Artificial Hand Using Embedded System

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***Abstract*: The loss of hand function following an injury and amputation of arm can severely affect a person's quality of life. Artificial hand is used to mitigate the handicap. Ideally, any artificial hand should be capable of emulating the natural hand in terms of grasping and gripping objects of varying geometries and physical properties. A low-cost artificial hand can be used to provide versatile grasp. Embedded system is used to control it. To strengthen the prosthetic hand hydraulic pumps are used. The sensor provided in the hand senses the mechanical activities of the hand. As the muscle contracts microcontroller senses the potential, which gives exclusive command to the artificial hand for specified action.**

***Keywords*: Claw hook, Embedded systems, Hydraulic pump, Microcontrollers, Prosthetic hand.**

1. Introduction

Microcontroller and microprocessor place an important role in all types of control applications. Embedded system is a combination of hardware using a Microprocessor and the suitable software along with some kind of additional mechanical or other electronic parts designed to perform specific task. The embedded system places a vital role in this prosthetic hand. The main factors for a loss of an upper extremity are accidents followed by general diseases and injuries from war. For the individual the loss of an upper limb results in a drastic restriction of various activities.

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2. Disadvantage of Conventional Prosthetic Hand

A. Heavy Weight

They have about the same mass as human hands, they appear to be unpleasantly heavy because a lever arm to the short stump of the amputated arm transmits the mass.

B. Low Functionality

A human hand can perform a large variety of different grip movements while conventional prosthetic hands can only perform a single pincer-like grip movement Therefore the grasping abilities are restricted, so it is impossible to pick up even a pinball with the artificial hand.

C. Cost

The costs of imported motorized hands, however, are prohibitive and it can be more than 3.00 lakhs. We are using the hydraulic pump for performing specified action. The servomotor drives the pump.

3. Components

A. EMG Electrodes

EMG is an acronym of electromagnetic, these electrodes are used to sense the electric field generated on the muscles .The electric fields that occur in living tissue are caused by charge separation electrolytes and not by the movement of electrons using silver chloride electrodes on the skin and couple it with a conducting gels .So that we can sense the voltage at the location.

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C. Analog to Digital Converter

Signals from instrumentation amplifier are in the form of analogue. For accurate control of artificial hand, we need Microcontroller for computations. Generally, microcontrollers are worked only with digital signals. So, we need to convert signal from the instrumentation amplifier in to digital form through analogue to digital converter (ADC). Here, successive approximation type of ADC is used.

D. Microcontroller

The 8051 is a low-cost microcontroller and also it has 4KB of flash memory two-timer and counters, and four ports respectively. It just gets the binary value from the ADC and generate control signals to the motors and get the feedbacks from the sensors placed in the artificial hand.

E. Servomotors and Hydraulic Actuators

A servomotor is an electromechanical device in which an electrical input determines the position of the armature of the motor Servo Motors are used extensively in robotics and cars, airplanes and bowls. Here small size of servomotors is used to give the force to the oil filled hydraulic actuators for specified action.

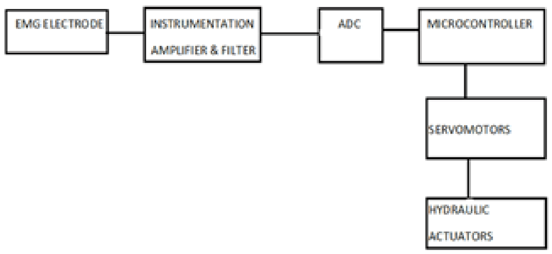

Fig. 1. Block diagram

4. Circuit Diagram and Working

Three surface electrodes sense the muscle contraction voltages. The two surface electrodes will be mounted close together above the muscle. The third electrode is a ground reference. The instrumentation amplifier is constructed with high cmrr (common mode rejection ratio). That is, it has cmrr in excess of 60 dB and a gain of 125 with an input impedance of 10 mohms. The instrumentation amplifier was chosen because it can extract a very small signal difference between the two signal electrodes (electrode 1 & 2) while significantly attenuating noise, common mode noise and other signals common to both electrodes. However, something called motion artifact can still occur due to relative motion between the electrodes and tissue. Relative motion can produce voltages sufficient to saturate the second stage amplifier. The frequencies of the motion artefact are usually at the low end of the bandwidth of the EMG signal. Therefore, the 2 Hz high pass filter is used on the second stage of the amplifier can be used to reduce these artefacts. At this point the EMG signal observed on the oscilloscope would look like the following.

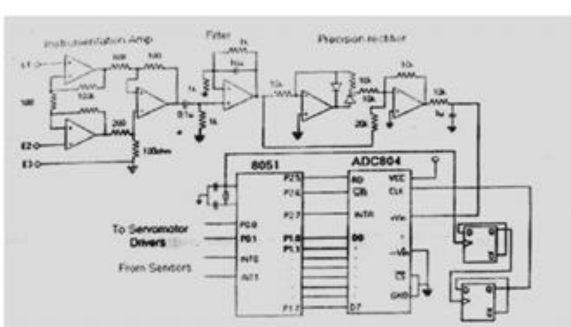

Fig. 2. Circuit diagram

This is a rather a high frequency signal with components between a few hertz and 250 hertz. To make this signal more useful for control purpose, we need to extract the envelope of the signal between 0v & it's maximum positive amplitude. We can accomplish this with a rectifier and low pass filter. A normal silicon diode would not be satisfactory to rectify the signal since it requires a 0.7v turn on voltage which is larger than the amplitude of the input signal. Because the signal is very small, we must use a precision rectifier circuit that more closely approximates the action of an ideal diode.

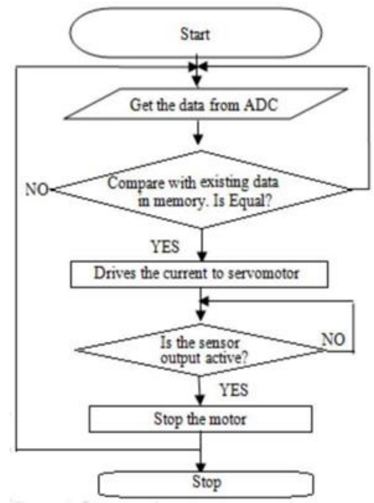

Fig. 3. Algorithm

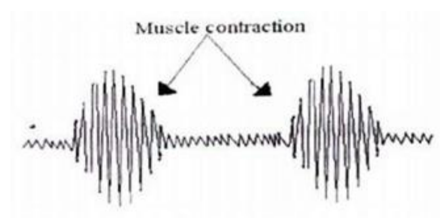

Fig. 4. Muscle contraction Voltage

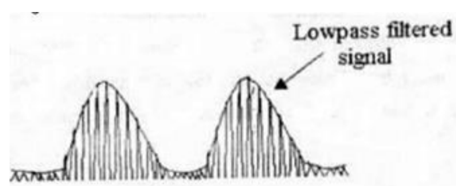

Fig. 5. Rectified muscle contraction signal

After rectification the analog signal is sampled and quantized by the chip ADC804 and give to the microcontroller 8051.Program is written to drive the servomotor, depending on the binary values and monitoring the sensor output. It will drive the motor until the sensor output is high.

5. Flexible Fluidic Actuators

Pneumatic and hydraulic actuators are of great practical importance in industrial process control. They are used in a wide variety of differential applications, such as heavy industries, mechanical engineering, and transportation systems and in medical engineering. The advantages of these actuators are: robust construction, high-power capacity, high reliability and reasonable efficiency. However, conventional actuators only have a small flexibility in their mechanical construction and consequentially have limited movement. Therefore, a new class of actuators has been developed having the following advantages: high flexibility designed into their mechanical construction realization of very complex movements, lightweight construction, very low manufacturing costs.

A single actuator element consists of a feeding channel for the pressurized air or liquid and a "chamber" which is connected to the two movable parts of a joint. During the inflation of the actuator element by air/liquid the volume of the element expands and the height of the element vertical to the flexible wall of the chamber increases. This change of distance between the opposite lateral surfaces is called the expansion behavior. During this process the volume energy is converted into deformation energy.

Fig. 6. A simple joint based on the expansion principle

A conventional powered prosthetic hand usually consists of an energy source, one or two actuators and a simple control unit. All components except for the myoelectric sensors and the energy source should be placed in the hand itself because there is very little space left in the socket. So, a total of 18 miniaturized flexible fluidic actuators were integrated into the mechanical construction of the fingers and the rest of the hand. The aim is to mimic as closely as possible the geometry of an adult human hand.

6. Results

The flexible fingers of the new hand are able to wrap around objects of different sizes and shapes. Because of the elastic properties of the actuators the contact force is spread over a greater contact area. Additionally, the surface of the fingers is soft and the silicone-rubber glove that covers the artificial hand increases the friction coefficient. The result is that a reduced grip force is needed to hold an object. As a side effect from the softness and elasticity of the hand it feels more natural when touched than a hard-robotic hand and the risk of injury in direct interaction with other humans is minimized.

7. Advantages

The advantages of the artificial hand using embedded system are low cost, high functionality, easy to grasp and grip of objects, less weight compared to other prosthetic hands

8. Future Enhancement

Further this artificial hand can be developed in some respects such as the ability to sense touch and write. The sensitivity can be developed by using accurate mechanical features. Furthermore, artificial hands can be improved by giving quick response for any action. Emulation of natural hand by means of perfect physical angle.

9. Conclusion

This paper presented an overview on artificial hand using embedded system.

References

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