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Design of Animatronics Effector

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Abstract The article describes the design procedure of animatronic effector. In addressing multiple element tentacles It is key to the design of mechanical gripper, gripper which defines agility as well as the type of grasping and handling options. The aim is to create a robotic arm. Approximation of kinematic human hand was our top priority in developing this animatronic hand. Each side of the joint range of motion is again the same or very close to that of a human hand.

Keywords: *robotics hand, animatronic, android hand, robot*

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1. Introduction

Animatronics is a multi-disciplinary department which integrates anatomy, robotics, mechatronics and puppetry that connects to bring vivid imitation. Animatronic creations are often driven by pneumatics, hydraulics or electrical drive can be controlled by computer or human. Moving mechanisms are often used to imitate muscles or to create real movement of the limbs. [7]

Innovative changes of robots used in the structure of the human hand effectors particular ability to move and softness grasping to the subject object manipulation. These qualities are the foundation of multiple element gripping heads. Multiple element head with its construction and development towards the hand and anthropomorphic to improving artificial intelligence robot in contact with the subject of object manipulation. [1]

The principle of multiple element gripping effectors based on the principle of biomechanics grasping manipulation by human hands. Providing positive and friction grip with the conclusion. Location object object manipulation is defined arrangement (configuration) of gripper fingers and force action. Shaped contact in shape Adaptive Gripper multiple element depends on the number of fingers configured in the tentacles, the number of cells of each finger, measuring length and shape their range, their of disposal position among themselves and also in the context of the entire layout of the gripper. An essential element in the construction of multiple element tentacles is a multiple-finger mechanism (kinematic chain articulated mechanical structure), the first joint is firmly connected to the gripper frame. Technical finger model based on the biological model system membered fingers and thumb of a human hand and mobility. [3]

2. Biomechanics of Hand

Most of the mechanical interaction between man and the environment is carried out by hand. They allow us to perform various tasks, from incurring high forces to perform precision tasks. This versatility is made possible by a complex of complexity, a large number of interconnected bones of various joints, complicated and dense muscle structure of the nervous system. [6]

Evolution of hand for many years made us what we are today. The human hand consists of 27 different bones and counteracting thumb is unique to humans. Counteracting inch for precise grip between the long fingers and thumb, which also allows us to write or perform precision tasks. Human hand (Figure 1) has 24 degrees of freedom, for each finger 4, 5, and 3 for the thumb to the wrist. Most of the muscle is located in the forearm where the muscle movement transmitted by tendons to the fingers. Larger muscles to move the thumb placed on the thumb and expands to the little finger.

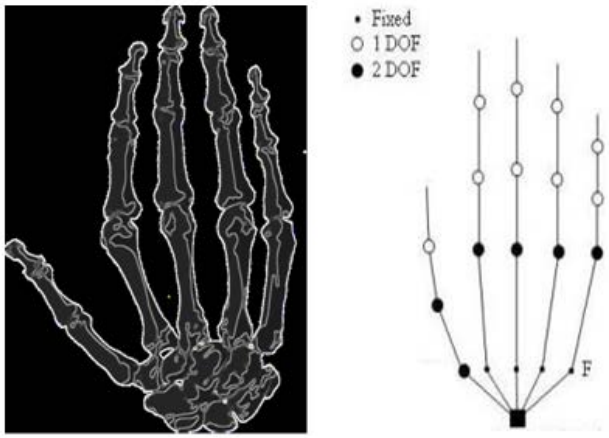

Figure 1. Degrees of freedom of a human hand

The hand is the tentacle multiple element biomechanical body, which is located at the end of upper limb primates. On the fingers it is one of the densest areas of nerve endings on the human body, are a rich source of

tactile feedback, and have the greatest positioning capability of the human body. [6]

3. Mechanical Design

In addressing multiple element tentacles It is key to the design of mechanical gripper, gripper which defines agility as well as the type of grasping and handling options. Requirements for the design of mechanical part focuses primarily on:

-Number of fingers

-Number one finger Articles

-Dimension and position the fingers [10]

The need for grasping cylindrical and spherical objects I chose a multiple-effector. The principle is based on biomechanics grasping grasping the object of manipulation by human hands, providing positive and friction grip with the conclusion, in which the position of the object manipulation object defines the arrangement of the gripper fingers and force action. [2]

I chose kinematics that uses the link rod cells, because in this way, it is possible to control the return movement without the addition of new members as in the case of the cable mechanism, the method is more compact than with the use of gears. [11]

When addressing I came out of the modular system, the advantage is the possibility of adapting the design and construction of the specified tasks, lower costs of implementation and operation (production and replacing individual parts).

3.1. Mechanism of Finger

The mechanism of the finger is designed as a planar closed kinematic chain consisting of six movable members which are movably connected to each other in two kinematic pairs of successive loops. On the phalanges are located projections for the location of the cables connecting the sensors and control unit, Figure 2. [8]

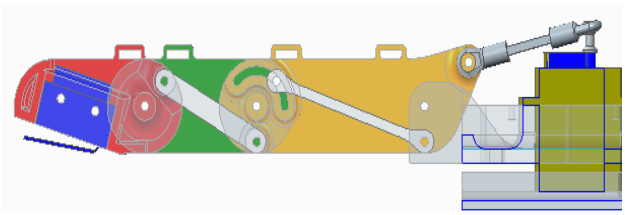

Figure 2. Kinematics of finger

Finger mechanism is designed so that it can be printed on a 3D printer. This meant that each joint of the finger had to be divided into two halves because the 3D printer needs some basis to impose additional layers of yourself. The number of degrees of freedom is determined by: [9]

$$\begin{aligned} i &= (n-1)\cdot i_V - \sum \xi_i + \eta \\ &= (6-1)*3-(7*2)+0=1 \end{aligned} \quad (1)$$

When calculating the gripper drive is based on the most unfavorable position the gripper Figure 3 where it operates the maximum gravitational force F_{om}, where the manipulated object is a direct load.

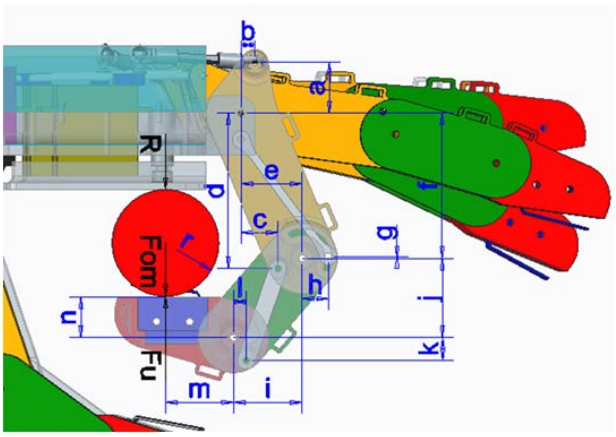

Figure 3. Forces in the mechanism of finger

$$N_2 = \frac{F_{om}\cdot m}{l\cdot\cos\gamma + k\cdot\sin\gamma} \quad (2)$$

$$N_3 = \frac{C_y\cdot i + C_x\cdot j}{\mathrm{h}\cdot\cos\Omega + g\cdot\sin\Omega} \quad (3)$$

$$F_v = \frac{-B_y\cdot e - B_x\cdot f + N_2(\mathrm{c}\cdot\cos\beta + d\cdot\sin\beta)}{a} \quad (4)$$

From these calculations, I found that finger to keep the object with a weight of 0.1 kg is required strength F_v minimum 10.25 N.

Lever actuators will be the length of 14mm, so you need to select the desired servo torque.

$$\mathrm{Mk} = \mathrm{ls}\cdot\mathrm{Fv} = 0,014\cdot 10,25 = 0,1435\ \mathrm{Nm} \quad (5)$$

I chose Emax ES3351 servo motor with torque of 0.22Nm. Figure 4

Figure 4. Servomotor Emax ES3351

In a similar way, I verified the calculation and thumb with similar results, so the drive fingers and thumb will use the same servo motor.

4. Sensors Proposal

The human hand has a huge number of receptors to capture pressure and temperature.

Sensors servo drives could be used to determine the position of the joints and effector cells, but the link

phalanges imperfections in the production of articles, links Articles by Bowden connection to servo drive via ball joints creates a great risk for the emergence of errors in calculating your location. The advantage would be if the joint angles were measured directly. Bend sensors providing reliable information, but their integration into the phalanges poses problems. [10]

Alternative solutions are pressure sensors for detecting the object snap. This provides the most reliable information about the condition that the object is gripped by the handling or not. These switches are of small size and can be easily integrated into the cell and effector base. The advantage is that the switch will not be influenced by external and internal influences such as electromagnetic energy of the actuators.

The palm of a person there are many receptors that are used to determine whether something is touched palms.

These receptors have been replaced by one switch, the switch is connected to the control unit and is used to effector to know whether the object touched by the palm of effector manipulation. [13]

The base of the animatronic effector is mechanically connected to another board that represents the entire surface of the palm.This plate is capable of moving only the two steps in one direction and sleep, so as not to make the plate reached the optimal position is designed such that it was not possible to Figure 5.

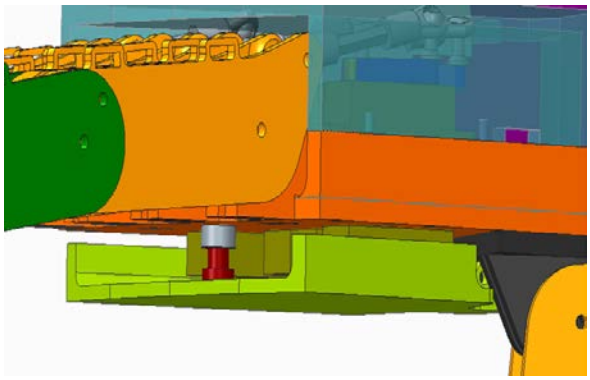

Figure 5. Tactile sensor on the palm

The ends of the fingers of a human hand are the receptors that can detect the pressure that is developed in them. [8]

These receptors have replaced the reed switches are connected to the controller. These serve to effector know whether the object handling enough grip. The switches are integrated in the end cells of the toe and with screws.

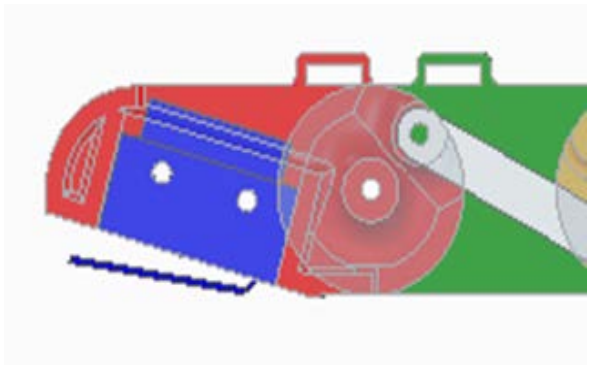

Figure 6. Tactile sensor on the finger

5. Control Board

As controller I decided to use Arduino Uno R3. Arduino is an open-source platform for easy design and development of electronic programmable devices. With the help of a simple development environment and programming language can create automated devices with sensors and actuators. [12]

Arduino microcontroller development platform. With 14 digital inputs / outputs and 6 analog connector for connecting the power supply, automatic reset button. Other peripheral devices can be connected separately.

Arduino advantage of the device is easy to connect to a computer and programming. Arduino is equipped with a micro USB connector, and when connected to a PC is reported as a serial port. Custom programming is done in a simple environment, using the Arduino IDE language derived from wiring. Sensors servo drives could be used to determine the position of the joints and effector cells, but the link phalanges imperfections in the production of articles, links.

Figure 7. Arduino Uno R3

The algorithm functions should work as follows:

First, a rotation servo drives to the baseline condition, open toes animatronic effector, after waiting for the command effector holding. When the gripping is commanded, and waits until the sensor switches on the hand, in the case of the switches, known effector, the cells may start close to the effectors. Closing the effector cells happens gradually, each servo is rotated by one step and after until the switching condition of the three tactile sensors. After switching effector sensors transmit information on the object snap and wait until he comes information about the release of object manipulation, in which case the program continues from the beginning of the shift servo drives to the starting position.

6. Conclusion

Needs in manufacturing and non-manufacturing processes impose requirements for the application of non-standard gripping heads. It is necessary to design non-standard grippers for grasping cylindrical and spherical objects, it is also necessary to devise a method of managing these warheads.

Innovative changes of robots used in the structure of the human hand effectors particular ability to move and softness grasping to the subject object manipulation. These qualities are the foundation of multiple element gripping heads. Multiple element head with its construction and development towards the hand and anthropomorphic to improving artificial intelligence robot in contact with the subject of object manipulation.

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References

[1] Jesenský, Ján: Uvedení do rehabilitace zdravotně postižených. Praha: Karolinum, 1995. 159 s.

[2] Smrčka, Václav – Dylevský, Ivan: Flexory ruky. Brno: IDV PZ, 1999. 162 s.

[3] Špakovský Filip.: Návrh animatronického efektora. Diplomová práca. 2016.

[4] Smrček, Juraj a kolektív : Robotika, 2013 TUKE, Sjf.

[5] Anton Palko, Peter Tuleja: Uchopovacie efektory, TUke Sjf 2007.

[6] Smrček. J.: prevádzka a údržba automatizovaných zariadení. Košice : elfa s.r.o., 1996, 50 s.

[7] Smrček, J.-Skařupka, J.:Aktuálni stav servisní robotiky. Zborník 1. medz. Sem. Servisní robotika“, VŠB-TU FS Ostrava, Brno (Česko) 2004, pp. 118-121.

[8] Smrček,J.: Problem of Metamorphic Structures in Service Robotics. MM Science Journal, ISSN 1212-2572, Vol. 2, N0 june/2008, MM publishing Praha, Praha 2008 (Czech), pp. 16-17.

[9] Mikolajczyk T., Manufacturing Using Robot. Advanced Materials Research, vol. 463-464, (2012), 1643-1646.

[10] Palko A.: Modular Robotics system. In: Proceedings 2th Project Workshop on CIM and Robotics Applications. Mihajlo Pupin Institute Beograd (Yugoslavia) 1991, pp. 54-60.

[11] Hajduk Mikuláš, Sukop Marek.: Structures and strategies of MAS in mobile robotics - robosoccer - 1. vyd - Lublin : Politechnika Lubelska - 2013. - 136 p.

[12] MILANESE, Steven et al.: Reliability and concurrent validity of knee angle measurement: Smartphone app versus universal goniometer used by experienced and novice clinicians. In: Manual Therapy. Roč. 19, č.6 (2014), s. 569-574.

[13] Yoon, Jungwon et al.: Control Optimization of the Rutgers Ankle Rehabilitation Interface. In: Proceedings of Advances in Robot Dynamics and Control Symposium 2002, ASME International Mechanical Engineering Congress and Exposition, Louisiana: 2002. IMECE2002-32655.