



Pediatric Arm Support

Team members: Camille Duan, James Tang, Maggie Zhou

Client: Ms. Megan Schiele

Advisor: Prof. Tracy Jane Puccinelli



Abstract

Children with upper limb muscle weakness face difficulties in performing daily activities. Occupational therapist, Megan Schiele, has approached us of designing an arm support system to help a 4-year-old girl with SMA symptoms. We came up with three preliminary design ideas and have chosen two proposed final designs. We hope to complete fabricating two prototypes by incorporating ideas from two preliminary designs. By rapid prototyping, we will decide on one final design to proceed. Finally, a more sophisticated testing method will be created to ensure the feasibility and safety of the design to help the little girl.



Figure 1 & 2. Competing Designs [2] [3]

Design Criteria

- The Design needs to be light (< 1 lbs)
- Mobile (preferably not fixed on a table)
- Lift the patient's arm weight (~ 3-6 lbs)
- Allow arm movements in all three planes
- Would not block the patient's vision
- Under \$200 budget

The goal of the design is to help the patient to support her elbow and wrist to move her arm to pick up game pieces. With the help of the device, the patient should be able to play with her friends either over the table or on the ground with the adult's constant help on the side. The device should be within 2 lbs over the shoulder and 1 lb over the arms and it should be able to lift 4-year-old kids' arms, which is about 6 lbs.[4]

MIME Robotic Device

- 6 degrees of freedom
- Involved bilateral upper extremity movement with the intent to promote neural changes within the brain to compensate for the affected hemisphere in controlling the paretic limb

WREX(Wilmington Robotic Exoskeleton)

- Uses parallel mechanisms with zero rest-length springs for gravity balancing
- Passive motion

Final Design



Figure 3. Final design

Expected Testing and Results

Testing protocol: our testing procedure would be that we will invite 15 participants, ideally around the same age with our client, to try our device. Healthy kids will be asked to wear the device and try not to use their arm muscles. The criteria used to evaluate the efficacy and safety of the design will be the following: comfortness, effectiveness and would the device be an extra burden for playing the games. Scores will be given on each criteria and overall feedback will be recorded.

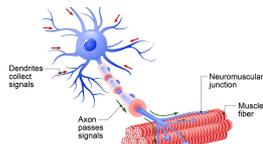
Expected Results: overall our design should not interfere with the kids' normal actions. However, it might achieve some low score for the comfortness since the healthy kids would not want an extra device on them. The device should help them lift their arms if they tried not to use their own arms to lift game pieces.

Problem Statement

Kids with upper limb muscle weakness have difficulty playing with their friends without the help of an adult because they do not have the adequate muscle strength to slide their arms. Our mission is to design an arm supportive device to help a 4-year-old girl who has similar symptoms with SMA (Spinal Muscular Atrophy) move her arm to pick up game pieces. The design needs to include straps to hold her arm and allow her arms to move in sagittal, transverse and frontal plane by moving her shoulders.

Background

Spinal Muscle Atrophy (SMA) is a disease that affects people's ability to walk, eat or breathe by affecting the motor neuron cell in the spinal cord. This genetic disease could lead to dysfunction in the central nervous system, peripheral nervous system, and voluntary muscle movement [1].



Discussion

- The design effectively lifted the kids' arm while they are playing pieces, multiple kids state that they feel the strength of support under their arms.
- Some kids say that they don't like the feel the arm holders are too tight, doesn't really fit.
- **Source of Error**
The participants for our testing procedure are all healthy kids, so their arm strength will not be the same as the SMA kids.
- Testing population is not big enough to support the conclusion that the device is effective for all kids.
- More statistical testing are needed with the SMA kids in order to obtain a more sophisticated testing results regard whether the device is holding up the arms.

Future Work

- Fabricate the design and to see if there's possibility to let our client to try on and achieve feedback.
- Revise the design based on the client's comments
- Research on more market potentially to pattern the design if there's clinical needs.

Acknowledgements

Thank you to our client Ms. Schiele, Dr. Willer and our advisor Prof. Tracy J. Puccinelli for their support and guidance throughout the design process.

References

- [1]. "About Spinal Muscular Atrophy (SMA)," 23-Jan-2020. [Online]. Available: <https://www.curesma.org/about-sma/>.
- [2] Lum, P.S., Burgar, C.G., Van, D.L., 2006, " MIME Robotic Device for Upper-limb Neurorehabilitation in Subacute Stroke Subjects: A Follow-Up Study," Journal of Rehabilitation Research and Development, 43 (5)pp. 631-642.
- [3] D. D. Ragonesi, "Control of a Powered, Gravity-Balanced Orthosis for Children with Limited Upper Limb Strength." Order No. 1585176, University of Delaware, Ann Arbor, 2014.
- [4]M. L. Gavin, Ed., "Growth and Your 4- to 5-Year-Old (for Parents) - Nemours KidsHealth," Jun-2019. [Online]. Available: <https://kidshealth.org/en/parents/growth-4-to-5.html>.

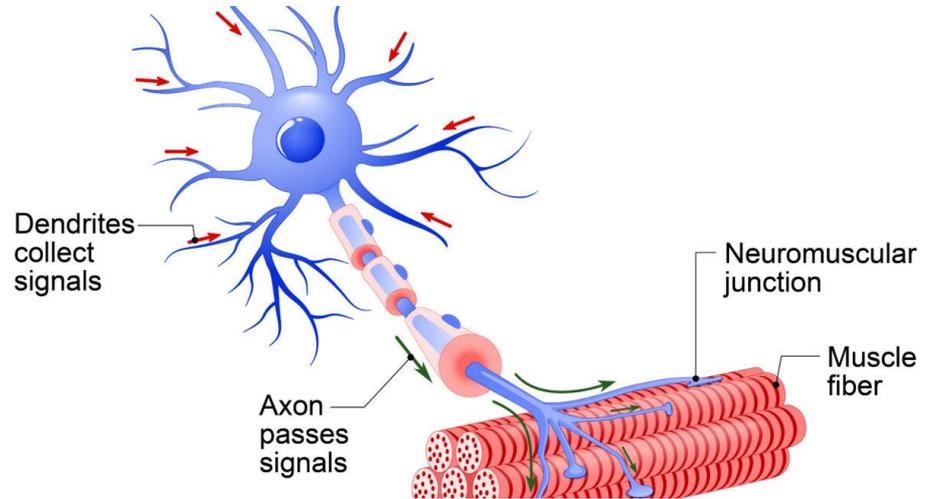
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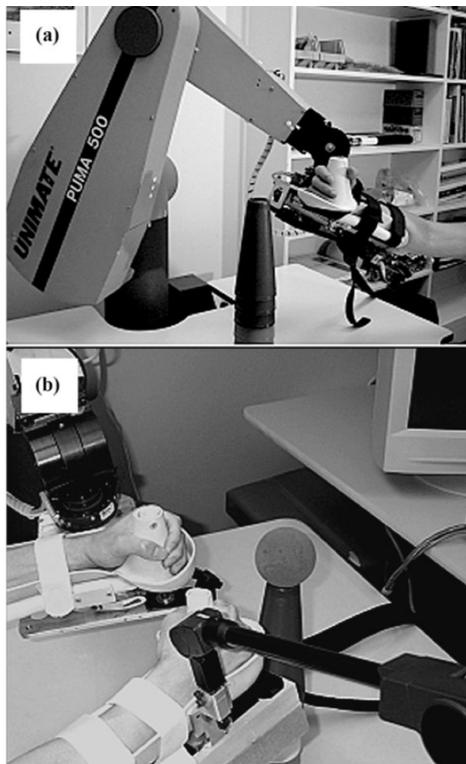
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Figure 3. Proposed Final Design



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Testing Audio

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Results Audio

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