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Performance Evaluation of Wireless Myoelectric Artificial Hand under ESD Test

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Wearable robots are being developed for various medical, healthcare and industrial applications. Myoelectric artificial hand is one of examples. At present, a wired myoelectric artificial hand is the mainstream but this is expected to be wireless in the point of view of convenience. Meanwhile, the influence of electromagnetic interference to myoelectric artificial hand cannot be ignored. Especially, electrostatic discharge (ESD) from charged human body may affect the normal action of such instruments. In this study, we first made an improvement for the wireless myoelectric artificial hand developed in our previous researches [1], and then evaluated its malfunction rate with bio-equivalent arm phantom [2] under the IEC61000-4-2 ESD testing conditions.

The wireless myoelectric artificial hand acquires the myoelectric signals from three sensing electrodes mounted on the human body surface. Then, the myoelectric signals are quantized to 12 bits at 2 kHz sampling rate and modulated to pulse signals. The modulation method is impulse radio-multiple pulse position modulation (IR-MPPM) in the 10-50 MHz band. IR-MPPM expresses information by temporally arrangement of multiple pulses that are very short with compared to information signals. The pulses are band-limited by a 10-50 MHz band pass filter and output as human body communication (HBC) signals from a transmit electrode mounted on the body surface. The packet rate of HBC signals is 2 kHz, and a low pass filter with 500 Hz cut-off frequency is used suppress the coupling of HBC signals to the myoelectric signals.

The block diagram of ESD immunity test of the wireless myoelectric artificial hand is shown in Figure 1. The myoelectric artificial hand was set to make an action of grasping and opening hand. It keeps each states for 5 seconds and repeated 5 times, where one time means grasping the hand for 5 seconds and then opening the hand for 5 seconds. The malfunction rate was calculated from the average values of 5 subjects under both positive polarity and negative polarity of discharge. From Figure 2, it was found that the malfunction rate in the wireless case is lower than that of wired connection. When the charging voltage is 4 kV, the malfunction rate reaches approximately 60 % in the wired connection but reduced to approximately 20 % in the wireless connection. The reason should be attributed to the wideband modulation scheme adopted in the wireless connection, which increases the immunity of the signal transmission with respect to impulse type noises such as ESD.

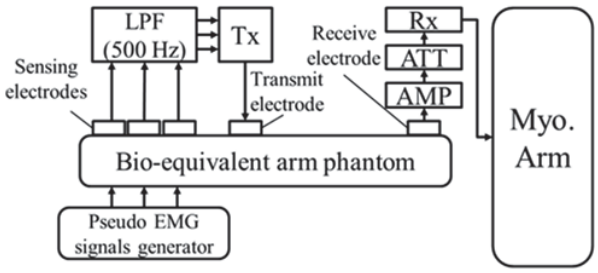

Figure 1. Block diagram of ESD testing.

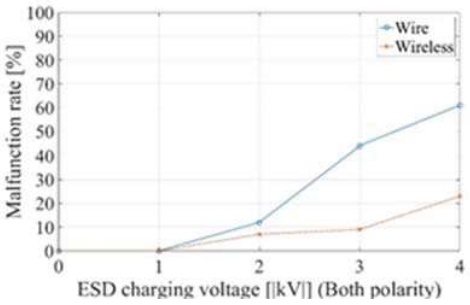

Figure 2. Malfunction rate vs. charaging voltage.

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2. J. Wang, R. Nakaya, K. Sato, D. Anzai, O. Fujiwara and F. Amemiya, "Development of an immunity test system with a pseudo biosignal generator for wearable devices and application to the ESD test of an artificial hand", *IEEE Trans. Electromagnet. Compat.*, DOI: 10.1109/TEMC.2017.2785353, 2018.