ARTIFICIAL HAND USING EMBEDDED SYSTEM

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Abstract - *The loss of hand function due to an injury, amputation of arm or any serious problem can severely affects a person's quality of life. Artificial hands are the replacement for natural hands in people, but the question is how artificial hands will work effectively. 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. Inspite of technological progress in achieved robotics in the last decades, prosthetic limbs still lack functionality, reliability, and comfort. The most common prosthetic hand is the Claw hook. Thus, to settle this problem Embedded System is used in artificial hand. The aim is to design and develop a low-cost artificial hand that can be used to provide versatile grasp. Microcontroller and microprocessor play an vital role in all types of control applications. Embedded system is a merging of both hardware using a Microprocessor and the suitable software along with additional mechanical or other electronic parts designed to perform a specific task. And this combination is known as Artificial Hand using Embedded System.*

Key Words*: *Prosthetic hands, claw hook, microcontrollers, embedded system, hydraulic pumps, servomotors.

1. INTRODUCTION

Recent technological advances and innovations have led to the development of sophisticated artificial hands, but high costs and difficulties of control have limited the number of users who can benefit from these developments[1]. More importantly, most of the artificial hands developed so far have failed to address the problems of achieving versatile grasp and grip. The goal is to design and develop a low-cost artificial hand that can be used to provide versatile grasp[2].It can be controlled by an Embedded system. The hydraulic pumps are used to provide strength to the prosthetic hand. The sensor given in the hand senses the mechanical activities of the hand. When the muscle is contracted, the microcontroller senses the electric potential and uses the unique command of the artificial hand to specify the action [3]. Microcontroller and microprocessor play 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 additional mechanical or other electronic parts designed to perform a specific task. Embedded system places a vital role in this prosthetic hand also called as Artificial hand[1]. However, surveys on using such artificial hands revealed that 30% to 50% of handicapped persons do not use prosthetic hand on daily basis[3]. The major factors for not using prosthetic hand on daily basis were:

Heavy weight: However prosthetic hands have about same mass that of normal human hand they appear to be unpleasantly heavy because a lever arm to the short stump to the amputated arm transmits the mass[2].

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[4].

2. Components Used in System:

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 in electrolytes and not by the movement of electrons. Using silver chloride electrodes on the skin and couple it with a conducting gel. We can sense the voltage at the location[5].

Instrumentation amplifier: The magnitude of the voltage is related to how much subcutaneous muscle contracts. The problem that remains that the electrodes produces a very small signal at best few millivolts. The instrumentation amplifier is necessary to provide the high input impedance, high common mode rejection ratio, and gain necessary to extract the biopotential signal produced by the contracting muscle[6].

Analog to digital converter (ADC): Signals from instrumentation amplifier are in the form of analog signal. For accurate control of artificial hand, the Microcontroller for computations is required. Generally, Microcontrollers are worked only with digital signals. So, there is need to convert signal from the instrumentation amplifier into digital form through analog to digital converter (ADC). In this project successive approximation type of ADC is used[5].

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

Servomotors and hydraulic actuators: A servomotor is an electromechanical device in which the input which is electrical determines the position of the armature of the motor. Servomotors are used mostly in robotics and cars, airplanes and boats. Here small size of servomotors is used to give the force to the oil filled hydraulic actuators for particular action[4].

3. Mechanical Construction and Design:

A single actuator element consists of a feeding channel for the pressurized air or liquid and "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 behaviour. While this process happens the volume energy is converted into deformation energy[7].

Joint structure: By using the single actuator elements described above different joint structures can be realized. In the below given figure- a joint based on the expansion behaviour is illustrated. By using many fluidic actuator elements together structures with very Complex flexibility can be created. Thus, making many different and unusual movements possible. For the effective design of such complex structures it is necessary to derive Mathematical models for the expansion behaviour of the actuator elements. Such models enable the deformation properties and the possible force behaviour of a potential structure to be found[7].

Fig 1: 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. 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 copy as nearly as possible to the geometry of an adult human hand. The new hand can be divided into two sections and one optional section.

Fingers: They contain the flexible fluidic actuators that lead to the flexion of the finger and flex sensors.

Metacarpus: Provides enough space to house a microcontroller, micro valves, the energy source and a micropump.

Wrist: Contains flexible fluidic actuators that bend the wrist. The extension of the joints is done passively through electrometrical spring-elements[7].

4. Operation and Implementation:

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 1 0 mega ohms. 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 volt electrodes. However, something called motion artefact can still occur due to relative motion between the electrodes and tissue.

Relative motion can produce voltages enough 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 on the input of the second stage of the amplifier that follows can be used to reduce these artefacts. At this point the EMG signal observed on the oscilloscope would look like the following, where the large amplitude bursts are associated with muscle contraction. As shown in the following figure.

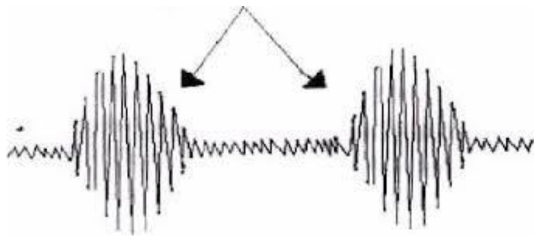


Fig 2: Muscle contraction voltage waveform

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, extract the envelope of the signal between 0 volt and its maximum positive amplitude. This can be achieved with a rectifier and low pass filter. A normal silicon diode would not be satisfactory to rectify the signal since it requires a 0.7 volt turn on voltage which is larger than the amplitude of the input signal. Because the signal is very small, use a precision rectifier circuit that more closely approximates the action of an ideal diode. The precision rectified EMG and the resulting low pass filtered signal look like those shown below.

Low pass filtered:

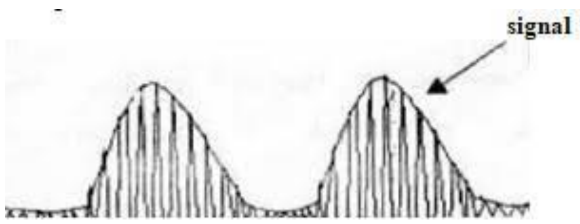
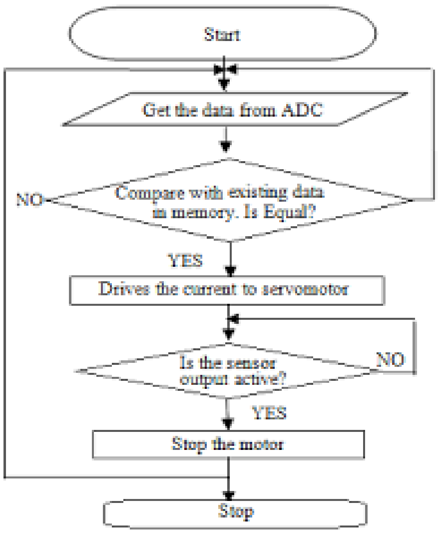


Fig 3: Rectified muscle contraction signal

After rectification the analog signal is sampled and quantized by the chip ADC804 and given to the microcontroller 8051. It is programmed to drive the servomotor depending upon the binary values and monitor the sensor output. It will drive the motor till the sensor output is high.

Flexible fluidic actuator: Pneumatic and hydraulic actuators are of great practical importance in industrial process control. The advantages of these actuators are a strong construction, a high-power capacity, a good reliability and a reasonable efficiency[6].

5. ALGORITHM:



6. Advantages:

- Low Cost.
- High Functionality.
- Easy to grip as well as grasp the objects.
- Light in weight compared to other prosthetic hand.

7. Future Enhancements:

- Touch sensing different parameters.
- Ability to write.
- Quick Response to any action

8. Conclusion:

In this paper the concept and design of the artificial hand is presented. It is able to grasp many different objects and movements also appear to be nearly natural. The motion are based on flexible actuators and most important all these actuators are very compact and light weighted. Because of the self -adapting features of the fingers many different objects can be grasped without sensory information from the hand. A Batch production for several exposition of the new hand proved the function to be reliable.

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