DEVELOPMENT AND ANALYSIS OF A MEDICAL PURPOSE MULTIPLE - FINGERED GRIPPER MECHANISM

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1. Introduction

In many cases, none of the currently available upper limb prostheses represent the optimal solution for patients. This can be caused by several factors; firstly, the actuation of the so-called powered arms with advanced technology cannot be acquired by its users due to biological reasons. Where the usage would be possible, such devices are not accessible because of the extremely high price.

For these reasons a development has begun to create a construction, which reduces the usability as little as possible ensuring easy controlling. In addition, by simplifying the structure of the device, development and manufacturing costs can be greatly cut.

Simplicity, as the main requirement imposed on the prototype is manifested in the fact, that it can be operated by a very few amount of actuators compared with the currently available, most “dextrous” hands. That also serves the simpler contollability, however a qualitative change in the development of the human - machine interface is also necessary to achieve really significant improvement.

While the high-tech equipments can contain up to five actuators per finger, the prototype under development can be operated using only one actuator in a single finger.

The experiments – based on the most common gestures – are aimed to determine how detailed and precise motion can be achieved with the prototype applying such major simplification.

During the development, the results of multiple methods will be compared. First, the specific movements of a real hand will be analyzed by motion-capture technique.

Markers placed on the fingers help in the subsequent analysis of the movements captured by camcorder.

With this technique, the characteristic hand gestures are recorded, and during the subsequent assessment of trajectories we approximate using different curve fitting methods.

The obtained trajectories will be compared to the results of a numerical simulation. The advantage of simulation is that the parameters of the computer model can be flexibly changed, thus leading to the expected outcome features quick and easy.

Then we examine the movement of a manufactured prototype. Since the prototype built can only be equal with the model under development on the principles of operation; there are significant differences in the dimensions and ratios, the anomaly arising between the trajectories can show the effect of changing the dimensions of the model.

Observing the relations between the results of experiments and numerical simulation, further improvement of the construction can be achieved.

As an additional investigation, the structural analysis of the computer model is carried out by finite element method. Furthermore, not only the strength of the construction can be inspected, but the force required for operation can be determined also by using concentrated or divided loads.

Since the device is planned to be driven by polymer gel actuators, it is important to examine if the actuator is able to exert sufficient force. If that is not feasible by changing the parameters of the polymer actuator, the hand can easily converted to be driven by DC servo motors.

2. Experimental Results

The operation of the gripper mechanism is based on the traction-element motion. Several proven constructions confirm the compliance of this solution (NASA, Tokyo Institute of Technology).

Fig. 1 presents the structure and operation of a single finger.

By the proper placement of the wires, the phalanges of a finger can only move simultaneously, so it is possible to use a single actuator to operate one finger of the device.

That consequently does not enable the realization of all gestures of the real hand, but the aim is the proper imitation of the most important motions. Therefore, the hand will be suitable for as many everyday activity as possible, so it helps its user the greatest extent possible.

Fig. 2 illustrates the trajectory of the fingertip.

The results are obtained from the numerical solution of the developed mathematical model. The endpoints of the trajectory represent the fully extended and fully flexed state. The aim is that the trajectories of the prosthesis and the real hand should be as similar to each other as possible.

From the foregoing, the finger of the prototype constitutes a motion that is quite close to the natural, but further results will illustrate this in full detail.

The information obtained by different methods, and the results of the structural and mechanical analysis greatly contribute to the detection of the causes of possible errors or deficiencies, so the production of the entire device can lead to proper results.

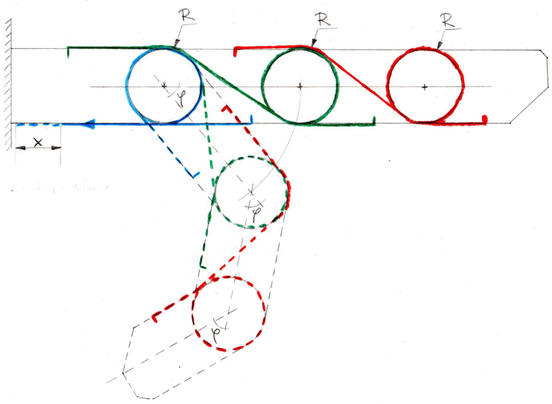

Fig. 1: The structure of one long finger of the gripper mechanism

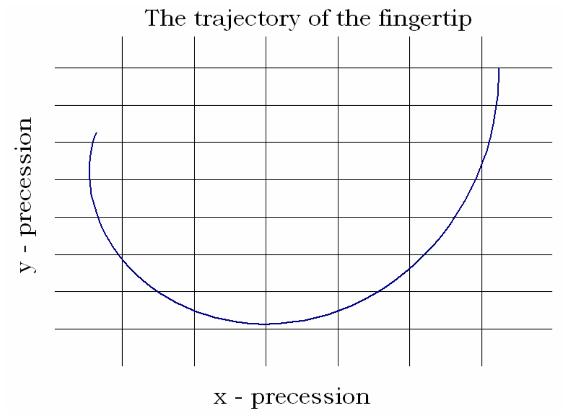

Fig. 2: The trajectory of the fingertip during bending

3. Acknowledgements

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4. References

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