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Wireless surface electrical stimulation with knee joint angle measurement system using gyroscope and flex bend sensors

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Abstract

The purpose of this study is to develop a wireless FES rehabilitation system to assist effective improvement of the lower limbs especially for Spinal Cord Injury (SCI) patients such as paraplegia. In this report, a prototype system combined with knee joint angle measurement using wireless surface electrical stimulator and the wireless MEMS vibratory gyroscope and flex bend sensors was developed and evaluated. Zigbee wireless modules were used for communication between controller and stimulator units in order to reduce wiring complexity and reduce movement limitation. In Body Sensor Network (BSN) field for medical purpose, body join tangle measurement system is quite important and useful for continuous monitoring in rehabilitation activities especially for Spinal Cord Injury (SCI) patients. Body join tangle measurement system is sensory type systems that provide information about angle movement of body joint. It is usually used at knee and arm joint to monitor the movement while patients do some exercises. This very important and helpful to the therapists and physicians in order to see the effectiveness of rehabilitations training. For knee angle movement evaluation, lower limb joint angles and segment angles were estimated by the Kalman filter from the data measured with wireless MEMS vibratory gyroscope and flex bend sensors. Electrical stimulation was applied to the common peroneal nerve or the tibialis anterior muscle by detecting stimulus timing automatically from the data of wireless sensor attached on the back of knee which known as popliteal fossa and shank of the paraplegic side. The developed system was performed well in monitoring the effectiveness of rehabilitations training and the measured data of the gyroscope and flex bend sensors showed the characteristics and difference of paralyzed side with and without electrical stimulation using the segment angles and joint angles.

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