Report on the Cybernetic Arm of the Kibertron Humanoid

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1. Introduction

Our hands and our face often speak for us in front of other people. Man studies how to use his/her hands during his whole lifetime. Thanks to our experience and consciousness we are able to perform complex movements with specific accuracy and speed. The humanoid's cybernetic arm has to cope successfully with different tasks like the human one does. In constructing a cybernetic arm one should aim at achieving great strength (the same as that of the human one or greater), speed of movement (depending mostly on the motors), good appearance, safety for exploitation (no sharp edges or dangerous zones when moving), protection from environment and others. The arm is one of the most important parts of the humanoid, on one hand it is an instrument for establishing its behaviour reactions and on the other, it is a basic instrument for accomplishing various tasks. Inside the arm there are a significant number of sensors for pressure, touch and temperature. It is also possible to place additional sensors unavailable in the human body (for humidity, pressure; sonars, radio waves receivers and others) depending on the application field of the humanoid.

The arm excels in dynamics the functionality even of the human one in certain aspects. It has 28 degrees of freedom, 20 of which are for the fingers, 1 for the palm, 2 for the wrist, 1 for the elbow, 2 for the shoulder and 2 for rotation around its own axis in the forearm and the armpit.

2. Description

2.1 Finger

When constructing the finger our objective is to achieve total equivalence to the functionality, size, durability and strength of the human one. It is also necessary to avoid sharp edges and points potentially dangerous to touch when moving the finger as well as to provide free movements of the joints independent of one another. Considering these requirements the construction of the exterior details presents a significant challenge.

The finger consists of three main components which besides forming the skeleton form the appearance as well. They are interconnected by a hinge joint which allows one degree of freedom. The joint control is performed by means of a metal rope which allows the controlling mechanisms to be placed outside the finger and to make the main elements stronger. There are a lot of specific requirements for the proper construction of the fingers because they are the direct working component of the arm. There are also a lot of sensors for touch, pressure, humidity and temperature placed in the fingers which makes them even more complicated.

Each finger has 4 degrees of freedom grouped in 3 joints by means of which their mobility is identical to the one of human fingers.

2.2 Wrist

The wrist has two degrees of freedom. The basic

construction requirements are to achieve the necessary divergence along each of the degrees of freedom similar to the human one and to avoid dangerous motion areas. The selection of materials is crucial as they determine its flexibility and durability. The wrist is under great pressure as it is filled with a number of metal ropes, lead and information conductors from different sensors.

2.3 Forearm

The front part of the forearm is covered with a soft material. The joint between it and the wrist is covered with the same material. The objective is to improve the appearance of the humanoid and to protect the interior mechanisms from the environment - dust, humidity, etc. In the forearm there is a mechanism providing the arm rotation in the area below the elbow along its long axis.

2.4. Armpit

The shoulder joint has three degrees of freedom but it is characterized by specific movements along each of them. In most robots the shoulder joint cannot perform all movements characteristic to the human one. However our project yields possibility to create larger range of grip, larger than the human one which results in impossible (to humans) movements. The section from the elbow to the shoulder has two muscular mechanisms by means of which it is possible to move the elbow up and down and a mechanism providing rotation along the long axis of the arm.

The electronic devices controlling the whole arm are located between the two muscular mechanisms. The muscular mechanism copies the human equivalent. It has a relaxed condition - free movement, tight condition - movement is restricted in one of the two directions (in the direction of strain), half-tight condition - in the case of certain strength it allows movement in the direction of strain, condition of movement - flexion or extension.

There is a possibility to perform the flexion sharply which depends solely on the strength of the components used.
Extension can be done either sharply or smoothly. The basic advantage of this muscle compared to other motors is the fact that it does not need energy to keep the arm in tight condition. Energy is needed only for transition from one state to another. A considerable amount of this energy is necessary for flexion and not for relaxed condition.

Man and all living creatures have evolved for thousands of years. During this process each of them has undergone a number of transformations to finally reach their current pattern, the result of the influence that nature exerts on all of us. There is no point in trying to be greater than nature in order to achieve our goal. Nature has already given us the key to every solution - all we have to do is discover the keyhole it was meant for...