Department of Computer Science and Engineering

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The CTAR All-Star

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1. *Abstract/Summary*

Our team will be joining another senior projects group in the Electrical Engineering department this year. We have been asked to create a medical therapy device for the UNR School of Medicine Speech Pathology and Audiology Department. Our contact there is Dr. Kristine Galek. We were introduced to this project by Dr. Fred Harris.

The project, a device used for rehabilitation, will consist of a rubber ball with an embedded system that will measure air pressure and transmit that data via bluetooth to a smartphone. Our part will be to create a mobile application that interfaces with this device and the data it outputs. We have been asked to make a cross platform application that presents the data in real time in the form of a line graph. We should be able to set goals and track stats, likely using a web or cloud-based database like SQL. We will need to learn how to work with that database, bluetooth, and real-time graphing. We have also been challenged to use the fingerprint functionality of modern phones for our login mechanism. If time permits, we may also create a game to make the program more interesting and interactive.

1. *Project Description*
   1. *Main goals and objectives*
      1. *What are the goals of your project?*

The intended audience for our product are doctors that specialize in Dysphagia rehabilitation. Our product is intended to be used with the Chin Tuck Against Resistance (CTAR) exercise. This is a therapy exercise that strengthens the suprahyoid muscles in the neck. This helps improve the symptoms of Dysphagia. Dysphagia is a condition which makes it difficult or painful to swallow and is common in stroke victims and the elderly.

Currently, the exercise uses an inflatable rubber ball. Patients place the ball under their chin and tuck the chin as hard as possible against the ball. They hold this for a number of seconds and release. This is repeated many times during their rehabilitation session. A similar exercise in which the patient opens their jaw against the resistance can also be performed with this device.

Our co-teams’ product will have an embedded sensor that will transmit the pressure being produced. Our team will take that data and store it. We will display the data in real time on a mobile device. This is intended to allow the patient to be more interactive with the exercise. They will be able to set goals and have a visual representation of their progress.

* + 1. *What is your project trying to achieve?*

The goal is to bring a higher level of technology to a very old rehabilitation technique. This will allow medical professionals and patients to set goals and track progress.

* + 1. *Why is it needed or significant?*

Practicing the traditional version of this exercise does not allow tracking of progress and therefore medical professionals and patients have to make subjective guesses about the type of progress they are making. This device would provide objective data which shows their improvement over time.

* 1. *Main functionality and characteristics*
     1. *High level business requirements and characteristics*

In order for this product to be successful it would need the following characteristics: easy to use, and attractive interface, affordability, reliability. In order to have a successful business, we would need to show the stakeholders how this product is an improvement over the existing CTAR exercise method and other competing products. If we cannot show that there is an objective improvement then the business would not be profitable.

* 1. *Intended audience*
     1. Identify and describe intended users or user groups

The intended users of this product are the patients undergoing rehabilitation, however, the medical professionals who help with patient rehabilitation make up the bulk of the target market.

* 1. *Key usability goals*
     1. *How users will benefit from your project*

Users will benefit from an attractive/user friendly interface, reliability, and affordability. Additionally, the device needs to be able to account for patients with a wide range of abilities so that the device can be marketed to a wider range of users.

* 1. *Potential for further development/product enhancements*
     1. *Describe future enhancements or additional products beyond cs425*

In the future, this software could be modified to be used with any other device that emits bluetooth data. Although aimed at medical rehabilitation exercises, it may also be useful in other fields. This specific project could also integrate a game to make rehabilitation exercises more fun and interactive.

* 1. *Challenges and obstacles*
     1. *List potential challenges you may encounter during the project’s development. This can include technology, market acceptance, team skills and involvement, and other*

Some potential challenges we can see are technological. Our team has limited knowledge of mobile and web application development. None of us have worked with cross platform applications, graphing, fingerprint implementation or bluetooth. We will need to look into different platforms, Ionic, Xamarin, etc, and determine which will work best for our project. We will also be learning new languages such as C# which will slow us down.

Another concern is working with another team. From our understanding the teams may not even form until next semester. We will need to be able to work with an imaginary device and imaginary data. We will probably build a simple arduino device that transmits random data through bluetooth to build our initial software. This could cause challenges in the future when the other team build the actual device.

Given our current class and work loads, another challenge may be finding enough time to work on our project while also balancing our other responsibilities.

* 1. *Technology description*
     1. *Intended technology, e.g. platform, languages, libraries, tools and devices*

At this point we are leaning towards using Xamarin. We will likely only create an iOS and Android application. A Windows application is not necessary. The languages will include C# and XAML. We will likely use libraries such as Bootstrap, SQLite and a Bluetooth library. We will use a real-time graphing tool such as Syncfusion. We may also use an arduino microcomputer with transceivers to test our program.

* 1. *Team overview*
     1. *Team members: brief background information, specific skills, and expected involvement in the project*

Terri Heglar is a Senior working towards her bachelor’s in Computer Science and Engineering. She is currently interning at Sierra Nevada Corporation where she joined a team working on a medical communication system for Medevac helicopters. The system integrates medical sensors and devices into a mobile application that transmits and displays real time patient stats on a web application at the ground station. Outside of school, she has had experience with web development, including ASP.NET Core and Razor Pages, and Android development. She has worked with the Agile method and been a part of a SCRUM team. She expects to work ten hours per week during the Fall semester and fifteen hours per week in the Spring.

Andrew Penrose is also a Senior in pursuit of a Bachelor’s in Computer Science and Engineering. He has experience with C++ and Python programming languages. He will be working 10 hours a week on the project. Andrew is the only group member with an apple computer, so he will be in charge of testing the ios side of the multiplatform application.

Austin Yount is a Senior in pursuit of a Bachelor’s in CSE. He has experience experience with multiple different programming languages and is looking to gain knowledge with mobile app development. He will be working 10 hours per week on the project and is currently trying to incorporate bluetooth functionality into the project.

* 1. *Advisory overview*
     1. *A brief note on current or potential external advisor(s)*

Our current advisor is Dr. Frederick Harris, Computer Science and Engineering Department at UNR.

* 1. *How you expect this project will help your professional growth*

This project will give us real world experience in software development. We will organize our project using a software process model used in industry. We will gain experience working on a team of developers and improve our communication skills. We will work with a client and integrate changes as required to meet the real needs of the user. All of these are skills that will help us in our future careers.

1. *Market Potential or Open Source Significance* 
   1. *Market analysis*
      1. *Describe market potential, commercial promise, or open source value*

Dysphagia is estimated to affect roughly 9 million adults of which approximately 37% are diagnosed with dysphagia in the US according to the Harvard Medical School Department of Otology & Laryngology. Therefore we estimate the number of people undergoing medical treatment for dysphasia to be around 3.3 million people per year. The upper limit for the number of units that could be sold in a year is close to 3 million conservatively.

* + 1. *Evidence of user interest ( provide references)*

The development of this device was requested by Kristine Galek from the Department of Speech Pathology and Audiology who believes that this will be useful in her field.

* 1. *Competitive analysis*
     1. *Notes on similar or related products (provide references)*

The PhagiaFlex is a similar device that targets the suprahyoid muscles underneath the chin (PhagiaFlex, website). While this device has a similar objective, it is primitive compared to the Senior Project. This device fits under the chin and is held with the user’s hands or a table, depending on the model. It is designed to give resistance to the user so that the muscles can be rebuilt over time.

The AliMed Theraball is another device designed to strengthen the suprahyoid muscles (AliMed, website). This device’s website targets elderly patients but this device can be used by anyone rehabilitating these muscles.

* + 1. *Identify direct and indirect competition*

The PhagiaFlex is a device that is targeting the market as the Senior Project device. While the PhagiaFlex is a solution that strengthens the suprahyoid muscles, it is lacking real time data and statistics. The AliMed Theraball is also lacking any type of technology or data feedback. The Senior Project device will provide real time data as well as store the user’s progress over time.

* 1. *Competitive advantage*
     1. *Novelty of your solution, innovative characteristics.*

We have a competitive advantage over many of the current devices on the market. From our research, we found that all of the competing products are very primitive in design and do not have any way of objectively tracking user improvement or strength.

* + 1. *What makes your solution better than the competition*

There are currently no products on the market with the same level of technology as this device. Medical professionals need a device that will provide measurements in order to track patient progress.

1. *Time worked on project concept*
   1. *Indicate how much time (in hours) each of the team members worked on this project, and on what specific activities*

Terri has worked 5.5 hours on this report. She set up the initial bullet point diagram. She also wrote a rough draft of the Abstract, challenges and obstacles, technology description, advisory overview and her portion of the team overview and time worked sections. She researched Dysphagia and the CTAR rehabilitation exercise and wrote that portion of the project description. She also helped complete the final editing.

Austin has spent 4 hours on the report. He wrote responses to most of the points in the project description as well as doing research and writing the market potential and evidence of user interest sections. He also did a fair amount of final editing.

Andrew spent 3.5 hours on this Senior Project project. He researched similar devices which were few and far between. He wrote answers for the Market Potential of the project as well as contributed to already answered questions throughout the paper. He also wrote references and did some editing.

*References*

AliMed (website). Retrieved from <https://www.alimed.com/alimed-theraball.html>

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