# Artificial Hand Using Embedded System

**Nivedha .P**

B.E Student, Department of Electronics and Communication Engineering,R.M.D Engineering college, Tamil Nadu, India

**Abstract:** ***The loss of hand function following an injury, amputation of arm or any serious problem can severely affects a person's quality of life. Artificial hands are the substitute 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. Despite the technological progress in robotics achieved in the last decades, prosthetic limbs still lack functionality, reliability, and comfort. The most common prosthetic hand is the Claw hook. Thus, to resolve this problem Embedded System is used in artificial hand. The goal is to design and develop a low-cost artificial hand that can be used to provide versatile grasp. 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. And here this combination is known as Artificial Hand using Embedded System.***

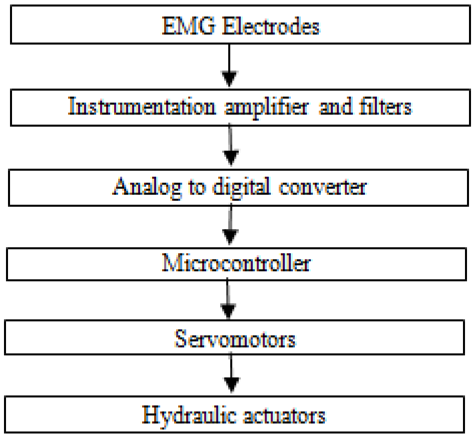
**Keywords:** Prosthetic hands, claw hook, microcontrollers, embedded system, hydraulic pumps, servomotors

## 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. More importantly, many 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. It can be controlled by an Embedded system . Here 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. 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 an artificial hand.

Some of the major reasons for the loss of hand are accidents, problems with blood circulation or diabetes, followed by injuries, including from traffic accidents and military combat, cancer or birth defects. For the individual the loss of hand results in a drastic restriction of function and cosmesis. 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 to 50% of the of the handicapped persons do not use their prosthetic hand regularly and the main factors were heavy weight, high cost and low functionality.

## 2. Components Used in the Proposed 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.

**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.

**Analog to digital converter (ADC):** Signals from instrumentation amplifier are in the form of analog signal. 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 into 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 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 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.

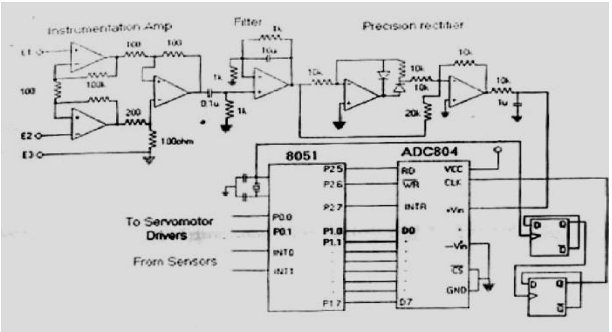



**Figure:** Circuit Diagram

## 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. 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 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.

**Fig:** 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. 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.

## 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

**Muscle contraction**

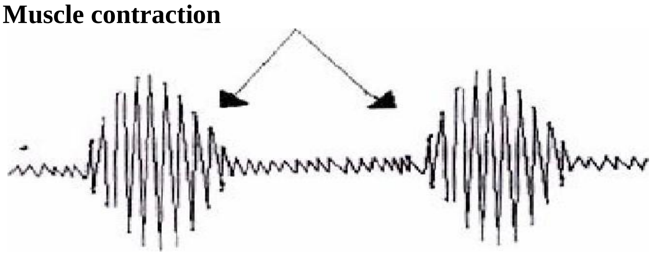


**Fig:** Muscle contraction voltage waveform

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 extract the envelope of the signal between 0 volt and its 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 0.7 volt 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 circuitthat 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**


**Figure:** 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 until the sensor output is high.

**Flexible fluidic actuator**

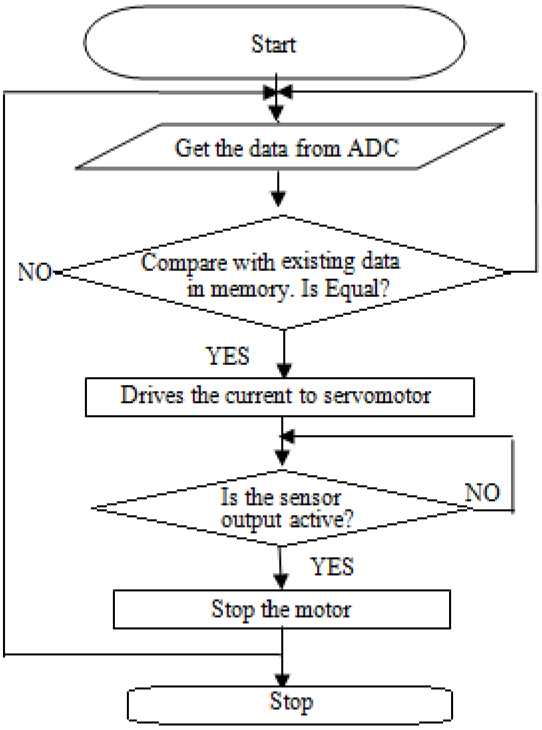
Pneumatic and hydraulic actuators are of great practical importance in industrial process control. They are used in a wide variety of differential applications, such as industries, mechanical engineering , and transportation systems and in medical engineering . The advantages of these actuators are a 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. flexibility designed into their mechanical construction realization of very complex movements, lightweight construction, very low manufacturing costs.

## 5. Results and Advantages

The flexible fingers of the new hand are able to wrap around objects of different sizes and shapes. Due to 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 which 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..

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.

## 6. Algorithm




## 7. Future Enhancements

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.

## 8. Conclusion

In this paper the concept and design of the artificial hand using embedded system are presented. It is able to grasp different objects and the movements appear to be nearly natural. The motion is based on flexible actuators. All these are very compact and lightweight actuators and have been completely integrated in the fingers of the artificial hand. The palm of the hand remained empty and provides enough space for a micro pump. Because of the self-adapting features of the fingers many objects can be grasped without sensory information from the hand. This enables the development of a less weight prosthetic hand with high functionality.

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