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NOVEL BIOELECTRICAL MEASUREMENT USING A DIGITAL BIOPOTENTIAL MONODE

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INTRODUCTION

In conventional biopotential recording, two or more electrodes are placed on the body. A *unipolar lead* records the time-varying electrical potential at a single point (relative to a reference potential) via one signal electrode. A *bipolar lead* records the time-varying potential difference between two points via two signal electrodes. In each case, the signal electrodes are connected to high impedance amplifier inputs, while an additional electrode provides a low-impedance path between the amplifier and human subject.

Bipolar leads are usually preferred since interference appearing at both signal electrodes can be eliminated using an instrumentation amplifier with high CMRR. A drawback of bipolar lead recording is that wires must connect all electrodes to the amplifier.

This paper presents preliminary work on a novel design for a digital biopotential measurement device which we call the *biopotential monode*. This device has only one physical point of contact with the body. Monodal measurement of electrical potential poses substantial circuit design challenges and has rarely been used in practice. However, several examples of single-point biopotential measurement are described in the literature (Harland et al., 2002 and Song-Hee et al., 2004). In particular, Maruyama et al. (2007) outline an interesting progression from a conventional three-electrode design to a true unipolar circuit design.

MATERIALS AND METHODS

The circuit used by Murayama et al. uses an ultra-low input bias current op-amp. Others have illustrated the use of ultra-low input bias current amplifiers in single-point bioelectric measurements referenced to earth (Prance et al., 2000). Using this design as a starting point, we developed a novel amplifier design in which the non-inverting input of the amplifier is connected to the circuit ground and the inverting input is connected to a wet electrode on the subject's skin. The electrical circuit is effectively completed by tiny capacitances between the subject, the monode and earth.

The circuit is battery powered, so there is no physical electrical connection between the circuit and earth or between the subject and earth. The amplifier output was recorded using a USB data acquisition unit (NI USB-6215) and a battery powered laptop. To test the monode, it and a conventional biopotential recording system were connected to a subject as shown in Figure 1 (the conventional system also used a driven right leg electrode which is not shown). Both signals were recorded simultaneously using LabVIEW.

RESULTS

Figure 1 shows bicep electromyogram (EMG) recorded during the following actions: 2s relaxing, 3s tensing, 2s relaxing, 3s tensing. The upper line is the monode signal and the lower line is the conventional system's signal. Naturally, the EMG is more evident in the conventional recording. However, correlation between the monode signal and the EMG is clearly visible.

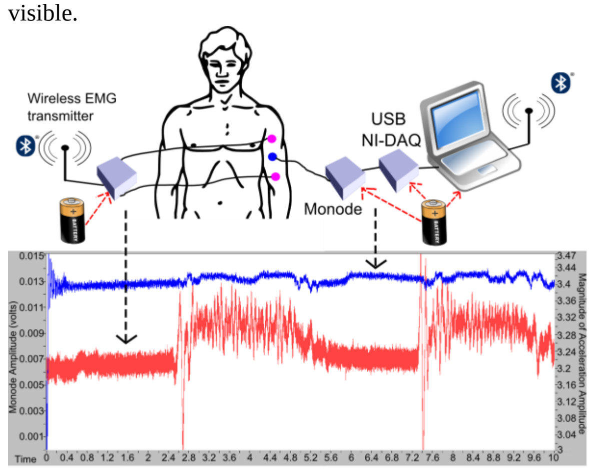

Figure 1 Diagram illustrating the experimental setup and a graph of the recorded bicep EMG signals.

DISCUSSION

The biopotential monode may open the door to interesting new biopotential applications, but its development is at an early stage. Future work will focus on refining the hardware and software design to improve signal quality and to capitalise on the benefits of a physically unburdened biopotential electrode.

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