

Portable knee health monitoring system by impedance spectroscopy based on audio-board

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Abstract-

Knee injuries are among the most common health problems in the world. They not only affect people who practice sports, but also those who lead a rather sedentary life. Factors such as age, weight, working and leisure activities can affect the health of the knees, causing disorders such as inflammation, edema, deterioration of cartilage and osteoarthritis. Although for the diagnosis and treatment of the various pathologies it is always advisable to contact orthopedists and specialized structures, it would often be useful to monitor the state of health of the knees in order to evaluate the healing (or worsening) process and the effects of sport/motion activities or rehabilitation. In this perspective, a portable knee health monitoring system was developed to be used at home or in gyms and sports environments in general. Besides requiring a simple custom front end, the system relies on a PC audio board capable of a sampling rate of 192 kHz to perform bioimpedance measurements at frequencies in excess of 50 kHz. A simple numerical calibration procedure allows to obtain high accuracy while maintaining low hardware complexity. The software developed for the operation of the system is freely available to any researcher willing to experiment with the bioimpedance measurement approach we propose, ensuring the conditions of portability and low complexity. Primary (intracellular and extracellular resistances and cell membrane capacitance) and secondary (real and imaginary parts of the total impedance) bioimpedance parameters can be obtained and analyzed through direct measurements with reference to an equivalent circuit model. The functionality of the system has been tested on nine subjects with different well-known health conditions, providing encouraging results in terms of the ability to correlate bioimpedance measurements to the health status of the knees. If proper clinical trials were to confirm our preliminary results, a system such as the one we propose could be used for fast and frequent monitoring of knee joints, thus possibly reducing the frequency at which complex and expensive medical exams, sometimes involving long waiting lists, must be performed.

Index Terms- impedance spectroscopy; knee health; bioimpedance; portable system; calibration; simulation

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