GATOR - Games and Assistive Technologies for Rehabilitation

Team Members: Chris Hesser (CE) Corey LeFevre (CE) Michael Rowack –(CE)

Supervisor: Sudeep Pasricha (ECE)

Customers/Occupational Therapy Group: Matt Malcolm, Robin Grasso, Roxie Mcfarland, Tara Klinedinst, Alexandra Gisetti

Summary

GATOR is a project focused on providing a new type of rehabilitation for patients in need of upper limb rehabilitation. GATOR features games and activities that utilize the Leap Motion controller and the MYO armband. The games provide positive reinforcement as well as an enjoyable experience for the patient. Developed with JavaScript, html, and torque script, the suite of games use 2D and 3D gameplay to give patients the ability to exercise their limbs in an XY plane as well as an XYZ plane. The Leap Motion controller is able to track user movement, and the MYO similarly is capable of tracking muscle movements; so the pair of devices will be able to provide advanced statistic tracking. Combining the controllers with easy to play games allows for a better interface between patients and rehabilitation activities, and ultimately be used to provide the therapist with data about the progress of their patients and help them better assess their rehabilitation needs.

Why is This Project Important?

Rehabilitation can be very tedious and as a result patients sometimes give up on the rehabilitation because they don’t have the motivation to go through with it. GATOR features games and activities that transform the tedious movements and exercises of rehabilitation into an enjoyable experience for the patient. GATOR will decrease recovery time for patients, it will increase therapist productivity, and it will reduce the cost of rehabilitation.
**Problem Statement**

Rehabilitation is currently not a fun experience for the patients, and the feedback given to the therapists can be greatly improved. One of the challenges lies in creating an enjoyable experience for patients who are not familiar with video games. On the other side of the spectrum, it is also challenging to create an enjoyable experience for someone who is very familiar with video games. Rehabilitation is the main goal of the games; the challenge lies in creating an enjoyable experience while using rehabilitation exercises.

**Objectives**

One of our main objectives will be to use the MYO armband as well as the Leap Motion controller to gather stats about the patient while they are playing the games. Currently, GATOR only provides the patient and the therapist with a progress page that shows a graph of the users score and their previous scores for that particular game. We would like to expand on this greatly. User score is not the best way to keep track of progress. We want to use the MYO to gather stats such as muscles used and overall muscle exertion. The Leap can be used to gather stats such as average hand movement, maximum height achieved, finger twitch speed, wrist twitch, etc. Statistics of this nature will better show the patient and the therapist the progress that the patient is making. Also by analyzing these statistics we can develop a system that is able to dynamically recommend games for the patient and inform them of which areas they are not making as much progress. In addition, the system can be used bi-directionally, meaning the therapist can prescribe areas/muscles the patient needs to work on, but the system can also recommend games that will utilize these muscles.

Another one of our objectives will be to create a large suite of games. This objective solves a couple of problems. By creating a more diverse set of games, we will in turn be implementing more rehabilitation exercises. A diverse set of games will also keep the patient entertained. However, we also want to improve on the current games we have by visually improving them and improving the current audio. In addition to this, the current reward system will be improved. We want to create a reward system for the games that provides more than just a message saying good job. The reward system will have achievements, high scores, level progression, and potentially alter game play.

The current games, as well as the planned games, are all in two dimensions. We believe that in order to cater to all audiences that are in need of upper limb rehabilitation, we need to create games that offer a slightly more captivating experience. We think that this can be accomplished by using the Torque 3d engine. The Torque 3d engine allows for the creation of better visuals, better audio, and gameplay that is similar to that of new style video games. Also, the nature of the MYO and Leap controllers allows for 3d motion and it would be a shame not to explore the full capabilities of these devices for rehabilitation.

**Final Design Info**

Keeping GATOR simple is key. We want to implement our objectives while still maintaining the simple style interface so that all of the users of GATOR can have an easy and enjoyable rehabilitation experience. Our final deliverable to be a product should have enough games to keep the patients entertained or at the very least distracted from the painful and/or mind-numbing exercises associated with upper limb rehabilitation. These games should also offer all the primary exercises needed to cater to each patient’s rehabilitation process, potentially making GATOR into a primary method for upper limb
rehabilitation. Lastly we want GATOR to make the therapist's life easier. If we can automate the therapy process, the therapist will be able to be more efficient, providing the patient with, not only the best, but the fastest recovery process possible.

**Design Constraints**

Our project is a continuation project, and therefore one of the biggest early constraints is assessing the current progress so as to avoid duplicating the previous team’s work. Although the code base was maintained in a repository; and the final product was excellent, no piece of software is perfect. We were initially constrained by figuring out what was wrong with the previous group’s code, as well as figuring out their hacks. The code was built in Python and JavaScript; so for the initial phases, we are forced to work in this environment and adapt to it. However, at the moment we have supplemented these constraints quite well; and we have adjusted to the majority of the problems that we have encountered. In the second semester we don’t anticipate this to be a large problem since we are hoping to change the primary delivery method of our project from an online website to a software package. However, it is important to note that we plan on keeping the initial website we have developed for the games accessible for a period of time (legacy support).

Another constraint is acceptance into the healthcare community. Tools used in the medical field are strictly regulated and we may eventually have to conform to FDA inspection standards for this product to be used outside of research.

Man power and time are other legitimate constraints. We will be able to achieve many things with our three person team (as outlined in our project timeline), but we will need to carefully assess our priorities to ensure that we are effective as possible on delivering an excellent product.

At the moment we have assessed these constraints quite well, and have adjusted to the majority of the problems encountered. In the second semester as the customer feedback loop improves we anticipate the constraints of the therapists to be a bigger priority than those outlined above.

**Budget**

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Specification</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leap Controllers- currently own 1</td>
<td></td>
<td>need to purchase at least 1 more</td>
<td>$80</td>
</tr>
<tr>
<td>MYO Development kit-purchased 1</td>
<td></td>
<td>we will need to purchase a second in second semester</td>
<td>$300</td>
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<tr>
<td>Torque IDE and Art &amp; sound packages</td>
<td></td>
<td></td>
<td>$150</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$530</strong></td>
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Potential Risks and Contingency Plan

The primary risk we deal with is simply put unhappy customers. The success of our product lives and dies with the success of the patients using it. If the patients are unhappy with the product or the therapists do not think the product is effective, our product loses its application. In order to deal with this, we plan on meeting with the occupational therapy group on a biweekly basis either in person or in video chats. By maintaining a consistent feedback loop, we can ensure that we are meeting our customers’ expectations and implementing their changes as well as possible improvements. It is imperative that we handle our risk in the most diligent way possible to avoid losing our customer as we do not have other customers to work with.
Project Timeline

<table>
<thead>
<tr>
<th>Phase #</th>
<th>Delivery Date</th>
<th>Description</th>
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Note: Tentative indicates that the dates are feedback dependent - we feel that we cannot be absolute as to our dates or exact goals the further we get out in the year, especially into next semester. This is because we are basing part of the project on the needs and feedback of the occupational therapy group. Obviously all dates are estimates, and we anticipate shifting our goals as we gather feedback from the customer.

Phase 1 | October 3 | Provide Sturdy Base for Patient Trials
- Simple game development
  - One tangible/playable game delivered based on java script old games
  - Fruit ninja
- Website Correction/enhancement
  - Contact us, feedback, readmes, etc…
  - Codes for therapist registration (non changing)
  - Dynamic codes for patient registration to prevent database floods
  - New splash pages between graphs and end of game
  - Setting for therapist to enter affected limbs
  - Flag in games to ensure correct limb usage (cheater flag)
  - Specifically used for in home therapy and also for stat keeping and tracking
- Clinical trials (starts Thursday)
  - Get feedback and adjust based on feedback
  - Set a second meeting and or more
- Basic Leap tracking for therapist statistics
  - Distance traveled
  - Max stats (field day type)
- Game enhancements
  - Add better visuals non 3d
  - Add better sounds

Phase 2 | October 24 | Enhance Patient and Therapist Experience
- Game enhancements (basic) –non visual / non performance related
  - Add levels to create advancement feeling but base it off current difficulty
- One tangible/playable game delivered based on java script old games
  - Fit your hand into the puzzle piece?
- Meeting with therapy group
  - Understand success/failures/likes/dislikes/etc.
    - Create report
    - Discuss new innovations and changes
- Therapy Program assignment for patients
  - Therapist bubble selections for areas of need
- MYO basic Development and stat generation for muscle tracking (tentative on delivery date of the MYO)
- First set of Torque games (these games will most likely be based on the current java script games)
- Website Correction/enhancement (tentative on first deliverable)
  - New achievement system in place
  - Updates for home therapy session delivered to therapist at login
Phase 3    November 21    Automate Therapy Experience

- MYO advanced development
  - Statistics generation
  - Muscle exertion and force
  - Muscles utilized and muscles not being used
- Meeting with Therapy group
  - Continue creating a usable product for the therapy team (feedback loop)
- Dynamic therapy scheduling based on statistics and MYO statistics
  - Auto difficulty adjustments
  - Generation of new therapy routines based on current progress and stats
    - Goal is to create routines where patient is working everything that therapist wants
- Advanced leap tracking for therapist statistics
  - Finger twitch speed
  - Wrist twitch speed
  - Etc…
- MYO game development
  - Make current set of games compatible with MYO worst case make at least 2 to 3 games compatible
    - If it is not possible to integrate games with both controllers, we will try to remake the games with MYO or adjust games to be compatible with MYO

Phase 4   December 8 (Tentative)   Final Fall Product Delivery

- Second Set of Torque games (date may change based on 561 reqs, these games will be based more off our own creative direction rather than OT direction, so that we can be able to create better games later on)
- Cumulative Report Stats (IP through the three phases, however we want it to contain all features by this date)
- Report on clinical trials, success and failures
- Handoff of MYO based therapy to OT group

Phase 5    February 9 (Tentative)

- We will be continuing our work with the occupational therapy group. From this meeting we will look at how the patients are responding to the torque based games, and we will look into their feedback on the automation.
  - Most importantly from this meeting we would like to hear about the responses from the patients and the therapists about the MYO, and what direction they would like us to head in from this.
- Basic software package available for games, software suite, etc…

Phase 6   March 6 (Tentative)

- Software package is able to communicate back and forth between a server (secure) that way the packages are not stand alone ie.. patient information is stored on database and they can still however log in from different locations etc and therapist can track progress, stats, etc.
- Assumed MYO Development
- Feedback with Occupational therapy group

Phase 7    March 27 (Tentative)

- Third set of Torque games (these games will be more similar to the second set of torque games, they will take on more challenge than the java script games however unlike the second set of games they will be based more on the needs of the OT group)
• Assumed MYO development
• Feedback with Occupational therapy group

Phase 8  April 17 (Tentative)
• Initial preparations for hand off to new senior design group
  o Set goals for new group
  o Go over unsolved problems
  o Prettify the current code base
• Discuss Unsolved problems with occupational therapy group and look into solutions
• Add base functionality for next piece of hardware
  o Potentially Oculus Rift/Leap virtual reality, or Google Glass, or Kinect 2
• Work on finding sponsorship to help support the next group
• Begin Creating Presentation, reports, and demos for E-days.

Phase 9  May 4 (Tentative)
• Finish product for E-days presentation
  o Reports
  o Presentations
  o Games
• Formal hand off of project to next group
  o Documents (read me’s), directions, suggestions, etc..

All phases after phase 4 will be formally set and adjusted sometime in late November or early December once we have a better idea of the direction of the occupational therapy group.