DOI: 10.20396/revpibic.

XXVII Congresso de Iniciação Científica Unicamp
16 a 18 de outubro de 2019 - Campinas | Brasil

Development of an optical fiber force myography sensor based on Raspberry Pi for identification of hand postures

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Abstract
This project reports the developement of an optical fiber force myography sensor based on Raspberry Pi computer for identifying the hand postures. The transducers are attached to two locations of the forearm, making it possible to characterizing up to 8 gestures based on the transient and stationary characteristics of the optical signal.

Key words: *Optical fiber sensor, force myography, Raspberry Pi*

Introduction

The development of novel interfaces to establish the communication between humans and computers is essential for several applications, such as bionic prostheses. In this context, the force myography (FMG) is a simple and non-invasive for monitoring of hand gestures according to the forces exerted by the forearm muscles. Therefore, this project reports an optical fiber FMG sensor based on 3D-printed transducers and Raspberry Pi microcomputer. The system is low-cost and straightforward and is suitable for further applications in human-computer interfaces.

Results and Discussion

The sensing system is illustrated in Fig.1. The light emitted by the 850 nm LED in launched into a multimode fiber. The fiber is connected to 3D-printed transducers that are positioned in user forearm for monitoring the muscles. The modulated optical signal is measured by a photodetector and processed by Python routines implemented in the Raspberry Pi. Two transducers were used: one of them was positioned on forearm posterior region, and the other on the wrist.

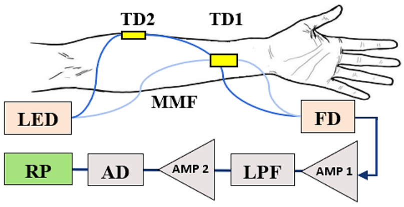

Fig 1. Experimental setup of FMG sensor. LED: LED source, MMF: multimode fiber, TD: transducer, FD: photodetector, AMP: amplifier circuit, LPF: low pass filter, AD: analog to digital converter RP: Raspberry Pi.

Due to the low current in photodiode, the circuit has two stages of amplification. In the absence of light in the photodetector, all the applied voltage remains over the component. On the other hand, a photocurrent is generated, so the voltage on the resistor tends to increase and it is amplified by an instrumentation amplifier (INA 122). The signal is filtered for noise suppression by an active filter, whereas a second stage amplifier is used for enhancing the signal for the measurement range[1]. This signal is adjusted using a potentiometer in order to improve the signal of the first channel.

In order to evaluate the sensor response, eight positions were tested: open hand, clench, wrist extension, wrist flexion, finger abduction, index finger, V sign, thumbs up, and relaxed hand [2]. The positions were performed for 5 s, as shown in Fig.2 for the clench and wrist flexion position.

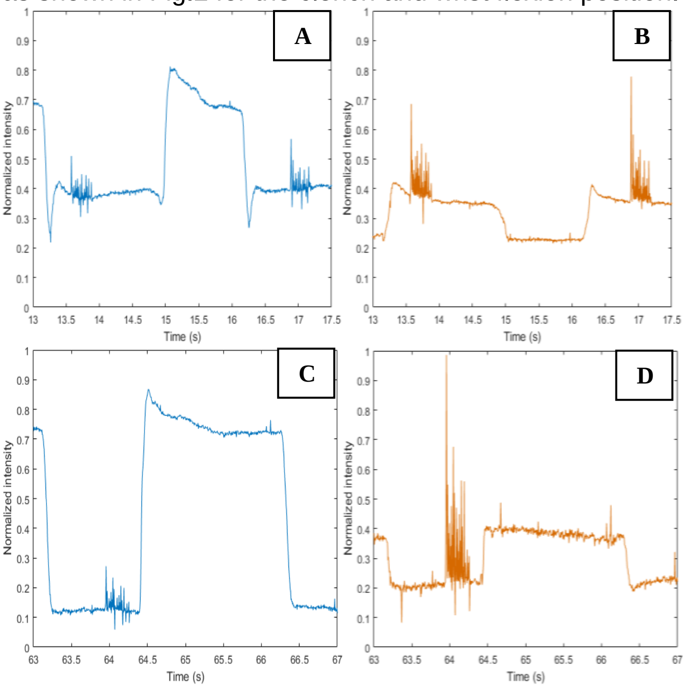

Fig 2. FMG signal obtained for the clench position. **A)** channel 1**. B)** channel 2. Wrist flexion position. **C)** channel 1. **D)** channel 2.

The signals present a rising edge when the muscle is stimulated. This condition is maintained until the muscle is no longer stimulated. In this situation, the falling edge occurs. It is worth noticing that for transducers placed in different locations of the forearm, there are particular responses. This result is useful for pose characterization, once each position has a different pattern of response.

Conclusions

The FMG sensor based in optical fiber was successfully applied in the characterization of hand positions. According to the results, specific FMG signal patterns are observed for each movement. Therefore, it was possible characterize 8 positions using only two channels.

Acknowledgement

This work was supported in parts by CNPq/PIBIC and FAPESP under grant 2017/25666-2.

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