Development of a new FES system with trained Super-Multichannel Surface electrodes

Fujii T 1, Seki K 1, Handa Y 1

1 Tohoku University Graduate School of Medicine

Email: fglabo@yp.boo.jp
Website: http://fes.med.tohoku.ac.jp

Abstract

We have developed a new FES system using surface matrix electrodes with a sub electric circuit. The matrix electrode contains small electrodes arrayed like matrix, and it is set almost on the motor point. The main unit with a pulse generator and sub units with matrix electrodes are connected by communication cables, and then provide a separated stimulation to each motor point. A prototype system was applied to four healthy subjects on forearm and hand, and then 1DI, 2DI, 3DI, 4DI, ED, ECR and EPL were selected to stimulate. This system has also many extensive functions, for example, acceleration sensor, and to the future we will make a total surface FES system.

1 Introduction

We have developed a FES system using percutaneous electrodes to patients with brain stroke or spinal cord injury [1]. For selecting to stimulate a motor point, the implanted electrode is useful. Therefore in long term application, some electrodes were broken.

In the other hand, many FES system using surface electrodes were developed [2] [3] [4]. In Surface FES are easy to apply, but are difficult to select a motor point.

In this study, we designed a new FES system using matrix electrodes with small sub unit which has CPU and pulse distribution function and can be connected each other as necessary. And using prototype system, matrix electrodes were applied in an experiment on forearm in vivo.

2 Methods

2.1 System Design

This system contains one main unit and some sub unit with matrix electrodes, and they are connected by communication cables.

The main unit has CPU(M16C) with internal 512 kb memory, a pulse generator which can make 160 negative pulse wave per second, power supply by two U3 battery, and communication ports (RS-232C) for PC and sub units.

The sub unit has CPU(PIC16F), pulse distributor, 2D Acceleration sensor, and two communication ports (RS-232C). It has no battery because it gets power from main unit by communication cable.

Figure 1 shows a prototype of the sub unit, 30x30x7mm.
2.2 Matrix electrodes

The matrix electrode contains many small electrodes arrayed like a matrix. The matrix electrode is set almost on the motor point at first, and then only small electrode, which is adequate on the motor point, is selected to stimulate. If the motor point is large, a few one are selected.

2.3 Experiment

A prototype system was applied to four healthy subject.

Figure 2 shows a future of prototype system. Two matrix electrodes with sub unit were set on the forearm and the hand, and a common electrode was set on the wrist. The main unit and two sub unit were connected by communication cables.

Intensity of stimulation to each small electrode was increased to joint motion appearing and searching the ability of stimulating the motor point selectively.

3 Results

The muscle contraction was appeared only by the motor point under the stimulated electrode, 1DI, 2DI, 3DI, 4DI, ED, ECR, ECU and EPL were stimulated selectively.

4 Discussion and Conclusions

As surface FES system in clinical use, there are HANDMASTER [2] [3] and Bionic Glove [4]. But any surface FES system with matrix electrode have never been reported.

And using surface electrodes, any FES system which ED and ECR could be selected to stimulate easily have never reported.

This system is proposed to be the first model that could select to stimulate each motor point easily.

This system has some extensions that are now developed. This system can be connected a new sub unit and increased the number of matrix electrodes, and then it can control multi-joint simultaneously. And it contains an acceleration sensor that detects the body motion for voluntary command and feedback control.

References


