Embedded sEMG Platform for Wearable Robotics

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***Abstract*—This paper presents a custom embedded surface electromyography (sEMG) acquisition and processing system for real-time closed loop control of wearable robotics, which include robotic prostheses and exoskeletons. General challenges related to control of wearable robotics using commercial sEMG systems are first described before detailing how the custom embedded system addresses those challenges. The custom system was evaluated in several lower-limb active robotic prosthesis applications to demonstrate its potential efficacy.**

***Index Terms*—EMG, prosthesis, exoskeleton, embedded system**

I. Introduction

sEMG is a primary sensing methodology for neural control of wearable robotics [1]. While there exist numerous commercial sEMG systems which are specialized for data recording in biomechanics research, utilizing these systems for closed loop control of wearable robotics presents several challenges. Design criteria include, but are not limited to: 1) portability; 2) low-latency and high-throughput I/O; 3) reconfigurable on-board DSP; and 4) wide compatibility with different types of electrodes. We designed a custom embedded system addressing these criteria for the purposes of utilizing sEMG signals in closed-loop control of wearable robotics [2].

II. System Design Summary

Fig. 1a shows the manufactured system. The 8-channel sEMG analog front end was designed with a high input impedance preamplifer and low-noise ADC and fully isolated from digital end of the system. The Cortex-M4 processor core was utilized for on-board DSP and external digital interfaces.

III. Applications and Discussions

The manufactured system was tested on several lower extremity robotic prostheses. To illustrate, Fig. 1d and Fig. 1e show the proposed system being effectively utilized in recording sEMG signals inside weight-bearing sockets via custom fabricated electrodes during walking with a dynamic robotic ankle prosthesis. In Fig. 1b and Fig. 1c, the sEMG system is shown providing real-time neural control inputs to the climbing robotic prosthesis for closed-loop control [3].

The designed and manufactured system presented its efficacy in use with wearable robotics applications. As a next step of this work, the next revision of the proposed sEMG system is currently in development. After the development phase, we plan to open-source the system in near future. The authors hope that the proposed system would facilitates the process of human clinical trials in the field of wearable robotics.

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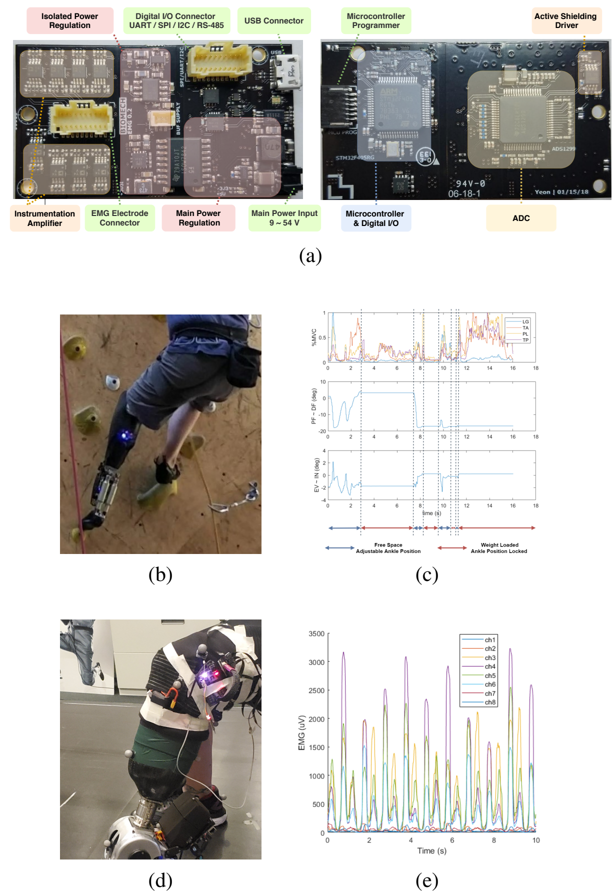

Fig. 1. The proposed sEMG system. (a) Hardware design summary. (b,c) A neurally-controlled climbing ankle prosthesis [3] controlled by the proposed sEMG system. (d,e) Within-socket sEMG measurement evaluation with a dynamic walking ankle prosthesis.

References

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