

Hand exoskeleton design and strength analysis

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1. Introduction

An inspiration for realization of the following subject was the young male adult, who is suffering for upper limbs' fingers' paresis, due to a certain damage of the spinal cord, caused by a motorcycle accident.

Existing solutions can be divided into two main groups: rehabilitation (complicated, large, cannot be used without qualified person) and domestic devices (not complicated construction, smaller, safe for using at home).

Exoskeleton described in this thesis was designed for home, independent using, that is why it should be lightweight, as simple as it can be, comfortable (each element, which contacts with the skin is provided with soft material). It should also be safe for using at home without surveillance and relatively cheap.

2. Hand exoskeleton project

Main features of the exoskeleton

Five fingers: four with one active degree of freedom, one (thumb) with extra passive DOF, fingers' flexion by fishing rod, mounted in the area of the engine, passive extension by elastic rubbers and compression springs.

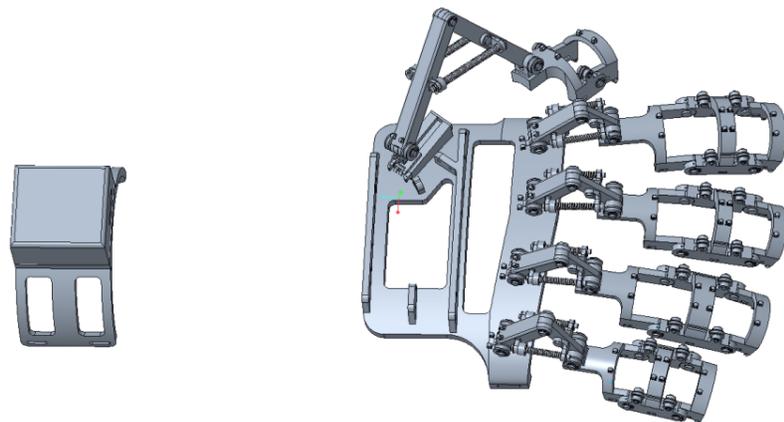


Figure: Hand exoskeleton parts: mounted on hand and on forearm

3. Strength analysis

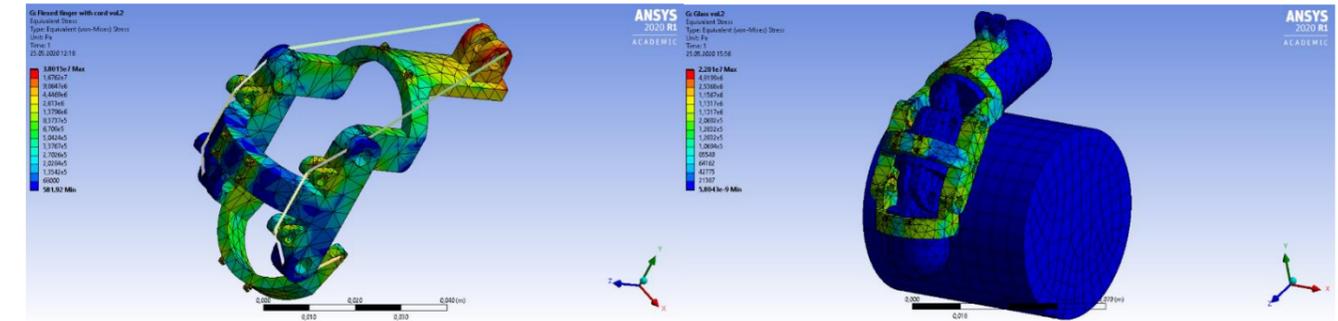


Figure: Stress in the maximum finger flexion (the most loaded configuration)

Figure: Stress in the finger holding glass

Short conclusion

Stress in the exoskeleton is below the yield stress of the material.

4. Conclusions

- further analysis are required – there is a need of using denser mesh and more exoskeleton elements (impossible in analysis above due to ANSYS Student limitations),
- considerable strain (maximum value approximately 3%) and stress (max. 38MPa), but stress is below the yield stress of the material (PLA, yield stress 50MPa),
- lightweight exoskeleton – approximately 218g.

5. Possible modifications

- changing the mechanical stop – instead of the shaped solution, spring latch can be used,
- making the construction more complicated – adding more degrees of freedom, for example abduction and adduction of the fingers,
- simplifying the constructions – removing the fingers, which are not necessary for the grip, and leaving only the necessary ones – thumb, index and middle finger,
- removal of the forearm part of the exoskeleton, and mounting the engine and other forearm elements on the hand part of the exoskeleton.