Design of a human body communication module for wearable robot control

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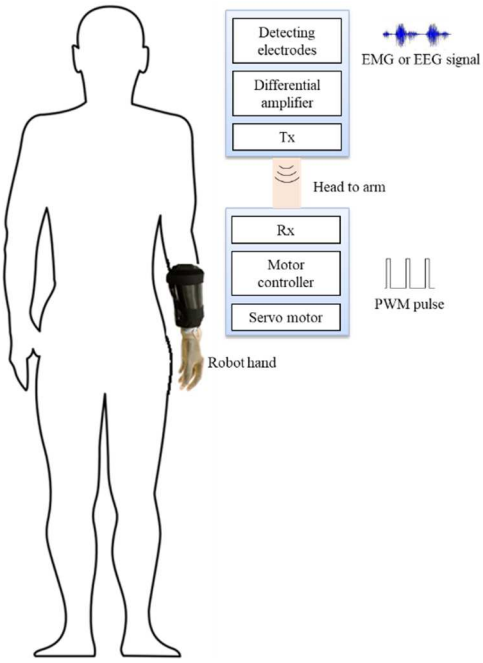
In recent years, wearable robots are being expected for the aging society. To realize a wireless control of wearable robot, an efficient bio-signal sensing circuit for EMG/EEG and small human body communication (HBC) module are required [1]. High reliability and high immunity are also essential to the sensor circuit and communication module. In this study, firstly, based on our previous work, we miniature the HBC module with EMG/EEG sensors. Fig. 1 shows the outline of using EMG/EEG to control a robot hand, and Fig. 2 shows the block diagram of the transmitter module with EMG/EEG sensors.



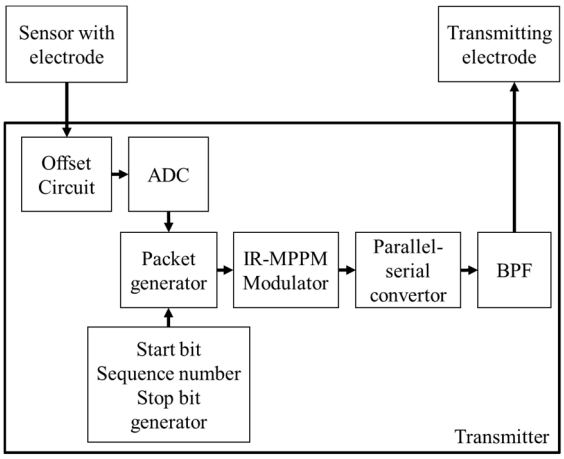


Fig. 1 (Left side) Outline of wireless control for a robot hand.

Fig. 2 (Right side) Block diagram of transmitter module with EMG/EEG sensors.

HBC employs 10 – 60 MHz wide band to increase the data rate for multiple channel EMG/EEG transmission. Impulse radio - multi pulse position modulation (IR-MPPM) is used to spread one bit to multiple chips to increase immunity to impulse noise. The data rate is determined by how many chips used for configuring one bit. When one bit is configured with one chip, the data rate is 20 Mbps and when one bit is configured with 16 chips, the data rate is 1.25 Mbps. The demodulation in the receiving module employs energy detection which detects information bits by calculating energy of received signal.

The performance evaluation was first conducted using a bio-equivalent gel phantom. The bit error rate was achieved to an acceptable at least a distance of 50 cm. A pseudo bio-signal generator was then used to output EMG/EEG signals, and the received signal has shown a correlation coefficient as high as 0.96 from the transmitted signals. Finally, a wireless control of robot hand using EMG signals detected at an actual human arm will be demonstrated.

Acknowledgement

This work was supported by JSPS KAKENHI Grant Number 19H02139.

References

[1] J. Wang, “Wide band human body communication technology for wearable and implantable robot control,” IEICE Trans. Commun., vol. E103-B, no. 6, pp. 628-636, June 2020.