ARTIFICIAL HAND USING EMBEDDED SYSTEM

Abstract

The loss of hand function following an injury and amputation of arm can severely affects a person's quality of life .Artificial hand are 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. However , despite many years of research , the most commonly used **prosthetic hand** is the **claw hook.**

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. More importantly , many of the artificial hands developed so far have failed to address the problems of achieving versatile grasp and grip.

Our goal is to design and develop a low cost artificial hand that can be used to provide versatile grasp. It can be controlled by an **Embedded system .** Hre we have used the **hydraulic pumps** to provide strength to the prosthetic hand. 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: Prosthetic hand, claw hook, microcontrollers, embedded systems, hydraulic pumps.

Introduction:

Microcontroller and microprocessor places 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 a specific task. T he 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 function and cosmesis. Therefore in the last 3 decades an increasing number of handicapped persons have been provided with prosthetic hands that have the shape of a human hand and that are actuated by a DC motor with reduction gear trains. However, surveys on using such artificial hands revealed that 30 to50% of the of the handicapped persons do not use theier prosthetic hand regularly. The main factors for the rejection of conventional prosthetic hands were:

Heavy weight:

Although commercial prosthetic hands have about the same mass as human hands they appear to be unpleasently heavy because a lever arm to the short stump of the amputated arm transmits the mass.

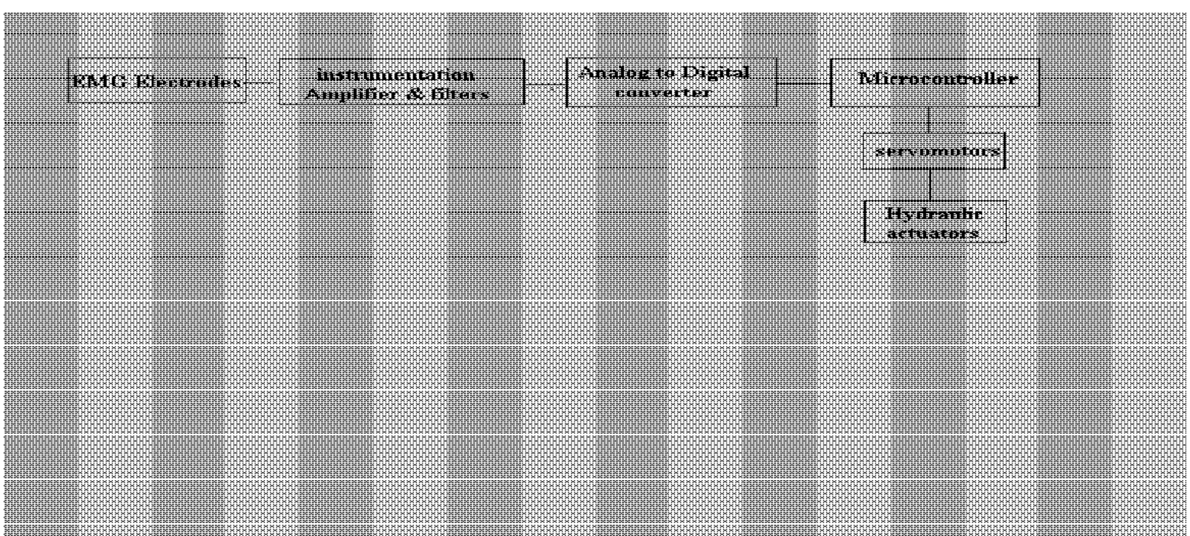
Low functionality:

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

Cost:

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

BLOCK DIAGRAM:



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 gels. We can sense the voltage at the location.

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 milivolts. 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.

Analog to digital converter:

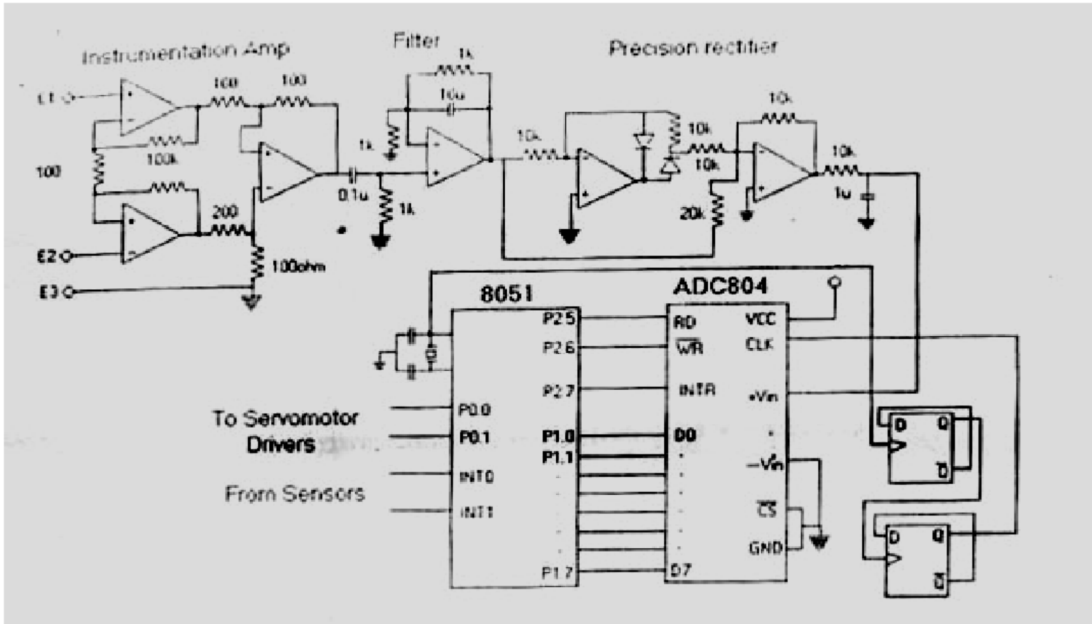
Signals from instrumentation amplifier are in the form of analog. For accurate control of artificial hand we need Microcontroller for computations. Generally Microcontrollers are worked only with digital signals. So we need to convert signal from the instrumentation amplifier in to digital form through analog to digital converter (ADC). In this project we use successive approximation type of ADC.

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 get the binary value from the ADC and generate control signals to the motors and get the feedbacks from the sensors placed in our artificial hand.

Servomotors and hydraulic actuators:

A servomotor is an electromechanical device in which an electrical input determines the position of the armature of the motor. Servomotors are used extensively 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 specified action. The elaborated explanations about hydraulic actuators will be discussed in the following sections.



Operation

Three surface electrodes sense the muscle contaction 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 impendance 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 significantle attenuating noise, common mode noise and other signals common to voth electrodes.however, somethimg called motion artifact can still occur due to relaive motion between the electrodes and tissue.

Relative motion can produce voltages sufficient ti saturate the second stage amplifier. The frequencies of the motion artifact 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 ued to reduce these artifacts. At this point the EMG signal observed on the oscilloscope would look like the following,

Where the large amplitude bursts are associated with muscle contaction. As shown in the following figure.

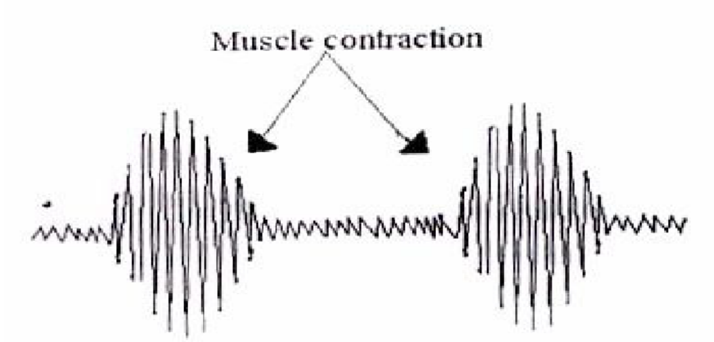


fig.2 :muscle contraction voltage waveform

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, we need to extact the envelope of the signal between 0v & it's maximum poitive 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. The precision rectified EMG and the resulting low pass filetered signal look like those shown in the following figure.

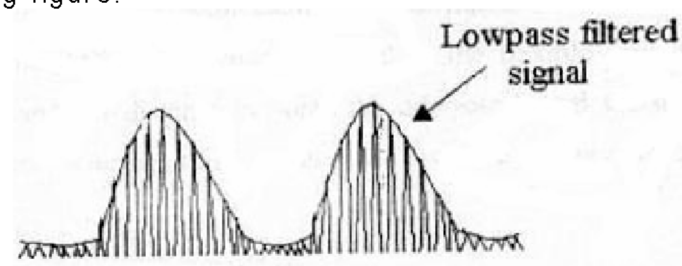


fig. 3: rectified muscle contraction signal

After rectification the analog sifnal is sampled and quantized by the chip ADC804 and give to the microcontroller 8051. we wrote a program to drive the servomotor depends upon the binary values and monitor the sensor output. it will drive the motor until the sensor output is high.

Flexible fluidic actuator:

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: a robust construction, a high power capacity, a high reliability and a 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. This class of new actuatirs will be described now.

Mechanical construction:

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 wallof 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.

Joint structure:

By using the single actuator elements described above different joint structures can be realized. In figure-4 a joint based on the expansion behavior 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.

Figure 4: A simple joint based on the expansion Principle.

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.

Mechanism and design

A conventional powered prosthetic hand usually consist of an energy source , on eor two actuators, asimple control unit and the mechanical construction . all components except for the myoelectric sensors and the energy source have to be in the hand itself because In the socket there is very little space left. So we integrated a total of 18 miniturized flexible fluidic actuators into the mechanical construction of the fingers and the rest of the hand . our aim was to mimic as closely as possible the geometry if an male adult human hand. the new hand can be divided into two(+1 optional) sections.

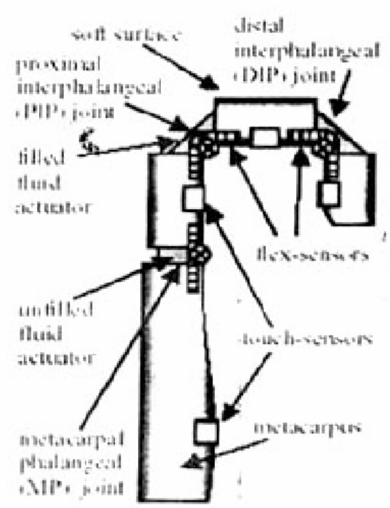


***Figure 5:* Schematic construction of a finger**

Fingers:

They contain the flexible fluidic actuators that lead to the flexion of the finger, flex sensors.

Metacarpus:

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

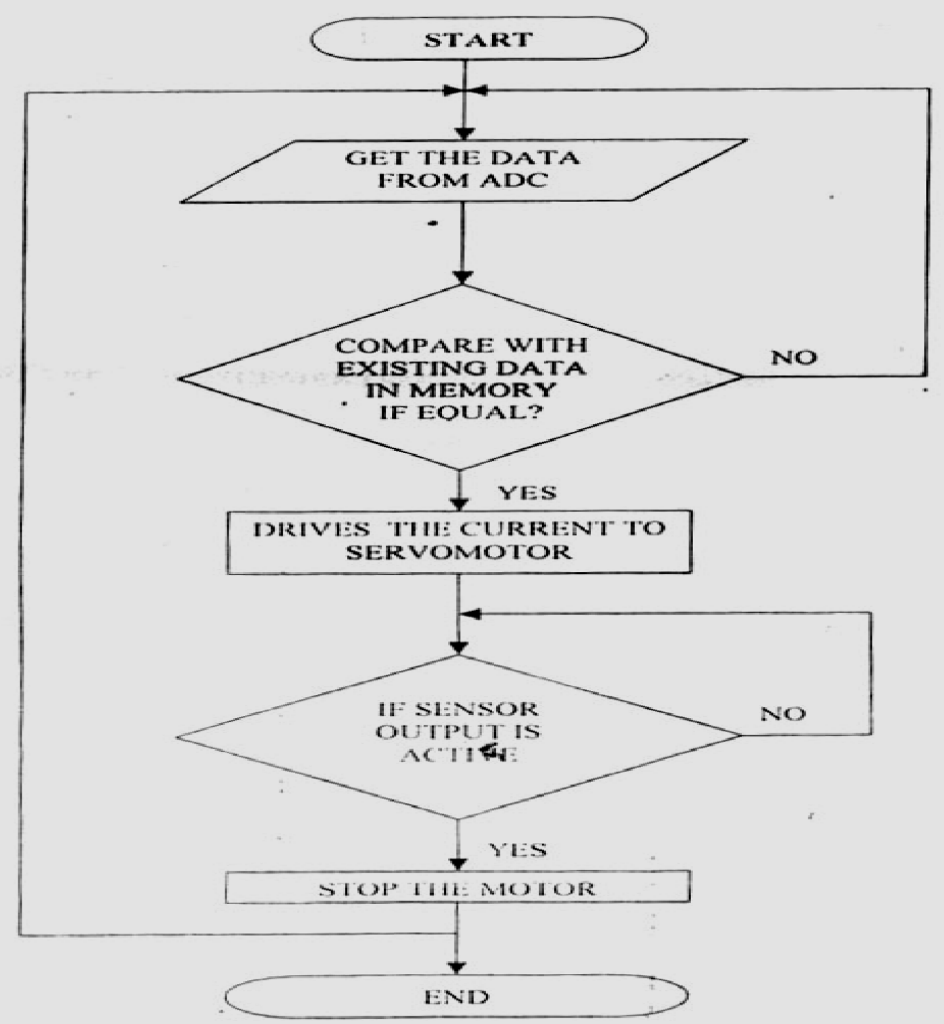
Wrist:

Contains flexible fluidic actuators that bend the wrist. The extension of the joints is done passively electrometrical spring-elements.

Self-adaptability:

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 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.

ALGORITHM:



ADVANTAGES:

- Low cost
- High functionality
- Easy to grasp and grip objects
- Less weight compared to other prosthetic hands

FUTURE ENHANCEMENTS:

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

Conclusion:

In this paper the concept and design of the prosthetic hand are presented. It is able to grasp many different objects and the movements appear to be nearly natural. The motions are based on flexible actuators. All of these are very compact and lightweight actuators have been integrated completely into the fingers of the artificial hand. The palm of the hand remained empty and provides enough space for a micropump. Because of the self-adapting features of the fingers many different objects can be grasped without sensory information from the hand. This enables the development of a low mass prosthetic hand with high functionality. A batch production for several exposition of the new hand proved the function to be reliable.

Bibliography

1.intoduction to mechatronics and measurement systems, david g.alciatore & Michael b .histand

2.biomedical instumentation &measurements , leslie Cromwell,fred j.weibell & erich a. Pfeiffer

3.laplante,m.p Carson , d:disability in the united states;prevalence & causes,1992. disability stastics center,university of califirnia , san franciso,January 1996.

4. silcox,d.h;rooks,m.d et al.:myoelectric protheses.the journal of joint and bone surgery,vol. 75

5.shadow robot project:Biomorphic arm, http://www.shadow.org.uk/projects/addprojects.shtml