

Chapter 2

An EMG Control System for an Ultrasonic Motor Using a PSoC Microcomputer

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ABSTRACT

The author investigated the possibility of developing a myoelectric elbow prosthesis powered by an ultrasonic motor. Ultrasonic motors have some features that make them uniquely suited to powering prosthetics: they deliver high torque under low-speed operation, they are compact in size and they produce no electromagnetic noise. Typically, the threshold-level of an EMG (electromyogram) is adopted as the method for myoelectrically controlling prostheses using a microcomputer. However, this method is not suitable for every prosthesis. Here, the author proposes an EMG control system for a myoelectric elbow prosthesis that uses a PSoC microcomputer combined with an accelerometer to create an ultrasonic motor. The chapter shows that the EMG control system developed by the author effectively controlled the ultrasonic motor.

INTRODUCTION

In muscle membrane, there is an electric potential of approximately -70mV . Depending on the muscle, measured EMG (electromyogram) potentials range from less than $50\ \mu\text{V}$ to $20\text{-}30\ \text{mV}$. EMG signals are used in many clinical and biomedical applications; for instance, EMG is used as a diagnostics tool to identify neuromuscular diseases, assess low back pain, in kinesiology

and to evaluate disorders of motor control. EMG signals are also used to control myoelectric prosthetic devices, including hands, arms and lower limbs (Raez, 2006).

The subject of EMG control is a very broad one, ranging from the purely practical objective of providing an amputee with a functional prosthesis to academic pursuits of modeling and extracting more and more information from the EMG signal. In the simplest terms, an EMG control system can be thought of conceptually as a switch that controls the power to an electric terminal device.

DOI: 10.4018/978-1-4666-2196-1.ch002

The signal that activates this switch is obtained via surface electrodes from the remnant muscles of residual limbs, whereas the power comes from a rechargeable battery. The early EMG control systems of the 1970s and 1980s were fundamentally muscle-controlled switches. Today, advances in low-power electronics have enabled control systems that can control more than one function and provide proportional speed control. Recently, control systems have been introduced that can be programmed to suit the needs of the client (Muzumdar, 2004). Electrically powered prostheses, including myoelectric prostheses, are now the accepted method for replacing the function of the upper limbs in amputees in the United States and Europe. However, electrically powered prostheses are not popular in Japan. One reason for this lack of popularity is that electrically powered prostheses are difficult to use. More research is needed to improve the prostheses' signal analyses, control systems and actuators, including their weight.

In comparison, ultrasonic motors have some unique features that make them particularly able to support a small actuator for an electrically powered upper limb prosthesis: they deliver high torque under low-speed operation, they have a compact size and they do not produce electro-

magnetic noise. In Japan, many researchers have proposed prosthetic hands, actuated by ultrasonic motors (Ooga, 2000; Osugi, 2001; Pecson, 1993). However, these methods are not suitable for every prosthesis.

Here we proposed an EMG control system for a myoelectric elbow prosthesis that uses a PSoC microcomputer combined with an accelerometer to create an ultrasonic motor. We show that the EMG control system we developed effectively controlled the ultrasonic motor.

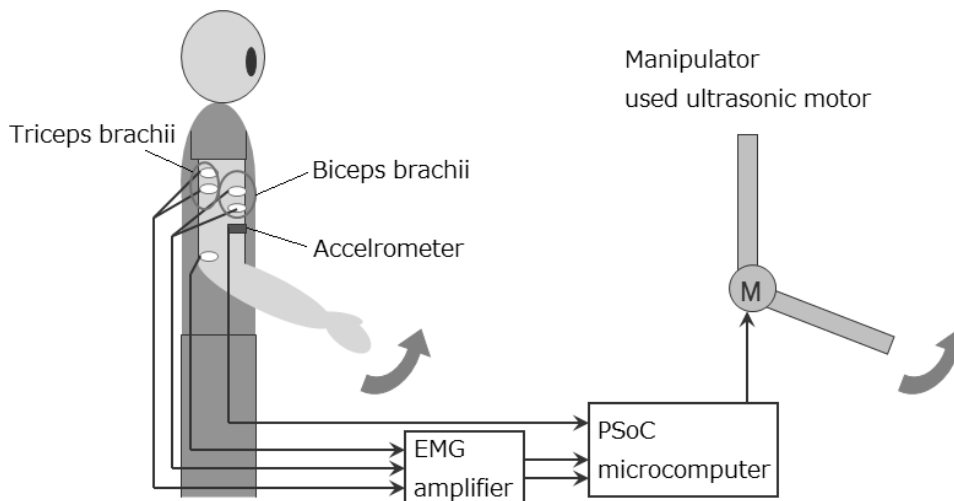
PROPOSED EMG CONTROL SYSTEM

The proposed EMG control system for an ultrasonic motor is shown in Figure 1. The system is composed of an EMG amplifier, a PSoC microcomputer with an accelerometer, and an ultrasonic motor.

EMG Amplifier

An EMG has very low amplitude; therefore, the EMG amplifier will need approximately 500 total gains. We used EMG-025 (Harada Electronic

Figure 1. EMG control system for an ultrasonic motor, using a PSoC microcomputer



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