

Tendon-Driven Anthropomorphic Dexterous end effector for Medical Assessment Tools

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ABSTRACT

The Primary objective of this project is to develop a prototype which as dexterous nature to help in the medical application when coated with the appropriate medical drugs. The muscles are responsible for human to perform any operation. Muscular operations can be performed by many devices, but tendon is most similar and simpler to muscles if used in an appropriate manner. By tendon actuation, the dexterity can be achieved.

KEY WORDS: Dexterity, tendon, anthropomorphic.

1. INTRODUCTION

Dexterity: The ability to perform a hard action quickly and skillfully with the hands, or capacity to think quickly and efficiently.

Anthropomorphic: Resembling or made to look like a human form.

Tendon: Muscle structure which serves to move the bone or structure.

Dexterity in the human being is achieved by the muscle which is actuated by the neural brain electrical signals. The signal will make the muscle contract and expand respect to it since muscles are made of elastic tissue which is thousands of muscle fibers similar to the rubber band. Artificial muscle which is discovered has less efficiency to be used as the substitute for real muscles. Contraction and expansion action resembling muscles can be done by a combination of motors and pneumatic system, but they cannot be considered as artificial muscles because they use the combination of systems to achieve the actuation. Electroactive polymers have high probability rate of being a replacement for muscles. Muscles controlling the hand finger action can be called as tendon muscles which have elastic property as of rubber band. In other words, tendons are strings with an elastic property that don't stretch in its size when an applied force is removed.

Muscle: A biological representation of tendon is (Anatomy) elastic collagenous tissue that attaches a muscle to a bone. Many researchers have presented tension-based controllers for tendon-driven fingers. Tissue attaching a muscle to other body parts, usually bones, to transmit the mechanical force of muscle contraction to the other part, which makes them remarkably sturdy and stable, with tensile strength to withstand the stresses generated by muscle contraction. Figure.1 shows the five muscles responsible for human finger actions, which are elastic tissue assuming to be non-stretchable strings. The five muscles are, Flexor digitorum profundus (FDP), Flexor digitorum superficialis (FDS), Extensor digitorum communis (EC), Interosseous (IN), Lumbrical (LU).

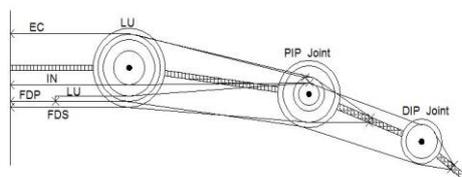


Fig.1. Biological representation of tendons by Leijnse and Kalker (1995) from human finger anatomical structure assuming tendons are non-stretch strings

These muscles actuated three joints which help the human finger to achieve the possible actions; Metacarpophalangeal (MP) joint, Proximal interphalangeal (PIP) joint, Distal interphalangeal (DIP) joint.

These joints can achieve pitch and partial yaw motions due to its tissue attachments.

Design:

3D model of the human finger: The human finger as three parts called as distal, middle, and proximal. Figure 2 shows the 3D Model done to mimic the human finger parts with a base finger part to support the finger.

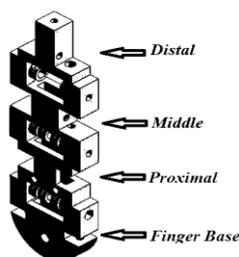


Fig.2. 3D model done to mimic human finger

The 3D model done can be manipulated in some tendon configurations to achieve a variety of human finger motions. Five fingers of human hand have dimensional variations [Little, Ring, Middle, Index and Thumb]. Thus, the 3D models are designed accordingly with respect to the human fingers. Suitable holes and grooves are provided to achieve the actions. The tendons are arranged in such a way each finger parts can move individually forward and reverse actuation dependence on the distal part. Figure 3 is the assembled version of the fingers on the palm of the hand.

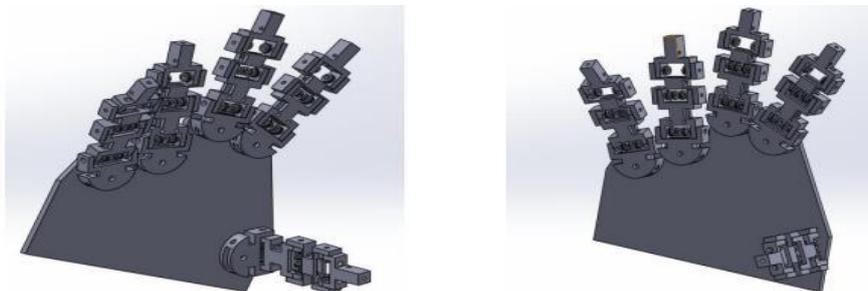


Fig.3. 3D Model of assembled human hand

Fabricated model: The model fabricated can be manipulated in many configurations to achieve some human finger actuation. The material used is aluminum which as low density, less weight, high strength which is suitable for the prototype to test it for some trails to coat them with medical drugs.

The Fabricated prototype finger parts are shown in figure 4 and the assembled fabricated anthropomorphic robotic hand in figure 5 respectively.



Fig.4.Fabricated dexterous finger



Fig.5. Fabricated Model

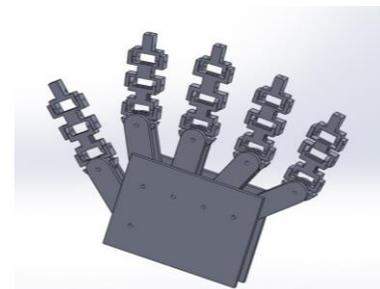


Fig.6. Modified 3D model

Thus, the fabricated model as some disadvantage to achieve yaw motion of the fingers. To overcome it an extra attachment is made to achieve the yaw motion, which will enable to achieve the aim in more efficient manner. Figure 6 show the 3D model of the new modification.

The attachment consists of a guide who can be used to manipulate the distance between the finger and the palm depending upon the requirement as the surgical assessment tool with healthy medical drugs.

2. CONCLUSION AND FUTURE WORK

The model can be manipulated in some tendon configurations to for achieving some motions. The figure parts can be controlled independent and dependent of any link parts with tendon settings. The importance depends upon the control unit to utilize for industrial and domestic purposes.

By using titanium grade5 material for prototype, fabrication will make it sound medical tool in operation and as well as surgical assessment tools respectively. Electromyography can be used to make the prototype into a bionic hand with the proper control unit and feedback system.

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