CNAT

Design Document

Sdmay20-51
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Executive Summary

Development Standards & Practices Used

List all standard circuits, hardware, software practices used in this project. List all the Engineering standards that apply to this project that were considered.

Summary of Requirements

- Design a dashboard to present a summary of data accumulated.
- Generate a playback feature on the dashboard that would allow us to select a data set and play it back.
- Implement a strategy that will help determine an improved anchor placement to achieve more accurate location information.
- Come up with some potential logic that will help better determine the room a healthcare staff actually went into.

Applicable Courses from Iowa State University Curriculum

- COMS 309
- SE 319
- SE 329
- COMS 363
- CPRE 489
- CPRE 430

New Skills/Knowledge acquired that was not taught in courses

List all new skills/knowledge that your team acquired which was not part of your Iowa State curriculum in order to complete this project.

Table of Contents

List of figures/tables/symbols/definitions (This should be similar to the project plan)

1 Introduction

1.1 Acknowledgement

We would like to acknowledge the contributions of the following organizations and individuals towards our successes during this senior design project:

In Motion Care, Iowa State University, Green Hills Retirement Community, WISER Systems, and Dr. Daji Qiao.

1.2 Problem and Project Statement

Currently, healthcare staff at Green Hills Retirement Community receive individual resident care plans, detailed information on individual residents and their needs, through paper packets. These packets are often updated multiple times throughout the day, causing these packets to be reprinted just as often as they were updated. This can cause multiple issues as employees may not be getting the most updated packet, meaning they may not be giving the proper care to a resident.

Each packet also has approximately 27 pages and 75 employees, so printing 75 copies every time an update happens uses quite a bit of paper.

This project sets out to create a system that will track the healthcare staff throughout their facility. Based on their location, the system will give workers real time updates on the requirements of patients' needs as they enter rooms. There are a number of tracking devices called anchors placed around the facility that actively look for another set of passive devices called tags that are carried by the staff and anything else that needs to be tracked throughout the building. The data from the tracking system is displayed to the staff and historical information is stored for later reference and playback

As part of this project, we are planning to have two favorable outcomes. An application with a dashboard view of important information specific to the logged in user and a playback feature to view the position of a tracking tag over a period of time. We will also develop a method of installing anchors with a focus on tracking efficiency.

1.3 Operational Environment

Our system will be implemented into Green Hills Retirement Community in Ames, IA. This facility is completely indoors, however hazards to consider are resident and healthcare staff interaction with the hardware.

1.4 Requirements

We will design a dashboard that will showcase a map of the facility, a display of healthcare staff time spent in areas and their route within the facility. Going into the features with this concept the user will be able to figure out areas in the room the healthcare staff is located at a given time historically.

When health care staff is in the room of a resident, they get tailored care instructions for the resident. They are sent a series of questions that interact step by step to checkbox all the steps of care. This helps track the actions of the staff and hold the staff accountable. Our dashboard will supply the historic and real-time data to support staff or hold them accountable.

The dashboard will acquire its data from anchors placed in the facility and tracker tags placed on the asset we will be tracking. The anchors and tags we are dealing with are by a company Wiser Systems. The tags cost $69 and the anchors cost $209. Accuracy of the data collected is directly proportional to the number of anchors. Data management systems are maintained on Google Cloud.

The anchors will be strategically placed in locations that will not disturb the patients or the health care staff's daily routine. The anchors require power through wall-outlet or ethernet. Implementing a method for tags to be carried with the least chance of damage while maintaining optimal accuracy.

1.5 Intended Users and Uses

Our intended users are Green Hills administrative staff, who are looking to introduce an immediate method of delivering updated patient care plans to healthcare staff, alongside a way to track where staff have been within the facility at any given time. The administrative staff would have the ability to view archived data of where the healthcare staff have been in the facility to make sure proper healthcare protocols have been followed during each patient visit.

Should an incident with a patient occur, administrative staff could view the location data of the medical staff and see who was last to work with the patient.

1.6 Assumptions and Limitations

Assumptions:

- The dashboard will not be used in any facility other than Greenhills Retirement Community.
- Users of the dashboard speak english.
- The facility has a consistent supply of power.

Limitations:

- No tag carrier can accurately be tracked if traveled between more than two rooms in less than .2 seconds.
- For power, anchors need to be placed near a power supply when wireless or be tethered to each other via ethernet cable when not.

1.7 Expected End Product and Deliverables

Tracking System User Interface

A React-based web application that acts as a dashboard to present applicable summary statistics to the user. Information to be presented includes an interactive map of the healthcare facility with all currently-in-use tags being monitored. Through the interactable map, a user will be able to access both room and tag specific information. (i.e. what tags

have entered and left the room, at what time, what other rooms has a tag accessed, etc.) Deliverable date is to be decided.

Location Playback feature

A playback feature implemented through the web application that accurately displays historical movement of targeted individuals. This feature allows the user to access a particular tag or room within the tracking system. When viewing a tag, the user will be able to track a user across all rooms that they will be moving between. For a given room, the user will be able to see what tags have entered the room, when they left the room, and any movement in the room in the interim.

2. Specifications and Analysis

2.1 Proposed Design

Thus far, we have researched the use of the WISER Systems tracking system and its normal use cases. These typical use cases are far different from those that represent the current project. We have discussed with our client their current shortcomings and how they have set up their system.

Our client has had many of the other students working on his project come to our meetings to show what they have been working on and the currently developed systems. Our team has started to learn the currently implemented system's technologies like React JS.

2.2 Design Analysis

We conducted meetings to gain a full understanding of our client's requirements over the course of the first few weeks. We discussed In Motion Care's requirements and what we as a team believe we can deliver. We broke down the system's use cases and specifically tailored questions for our client to get the most details and requirements to properly define our scope. We are drafting our front-end screen designs which will be brainstormed with our client and passed on to his partners. Based on the data our client is gathering, we are designing an intuitive database design that we will be able to query from efficiently.

So far, we have been using an iterative design philosophy with our client, going back and forth with different ideas as we come up with and further refine them. This process helps us understand empathy behind each use case to help us ideate and prototype a perfect goal. We identified that our sessions of scoping as a team needed an affirmation or guidance and in this case, our client has been a great mentor. We have seen that our methods help keep us from producing redundant work and that our ideas are in line with our client's vision.

2.3 Development Process

For this project, an Agile/Scrum development process is to be implemented. This development style was chosen as it allows developers to focus on an iterative approach to development where all requirements, solutions, and goals are decided through collaboration of the entire team. Agile and scrum help to create a strongly structured project management process where issues are handled as they arrive and progress is consistently made. Furthermore, the development process strongly encourages teamwork, self-organization, and accountability.

2.4 Design Plan

The project will be broken into the following modules:

1. Front-end Design
    a. UX Design
        i. Use design software to create mock-ups of application views.
        ii. Look for client approval of designs to move on to implementation.
    b. Implementation
        i. Use the React Javascript library to build the graphical user interface for the dashboard.
        ii. Application.
2. Back-end Design
    a. Database design
        i. ER Diagram
            1. Begin by creating a detailed diagram high-lighting the dependencies between our data. Aim is to create an efficient database.
            2. Propose database to client. Add any further dependencies or tables based on feedback.
        ii. Implementation
            1. Create a back-end with direct connection to the database.
            2. Build in functionality to access multiple sets of data for playback program.
            3. Using Ajax, create a connection to the back-end to accept requests from the front-end to query and process information from the database.
        iii. Deployment
            1. Begin data collection within Green Hills utilizing create back-end and database.

3. Statement of Work

3.1 Previous Work And Literature

Currently, Centrak offers a similar product to what In Motion Care hopes to deliver. Centrak's "Real Time Tracking System" uses a combination of IR, RFID, and other technologies to create a personnel and equipment tracking system specifically for healthcare facilities. Their combination of multiple sensor technologies allows for accurate tracking of personnel, even within non-optimal environments for signal propagation.

In Motion Care's technology currently only utilizes WISER System's RFID sensors. Where their product differs, is they hope to deliver updated care plans to nurses based on proximity to a patient's room alongside the personnel and equipment tracking capabilities that Centrak currently provides.

Our project for In Motion Care is wto create the UI and back-end to support real-time and legacy viewership of location data, along with the integration of the care plan updating application. We will be using In Motion Care's current database, which stores location data, to populate our web application.

3.2 Technology Considerations

We are implementing a web-based interface for our application that needs to update in real-time. To implement a real-time web-based application, the application should use javascript. There are many javascript frameworks that can be used for applications like this.

For this application, the decision was made to use ReactJS because of its single-page application design. Because the application is broken down into a few sub-applications, making each of those their own page will give the user a feeling of separation between each despite being on the same website.

Another front-end frameworks we could use was Vue JS, but because there was already existing work on the project done in React, it made more sense to not change the system.

We have decided to work with Java and the Spring Boot framework to construct the back-end for our project. This decision was made due to the client's own preference towards the system, as they have used it before we came on to the project. We are also using a MySql database connected to the Google Cloud Platform (GCP) as the client already had the database in their possession.

3.3 Task Decomposition

This project is broken up into a front-end and a back-end with about half the team on each.

The front-end is broken up into three separate sections that can each exist mostly independently, but they are tied together with the front-end framework. The front-end makes API calls to the back-end to get data to present to the user on the front-end and do processing that is considered too taxing for a web browser.

The back-end has to connect to the client's database and conglomerate data when the front-end requests it.

3.4 Possible Risks And Risk Management

The inherited portion of this project is spread across several separate applications with only one or two people who are knowledgeable on their use and implementation. Our team does not have a solid understanding of how each piece fits in with all of the other pieces despite them playing a major part in the end-product.

The desired outcomes of the project change readily and quickly and it invokes a lot of discussion between the client and team members. The discussions involve feasibility and scoping issues because of the number of things currently involved in the creation of the product.

3.5 Project Proposed Milestones and Evaluation Criteria

The project milestones can be broken up between the front-end and the back-end and even more within each of those.

Front-end:
One of the biggest milestones is to create the map interface. The interface has to be intuitive and able to seamlessly transform into other views and maps.
Along with that, the application needs to create a connection with the live-data server to update

the nurses position in real-time.
The application also needs to make API calls to the historical data server for replay capability. The APIs should return the data for each tracked asset and each room along with the playback we want.

Back-end:
To test this our system, we will first use mock data on local systems. Later, we will use live data from our client and validate the information onsite and historical data from their database.

3.6 Project Tracking Procedures

To track our progress throughout this project, our team is utilizing the issues feature on GitLab. Using this, we are developing our application in an Agile process, creating issues to be completed in short two week sprints. These issues are assigned to certain members of our group, so individual contributions are tracked by tracking the completion of issues on the GitLab issue board.

3.7 Expected Results and Validation

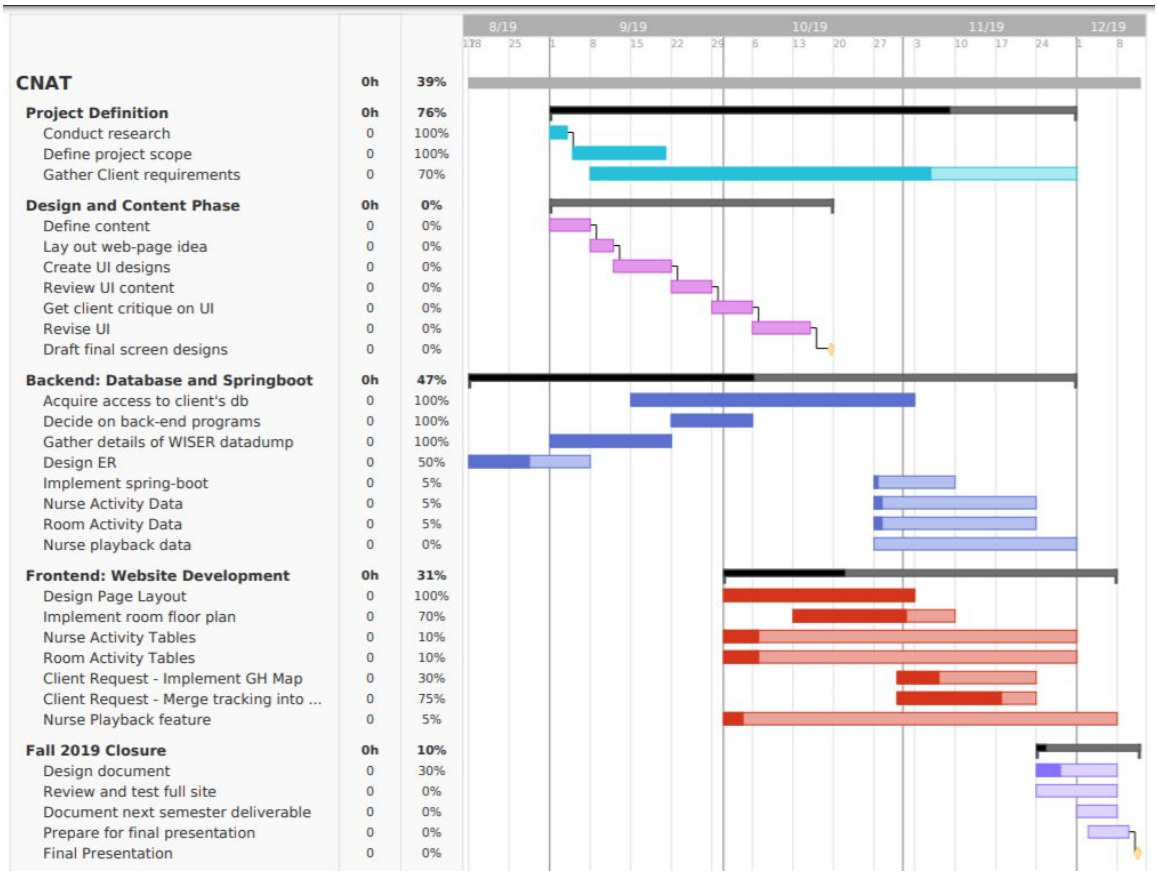
We expect our system to provide a real-time view of tracked assets in Green Hills and a way to view historic data points. It will also show the care plan for each patient and a log of the changes made to them for bookkeeping and audit purposes.

The system is set to be used at Green Hills and will be tested live by the staff on premises and the administrative staff behind the scenes.

4. Project Timeline, Estimated Resources, and Challenges

4.1 Project Timeline

Gantt Chart v2:



We planned our semester to deliver our client a structure of the website the fall semester and we spend the spring semester working on improving the accuracy of parameters displayed on our dashboard. We are mapping our semester planning in an agile approach. We had a planning phase where we included our client to draft ideas and set the exact requirements for our project analysis and design phase. As shown in the above Gantt chart our team has laid out tasks after our design phase strategically to account each activity enough time for implementation and testing.

Project definition was the starting point of our project where we had meetings to kickoff the team and kickoff with our client. During the later meetings we outlined our client's requirements and understand the scope for our project. Debated on our team's possible deliverables through the two semesters with our client and advisor. We defined the scope of our project.

As we mentioned above we split our team into front-end and back-end. Front-end team is working on developing the web application and our back-end team is working on cleaning up the data dump by WISER Systems data dump and use spring boot to help with the playback feature of ur

website. Within the groups we broke down tasks to track different features of the website like maps, nurse location and time tracking, activity in a room and location playback.

Our timeline for the front-end will be developed simultaneous getting the data and the support from back-end. We set our timelines for back-end based on the data required for our front-end applications to play out tasks simultaneously, this way we avoid either groups stalling due to requirements from the other group.

Much of our development's skeleton will be tackled over the fall semester and we will utilize the spring semester to upgrade the esthetics, features and then work up to improve accuracy as much as we can to build a reliable tracking system. One task for example and the most challenging crucial feature is the nurse playback data where the front-end will play the nurse's path within the period selected where back-end provides the exact route coordinates.

4.2 Feasibility Assessment

Realistically, our project will be a fully-implemented dashboard specified in sections 1 of this design document. This deliverable will be done by the end of April 2020. By the end of December 2019, a working dashboard will be implemented with minimal functionality and minimally tested. Some challenges we might face going forward include the project specifications changing from our client, inadequate access to resources, and failure of the Wiser system.

4.3 Personnel Effort Requirements

	Project Definition	Design and Content	Database	Website Development	Backend Development
Kirkland Keith	20%	0%	20%	0%	60%
Suzanna Gudivada	20%	15%	5%	60%	0%
Brandon Elizondo	10%	5%	5%	80%	0%
Austin Sehnert	20%	20%	0%	60%	0%
Benjamin Zaley	20%	5%	20%	0%	55%

Based requirements of our projects we have broken down tasks and divided how our team addresses these challenges. Based on our individual interests and demand for the task, we have listed our efforts divided in areas listed above. Austin, Brandon and Suzanna form the front-end team, thus focusing most of their effort on website development and design. Benjamin and Kirkland are tackling back-end, resulting in them focusing their efforts in backend development and database. Based on demand of a task, we will switch around and handle the issue. Making all of us involved in every part of the project.

4.4 Other Resource Requirements

This project requires the tracking equipment from Wiser Systems for its tracking and a server with a database to store the information. The client has already provided this and a platform to host systems created for this project on the cloud.

4.5 Financial Requirements

Our project was stated as no financial support from our client. Foreseeing our deliverables, implementation and testing we are not expecting any financial resources.

5. Testing and Implementation

Testing is an extremely important component of most projects, whether it involves a circuit, a process, or a software library

Although the tooling is usually significantly different, the testing process is typically quite similar regardless of CprE, EE, or SE themed project:

1. Define the needed types of tests (unit testing for modules, integrity testing for interfaces, user-study for functional and non-functional requirements)
2. Define the individual items to be tested
3. Define, design, and develop the actual test cases
4. Determine the anticipated test results for each test case 5. Perform the actual tests
6. Evaluate the actual test results
7. Make the necessary changes to the product being tested 8. Perform any necessary retesting
9. Document the entire testing process and its results

Include Functional and Non-Functional Testing, Modeling and Simulations, challenges you've determined.

5.1 Interface Specifications

– Discuss any hardware/software interfacing that you are working on for testing your project

5.2 Hardware and software

- Indicate any hardware and/or software used in the testing phase
- Provide brief, simple introductions for each to explain the usefulness of each

5.3 Functional Testing

Examples include unit, integration, system, acceptance testing

5.4 Non-Functional Testing

Testing for performance, security, usability, compatibility

5.5 Process

– Explain how each method indicated in Section 2 was tested

– Flow diagram of the process if applicable (should be for most projects)

5.6 Results

– List and explain any and all results obtained so far during the testing phase

- – Include failures and successes
- – Explain what you learned and how you are planning to change it as you progress with your project
- – If you are including figures, please include captions and cite it in the text

• This part will likely need to be refined in your 492 semester where the majority of the implementation and testing work will take place

-**Modeling and Simulation**: This could be logic analyzation, waveform outputs, block testing. 3D model renders, modeling graphs.

-List the **implementation Issues and Challenges**.

6. Closing Material

6.1 Conclusion

Summarize the work you have done so far. Briefly re-iterate your goals. Then, re-iterate the best plan of action (or solution) to achieving your goals and indicate why this surpasses all other possible solutions tested.

6.2 References

This will likely be different than in project plan, since these will be technical references versus related work / market survey references. Do professional citation style(ex. IEEE).

6.3 Appendices

Any additional information that would be helpful to the evaluation of your design document.

If you have any large graphs, tables, or similar that does not directly pertain to the problem but helps support it, include that here. This would also be a good area to include hardware/software manuals used. May include CAD files, circuit schematics, layout etc. PCB testing issues etc. Software bugs etc.