSTRAINTS

None

3.8.4 STANDARDS

None

3.8.5 PRIORITY

Moderate

3.9 THE VR ENVIRONMENT WILL ONLY SHOW DATA PRODUCED BY THE RASPBERRY PI

3.9.1 DESCRIPTION

The data produced by the Raspberry Pi will all be pushed to a data file but the only data being modeled is the Raspberry Pi data.

3.9.2 SOURCE

Jesse Lee, Raytheon

3.9.3 CONSTRAINTS

The Raspberry Pi must read signals otherwise there will be no data to display.

3.9.4 STANDARDS

None

3.9.5 PRIORITY

High

3.10 THE SOURCE CODE SHALL BE HELD PRIVATELY AND NOT OPEN SOURCE

3.10.1 DESCRIPTION

Due to Raytheon´s NDA there is a necessity to keep this information private.

3.10.2 SOURCE

Jesse Lee, Raytheon

3.10.3 CONSTRAINTS

A secure method to store code, such as a BitBucket repository, must be used.

3.10.4 STANDARDS

None

3.10.5 PRIORITY

High

3.11 THE WIFI SIGNALS META-DATA WILL NOT CONTAIN ANY PERSONAL OR CONFIDENTIAL INFORMATION

3.11.1 DESCRIPTION

This project is meant to be non-intrusive so breaking this requirement would break one of the goals of the project.

3.11.2 SOURCE

Jesse Lee, Raytheon

3.11.3 CONSTRAINTS

None

3.11.4 Standards

None

3.11.5 Priority

High

3.12 The VR environment shall display the WiFi signals at the accurate height and GPS coordinates

3.12.1 Description

The WiFi domes must be at the correct height and GPS coordinates to ensure at accurate representation of the state of the building.

3.12.2 Source

Jesse Lee, Raytheon

3.12.3 Constraints

The Raspberry Pi must record altitude and GPS data for the WiFi signals.

3.12.4 Standards

None

3.12.5 Priority

Critical

3.13 The user shall be able to view a 2D map of the environment within VR

3.13.1 Description

While in the 3D environment, the user will be able to pull up a map of the whole environment, and view all the locations.

3.13.2 Source

Jesse Lee, Raytheon

3.13.3 Constraints

None

3.13.4 Standards

None

3.13.5 Priority

Low

3.14 The user shall be able to select a location on the map to move to

3.14.1 Description

When the user views the map, they will be able to interact and teleport to a location of their choosing.

3.14.2 Source

Jesse Lee, Raytheon

3.14.3 Constraints

Map must be created and view able by user.

3.14.4 Standards

None

3.14.5 Priority

Moderate

3.15 THE SYSTEM SHALL BE ABLE TO PINPOINT THE ORIGIN OF THE SIGNALS AND DISPLAY IT WITHIN THE ENVIRONMENT

3.15.1 Description

Using the GPS location and strength of the signals, the system will calculate the origin of the signals and indicate that location in the VR environment.

3.15.2 Source

Jesse Lee, Raytheon

3.15.3 Constraints

The location of the origin will not be given and therefore must be calculated using triangulation on the signal data given through the Raspberry Pi.

3.15.4 Standards

None

3.15.5 Priority

Moderate

4 Packaging Requirements

The WiDROS system will be delivered to product owner, Dr. Conly and the product sponsor Raytheon company. This section describes the hardware logistics of the system and details on how the product can be used/accessed. The section also iterates the final form of the deliverable product and the pre-conditions required to start utilizing the product.

4.1 THE SYSTEM SHALL RUN ON AN VR HEADSET

4.1.1 Description

The system is guaranteed to function when using VR Headset equipment.

4.1.2 Source

Jesse Lee, Raytheon

4.1.3 Constraints

The computer running the virtual environment must meet the performance requirements. This includes a sufficiently powerful CPU and GPU.

4.1.4 Standards

None

4.1.5 Priority

Critical

4.2 THE DELIVERABLE SHALL BE AN EXECUTABLE TO INSTALL THE SOFTWARE

4.2.1 Description

The deliverable will be an executable, generated by Unity, to install the software.

4.2.2 Source

Jesse Lee, Raytheon

4.2.3 Constraints

Sufficient hard drive space will be required to install the software.

4.2.4 Standards

None

4.2.5 Priority

Critical

4.3 THE VR ENVIRONMENT SHALL RUN ON A WINDOWS 10 PC

4.3.1 Description

The system must be guaranteed to run on a PC with the Windows 10 operating system.

4.3.2 Source

Jesse Lee, Raytheon

4.3.3 Constraints

The system must have the required software to run the simulation installed.

4.3.4 STANDARDS

None

4.3.5 PRIORITY

High

5 PERFORMANCE REQUIREMENTS

The WiDROS is a system that runs on the signals provided to it by the Raspberry Pi. This sections describes the performance requirements that are specific only to the abilities of the WiDROS system. Hence, the overall performance of the system may vary from the following requirements based on the performance of the Raspberry Pi. The following requirements describe details regarding the abilities and capacities of the system.

5.1 THE SYSTEM SHALL UPDATE RELEVANT PORTIONS TO THE DATA FILE OF WIFI DOMES EVERY 30 SECONDS, WHILE THE DRONE IS COLLECTING DATA

5.1.1 DESCRIPTION

If the drone is currently collecting data on wireless signals, the data file will be updated from the database at least every 30 seconds.

5.1.2 SOURCE

Jesse Lee, Raytheon

5.1.3 CONSTRAINTS

A stable internet connection for both the drone, and the Raspberry Pi that is running the scan will be required.

5.1.4 STANDARDS

None

5.1.5 PRIORITY

Moderate

5.2 THE SYSTEM SHALL BE ABLE TO DISPLAY BOTH LOW AND HIGH FIDELITY INFORMATION

5.2.1 DESCRIPTION

The system shall be able to display data in an area where we have little information and in an area where we have more information both in a way that is clear to the user.

5.2.2 SOURCE

Jesse Lee, Raytheon

5.2.3 CONSTRAINTS

If there is not much information about an area, the system should be able to implement some sort of placeholder so that the user can see there is supposed to be something there.

5.2.4 STANDARDS

None

5.2.5 PRIORITY

High

5.3 THE 3D VR ENVIRONMENT OF THE MODEL SHALL ONLY COVER THE EXTERIORS OF THE BUILDING

5.3.1 DESCRIPTION

The system will not be able to take the users to the interior VR environment of the mapped building. When a user approaches the walls of any building the system shall not move any further inside the buildings.

5.3.2 SOURCE

Jesse Lee, Raytheon

5.3.3 CONSTRAINTS

The exteriors of the building must be captured in some way. Either by using the CAD drawing of the campus, using the Google Maps Platform, or some other method.

5.3.4 STANDARDS

None

5.3.5 PRIORITY

High

5.4 THE SYSTEM SHALL MAINTAIN A CACHE SO THAT IT WILL FUNCTION WITH OR WITHOUT AN INTERNET CONNECTION

5.4.1 DESCRIPTION

The system will store the previous simulationâs data so that the simulation can still be run in the event that an internet connection is not available to download the most recent data.

5.4.2 SOURCE

Jesse Lee, Raytheon

5.4.3 CONSTRAINTS

An internet connection or some other method of retrieving the data must first be done so that there is at least one copy of the necessary data stored locally. Disk space will also be required to store this data.

5.4.4 STANDARDS

None

5.4.5 PRIORITY

High

6 Safety Requirements

In order to ensure that no harm or damage is caused by WiDROS, the following section covers some of the safety requirements for the system. It explains the safety standards the development team will adhere to in order to secure the safe nature of the resulting product. While WiDROS is a software heavy system, the following safety requirements were iterated in order to guarantee complete safety of the product users.

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 NO-CONTACT COLLABORATION

6.2.1 Description

Starting in March 2020, team members will not be allowed to collaborate and work on the project in the same setting out of precaution for preventing the contraction and spread of COVID-19. Laboratory access is restricted for members whose work is solely software-based; they are encouraged to work from home.

6.2.2 Source

CSE Senior Design Professor

6.2.3 Constraints

None

6.2.4 Standards

None

6.2.5 Priority

Critical

6.3 ALL SYSTEM WIRING SHALL CONFORM TO NATIONAL ELECTRIC CODE (NEC)

6.3.1 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.

6.3.2 Source

CSE Senior Design laboratory policy

6.3.3 Constraints

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

6.3.4 Standards

NFPA 70

6.3.5 Priority

Critical

6.4 ALL ROBOTIC SYSTEMS SHALL COMPLY WITH RIA SAFETY STANDARDS

6.4.1 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.

6.4.2 Source

CSE Senior Design laboratory policy

6.4.3 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.

6.4.4 Standards

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

6.4.5 Priority

Critical

7 Maintenance & Support Requirements

In order to provide maintenance for the application, the team must keep track of all source code and add all of the documentation needed for the next team to make the necessary changes. This will require the team to use an online repository to store the source code as well as other files that are required to run the project and understand how it works. The team will also need to install certain software in order to make changes to the user interface and run the project on their local machine.

7.1 ACCESS TO BITBUCKET

7.1.1 Description

The maintenance team will need access to the BitBucket and Jira account which will be provided through the group Microsoft Teams.

7.1.2 Source

Jesse Lee, Raytheon

7.1.3 Constraints

None

7.1.4 Standards

None

7.1.5 Priority

High

7.2 INSTALLING UNITY

7.2.1 Description

The maintenance team will need to download and install any version of Unity in order to open, run, and make any necessary changes to fix errors relating to the UI. Unity will also be used to pull in data from the data file, so it is important to have Unity to fix any data flow issues.

7.2.2 Source

Jesse Lee, Raytheon

7.2.3 Constraints

Unity and Microsoft Visual Studio require a lot of packages to create AR applications, and they take up large amounts of space.

7.2.4 Standards

None

7.2.5 Priority

High

7.3 ACCESS TO MICROSOFT TEAMS

7.3.1 Description

The maintenance team will be needing to access the files on the group Microsoft Teams in order to see all the charts, documents, models, login information, and contact information of the previous team members.

7.3.2 SOURCE

Jesse Lee, Raytheon

7.3.3 CONSTRAINTS

None

7.3.4 STANDARDS

None

7.3.5 PRIORITY

High

8 Other Requirements

This section features requirements not specific to any of the other sections featured, including those that will be attempted to be fulfilled depending on available time in the project schedule.

8.1 THE VR ENVIRONMENT SHALL BE CREATED IN UNITY

8.1.1 Description

The production of any code for the virtual environment shall run in Unity.

8.1.2 Source

Jesse Lee, Raytheon

8.1.3 Constraints

Objects that are desired to be in the simulation must be modeled and provided to Unity as .obj files.

8.1.4 Standards

None

8.1.5 Priority

Moderate

8.2 THE VR SYSTEM SHALL BE AVAILABLE FOR OFFLINE AND ONLINE USE

8.2.1 Description

You do not need to maintain a connection to the internet for the VR environment to operate.

8.2.2 Source

Jesse Lee, Raytheon

8.2.3 Constraints

All data required to run the VR environment must be stored locally on the machine. Hard drive space must be sufficient..

8.2.4 Standards

None

8.2.5 Priority

Moderate

8.3 ANY REQUIRED CODING FOR THE SYSTEM SHALL BE DONE USING PYTHON

8.3.1 Description

The primary language used to create the sensor is Python, therefore to maintain consistency, any further code will be written in Python with its extensive libraries.

8.3.2 Source

Jesse Lee, Raytheon

8.3.3 Constraints

The necessary libraries will need to be available for Python. Team member familiarity with Python will also affect the difficulty of fulfilling this requirement.

8.3.4 STANDARDS

None

8.3.5 PRIORITY

Moderate

9 Future Items

The WiDROS project has many high level requirements that are seen as future items due to the time that it requires to get those items done. This sections represents that information in further description.

9.1 ADDING A DRONE

9.1.1 Description

Attach a Raspberry Pi to a drone to gather data quickly and access hard to reach places.

9.1.2 Source

Jesse Lee, Raytheon

9.1.3 Constraints

Dangerous in crowded areas and privacy concerns.

9.1.4 Standards

None

9.1.5 Priority

Low

9.2 THE SYSTEM WILL BE ABLE TO GATHER THE DATA AT REAL-TIME SPEEDS

9.2.1 Description

The data will be gathered and transferred at real-time speeds, such that if plotted on a graph it would appear to be continuous.

9.2.2 Source

Jesse Lee, Raytheon

9.2.3 Constraints

A fast, reliable internet connection will be required during the simulation to ensure a satisfactory experience for the user.

9.2.4 Standards

None

9.2.5 Priority

Low

9.3 THE SYSTEM WILL BE ABLE TO DIFFERENTIATE BETWEEN DIFFERENT TYPES OF WIRELESS SIGNALS

9.3.1 Description

The system will be able to differentiate between different types of wireless signal base on SSID and signal strength.

9.3.2 Source

Jesse Lee, Raytheon

9.3.3 Constraints

None

9.3.4 STANDARDS

None

9.3.5 PRIORITY

Medium

REFERENCES

[1] Kenneth S Rubin. Essential Scrum: A Practical Guide to the Most Popular Agile Process. Addison-Wesley Professional, 1st edition, 2012.