Abstract - This work is devoted to the development of mechatronic hand that can be used as prosthetic hand and as grasper for humanoid robot. The structure and kinematics of the construction, physical appearance, the principle of fingers flexion were inspired by human hand. In order to analyze flexing principle, direct kinematics task and force analysis had defined. This study has allowed define more precise information for construction design and creating more useful prosthetic hand. Defined force analysis has allowed calculate the length of the phalanges, generalized force tendon tension and to pick up by the motor. The assembly of the hand components makes it possible to install the device on the stump of the patient due to its compactness and light weight. Control system will have been based on EMG signals getting from muscles. For this moment prosthetic hand is controlled by the glove that was worn on the human hand. Besides a research devoted to sensors that we have to install to devices was conducted.

I. INTRODUCTION

Developing of android robots is a one of the promising fields of Robotics and Mechatronics. In the future, invented robots will be able to help humans with boring and routine activity or robots will take place of humans in dangerous and harmful working conditions. Many fantasists are imaging the future of humankind in the way of integration of living and nonliving or more precise – human and machine making humans more powerful. The field is unbounded for researches, experiments, test and new construction inventing.

In recent years, a huge number of great devices such as electromechanical prosthetic hand or robotic grasper have been created and analyzed. In the field of dexterous hand, plentiful achievements have been made. For example, MIT/S. Jacobsen dexterous hand has 4-DOF fingers with 32 independent tendons and 32 pneumatic cylinders[1]; Tsinghua University/GCUA Hand II was designed and analyzed by DemengChe and Wenzeng Zhang, which make traditional under-actuated hands more dexterously but needs more actuators and tendons per finger [2]. However, dexterous hand can provide almost all the movements of human hand.

This paper presents an under-actuated humanoid robot hand, which is based on tendons system. The hand has 5 fingers and 6 DOM (degrees of modality). All finger use tendon mechanisms to achieve needed position, which based on under-actuated grasping motion. Thus, each finger needs only one actuator to drive. Humanoid robot developing is comprehensive like any complex mechatronic devices including the development of design, control systems and a feedback system.

II. DESIGN

This paper present developing of mechatronic hand, which can be used as prosthetic hand and as grasper for humanoid robot. The construction was developed and created (Fig. 1).

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Fig. 1. Hand design.
information for construction design and creating more useful prosthetic hand. In term of kinematics a finger is an unclosed chain of links connected between in a rotary pairs. One end of chain (distal phalanx) is free; the other end is fixed relatively to the hand. The degree of freedom of the finger equals 3, but the degree of mobility equal 1. The degree of mobility of the entire structure is 6, since the thumb has two degrees of mobility.

![Fig. 2. Scheme of fingers flexing.](image)

Defined direct kinematics task has allowed define the relationship between the coordinates of the fingertips and finger flexion angles. Defined force analysis has allowed calculate the length of the phalanges, generalized force tendon tension and to pick up by the motor. Into construction geared motor with a 4.8 (kg cm) torque was installed.

### III. Control

In an abstract sense, the control is a set of algorithms for processing of the inputs signals, their conversion and transmission of output signals. Myoelectric control systems based on pattern recognition have been proposed for the next generation of multifunctional upper-limbs prostheses [4]. So, control system will have been based on EMG signals getting from mussels. During pattern-recognition control, a program identifies user’s movements by using pattern by few channels of surface electromyography signals. The program classifies the pattern and sends commands to the prosthetic hand.

At the moment, an algorithm for the analysis of the input signals and their conversion values was developed; this data will be used as control signals. The prosthesis will use EMG signals as an input signals; EMG values will be taken off from the amputees stump by the electrodes. The signals have got a different duration and directions of muscles contraction, for example, the following muscles contraction were used at creation of the algorithm: single muscle contraction with the duration less than 1.5 seconds; two muscle contractions with an interval less than 2 seconds; single long muscle contraction with the duration more than 1.5 seconds Algorithm was analyzing and comparing the input signals and converting it into an output signal.

As mentioned previously, the device can be used not only as a prosthesis, but also as a grip of humanoid robot. In this case, the control system can be realized by a different way. For this moment prosthetic hand is controlled by the glove that was worn on the human hand. There are strain gauges, controller and Bluetooth transmitter located on the glove. Strain gauges resistance changes while bending the fingers of a human hand proportional to the bending angles of the fingers. This data is sent to the Bluetooth receiver, which is located on the prosthesis. Thus, the prosthesis does exactly the same movement like a human hand.

### IV. Feedback

The third component of the development of electromechanical hand is a feedback. Feedback is important feature for amputees and for developers. It allows to bring various adjustments related to the individual characteristics of operation [5]. Electromechanical prosthetic hand must automatically adapt to the shape of the object and to provide a firm grip without slipping. There is a quite difference between grasping of a plastic cup and grasping of glass cup.

According to the classification of Sherrington [6] sensors must provide two types of "artificial sensations": the proprioceptive and exteroceptive subsystems for maximum similarity with human feelings. The proprioceptive sensors provide information about hand position and movement and about internal forces, and the exteroceptive subsystem produces information about the interaction between the object and the hand and between the object and the environment.

The proprioceptive subsystem can be created by using joint angle sensors embedded in the mechanism, besides we are able to use tension sensors that will be integrated to transmission. The exteroceptive subsystem would be developed by using force sensor integrated in the fingertips and a flexible layer with contact sensor along fingers. Thus, the prosthesis feedback can be created with an accuracy similar to the human sensitization.

### V. Conclusion

During researching work a prototype of prosthetic hand was created. The structure and kinematics of the construction, physical appearance, the principle of fingers flexion were inspired by human hand. In order to analyze flexing principle, direct kinematics task and force analysis had defined. This study has allowed define more precise information for construction design and creating more useful prosthetic hand. Defined force analysis has allowed calculate the length of the phalanges, generalized force tendon tension and to pick up by the motor. The assembly of the hand components makes it possible to install the device on the stump of the patient due to its compactness and light weight. Control system will have been based on EMG signals getting from mussels. For this moment prosthetic hand is controlled by the glove that was worn on the human hand. Besides, a research devoted to sensors that we have to install to devices was conducted.

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