The Hope Device

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Abstract

Physical challenges and disabilities create complex, multidimensional barriers which reduce freedom of movement. An individual that has restricted body movement can move around with some assistive support and the support could be a wheelchair or a crutch. The project required the team to develop a design that can support the person with a disability to walk around without the use of any wheelchair.

Introduction

There are many disabled people with foot paralysis. The team created a device for them to get rid of the wheelchairs and be able to walk like others. The device will make them able to walk using their hands to control. The device look like developed crutches.

Design Description

The device enhances mobility by enabling the hands to hold the two different crutches that were attached to legs, and an optional chest supporter to give more balance. Therefore, the person who uses the assistive device must be strong enough to lift the whole-body weight using hands.

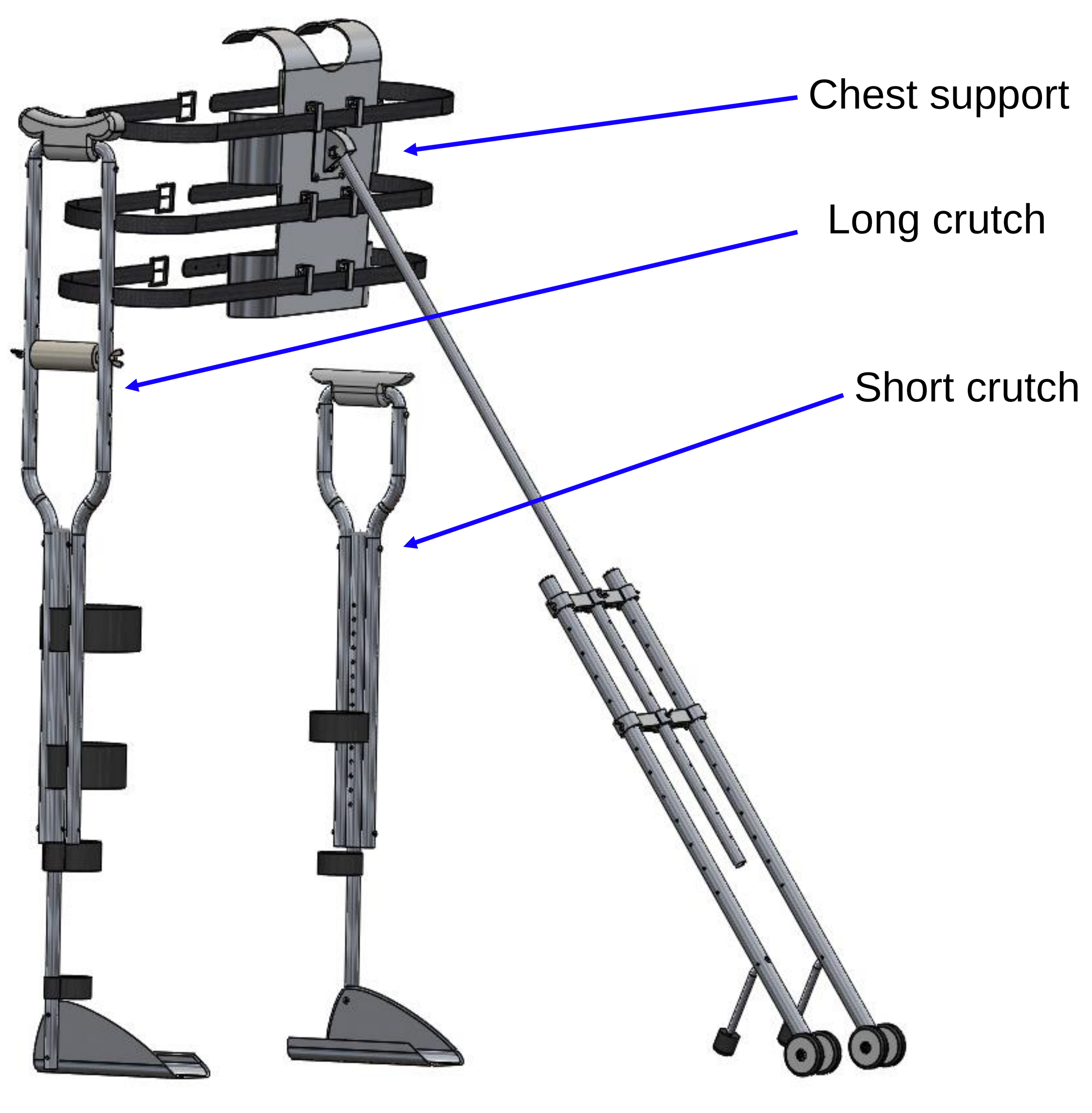

Figure 1: The Hope Device

Engineering Design

Design Research

Information and knowledge gained from existing designs and product features of the assistive devices that were marketed under various internal brands were used for making our prototypes more suitable, perfect and satisfactory. The research was done over the internet and few existing designs have been found for the system level designs and the sub-system levels. The research was important in determining the actual requirements for developing the assistive devices. [1]

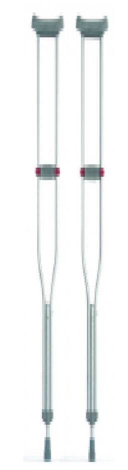

Figure 2: underarm crutches [2]

Figure 3: Exoskeleton [3]

Figure 4: walker crutches [4]

Engineering Requirements

Table 1: Engineering Requirements

Engineering Requirements	Target Values
1. Costs ≤$800	$775
2. Weight ≤35 lb.	28 lb.
3. Lifting capability of user ≤15 lb.	10 lb.
4. Height of Device	5 – 6.5 ft.
5. safety (not falling)	Factor of safety ≥1
6. comfortability for the user	Attach point has comfy material (foam)
7. Appropriate price for spare parts ≤$40	$25≤$40

Results

The team assumed that the coefficient of friction is 0.9. This is the value of dry road made of asphalt. The following equations used related to braking are as follows:

$$F_f = N\,\mu_k$$
$$N = W\,Cos\theta$$

This is the angle at which the brakes will be available to stop the brocket and stop the person from falling

$$\theta = 42°$$

This is the force available at the brake, it is also the frictional force available at that point.

$$F_f = 150\ lb$$

Analysis was carried out on this design of underarm leg support with the help of Ansys to check whether it would work or it needs a redesign. Force of 1000N was applied on it and the Factor of safety of 1.6 was obtained

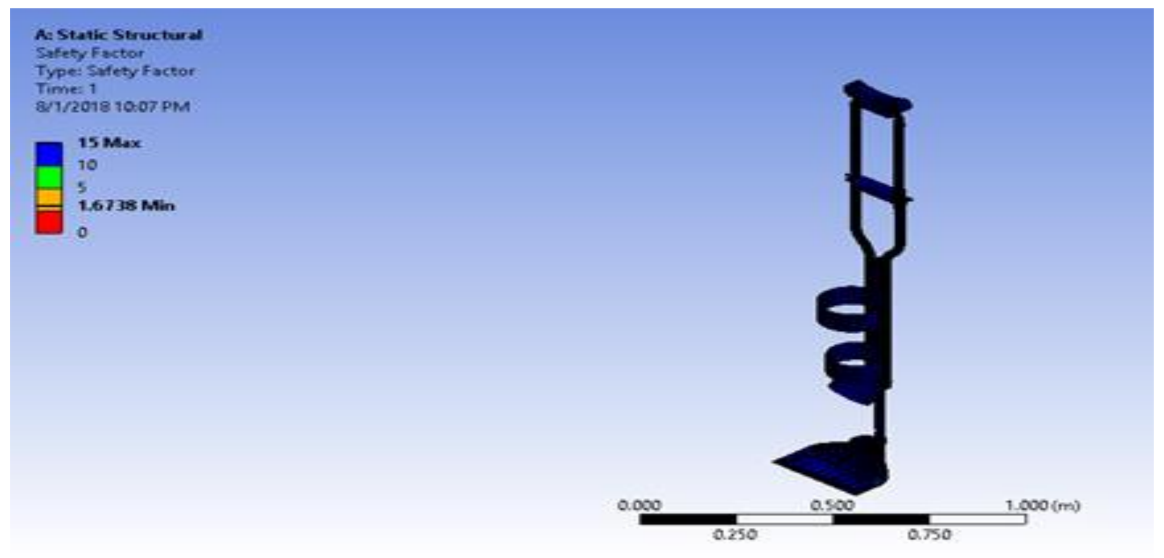

Figure 5: FEA calculation

Same type of analysis was carried out on the second leg support as on first and factor of safety of about 5.5 was obtained in this case which is more than enough.

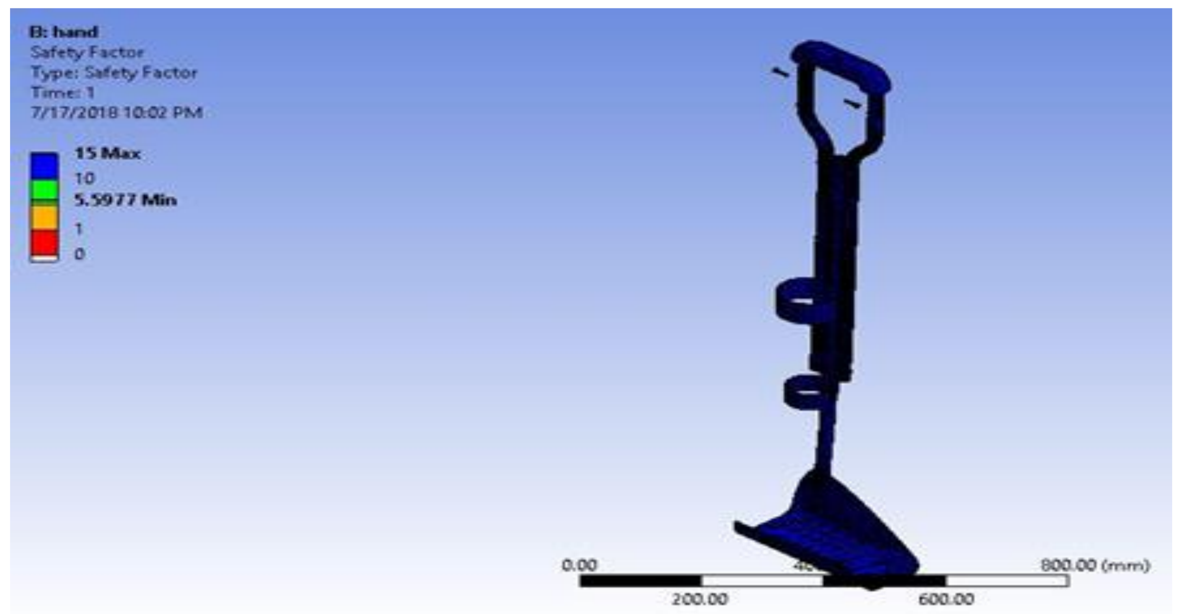

Figure 6: FEA calculation

After redesign the chest support by increasing the thickness of the rod and adding two more rods to keep the balance which improved the factor of safety of support assembly attached with chest support. By applying 743N to the rods based on the angle where the brake system stops the body from falling. And the minimum of the factor of safety is 2.5 as shown below.

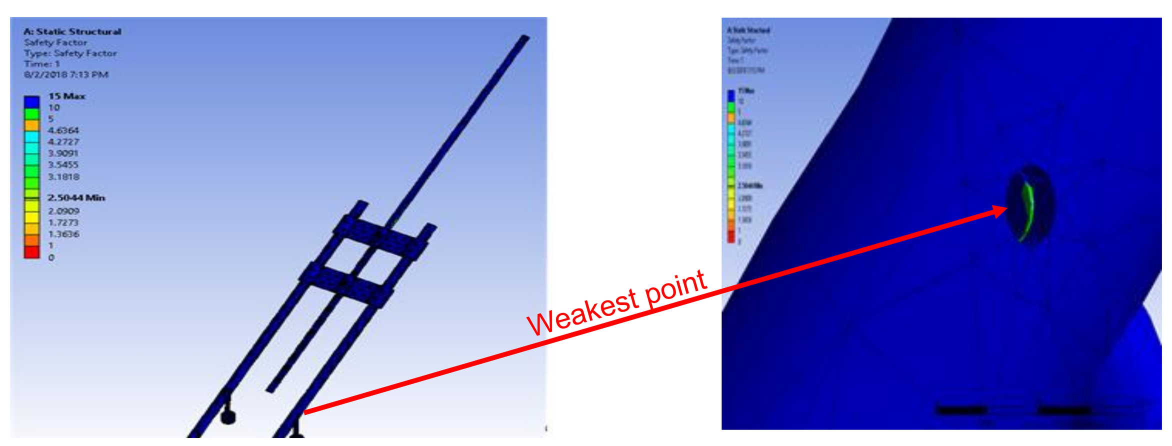

Figure 5: FEA chest support redesign

Manufacturing

The team implemented the design in SolidWorks and all parts can be manufactured. In addition, the whole device can be assembled using screws and pins.
Here is an example of the assembled parts:

Figure 7: long crutch disassembled

Conclusion

The finite element results of leg supports are under the safe region. The FEA of chest support yields a factor of safety of 0.09. This means the design of chest support is not safe to use and it is needed to be redesigned. The rod at the front of the chest support is weak to hold the force and it will break. The rod can be redesigned by using larger diameter and smaller gauge. This will add extra strength with a very little contribution to weight of the body. Also, the chest support was redesign to more balanced by adding two rods with two wheels and brake systems. After redesigned the chest support the team did the FEA calculations again and get the factor of safety about 2.5044 which will meet the engineering requirements.

References

[1] U. California, “Controller Design and Implementation for a Powered Prosthetic Knee”, (Doctoral dissertation, University of California, 2012) (pp. 1-98). Berkeley, U.S.A: University of California. Retrieved February 26, 2018, from *http://digitalassets.lib.berkeley.edu/etd/ucb/text/Rosa_berkeley_0028E_12182.pdf*

[2] E. Axial, “Aluminum Axilla Crutches”, available [online], https://www.essentialaids.com/aluminium-axilla-crutches.html

[3] S. Hollister, “Exoskeleton to walk again”, March 2, 2013 published by CNET, available [online], https://www.cnet.com/news/cyberdyne-hal-exoskeleton-medical-rehabilitation/

[4] V. Medical, “Light Weight Walker”, available [online], http://www.viennamedical.com/c/walkers-canes-crutches.html

Acknowledgments

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