Wearable Piezoresistive Nanocomposite Sensing Mechanism for Non-Invasive Knee Pain Monitoring

Arumugaraja M. [1], Padmapriya B. [1], Poornachandra S. [2], Ramya P. [3], Amitava Bhattacharyya [4], Sarathi T. [5], Senthilkumar R. [5]

[1]*Department of Biomedical Engineering, PSG College of Technology, Coimbatore, India*
[2]*Department of Electronics & Communication Engineering, Excel Engineering College, India*
[3]*Department of Biomedical Engineering, PSG College of Technology, Coimbatore, India*
[4]*Biomedical Instrumentation Lab, PSG Institute of Advanced Studies, Coimbatore, India*
[5]*Department of Electronics & Communication Engineering, PSG College of Technology, Coimbatore, India*
Email: mail2me.raja@gmail.com

Abstract

Arthritis, an informal way of referring to joint pain or joint disease, is common among elderly people in industrialized countries. Epidemiology studies have reported that 19% of people at the age of 45 have radiographic evidence of knee arthritis, which increases to 27% for people aged 63 to 69 years and to 44% for people older than 80 years. Presently, diagnosis of arthritis is based basically on physical examination, followed by laboratory tests and imaging test, which are prohibitively costlier. Hence, this paper proposes a cost effective method to acquire stress and strain values from the knee joints by using light weight flexible piezo-resistive nano-composite sensor placed in suitable patella package. It is obvious that the stress and strain exerted by an arthritis affected knee will be different from its normal counterpart. The proposed biocompatible flexible piezo-resistive nano-composite is made up of conducting polymer composites. Conducting polymer composites consist of thermoplastic urethane (TPU) with uniformly distributed conductive filler carbon nano-fiber (CNF). Deformation due to stress and strain on the conducting polymer composite changes the mean particle distance of the conductive filler, which in turn results changes in surface or bulk resistivity of the material. This change in resistivity can easily be converted into equivalent electrical signals which are proportional to movements of knee joints. A meticulous analysis on these electrical signals may reveal the problem spectrum from which the nature of the knee problem can be analysed for subsequent treatment. The signals obtained through the prototype developed with the aforesaid materials are presented here which clearly distinct the variations between the normal knee movements and strained knee movements.

Keywords: Nanocomposites, Piezoresistive, Non-invasive sensors, Arthritis, Knee Pain Monitoring