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Modeling of Sports Training Simulation Based on Energy Harvesting in Wireless Sensor Networks

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ABSTRACT

For patients with limb motor dysfunction, the effect of physical exercise is directly related to their future quality of life. This article combines the physical training plan of rehabilitation therapists with the training of rehabilitation robots, which can effectively improve the training performance of existing lower limb rehabilitation robots. Therefore, a teaching and training method and a wireless data acquisition system based on energy acquisition wireless network sensor are proposed. Based on wireless wearable technology, wireless network sensors, PCs and electronic devices are used to monitor the activity information of human walking and standing in real time, and the physical fitness is tested by means of mean, variance, and standard deviation. Through the analysis of rehabilitation health, this article consists of two parts: power module and physical exercise. Finally, experiments show that the accuracy of wireless network sensors based on SVM algorithm is the most accurate under physical training. It provides a good means for wireless body area network technology.

KEYWORDS

Energy acquisition, Physical training, simulation model, Wireless sensor network detection

INTRODUCTION

Wireless sensor networks (WSNs) have emerged as a promising technology for sports training simulations, enabling real-time monitoring and analysis of athletes' performance. The integration of WSNs with energy harvesting techniques promotes sustainability by eliminating the need for battery replacements or recharging. In recent years there has been an increasing interest in developing models for sports training simulations based on energy harvesting in WSNs.

Modern society is also marked by global aging, resulting in a significant number of patients with heart and brain diseases. These patients often experience interrupted blood supply to the brain caused by cerebral vascular thrombosis or cerebral vascular rupture and hemorrhage, leading to corresponding movement issues (Wen & Yu, 2021). Recent statistics from China indicate that there are approximately 24.07 million people with physical disabilities in the country. The continuing aging of society will further increase the number of disabled

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individuals. With the development of the social economy, sensory and cognitive functions have been lost or damaged, and the number of people suffering from severe diseases due to aging continues to rise each year (He & He, 2022). Research reports demonstrate that active rehabilitation training for serious disabling diseases, such as heart and brain diseases, can allow 90% of patients to recover their ability to walk and take care of themselves, while 30% of patients can resume some light work. In contrast, without rehabilitation training, the recovery rates for these aspects of life are only 60% and 5%, respectively. Furthermore, the mortality rate in the rehabilitation group is approximately 12% lower than that in the non-rehabilitation group (Zhang et al., 2022).

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder that affects millions of individuals worldwide. It is characterized by impaired insulin secretion and insulin resistance, which result in various complications, including liver dysfunction and dyslipidemia. Recent studies have shown that aerobic training and vitamin D supplementation effectively improve liver enzyme levels and lipid profiles in T2DM patients (Hoseini et al., 2022a). Additionally, these interventions have been found to simultaneously modulate inflammatory gene expression and oxidative stress, contributing to the improvement of T2DM (Hoseini et al., 2022b). The COVID-19 pandemic has underscored the importance of health-related factors in the adult population. Physical activity levels, eating behavior, quality of life, general health, and mood states have been identified as crucial elements that influence overall well-being (Rahim et al., 2023). Exercise interventions, such as resistance training, have demonstrated their ability to reduce muscle damage even in non-athletic individuals, suggesting potential benefits for improving fitness levels (Mohammed et al., 2022). Moreover, endurance training and L-arginine intake have been investigated for their effects on antioxidant indices in cardiac muscles, indicating their potential role in cardiovascular health (Saifaddin et al., 2023). Similarly, walking exercise and folate supplementation have been explored for their impact on plasma homocysteine levels in elderly non-athletes (Saifalddin et al., 2023).

Rehabilitation plays a key role in the treatment of motor dysfunction (Cui, 2021). For patients with limb motor dysfunction, the effectiveness of physical exercise directly influences their future quality of life and even the quality of life of the patient's entire family (Jia, 2021). Patients with dyskinesia typically undergo two clinical treatments: drug therapy and physical therapy. Drug therapy stimulates the nerves associated with dyskinesia through various hormones and psychoactive drugs to awaken motor function, while physical therapy is relatively mild and active, gradually regulating motor muscles and nerves through acupuncture, massage, and exercise programs (Gao et al., 2020). However, the current rehabilitation situation in China is characterized by a large number of patients with physical disabilities, a significant shortage of rehabilitation doctors, and a severe lack of high-end rehabilitation medical equipment, particularly advanced intelligent rehabilitation equipment for patient physical training. On the basis of clinical experience, rehabilitation doctors conduct rehabilitation training for patients using methods that are not real-time, lack subjectivity, and are cost-prohibitive.

With the development of telemedicine, microsensors, and other technologies, there is an increasing focus on remotely guiding, monitoring, and managing home rehabilitation for the elderly and patients with chronic diseases using wireless somatic sensor networks composed of multiple microsensors (Idrees et al., 2016). Generally, this network consists of a data acquisition node with wireless communication functionality and a network coordinator. Wireless sensors possess biomechanical characteristics that allow for testing and rehabilitation of sensors distributed in different parts of the human body (Dai et al., 2022). Employing various *instruments worn on the bod*y keeps the power consumption based on wireless sensors relatively low, making them highly valuable for monitoring human movement. Additionally, the sensors are sensitive and hold significant value for physical training (Lin et al., 2022).

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