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

Project Charter
CSE 4316: Senior Design I
Summer 2021

Raytheon Team
SENSORIUM AUGMENTED VIEW

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Revision History

Revision	Date	Author(s)	Description
0.1	07.28.2020	RCA	document creation
0.2	07.29.2020	DT, JS, JP, RCA, TF	complete draft

Contents

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1 Problem Statement

The endgame of this project reflects the teams and clients desire to track the radio frequency (RF) signals which will indicate what activities are being conducted in the environment. In doing so, we can use this valuable information for logistics, micromanagement, and many other applications not described in this project.

2 Methodology

To solve our problem the team will be continuing development of the cloud infrastructure and the Augmented Reality code base. The cloud infrastructure is capable of collecting, storing, analyzing, and transmitting environmental data. The cloud infrastructure will be built off of an IoT sensor network that will sniff out RF signals and transmit that data up to the cloud. The cloud portion will analyze this data and use machine learning and other computational techniques to predict points of concern. It will also host APIs that are accessible for retrieving required information to render in augmented reality onto a HoloLensTM. The Augmented Reality side will use the data that the cloud infrastructure stores and display it to the user.

3 Value Proposition

Sensorium could eliminate the need for "smart" electronics entirely. This would have applications in not only residential settings, but business settings as well. Sensorium can monitor RF signals and create appropriate responses to the signals received. These signals would contain information on the current status of various systems, business or residential, that are currently in use. This makes Sensorium an excellent monitoring system for various purposes. There are client-proposed use cases such as rendering the RF signals in augmented reality which can be used to analyze a system in real time.

4 Development Milestones

All known milestones for this project, if the date is not known it is given a tentative to be determined (TBD) designation.

Provide a list of milestones and completion dates in the following format:

- Project Charter first draft - 08/2021
- System Requirements Specification - 08/2021
- Architectural Design Specification - TBD
- Detailed Design Specification - TBD
- CoE Innovation Day poster presentation - TBD
- Final Project Demonstration - TBD

5 Background

The current business use case of this project is to be able to monitor RF signals and create appropriate responses to the signals received. Ideally these signals will help to give information on the current status of various business systems that are currently in operation, making it an excellent monitoring system to keep track of business operations. Furthermore, there are additional use cases which can be found for the data collected such as rendering RF signals in augmented reality, which could be used to analyze a broken system and find a solution to fix it. The current customer for this project is Raytheon. They have been the sponsor of this project for four years now and want us to work on this technology to help them improve their monitoring systems within the company itself. There are currently existing relations between the customer and past development teams that will be connected to the current team working on this assigned project. Furthermore, there is another team assigned to this project for the next year. The other electrical engineering team that is continuing development on the sensor boards that will sniff out the RF signals and transmit this data up to our cloud infrastructure which is where the HoloLens TM will pull data from to display to the user.

6 Related Work

Since its inception back in the 1980s, RF technology has been widely used to track objects such as parcels, goods, and animals. At present time, however, a lot of research is being focused on the IoT applications of the RF sensing technologies, which is considered to be the future of information systems [6]. In the industry, they are being widely applied for the sensing of temperature and humidity [8], strain [7], pressure [9], steel corrosion and cracks [15], concrete structure [3], pipeline integrity monitoring [14], etc. They are also popular in healthcare, in devices such as wearable and implanted sensing devices for glucose monitoring [13], blood pressure [4], intraocular pressure [11], and on-skin monitoring discrimination of breath anomalies [2]etc. A lot of related work that deals with real time monitoring of the environment and collection of data from it such as humidity, temperature, positions of different objects, pressure, has already been done. However, the characterization of obtained environmental data in order to visualize the surroundings in three dimension using a Virtual Reality headset such as the Hololens is a fairly new field. The first major development platforms for AR were released as recently as 2017 [5] and primarily were designed for smartphones. Example like the ARKit [10] uses simple self contained applications that store their input data locally without the need of constantly pulling data from an outside database. One such example takes radio/network data collected locally by a smartphone/tablet and displays it over an image of the local environment removing the surroundings but allowing the user to view the data and its origin point. [12] The key problem with this implementation and others that exist is that all the data is collected and displayed on the same device, usually a smartphone. This implementation will not work for our project because we will be pulling the data from the cloud service in real time instead of using sensors on our device to display the data. Since we need real-time updates to the device from our database, the use of cloud API endpoints will be crucial to the success of this project. Fortunately, Amazon has included with their AWS services an API Gateway which we can use to set up our API end points and monitor them [1]. This is a perfect fit for our needs and will make the API creation simple and efficient for our team at no additional cost to the customer.

7 System Overview

The goal of the Sensorium Augmented View is to provide a user with an AR representation of various data signals that a user would need to interact with. The Sensorium Augmented View will consist of three major systems: The Sensorium Boards, The Amazon Web Service, and the AR data projection. First The Sensorium Boards which will serve to collect a wide range of signal data to be operated on and displayed to the user. This data will include radio signals, WiFi network data, and environmental data. After collecting this data the boards will send it over AWS to be stored in a Database. The boards will also store the most recent signals locally to send to the AR projection in the event of a temporary service loss from AWS. The second Major System will be The Amazon web Service (AWS). The AWS performs three roles. First it will communicate between the boards, the database and the hololens sending data between these devices. Second it will perform operations on the raw data taken from the Sensorium Boards to convert it into information that will be useful to the user. Third the AWS will keep a record of all data recorded on the Sensorium boards and store those records in a database. In the event of an erorr the AWS will be able to reboot itself to resume service. The final system is the AR Data Projection. This system will use the AWS to pull stored records from the database and display them to the user in real time. This data will have been operated on by the AWS prior to being sent to the AR projection. The data will be displayed on the Microsoft Hololens. The User should be able to view an overview of all the data signals currently being displayed, and also select specific signals to view with more detail. This System will be able to pull records directly from the boards in the even of a service outage from AWS so that the user can continue to view signals even during a loss of service. Below is a diagram of these systems that outlines their interactions and the data sent between them.

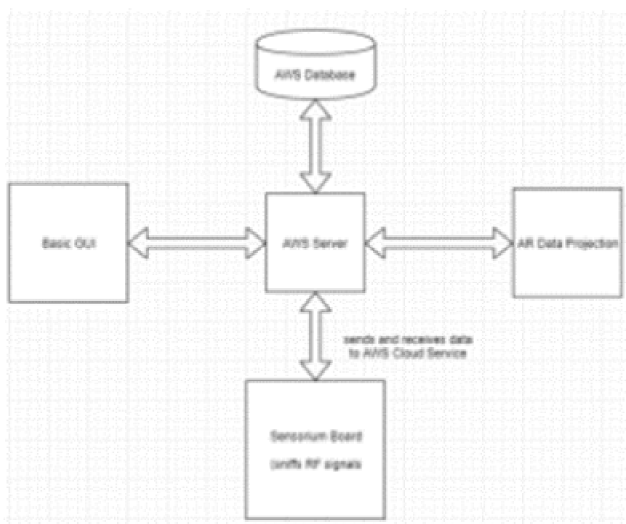

Figure 1: System Overview

8 Roles & Responsibilities

The stakeholders of the project:

- Raytheon Company

Point of contact from the sponsor or customer:

- Jesse Lee

Project team members and their roles:

- Tiffany Frias (Product Owner)
- Renato Cruel Amado (Scrum Master)
- Joell Soriano (Software Developer)

- Daniel Tam (Software Developer)
- Joshua Pearson (Software Developer)

If performance from either of the individuals currently assigned to the expressed roles is not up to expectations, the team holds the right to pullback their given title and pass it on to another member of the team. Also, if a member willingly agrees to swapping roles with another member and that particular member wants the role, then that is allowed.

9 Cost Proposal

For this project, there are two major expenses: the monthly fee for Amazon Web Services (AWS) and the Microsoft HoloLens II. The Amazon Web Services (AWS) is a major component in this project as this will be the tool used to set up the API endpoints, and the transfer of data from sensors to the cloud services and to the HoloLens II. The Microsoft HoloLens II will serve as the AR device used for the project. We also have access to the Microsoft HoloLens I from the previous team.

9.1 PRELIMINARY BUDGET

1. Amazon Web Services (AWS) - 150 dollars per month
2. Microsoft HoloLens I
3. Microsoft HoloLens II

9.2 CURRENT AND PENDING SUPPORT

1. University of Texas at Arlington - 800 dollars
2. Raytheon - 150 dollars per month

10 Facilities & Equipment

The lab space being used for this project will consist of the given lab inside of the University of Texas at Arlington for senior design projects. This lab will be used as the general meeting area for our team to discuss and develop the cloud infrastructure. In addition to our team´s lab space, the team may be required to demo the project´s capabilities at Raytheon´s facility.

Special equipment needed for the project are as follows:

- 1. Sensorium Board
- 2. Microsoft HoloLens I and II
- 3. Amazon Web Services (AWS)
- 4. Open Source Software

The equipment mentioned above are already present on campus and under the control of the adjacent teams assigned to this project. If a case arises where it requires us to use special equipment that are not in our team´s possession, we will reach out to the appropriate team and borrow it from them. Any equipment that cannot be borrowed will be purchased. We are in possession of both the Microsoft HoloLens I and II, however, our team´s focus is on the Microsoft HoloLens I because of the current and potential issues of the Microsoft HoloLens II.

11 Assumptions

The list below contains assumptions that will be crucial to the team´s ability in continuing optimal development.

- Data of satisfactory quality will be transmitted from the Sensoriums to our API end points.
- Access will be granted to the customerâs network credentials for deployment.
- Access to the previous code for cloud deployment, as well as to the HoloLens emulator with the application.
- The customer will cover the cost of AWS services.
- The credentials to the previous AWS account will be passed on for the current team for deployment.
- Upon receiving the HoloLens 2, porting over existing code and continuing development will be seamless.

12 Constraints

The following list contains key constraints related to continuing implementation and testing of the project.

- Final prototype demonstration must be completed by August 1st, 2021
- The customer will not provide network architects to assist in development.
- Total expenses must not exceed 800 dollars as well as the supplementary budget offered by the customer.
- The team must continue developing using AWS' cloud, no other cloud service will be accepted.
- The team will be provided one Sensorium at a time.
- Due to COVID, one team member will have the physical HoloLens headset at a time.
- Due to COVID, meetings will be limited to Microsoft Teams conferences, and schedule will be adjusted as necessary based on obligations team members have outside of this project.

13 Risks

This section should contain a list of at least 5 of the most critical risks related to your project. Additionally, the probability of occurrence, size of loss, and risk exposure should be listed. For size of loss, express units as the number of days by which the project schedule would be delayed. For risk exposure, multiply the size of loss by the probability of occurrence to obtain the exposure in days.

For example:

The following high-level risk census contains identified project risks with the highest exposure. Mitigation strategies will be discussed in future planning sessions.

Risk description	Probability	Loss (days)	Exposure (days)
Availability of sensor data at all times	0.50	20	10
Not having the board on hand for data to be sent	0.20	14	2.8
Internet access not available at installation site	0.30	9	2.7
Not knowing AWS	0.09	14	12.6
Hardware bugs of board and/or Hololens	0.50	14	7

Table 1: Overview of highest exposure project risks

14 Documentation & Reporting

14.1 Major Documentation Deliverables

14.1.1 Project Charter

The initial version of the project charter is planned to be delivered on July 9, 2021 but is subject to change.The final version is expected to be delivered on July 30, 2021. Any changes to the project charter will be done when a major change is noticed by the team that requires parameters to be modified within the document.

14.1.2 System Requirements Specification

The initial version of the system requirements specification is planned to be delivered on July 30, 2021 but is subject to change. The second version is expected to be delivered on August 12, 2021. Any updates will be made when the customer requests the change.

14.1.3 Architectural Design Specification

TBD

14.1.4 Detailed Design Specification

TBD

14.2 Recurring Sprint Items

14.2.1 Product Backlog

Items will be added to the product backlog from the SRS based on current customer needs. They will also be prioritized by the customer and updated by the scrum master. All decisions to update the backlog will be made by the team collectively and confirmed by the team lead. The software used to maintain and share this information is Microsoft Teams.

14.2.2 Sprint Planning

There will be a total of 7-10 sprints depending on conditions faced during the project. The sprints will be planned via group meeting at the end of the previous sprint. This meeting will be led by the team lead.

14.2.3 Sprint Goal

The team lead will decide the sprint goals based on what the customer expresses to the product owner in the weekly meetings.

14.2.4 Sprint Backlog

The team lead decides which items makes it into the sprint backlog. These items will be discussed in group meetings over Teams conference and documentation will be maintained on a sprint board via

Microsoft Teams.

14.2.5 Task Breakdown

Individual tasks will be voluntarily claimed by each team member. If necessary, individual tasks will be assigned by the team lead based on the product ownerâs expressed needs for the project. The work done into a task will be tracked in hours collaboratively on the documentation in Microsoft Teams.

14.2.6 Sprint Burn Down Charts

A designated team member will be the one generating the burn down charts for each sprint. They will be accessed through Microsoft Teams.

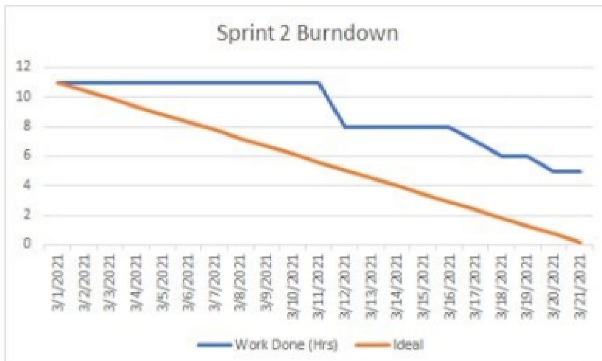

Figure 2: Example sprint burn down chart

14.2.7 Sprint Retrospective

The sprint retrospective will be handled at the same time as the next sprint planning. The team lead will produce the document during this meeting containing all the pertinent information.

14.2.8 Individual Status Reports

Individual status reports are expected from each team member every Wednesday following the sprint reviews. Members will be given a rating in participation, communication, professionalism, work quality, and overall scoring.

14.2.9 Engineering Notebooks

Engineering notebooks will be updated at least 2 times per sprint summing up to 1 page minimum if multiple synopsis entries are documented.

14.3 Closeout Materials

14.3.1 System Prototype

As established by previous teams, the initial prototype infrastructure will be deployed and field tested before a final infrastructure is provided to the customer.

14.3.2 Project Poster

For the final project poster, we will display the design and implementations of our software infrastructure.

14.3.3 Web Page

There will be a final private web page available for the customer to view the data stored in the cloud.

14.3.4 Demo Video

The demo video for this project will show a captured feed of the Sensorium as viewed by a user.

14.3.5 Source Code

The source code used was established by previous teams. The standards and documentation used for the source code will be done through AWS CloudFormation.

14.3.6 Source Code Documentation

The source code documentation used is as established by previous teams. Code will be documented within the programming file itself. READMEs will be provided within each directory to know each directory´s indented functionalities. This will be conducted through AWS CloudFormation.

14.3.7 Hardware Schematics

N/A

14.3.8 CAD files

N/A

14.3.9 Installation Scripts

Installation scripts will be used as established by previous teams. AWS CloudFormation will be the deployment software. Any scripts used to deploy the infrastructure from cloud formation will be provided to the customer upon completion.

14.3.10 User Manual

The user manual will be used as established by previous teams. A virtual copy of all instructions needed to deploy the infrastructure will be provided to the customer upon completion.

References

[1]X.400 Gateway Api Specification. 1989.

[2]Occhiuzzi C. Di Natale C. Marrocco G. Caccami M.C., Mulla M.Y.S. Design and experimentation ofa batteryless on-skin RFID graphene-oxide sensor for the monitoring and discrimination of breathanomalies. 2018.

[3]DiGiampaolo E. Caizzone S. DiGiampaolo E. Passive RFID Deformation Sensor for Concrete Structures. 2014.

[4]Re V. Caldara M., Nodari B. Bonandrini B. Miniaturized and low-power blood pressure telemetrysystem with RFID interface. 2014.

[5]Alex Chuang. Introduction to the AR Cloud with Use Case Examples. 2019.

[6]Gao N. Meng Z. Li Z. Lei C., Zhang Z. Radio Frequency Identification and Sensing Techniques andTheir ApplicationsÃ¢A Review of the State-of-the-Art. 2019.

[7]Marrocco G. Occhiuzzi C., Paggi C. Passive RFID strain-sensor based on meander-line antennas.2011.

[8]Weimar U. Bauersfeld M.L. Ebling D. Wollenstein J. Oprea A., Barsan N. Capacitive humiditysensors on flexible RFID labels. 2008.

[9]Kaddour D. Touhami R. Tedjini S. Rennane A., Abdelnour A. Design of passive UHF RFID sensoron flexible foil for sports balls pressure monitoring. 2018.

[10]David Spector. Powering Augmented Reality with realtime data: ARKit+Realm. 2017.

[11]Naber J. Turner M. The Development of a RFID Based Mixed Signal ASIC for the Wireless Measurement of Intraocular Pressure. 2010.

[12]Richard Vijgen. Architecture of Radio. 2016.

[13]Chen X. Chen S. Zhang Z. Zhang H. Wang J. Huang Y. Zhang P. Zheng L. et al. Xiao Z., Tan X. Animplantable RFID sensor tag toward continuous glucose monitoring. 2015.

[14]Daneshmand M Zarifi M.H., Deif S. Wireless passive RFID sensor for pipeline integrity monitoring.2017.

[15]Zhao A.B. Zhang J., Tian G.Y. Passive RFID sensor systems for crack detection and characterization.2017