Project created on 08.09.2016 13:53.

Report for project Senior Design Electronic book

Task created on 02.03.2017 21:45.

No due date

Verification and Validation Plan

No description

Task tags: *No tags*

Completed by Shirshak Aryal on 03.03.2017 16:08.

Step 1: Verification and Validation Plan

Verification for Design Specs: Static Progressive: The static progressive nature of the exoskeleton is ensured by the multiple plate design connected by adjustable strings. The locking mechanism ensures the exoskeleton can remain static at each interval. Waterproofness: The 3-D printed material of the exoskeleton is plastic which is resistant to any kind of water damage. The material can be tested for water damage in a test where the product is soaked in water for one hour. Since it is unlikely that our product will be in constant contact with water for more than one hour during its practical use, this test should provide verification for the waterproofness. Resistance to Temperature: The temperature resistance capacity of the exoskeleton can be tested for by exposing the exoskeleton to wide ranges of temperature. For test in low temperatures, the exoskeleton will be tested by placing it in deep freeze refrigerator (0 degree Celsius), for one hour. For test in high temperatures, the exoskeleton will be tested by placing it in water bath (50 degree Celsius), for one hour. Drop Test: For the drop test, the exoskeleton can be dropped off from a two story building. Then the exoskeleton can be tested for any cracks or dentures. The ABS material has moderate sturdiness and passing this test would fulfill the drop threshold of 2m.Verification Testing for Elastic Glove Breathability: The material that we are going to use to make our elastic glove component is spandex, which is commonly used for workout apparels, so it is generally high in breathability. The testing that we can do to check the breathability is have one team member wear the glove for multiple hours a day, and check to see if he suffers excessive sweating or heating. Dimensional Analysis : All the components involved in our prototype will be tested and measured to see if they are the correct dimensions. The length, breadth, circumference and other measurements of distance will be done using a measuring tape. The final product will also be weighed in a weighing machine to verify it is the right weight.Validation Testing Patient Compliance : The final device will be handed to multiple burn victims and checked whether they find it comfortable to wear. A brief survey of their compliance to wear the device for

multiple hours a day will be taken. Post Supervision: A brief survey will be carried out to check whether the patients are being able to use the device on their own, and are able to use all the function of the device without any major issues.

Activity of task Verification and Validation Plan

02.03.2017 21:45 *Shirshak Aryal* created task **Verification and Validation Plan**.
03.03.2017 16:08 *Shirshak Aryal* created Step 1 **Verification and Validation Plan**.
03.03.2017 16:08 *Shirshak Aryal* completed Step 1 **Verification and Validation Plan** (1/1 completed).

Task created on 02.03.2017 21:45.

No due date

Overall Project Status

No description

Task tags: *No tags*

Completed by Shirshak Aryal on 02.03.2017 21:51.

Step 4: Moving Forward

Our short-term goal is to 3D print the tentative model of exoskeleton by March 19 2017. Starting March 20 2017, we will start working on making gloves using spandex.

Completed by Shirshak Aryal on 02.03.2017 21:50.

Step 3: Part 2

As stated earlier in the report, we have been focusing on exoskeleton part first. We started making hand sketches of exoskeleton which fulfills the need and design specifications well. The hand sketch presented in the report is the tentative final version of hand sketch. Starting third week of February, we started making CAD design based on final hand sketch we agreed on. We are still working of finishing up the CAD design. Out of four major pieces of exoskeleton, CAD figures and picture of it's 3D printed version for only the completed pieces has been included in this report. All of which was used for proof of concept part. Since last week, we have been solely focused on brainstorming, researching and coming up with ideas for verification and validation tests. Based on findings and agreement, we have included our plans for verification and validation in this report.

Completed by Shirshak Aryal on 02.03.2017 21:50.

Step 2: Part 1

Work on this project started towards the end of January. Firstly, upon getting license for TechShop approved, we were planning to make it our primary work station for the project. However, due to membership restrictions, it was not

feasible. Thus, we decided that Professor Widder's Lab would be our primary work station. Next, supplies needed to build our devices was researched. ABS, Hypafix, connecting strings & Velcro were relatively easy to find, whereas we are still in search of suppliers who sells raw spandex material without post processing, interestingly we have only could find finished spandex gloves products. As of now, we already purchased Velcro and guitar string, and we are expecting ABS & Hypafix to be delivered before end of next week.

Completed by Shirshak Aryal on 02.03.2017 21:50.

Step 1: Intro

Currently, this project is in prototyping phase. Our simplest prototype for exoskeleton is almost complete at this point. Likewise, we have also finalized the materials to be purchased and have also identified the right products and suppliers. We are expecting the required materials to arrive before spring break, March 10 2017.

Activity of task Overall Project Status

02.03.2017 21:45 *Shirshak Aryal* created task **Overall Project Status**.
02.03.2017 21:50 *Shirshak Aryal* created Step 1 **Intro**.
02.03.2017 21:50 *Shirshak Aryal* completed Step 1 **Intro** (1/1 completed).
02.03.2017 21:50 *Shirshak Aryal* created Step 2 **Part 1**.
02.03.2017 21:50 *Shirshak Aryal* completed Step 2 **Part 1** (2/2 completed).
02.03.2017 21:50 *Shirshak Aryal* created Step 3 **Part 2**.
02.03.2017 21:50 *Shirshak Aryal* completed Step 3 **Part 2** (3/3 completed).
02.03.2017 21:51 *Shirshak Aryal* created Step 4 **Moving Forward**.
02.03.2017 21:51 *Shirshak Aryal* completed Step 4 **Moving Forward** (4/4 completed).

Task created on 24.02.2017 15:58.

No due date

Hand Sketches

No description

Task tags: *No tags*

Completed by Shirshak Aryal on 27.02.2017 00:10.

Step 4: CAD Design

Currently, we are making CAD design based on the exoskeleton uploaded above.

Completed by Shirshak Aryal on 27.02.2017 00:07.

Step 3: Exoskeleton: Hand Sketch

No description

[Exoskeleton_Hand_Sketch.jpg] File uploaded on 27.02.2017 00:07.

Comments for step Exoskeleton: Hand Sketch

Shirshak Aryal on 27.02.2017 at 00:09: Currently, we are making CAD design based on this hand sketch of the exoskeleton

Completed by Shirshak Aryal on 24.02.2017 16:07.

Step 2: Proof of Concept.

The final version of hand sketch will be uploaded in the proof of concept section in the upcoming report.

Completed by Shirshak Aryal on 24.02.2017 16:05.

Step 1: Hand Sketches

Our group worked on making Hand Sketches this week. The task was a bit more complex and time intensive than our originally allocated time slot for this work. Thus, it took us an extra week to come up with suitable sketch. The final version of the sketch will be ready by tomorrow (February 25 2016). And it will be uploaded in this tab.

Activity of task Hand Sketches

24.02.2017 15:58 *Shirshak Aryal* created task **Hand Sketches** .
24.02.2017 16:05 *Shirshak Aryal* created Step 1 **Hand Sketches** .
24.02.2017 16:05 *Shirshak Aryal* completed Step 1 **Hand Sketches** (1/1 completed).
24.02.2017 16:07 *Shirshak Aryal* created Step 2 **Proof of Concept.**.
24.02.2017 16:07 *Shirshak Aryal* completed Step 2 **Proof of Concept.** (2/2 completed).
24.02.2017 16:37 *Shirshak Aryal* edited Step 1 **Hand Sketches** .
27.02.2017 00:07 *Shirshak Aryal* created Step 3 **Exoskeleton: Hand Sketch**.
27.02.2017 00:07 *Shirshak Aryal* completed Step 3 **Exoskeleton: Hand Sketch** (3/3 completed).
27.02.2017 00:09 *Shirshak Aryal* commented on Step 3 **Exoskeleton: Hand Sketch**.
27.02.2017 00:10 *Shirshak Aryal* created Step 4 **CAD Design**.
27.02.2017 00:10 *Shirshak Aryal* completed Step 4 **CAD Design** (4/4 completed).

Task created on 24.02.2017 16:07.

Proof of Concept

No due date

No description

Task tags: *No tags*

Completed by Nischal Khanal on 03.03.2017 15:00.

Step 7: CAD Design for exoskeleton.

Attached are the images of the three parts of the exoskeleton (This includes the plates for Planes 1 and Planes 2 (as defined in the updated Design Specifications). Scinote did not allow us to upload the STL files associated with each design. We redesigned and reprinted the plate for the dorsal side of the hand/wrist to make it flat and to scale with the other two pieces. Each one of the three pieces has two sets of three small holes which will be used to pass the wire that connects them together. In addition, there are two long cutouts on the edges of each piece (two sets on the larger piece); these will be used to attach the VELCRO straps. The knob on the third piece is a placeholder for the knob mechanism which will allow us to change the tension in the wires to pull the pieces closer together or allow them to pull apart; for now, tension testing was performed by pulling the wires by hand.

[First_Piece.png] File uploaded on 03.03.2017 14:35.

[Second_Piece.png] File uploaded on 03.03.2017 14:35.

[Third_Part.png] File uploaded on 03.03.2017 14:59.

Completed by Utsav Malla on 03.03.2017 15:00.

Step 6: CAD Drawing of the bottom half.

The CAD design was done in two parts. Nischal was responsible for designing the top two plates. I was assigned to design the bottom half of the exoskeleton. The CAD drawing is attached.

[exoskeleton.JPG] File uploaded on 03.03.2017 00:54.

Completed by Utsav Malla on 03.03.2017 15:00.

Step 5: CAD Design - Bottom Half

Completed the CAD design for the bottom half of the exoskeleton splint. The exoskeleton was printed in Dr. Widder's lab. The CAD Design for this bottom half has a snapping locking mechanim.

Completed by Shirshak Aryal on 02.03.2017 21:43.

Step 4: Tentative Descriptive Concept of Exoskeleton

The exoskeleton contains 4 major individual components which will be 3D printed separately. Two anterior pieces will be used to provide support four fingers above metacarpals. The posterior piece will start at wrist level and cover up to metacarpals. This piece will also consist of an adjustable knob, which will be useful to provide the static progressive functionality. Fourth and final piece will cover and support the thumb starting at metacarpal level. Each of the pieces, expect for thumb piece, will have 3 depression ridges (on middle, left and right side) to accommodate the connecting wire/strings. Similarly, each of the piece will have thin rectangular holes on each side to provide the attachment for Velcro straps. After all the parts are printed, each of the parts will be assembled together using wires (guitar strings). All the pieces will be oriented as shown in the figure (1) below, then three wires will be tied on each of arch of the anterior most part of every pieces and the wires will run straight down through the depression ridges, down to adjustable knob. So, there will be four wires in total, 3 of which will be running through the 3 main pieces and fourth one will run through the thumb pieces. At the knob, all the four wires will be tied together making a tight grip, which provides needed stability and holds all the pieces together to provide the functionality of exoskeleton. The knob component can be readjusted to different tightness level to change the position of the exoskeleton as needed, providing an important static progressive functionality. Velcro strap will me attached to the rectangular holes present on both side of each individual pieces. This will provide a stable locking mechanism to attach the entire exoskeleton, which will prevent any possible deviation of exoskeleton pieces from it’s initial location while performing movement tasks and functions.

Comments for step Tentative Descriptive Concept of Exoskeleton

No comments

Completed by Shirshak Aryal on 02.03.2017 21:42.

Step 3: Overview

Our final prototype of Hand Burn Rehabilitation device will have three separate components: inner lining of Hypafix, compression gloves made from spandex just outside the Hyapfix lining, and outer support and encapsulation via exoskeleton. Since Hyapafix and compression gloves are relatively general components, they can be made without making prior sketches and CAD designs. Thus, we focused on making exoskeleton models first. The design of this model will be used to show the proof of our concept prototype. We will be showing the proof of concept in three different stages: Hand Sketch, CAD Design and 3D printed component of exoskeleton.

Completed by Shirshak Aryal on 24.02.2017 16:15.

Step 2: Final version of CAD

The final version of the CAD design will be used for the proof of concept in the

next report, along with the hand sketch.

Completed by Shirshak Aryal on 24.02.2017 16:14.

Step 1: CAD Design for Exoskeleton

CAD design for the outer exoskeleton is currently being made using Autodesk. Since, TechShop license issue wasn't solved, we are using desktop in Whitaker to come up with the design. After the completion of Hand Sketch, we will make final modification in the CAD design based on any design change seen from our proposed hand sketch. CAD sketches will be completed and uploaded in this section by Sunday.

Activity of task Proof of Concept

24.02.2017 16:07 *Shirshak Aryal* created task **Proof of Concept**.
24.02.2017 16:14 *Shirshak Aryal* created Step 1 **CAD Design for Exoskeleton** .
24.02.2017 16:14 *Shirshak Aryal* completed Step 1 **CAD Design for Exoskeleton** (1/1 completed).
24.02.2017 16:15 *Shirshak Aryal* created Step 2 **Final version of CAD**.
24.02.2017 16:15 *Shirshak Aryal* completed Step 2 **Final version of CAD** (2/2 completed).
02.03.2017 21:42 *Shirshak Aryal* created Step 3 **Overview**.
02.03.2017 21:42 *Shirshak Aryal* completed Step 3 **Overview** (3/3 completed).
02.03.2017 21:42 *Shirshak Aryal* created Step 4 **Tentative Descriptive Concept of Exoskeleton**.
02.03.2017 21:43 *Shirshak Aryal* completed Step 4 **Tentative Descriptive Concept of Exoskeleton** (4/4 completed).
02.03.2017 21:43 *Shirshak Aryal* created Step 5 **CAD Design (Upload here)**.
02.03.2017 21:44 *Shirshak Aryal* created Step 6 **Picture of 3D printed parts (Upload Here)**.
02.03.2017 22:15 *Shirshak Aryal* edited Step 5 **CAD Design (Upload here as Image)**.
02.03.2017 22:15 *Shirshak Aryal* edited Step 6 **Picture of 3D printed parts (Upload as Images)**.
03.03.2017 00:48 *Utsav Malla* created Step 7 **CAD Design - Bottom Half**.
03.03.2017 00:49 *Utsav Malla* deleted Step 6 **Picture of 3D printed parts (Upload as Images)**.
03.03.2017 00:49 *Utsav Malla* deleted Step 5 **CAD Design (Upload here as Image)**.
03.03.2017 00:54 *Utsav Malla* created Step 6 **CAD Drawing of the bottom half.**.
03.03.2017 14:32 *Nischal Khanal* created Step 7 **CAD Design for exoskeleton.**.
03.03.2017 14:35 *Nischal Khanal* edited Step 7 **CAD Design for exoskeleton.**.
03.03.2017 14:38 *Nischal Khanal* edited Step 7 **CAD Design for exoskeleton.**.
03.03.2017 14:59 *Nischal Khanal* edited Step 7 **CAD Design for exoskeleton.**.
03.03.2017 15:00 *Nischal Khanal* completed Step 7 **CAD Design for**

exoskeleton. (5/7 completed).

03.03.2017 15:00 *Nischal Khanal* completed Step 6 **CAD Drawing of the bottom half.** (6/7 completed).

03.03.2017 15:00 *Nischal Khanal* completed Step 6 **CAD Drawing of the bottom half.** (6/7 completed).

03.03.2017 15:00 *Nischal Khanal* completed Step 5 **CAD Design - Bottom Half** (7/7 completed).

03.03.2017 15:00 *Nischal Khanal* completed Step 5 **CAD Design - Bottom Half** (7/7 completed).

03.03.2017 15:00 *Nischal Khanal* uncompleted Step 5 **CAD Design - Bottom Half** (6/7 completed).

03.03.2017 15:00 *Nischal Khanal* uncompleted Step 5 **CAD Design - Bottom Half** (6/7 completed).

03.03.2017 15:00 *Nischal Khanal* completed Step 5 **CAD Design - Bottom Half** (7/7 completed).

03.03.2017 15:00 *Nischal Khanal* completed Step 5 **CAD Design - Bottom Half** (7/7 completed).

Task created on 02.03.2017 21:48.

No due date

V&V Report

No description

Task tags: *No tags*

Completed by Utsav Malla on 03.03.2017 15:08.

Step 6: Validation Report

Validation Testing Patient Compliance : The final device will be handed to multiple burn victims and checked whether they find it comfortable to wear. A brief survey of their compliance to wear the device for multiple hours a day will be taken. Post Supervision: A brief survey will be carried out to check whether the patients are being able to use the device on their own, and are able to use all the function of the device without any major issues.

Completed by Utsav Malla on 03.03.2017 15:08.

Step 5: Verification for the Elastic HandGlove

Verification Testing for Elastic Glove Breathability: The material that we are going to use to make our elastic glove component is spandex, which is commonly used for workout apparels, so it is generally high in breathability. The testing that we can do to check the breathability is have one team member wear the glove for multiple hours a day, and check to see if he suffers excessive sweating or heating. Dimensional Analysis : All the components involved in our prototype will be tested and measured to see if they are the correct dimensions. The length, breadth, circumference and other measurements of distance will be done using a measuring tape. The final product will also be weighed in a weighing machine to verify it is the right weight.

Completed by Utsav Malla on 03.03.2017 15:01.

Step 4: Verification for the Exoskeleton:

Verification and Validation Test: Verification for Design Specs: Static Progressive: The static progressive nature of the exoskeleton is ensured by the multiple plate design connected by adjustable strings. The locking mechanism ensures the exoskeleton can remain static at each interval. Waterproofness: The 3-D printed material of the exoskeleton is plastic which is resistant to any kind of water damage. The material can be tested for water damage in a test where the product is soaked in water for one hour. Since it is unlikely that our product will be in constant contact with water for more than one hour during its practical use, this test should provide verification for the waterproofness. Resistance to Temperature: The temperature resistance capacity of the exoskeleton can be tested for by exposing the exoskeleton to wide ranges of temperature. For test in low temperatures, the exoskeleton will be tested by placing it in deep freeze refrigerator (0 degree Celsius), for one hour. For test in high temperatures, the exoskeleton will be tested by placing it in water bath (50 degree Celsius), for one hour. Drop Test: For the drop test, the exoskeleton can be dropped off from a two story building. Then the exoskeleton can be tested for any cracks or dentures. The ABS material has moderate sturdiness and passing this test would fulfill the drop threshold of 2m.

Completed by Nischal Khanal on 03.03.2017 15:00.

Step 3: Changes to design specifications

One addition was made to the design specification: We further specified the angular movement of the progressive static functionality. There will be two separate planes starting at metacarpal region to tip of the phalanges. Plane 1 from metacarpal to mid phalanges will allow 45-90 degrees angular movement, likewise from mid phalanges to top of the finger will also allow 45-90 degree angular movement.

[Design_Spec.png] File uploaded on 03.03.2017 14:55.

Completed by Nischal Khanal on 03.03.2017 15:00.

Step 2: Changes to design schedule/team responsibilities

No changes were made to the design schedule and team responsibilities.

Completed by Shirshak Aryal on 02.03.2017 21:52.

Step 1: Changes to Project Scope and Need State Statement

No changes were made in the need statement and project scope as details of our problem and targeted population is still the same since the progress report.

Comments for step Changes to Project Scope and Need State Statement

No comments

Activity of task V&V Report

02.03.2017 21:48 *Shirshak Aryal* created task **V&V Report**.
02.03.2017 21:52 *Shirshak Aryal* created Step 1 **Changes to Project Scope and Need State Statement** .
02.03.2017 21:52 *Shirshak Aryal* completed Step 1 **Changes to Project Scope and Need State Statement** (1/1 completed).
02.03.2017 21:53 *Shirshak Aryal* created Step 2 **Verification Validation Report (Upload Here)**.
03.03.2017 14:41 *Nischal Khanal* created Step 3 **Changes to design schedule/team responsibilities** .
03.03.2017 14:43 *Nischal Khanal* created Step 4 **Changes to design specifications**.
03.03.2017 14:53 *Utsav Malla* deleted Step 4 **Verification Validation Report (Upload Here)**.
03.03.2017 14:55 *Nischal Khanal* edited Step 3 **Changes to design specifications**.
03.03.2017 15:00 *Nischal Khanal* completed Step 2 **Changes to design schedule/team responsibilities** (2/3 completed).
03.03.2017 15:00 *Nischal Khanal* completed Step 3 **Changes to design specifications** (3/3 completed).
03.03.2017 15:01 *Utsav Malla* created Step 4 **Verification for the Exoskeleton:**.
03.03.2017 15:01 *Utsav Malla* completed Step 4 **Verification for the Exoskeleton:** (4/4 completed).
03.03.2017 15:04 *Utsav Malla* created Step 5 **Verification for the Elastic HandGlove**.
03.03.2017 15:05 *Utsav Malla* created Step 6 **Validation Report**.
03.03.2017 15:08 *Utsav Malla* completed Step 5 **Verification for the Elastic HandGlove** (5/6 completed).
03.03.2017 15:08 *Utsav Malla* completed Step 6 **Validation Report** (6/6 completed).